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UTILITY PATENT APPLICATION TRANSMITTAL

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Attorney Docket No.	IMM637 (051851-0971162)
First Named Inventor	Vahid Khoshkava
Title	Systems and Methods for Proximity-Based Haptic Feedback
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☐ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☑ **Specification** [*Total Pages* 23] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. ☑ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 6]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. ☑ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
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SYSTEMS AND METHODS FOR PROXIMITY-BASED HAPTIC FEEDBACK

Field of Invention

[0001] The present disclosure relates generally to user interface devices. More specifically, but not by way of limitation, this disclosure relates to systems and methods for proximity-based haptic feedback.

Background

[0002] Many modern devices include a touch-sensitive input device that can be used by a user to interact with a device. However, such devices may be difficult or confusing to operate. Further, in some cases, such devices may be used in situations in which the user is unable or unwilling to look at the device during use. Such devices may benefit from the presence of haptic feedback

Summary

[0003] Various embodiments of the present disclosure provide systems and methods for proximity-based haptic feedback.

[0004] In one embodiment, a device of the present disclosure may comprise a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device and outputting a first sensor signal. The device further comprises a touch sensor capable of detecting a touch and outputting a second sensor signal. One such device also comprises a processor configured to receive the first and second sensor signals, generate a haptic output signal based at least in part on the first and second sensor signals, and transmit the haptic output signal to a haptic output device, which then outputs the haptic effect.

[0005] In another embodiment, a method of the present disclosure may comprise detecting by a proximity sensor, a non-contact interaction with a touch-sensitive device and transmitting a first sensor signal associated with the non-contact interaction to a processor. The method further comprises detecting by a touch sensor a touch on the touch-sensitive surface and transmitting a second sensor signal associated with the touch to a processor. The method may further comprise receiving, by the processor, the first and second sensor signals, generating, by the processor, a haptic output signal based at least in part on the first and second sensor signalsand transmitting, by the processor, the haptic output signal to a haptic output device. The method may further comprise outputting, by the haptic output device, a haptic effect in response to the haptic output signal. Yet another

embodiment comprises a computer-readable medium for implementing such a method.

[0006] These illustrative embodiments are mentioned not to limit or define the limits of the present subject matter, but to provide examples to aid understanding thereof. Illustrative embodiments are discussed in the Detailed Description, and further description is provided there. Advantages offered by various embodiments may be further understood by examining this specification and/or by practicing one or more embodiments of the claimed subject matter.

Brief Description of the Drawings

[0007] A full and enabling disclosure is set forth more particularly in the remainder of the specification. The specification makes reference to the following appended figures.

[0008] Figure 1 is a block diagram showing a system for proximity-based haptic feedback according to one embodiment.

[0009] Figures 2A and 2B show an embodiment of a dual proximity sensor and haptic actuator device according to one embodiment.

[0010] Figure 3 show an embodiment of a dual proximity sensor and haptic actuator device according to another embodiment.

[0011] Figure 4 is a flow chart of steps for performing a method for providing proximity-based haptic feedback.

[0012] Figure 5 is a flow chart of steps for performing another method for providing proximity-based haptic feedback.

Detailed Description

[0013] Reference now will be made in detail to various and alternative illustrative embodiments and to the accompanying drawings. Each example is provided by way of explanation, and not as a limitation. It will be apparent to those skilled in the art that modifications and variations can be made. For instance, features illustrated or described as part of one embodiment may be used in another embodiment to yield a still further embodiment. Thus, it is intended that this disclosure include modifications and variations as come within the scope of the appended claims and their equivalents.

Illustrative Proximity-Based Haptic Feedback

[0014] One illustrative embodiment of the present disclosure comprises a computing device, such as a smartphone or a smartwatch. The computing device

comprises a sensor, a memory, a haptic output device, and a processor in communication with each of these elements.

[0015] In the illustrative embodiment, the sensor may comprise a dual-mode sensor. Such as sensor is capable of detecting a user's finger in proximity to but not in contact with a touch-sensitive surface and also of detecting when the user's finger is in contact with the touch-sensitive surface. The sensor is also able to detect the approximate location of the finger with respect to the touch-sensitive surface in either contact or non-contact modes. One such sensor utilizes capacitance for sensing.

[0016] In the illustrative embodiment, the sensor detects changes in capacitance as a finger or other object approaches the sensor. For example, the user's skin is an insulator, and the fluid behind the skin is a conductive layer. As the user's finger approaches the sensor, the capacitance of the sensor changes near a particular point on the touch-sensitive surface. The change in capacitance may occur before the user's finger makes contact with the surface. Thus, the sensor may be able to detect the user's finger or other objects when they are near, but not yet contacting, the surface.

[0017] In response to detecting the presence of the user's finger, the sensor generates and sends a sensor signal to the processor of the device. The sensor signal includes three-dimensional information associated with the position of the user's finger. For example, the information associated with the position of the user's finger may include data that reflects the distance of the finger from the surface of the touch-sensitive device and/or the pressure the finger is exerting on the touch-sensitive service (e.g., the Z component of the finger's location). The information may also include data that reflects the position of the finger in contact with the surface or if the finger is not in contact, then the location of the finger were it in contact with the surface (e.g., the X and Y components of the finger's location).

[0018] The processor receives the sensor signal and determines the position of the finger. In the illustrative embodiment, the processor may also determine, for example, the position of an element of the user interface displayed on the touch sensitive interface. Given the two pieces of information, the processor can then determine in which direction the finger should move in order to make contact with the user interface element.

[0019] In the illustrative embodiment, once the processor has determined in which way the finger should move, the processor generates an appropriate haptic

effect to provide the information to the user. For example, the magnitude and frequency of the effect may be used to convey a direction. The processor may then transmit the haptic output signal to a haptic output device. The haptic output device receives the signal and based on the signal outputs the haptic effect to the user. In one such embodiment, the capacitive sensor also functions as a haptic output device.

[0020] The illustrative embodiment may be used for any number of applications. For instance, the user may be operating an automobile and wish to interact with the radio by, for instance, muting the radio without taking her eyes off the road. The radio may include the illustrative touch-sensitive interface and sensor described herein. As the user's finger approaches the mute button on the radio control displayed on the surface, the sensor detects the user's finger. The processor determines where on the surface the finger is approaching and also determines where on the surface the mute button is displayed. The processor then determines in which direction the finger must travel to interact with the button. The processor generates the appropriate haptic output signal and transmits it to the sensor, which in this embodiment, also functions as the haptic output device. The sensor outputs the haptic signal to the user, and she is able to move her finger so that it contacts the surface at the location of the button.

[0021] These illustrative examples are given to introduce the reader to the general subject matter discussed here and are not intended to limit the scope of the disclosed concepts. The following sections describe various additional features and examples with reference to the drawings in which like numerals indicate like elements, and directional descriptions are used to describe the illustrative examples but, like the illustrative examples, should not be used to limit the present disclosure.

Illustrative Systems for Haptic Feedback for Opportunistic Displays

[0022] Figure 1 is a block diagram showing a system 100 for haptic feedback displays according to one embodiment. In the embodiment depicted in Figure 1, the system 100 comprises a computing device 101. While the system 100 shown in Figure 1 comprises a single, integrated computing device 101 in this embodiment. In other embodiments, the system 100 may comprise multiple separate devices in communication with one another.

[0023] The computing device 101 shown in Figure 1 includes a processor 102 in communication with other hardware elements via a bus 106. The computing device

101 may comprise, for example, a mobile device (e.g., a smartphone), tablet, e-reader, smartwatch, a head-mounted display, glasses, a wearable device, an automotive dashboard, a touch-sensitive screen on an appliance, or any other suitable device.

[0024] The embodiment shown in Figure 1 also includes a memory 104. Memory 104 can comprise any suitable tangible (and non-transitory) computer-readable medium such as RAM, ROM, EEPROM, or the like, and embodies program components that configure operation of the computing device 101. In the embodiment shown, computing device 101 further includes one or more network interface devices 110, input/output (I/O) interface components 112, and storage 114.

[0025] Network interface device 110 can represent one or more of any components that facilitate a network connection. Examples include, but are not limited to, wired interfaces such as Ethernet, USB, IEEE 1394, and/or wireless interfaces such as IEEE 802.11, Bluetooth, or radio interfaces for accessing cellular telephone networks (e.g., transceiver/antenna for accessing a CDMA, GSM, UMTS, or other mobile communications network).

[0026] I/O components 112 may be used to facilitate wired or wireless connection to devices such as one or more displays 134, game controllers, keyboards, mice, joysticks, cameras, buttons, speakers, microphones and/or other hardware used to input or output data. Storage 114 represents nonvolatile storage such as solid state, magnetic, optical, or other storage media included in computing device 101 or coupled to the processor 102.

[0027] The computing device 101 also includes or is in communication with a touch sensitive surface 116. Touch sensitive surface 116 represents any surface that is configured to sense tactile input of a user. One or more touch sensors 108 are configured to detect a touch in a touch area (e.g., when an object contacts the touch sensitive surface 116) and transmit signals associated with the touch to the processor 102.

[0028] The touch sensor 108 can additionally or alternatively comprise other types of sensors. For example, optical sensors with a view of the touch sensitive surface 116 may be used to determine the touch position. As another example, the touch sensor 108 may comprise a LED (Light Emitting Diode) finger detector mounted on the side of a display. In some embodiments, touch sensor 108 may be configured to detect multiple aspects of the user interaction. For example, touch

sensor 108 may detect the speed, pressure, and direction of a user interaction, and incorporate this information into the signal transmitted to the processor 102.

[0029] In another embodiment, the sensor comprises conductive nanoparticles in a coil shape inside a semi-flexible insulator. The coil shape allows for more flexibility, stretchability and self-inductance characteristic of the nanoparticles. Examples of such materials include coiled carbon nanotubes, nano-metals (copper, silver, etc.) or conductive polymers (conjugated polymers) insude an insulator material. As a user interacts in a non-contact mode with such a sensor, the mutual inductance and/or capacitance between the user's finger and the fabricated sensor varies.

[0030] In some embodiments, the computing device 101 comprises a touch-enabled display that combines a touch sensitive surface 116 and a display 134 of the computing device 101. The touch sensitive surface 116 may correspond to the display 134 exterior or one or more layers of material above components of the display 134. In other embodiments, the computing device 101 comprises a touch sensitive surface 116, which may be mapped to a graphical user interface provided in the display 134 that is included in the system 11 interfaced to computing device 101.

[0031] In some embodiments, the computing device 101 comprises one or more proximity sensors 132. In some embodiments, the sensor 132 may comprise a capacitance based sensor. For instance, in one such embodiment, the sensor 132 comprises a smart material. In other embodiments, the proximity sensor may comprise an optical sensor, wherein the scattering or reflection of light is the basis for detecting a user's finger. Such an embodiment may have a longer range of detection. Such sensors may comprise, for example, infra-red, laser and other sources of light. Such sensors may comprise a photo-resistor based system in which the user's finger blocks light when approaching the surface such that the system can detect the user's finger.

[0032] In some embodiments, the processor 102 may be in communication with a single sensor 132 and, in other embodiments, the processor 102 may be in communication with a plurality of sensors 132. The sensor 132 is configured to transmit sensor signals to the processor 102.

[0033] In the embodiment shown in Figure 1, the system 100 further includes haptic output device 118 in communication with the processor 102. Haptic output device 118 is configured to output a haptic effect in response to a haptic signal. For

example, the haptic output device 118 can output a haptic effect in response to a haptic signal from the processor 102. In some embodiments, haptic output device 118 is configured to output a haptic effect comprising, for example, a vibration, a squeeze, a poke, a change in a perceived coefficient of friction, a simulated texture, a stroking sensation, an electro-tactile effect a surface deformation (e.g., a deformation of a surface associated with the computing device 101), an ultrasonic or laser-based effect, and/or a puff of a solid, liquid, or gas. Further, some haptic effects may use multiple haptic output devices 118 of the same or different types in sequence and/or in concert. Although a single haptic output device 118 is shown in Figure 1, some embodiments may use multiple haptic output devices 118 of the same or different type to produce haptic effects.

[0034] In some embodiments, the haptic output device 118 is in communication with the processor 102 and internal to the computing device 101. In other embodiments, the haptic output device 118 is external to the computing device 101 and in communication with the computing device 101 (e.g., via wired interfaces such as Ethernet, USB, IEEE 1394, and/or wireless interfaces such as IEEE 802.11, Bluetooth, or radio interfaces). For example, the haptic output device 118 may be associated with (e.g., coupled to) a wearable device (e.g., a wristband, bracelet, hat, headband, etc.) and configured to receive haptic signals from the processor 102.

[0035] In some embodiments, the haptic output device 118 is configured to output a haptic effect comprising a vibration. The haptic output device 118 may comprise, for example, one or more of a piezoelectric actuator, an electro-magnetic actuator, such as an electric motor, an eccentric rotating mass motor (ERM), a voice coil, a solenoid, a shape memory alloy or polymer, a thermal based actuator, a laser, an electro-adhesion actuator, a parallel plate actuator, a micro-fluidic system, an electro-active polymer, or a linear resonant actuator (LRA).

[0036] In some embodiments, the haptic output device 118 is configured to output a haptic effect modulating the perceived coefficient of friction of a surface associated with the haptic output device 118. In one embodiment, the haptic output device 118 comprises an ultrasonic actuator. An ultrasonic actuator may vibrate at an ultrasonic frequency, for example 20 kHz, increasing or reducing the perceived coefficient of friction of the surface associated with the haptic output device 118. In some embodiments, the ultrasonic actuator may comprise a piezo-electric material.

[0037] In some embodiments, the haptic output device 118 uses electrostatic attraction, for example by use of an electrostatic actuator, to output a haptic effect. The haptic effect may comprise a simulated texture, a simulated vibration, a stroking sensation, or a perceived change in a coefficient of friction on a surface associated with computing device 101 (e.g., the touch sensitive surface 116). In some embodiments, the electrostatic actuator may comprise a conducting layer and an insulating layer. The conducting layer may be any semiconductor or other conductive material, such as copper, aluminum, gold, or silver. The insulating layer may be glass, plastic, polymer, or any other insulating material. Furthermore, the processor 102 may operate the electrostatic actuator by applying an electric signal, for example an AC signal, to the conducting layer. In some embodiments, a high-voltage amplifier may generate the AC signal. The electric signal may generate a capacitive coupling between the conducting layer and an object (e.g., a user's finger or other body part, or a stylus) near or touching the touch sensitive surface 116. Varying the levels of attraction between the object and the conducting layer can vary the haptic effect perceived by a user.

[0038] In some embodiments, the haptic output device 118 comprises a deformation device configured to output a deformation haptic effect. The deformation haptic effect may comprise raising or lowering portions of a surface associated with the computing device 101. For example, the deformation haptic effect may comprise raising portions of the touch sensitive surface 116. In some embodiments, the deformation haptic effect may comprise bending, folding, rolling, twisting, squeezing, flexing, changing the shape of, or otherwise deforming a surface associated with the computing device 101. For example, the deformation haptic effect may apply a force on the computing device 101 or a surface associated with the computing device 101 (e.g., the touch sensitive surface 116), causing it to bend, fold, roll, twist, squeeze, flex, change shape, or otherwise deform.

[0039] In some embodiments, the haptic output device 118 comprises fluid configured for outputting a deformation haptic effect (e.g., for bending or deforming a surface associated with the computing device 101). For example, the fluid may comprise a smart gel. A smart gel comprises a fluid with mechanical or structural properties that change in response to a stimulus or stimuli (e.g., an electric field, a magnetic field, temperature, ultraviolet light, shaking, or a pH variation). For instance, in response to a stimulus, a smart gel may change in stiffness, volume,

transparency, and/or color. In some embodiments, stiffness may comprise the resistance of a surface associated with the computing device 101 (e.g., the touch sensitive surface 116) against deformation. In some embodiments, one or more wires may be embedded in or coupled to the smart gel. As current runs through the wires, heat is emitted, causing the smart gel to expand or contract, which may cause the computing device 101 or a surface associated with the computing device 101 to deform.

[0040] As another example, the fluid may comprise a rheological (e.g., a magneto-rheological or electro-rheological) fluid. A rheological fluid comprises metal particles (e.g., iron particles) suspended in a fluid (e.g., oil or water). In response to an electric or magnetic field, the order of the molecules in the fluid may realign, changing the overall damping and/or viscosity of the fluid. This may cause the computing device 101 or a surface associated with the computing device 101 to deform.

[0041] In other embodiments utilizing a deformation-based haptic effect, the haptic output device 118 comprises a mechanical deformation device. For example, in some embodiments, the haptic output device 118 may comprise an actuator coupled to an arm that rotates a deformation component. The deformation component may comprise, for example, an oval, starburst, or corrugated shape. The deformation component may be configured to move a surface associated with the computing device 101 at some rotation angles but not others. The actuator may comprise a piezo-electric actuator, rotating/linear actuator, solenoid, an electroactive polymer actuator, macro fiber composite (MFC) actuator, shape memory alloy (SMA) actuator, and/or other actuator. As the actuator rotates the deformation component, the deformation component may move the surface, causing it to deform. In such an embodiment, the deformation component may begin in a position in which the surface is flat. In response to receiving a signal from processor 102, the actuator may rotate the deformation component. Rotating the deformation component may cause one or more portions of the surface to raise or lower. The deformation component may, in some embodiments, remain in this rotated state until the processor 102 signals the actuator to rotate the deformation component back to its original position.

[0042] Further, other techniques or methods can be used to deform a surface associated with the computing device 101. For example, the haptic output device

118 may comprise a flexible surface layer configured to deform its surface or vary its texture based upon contact from a surface reconfigurable haptic substrate (including, but not limited to, e.g., fibers, nanotubes, electroactive polymers, piezoelectric elements, shape memory alloys or polymers or smart gels). In some embodiments, the haptic output device 118 is deformed, for example, with a deforming mechanism (e.g., a motor coupled to wires), air or fluid pockets, local deformation of materials, resonant mechanical elements, piezoelectric materials, micro-electromechanical systems ("MEMS") elements or pumps, thermal fluid pockets, variable porosity membranes, or laminar flow modulation.

[0043] While in the embodiment shown in Figure 1, the proximity sensor 132 and touch sensor 108 are shown as separate elements, in some embodiments, they may be combined into a single component for the computing device 101. For example, in some embodiments, the touch sensor 108 comprises a dual proximity and touch sensor for sensing both a contact and non-contact interaction with the touch-sensitive surface. In yet another embodiment, the touch-sensor 108, proximity sensor 132, and haptic output device 118 are combined in a single component capable of detecting contact and non-contact interactions with the device and providing haptic effects to the user both during contact and non-contact interactions.

[0044] Turning to memory 104, modules 124, 126, and 128 are depicted to show how a device can be configured in some embodiments to provide haptic feedback. In this example, a detection module 124 configures the processor 102 to monitor the touch sensitive surface 116 via the touch sensor 108 to determine a position of a touch. For example, the detection module 124 may sample the touch sensor 108 in order to track the presence or absence of an object, such as a user's finger and, if an object is present, to track one or more of the location, path, velocity, acceleration, pressure and/or other characteristics of the object over time.

[0045] In some embodiments, the haptic effect determination module 126 represents a program component that analyzes data to determine a haptic effect to generate. The haptic effect determination module 126 may comprise code that selects one or more haptic effects to output using one or more algorithms or lookup tables. In some embodiments, the haptic effect determination module 126 comprises one or more algorithms or lookup tables usable by the processor 102 to determine a haptic effect.

[0046] Particularly, in some embodiments, the haptic effect determination module 126 may determine a haptic effect based at least in part on sensor signals received from the touch sensor 108 and/or proximity sensor 132. For example, the processor 102 may receive sensor signals from the proximity sensor 132 and determine that a user's finger is near the touch sensitive surface 116. The haptic effect determination module 126 may then determine a haptic effect based at least in part on the sensor signal from the proximity sensor. For example, in one such embodiment, the haptic effect determination module 126 may determine a first haptic effect that is output to a user associated with the computing device 101 to indicate to the user that the user should move a finger in a certain way as it approaches the touch-sensitive surface 116.

[0047] In some embodiments, the computing device 101 may include one or more haptic output devices 118 for providing various output effects associated with the proximity and location relative to the touch-sensitive surface 116 of the computing device 101. In some embodiments, the haptic effect determination module 126 may comprise code that determines, based on a location of a finger in proximity to or a based on a touch on the touch sensitive surface 116, a haptic effect to output and code that selects one or more haptic effects to provide in order to simulate the effect. For example, different haptic effects may be selected based on the location of a touch in order to simulate the presence of a virtual object (e.g., a virtual button, dial, or lever.) on the display 134.

[0048] In some embodiments, the haptic effect determination module 126 comprises code that determines a haptic effect based on an event. An event, as used herein, is any interaction, action, collision, or other event which occurs during operation of the computing device 101, which can potentially comprise an associated haptic effect. For example, in some embodiments, an event may comprise user input (e.g., a button press, manipulating a joystick, or otherwise interacting with a touch sensitive surface 116), a system status (e.g., low battery, low memory, or a system notification, such as a notification generated based on the system receiving a message, an incoming phone call, a notification, or an update), sending data, receiving data, or a program event (e.g., if the program is a game, a program event may comprise explosions, gunshots, collisions, interactions between game characters, advancing to a new level, or driving over bumpy terrain).

[0049] In some embodiments, the haptic effect generation module 128 represents programming that causes the processor 102 to generate and transmit haptic signals to the haptic output device 118 to generate the selected haptic effect. In some examples, the haptic effect generation module 128 causes the haptic output device 118 to generate a haptic effect determined by the haptic effect determination module 126. For example, the haptic effect generation module 128 may access stored waveforms or commands to send to the haptic output device 118 to create the selected haptic effect. In some embodiments, the haptic effect generation module 128 may comprise algorithms to determine the haptic signal. The haptic effect generation module 128 may comprise algorithms to determine target coordinates for the haptic effect (e.g., coordinates for a location on the computing device 101, such as on the touch sensitive surface 116, at which to output the haptic effect).

Illustrative Dual Proximity and Pressure Sensor Embodiment

[0050] Figures 2A and 2B are drawings of a dual proximity and pressure sensor according to one embodiment of the present disclosure. In the figures shown, the non-contact capacitive and contact pressure based sensor are integrated into a smart material haptic actuator 202. Such a sensor/actuator combination may be referred to herein as an integrated sensor.

[0051] In the embodiment shown in Figure 2A, the user's hand 200, and in particular, the user's finger is approaching the surface of the actuator 202. The actuator 202 includes three layers. The first layer is a thin insulator 204.

[0052] In the embodiment shown in Figures 2A and 2B, the second layer 204 is an electro-active polymer (EAP), such as PVDF, piezoelectric, or dielectric elastomer. On one side of that layer is applied a uniform electrode pattern. Applying a pattern on one side allows for creating location haptic actuation. In other embodiments, both sides of the EAP may have such an array of electrodes applied. However, in the embodiment shown, on the other side of the electro-active polymer network arrays of electrodes are applied. Thus, as illustrated, the second layer 206 comprises an electro-active polymer with one side having a uniform electrode pattern and the other side a network pattern.

[0053] The third layer 208 is an elastomer (e.g., rubber) layer placed under the surface of the second layer 206 that has the network array of electrodes applied. Finally, network arrays of electrodes are placed on the side of the third layer 208 opposite the second layer 206 to complete the sensor. The soft material acts as an

insulator for the capacitance where the electrodes are dispersed in a pattern. In that way, the electrode can be used to activate a smart material actuator.

[0054] Such an embodiment provides a contact and non-contact mode. In a non-contact mode, the user finger 200 adds another capacitance to the system (in series), and therefore the sensor/actuator can recognize the finger based on the change in total capacitance.

[0055] In such an embodiment, the user also can press (contact mode) as shown in Figure 2B and therefore, compress the insulator material 208 (elastomer layer) and therefore the capacitance changes and the sensor is able to measure the pressure level (the more pressure, the lower thickness of the insulator material).

[0056] Various modifications and alternatives to the embodiment described in relation to Figure 2 are possible. For instance, in some embodiments, the same type of material can serve as the actuator and the sensor. For example, in some embodiments, the elastomer (e.g., rubber) can act as both the sensor and the actuator. The EAP may comprise, for example, a dielectric elastomer (DEA), PVDF or any other material that exhibits a piezoelectric response, or an electrostrictive material. In some embodiments, the EAP can act as both the sensor and the actuator. In some such embodiments, such as when used in combination with a display, the various layers are configured to be transparent so that the display can be viewed through the sensor/actuator.

[0057] The top layer 202 in the embodiment shown is an insulator to avoid potentially shocking the user of the device when the user contacts the surface. In other embodiments, the top layer can be eliminated, but the electrode of the second layer 206 in contact with the user is then grounded.

[0058] The dual proximity sensor and haptic actuator shown in Figures 2A and 2B can be used to provide a variety of haptic effects. For example, the actuator 202 may be used to provide a static electrostatic friction sensation. While the dual proximity sensor and haptic actuator shown in Figures 2A and 2B is illustrated as single device, comprising three layers, the sensor/actuator may be constructed in any number of ways. For example, the device 200 could be implemented as a plurality of the devices 202 illustrated in Figures 2A and 2B which are arranged to form a surface, such as by arranging sixteen devices 202 as a four-by-four grid of sensor/actuator devices 202.

[0059] Figure 3 show one embodiment of a dual proximity sensor and haptic actuator device according to an embodiment. In the embodiment shown in Figure 3, one surface of the bottom layer 208 is shown. In the embodiment shown, the electrodes are arranged as a network array that includes seven columns 302 and four rows 304. Other embodiments can include any suitable number of electrodes arranged in any suitable manner.

Illustrative Methods for Providing Haptic Feedback

[0060] Figure 4 is a flow chart of steps for performing a method 400 for providing haptic feedback for opportunistic displays according to one embodiment. In some embodiments, the steps in Figure 4 may be implemented in program code that is executable by a processor, for example, the processor in a general purpose computer, a mobile device, or a server. In some embodiments, these steps may be implemented by a group of processors. In some embodiments, one or more steps shown in Figure 4 may be omitted or performed in a different order. Similarly, in some embodiments, additional steps not shown in Figure 4 may also be performed. The steps below are described with reference to components described above with regard to the devices shown in Figure 1.

[0061] The method 400 begins at step 402 when the proximity sensor 132 of the computing device 101 detects a user's finger in proximity to a touch-sensitive surface 116. For instance, the proximity sensor 132 may be a capacitance sensor that senses a change in capacitance as the user's finger approaches the sensor. The proximity sensor 132 next transmits a proximity sensor signal to the processor 102.

[0062] The method continues at step 404 where the proximity sensor transmits a proximity sensor signal to the processor 102 and then at step 406 when the processor 102 receives the proximity sensor signal. The method 400 continues at step 408 when the processor 102 determines a haptic effect based at least in part on the proximity sensor signal. For instance, the processor 102 may be configured to direct the user's interactions with a user interface element displayed on the touch sensitive surface 116. Thus the processor 102 determines a haptic effect that will cause the user to move her finger in the appropriate direction. In some embodiments, the haptic effect can include one or more haptic effects. For example, the haptic effect can include a haptic effect based on direction to the user interface element and a haptic effect based on the distance from the user's finger to the

control, e.g., a larger magnitude and frequency corresponding to a further distance and a direction towards the top of the touch sensitive surface.

[0063] The method continues at step 410 when the processor 102 transmits a haptic signal associated with the haptic effect to the haptic output device 118. In some embodiments, the processor 102 may transmit one or more haptic signals to the haptic output device 118. In some embodiments, the haptic effect generation module 128 causes the processor 102 to generate and transmit the haptic signal to the haptic output device 118.

[0064] The method 400 continues at step 412 when haptic output device 118 outputs the haptic effect. In some embodiments, the haptic effect comprises a vibration, a surface deformation, a squeeze, a poke, and/or a puff of a solid, liquid, gas, or plasma. In other embodiments, the haptic effect may comprise a change to the coefficient of friction of the device. In yet another embodiment, the haptic effect may comprise a vibration.

[0065] Figure 5 is a flow chart of steps for performing another method for providing proximity-based haptic feedback. Like the method illustrated in Figure 4, in some embodiments, the steps in Figure 5 may be implemented in program code that is executable by a processor, for example, the processor in a general purpose computer, a mobile device, or a server. In some embodiments, these steps may be implemented by a group of processors. In some embodiments, one or more steps shown in Figure 5 may be omitted or performed in a different order. Similarly, in some embodiments, additional steps not shown in Figure 5 may also be performed. The steps below are described with reference to components described above with regard to the devices shown in Figure 1.

[0066] The method 500 begins at step 502 when the touch sensor 108 of the computing device 101 detects a user's finger contacting a touch-sensitive surface 116. For instance, the touch sensor 108 may be a capacitance sensor that senses a change in capacitance as the user's finger touches the sensor 108. The touch sensor 108 may be integrated with the proximity sensor 132 and/or with the haptic output device 118. The touch sensor 108 next transmits a touch sensor signal to the processor 102.

[0067] The method continues at step 504, where the touch sensor 108 generates a signal and transmits the signal to the processor 102. At step 506 the processor 102 receives the touch sensor signal. The method 500 continues at step 508 when the

processor 102 determines a haptic effect based at least in part on the touch sensor signal and on the proximity signal. For instance, the processor 102 may be configured to output a particular haptic effect associated with a particular control on a user interface element displayed on the touch sensitive surface 116. Such a haptic effect may further be modified or combined with another haptic effect based on the proximity sensor signal. In some embodiments, the haptic effect can include one or more haptic effects. For example, the haptic effect can include a haptic effect meant to confirm “pushing” on a virtual button.

[0068] The method continues at step 510 when the processor 102 transmits a haptic signal associated with the haptic effect to the haptic output device 118. In some embodiments, the processor 102 may transmit one or more haptic signals to the haptic output device 118. In some embodiments, the haptic effect generation module 128 causes the processor 102 to generate and transmit the haptic signal to the haptic output device 118.

[0069] The method 500 continues at step 512 when haptic output device 118 outputs the haptic effect based on the availability and location of the display device 136. In some embodiments, the haptic effect comprises a vibration, a surface deformation, a squeeze, a poke, and/or a puff of a solid, liquid, gas, or plasma. In other embodiments, the haptic effect may comprise a change to the coefficient of friction of the device. In yet another embodiment, the haptic effect may comprise a vibration.

Advantages of Proximity-Based Haptic Feedback

[0070] Embodiments of the present disclosure provide advantages in a variety of implementations. For example, as described above, an embodiment implemented in conjunction with a user interface in an automobile or any vehicle or equipment in which the user may wish to interact with a user interface while maintaining focus outside the vehicle provides the benefit of allowing the operator to focus on the road or any outside element while interacting with the user interface. For instance, a heavy equipment operator could continue to watch an implement on the equipment while simultaneously interacting with a user interface on the vehicle. Embodiments of the present disclosure may also be advantageous in small screen devices. For example, a watch incorporating proximity-based haptic feedback may allow the user to more accurately choose controls on the small screen.

[0071] Other embodiments may be advantageous when implemented in mobile devices, such as phones. Such an implementation may allow a user to navigate the user interface without looking at the screen. For instance, if a user were running and holding a phone in the user's hand, the user may be able to navigate the user interface without looking at the screen. Another similar embodiment would include a game controller. With such an embodiment, the user is able to focus on the screen while simultaneously interacting with a user interface, without the need to look extensively at the user interface display on the game controller.

General Considerations

[0072] The methods, systems, and devices discussed above are examples. Various configurations may omit, substitute, or add various procedures or components as appropriate. For instance, in alternative configurations, the methods may be performed in an order different from that described, and/or various stages may be added, omitted, and/or combined. Also, features described with respect to certain configurations may be combined in various other configurations. Different aspects and elements of the configurations may be combined in a similar manner. Also, technology evolves and, thus, many of the elements are examples and do not limit the scope of the disclosure or claims.

[0073] Specific details are given in the description to provide a thorough understanding of example configurations (including implementations). However, configurations may be practiced without these specific details. For example, well-known circuits, processes, algorithms, structures, and techniques have been shown without unnecessary detail in order to avoid obscuring the configurations. This description provides example configurations only, and does not limit the scope, applicability, or configurations of the claims. Rather, the preceding description of the configurations will provide those skilled in the art with an enabling description for implementing described techniques. Various changes may be made in the function and arrangement of elements without departing from the spirit or scope of the disclosure.

[0074] Also, configurations may be described as a process that is depicted as a flow diagram or block diagram. Although each may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be rearranged. A process may have additional steps not included in the figure. Furthermore, examples of the

methods may be implemented by hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof. When implemented in software, firmware, middleware, or microcode, the program code or code segments to perform the necessary tasks may be stored in a non-transitory computer-readable medium such as a storage medium. Processors may perform the described tasks.

[0075] Having described several example configurations, various modifications, alternative constructions, and equivalents may be used without departing from the spirit of the disclosure. For example, the above elements may be components of a larger system, wherein other rules may take precedence over or otherwise modify the application of the invention. Also, a number of steps may be undertaken before, during, or after the above elements are considered. Accordingly, the above description does not bound the scope of the claims.

[0076] The use of “adapted to” or “configured to” herein is meant as open and inclusive language that does not foreclose devices adapted to or configured to perform additional tasks or steps. Additionally, the use of “based on” is meant to be open and inclusive, in that a process, step, calculation, or other action “based on” one or more recited conditions or values may, in practice, be based on additional conditions or values beyond those recited. Headings, lists, and numbering included herein are for ease of explanation only and are not meant to be limiting.

[0077] Embodiments in accordance with aspects of the present subject matter can be implemented in digital electronic circuitry, in computer hardware, firmware, software, or in combinations of the preceding. In one embodiment, a computer may comprise a processor or processors. The processor comprises or has access to a computer-readable medium, such as a random access memory (RAM) coupled to the processor. The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs including a sensor sampling routine, selection routines, and other routines to perform the methods described above.

[0078] Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable

read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

[0079] Such processors may comprise, or may be in communication with, media, for example tangible computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, all electronic, optical, magnetic, or other storage devices capable of providing a processor, such as the processor in a web server, with computer-readable instructions. Other examples of media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other devices may comprise computer-readable media, such as a router, private or public network, or other transmission device. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein.

[0080] While the present subject matter has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, it should be understood that the present disclosure has been presented for purposes of example rather than limitation, and does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art.

Claims

What is claimed is:

1. A device comprising:

a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device and outputting a first sensor signal;

a touch sensor capable of detecting a touch with the touch-sensitive input device and outputting a second sensor signal;

a haptic output device configured to receive a haptic output signal and output a haptic effect in response to the haptic output signal; and

a processor configured to:

receive the first sensor signal and the second sensor signal;

generate a haptic output signal based at least in part on the first and second sensor signals; and

transmit the haptic output signal to the haptic output device.

2. The device of claim 1, wherein the proximity sensor is integrated into the touch-sensitive input device.

3. The device of claim 1, wherein the proximity sensor comprises one of a capacitive sensor or an optical sensor.

4. The device of claim 1, wherein the haptic output signal is designed to direct a user to contact the touch-sensitive device at a particular location.

5. The device of claim 1, wherein the an integrated sensor comprises the proximity sensor and the touch sensor.

6. The device of claim 5, wherein the integrated sensor further comprises the haptic output device.

7. The device of claim 5, wherein the integrated sensor comprises an electro-active polymer.

8. The device of claim 7, wherein the electro-active polymer comprises a first side with a uniform electrode pattern layer affixed thereto and a second side with a network electrode pattern layer affixed thereto.

9. The device of claim 8, further comprising an elastomer layer having a first side with a network pattern electrode layer affixed thereto and a second side configured adjacent to the second side of the electro-active polymer.

10. The device of claim 9, further comprising an insulator layer adjacent to the first side of the electro active polymer.

11. The device of claim 3, wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor.

12. The device of claim 1, wherein the haptic output device comprises an electrostatic friction actuator.

13. The device of claim 1, wherein the haptic output device comprises an air puff actuator.

14. The device of claim 1, wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure.

15. A method comprising:

detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device;

detecting, by a touch sensor, a touch on the touch-sensitive input device;

transmitting a first sensor signal associated with the non-contact interaction to a processor;

transmitting a second sensor signal associated with the touch to a processor;

receiving, by the processor, the first and second sensor signals;

generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals;

transmitting, by the processor, the haptic output signal to a haptic output device; and

outputting, by the haptic output device, a haptic effect in response to the haptic output signal.

16. The method of claim 15, wherein the haptic output signal designed to direct a user to contact the touch-sensitive device at a particular location.

17. The method of claim 15, wherein outputting a haptic effect comprises outputting, by an electrostatic friction actuator, an electrostatic friction haptic effect.

18. The method of claim 15, wherein outputting a haptic effect comprises outputting, by an air puff actuator, an air puff haptic effect.

19. A computer-readable non-transitory medium encoded with executable program code, the computer-readable medium comprising:

program code for detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device;

program code for detecting, by a touch sensor, a touch on the touch-sensitive input device;

program code for transmitting a first sensor signal associated with the non-contact interaction to a processor;

program code for transmitting a second sensor signal associated with the touch to a processor;

program code for receiving, by the processor, the first and second sensor signals;

program code for generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals; and

program code for transmitting the haptic output signal to a haptic output device.

Abstract

One illustrative device disclosed herein includes a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device and outputting a first sensor signal. The device also includes a touch sensor for detecting a touch on the touch-sensitive device and outputting a second sensor signal. The disclosed device also includes a processor configured to receive the first and second sensor signals, generate a haptic output signal based at least in part on the first and second sensor signals, transmit the haptic output signal to a haptic output device. The haptic output device in the disclosed device then outputs the haptic effect.

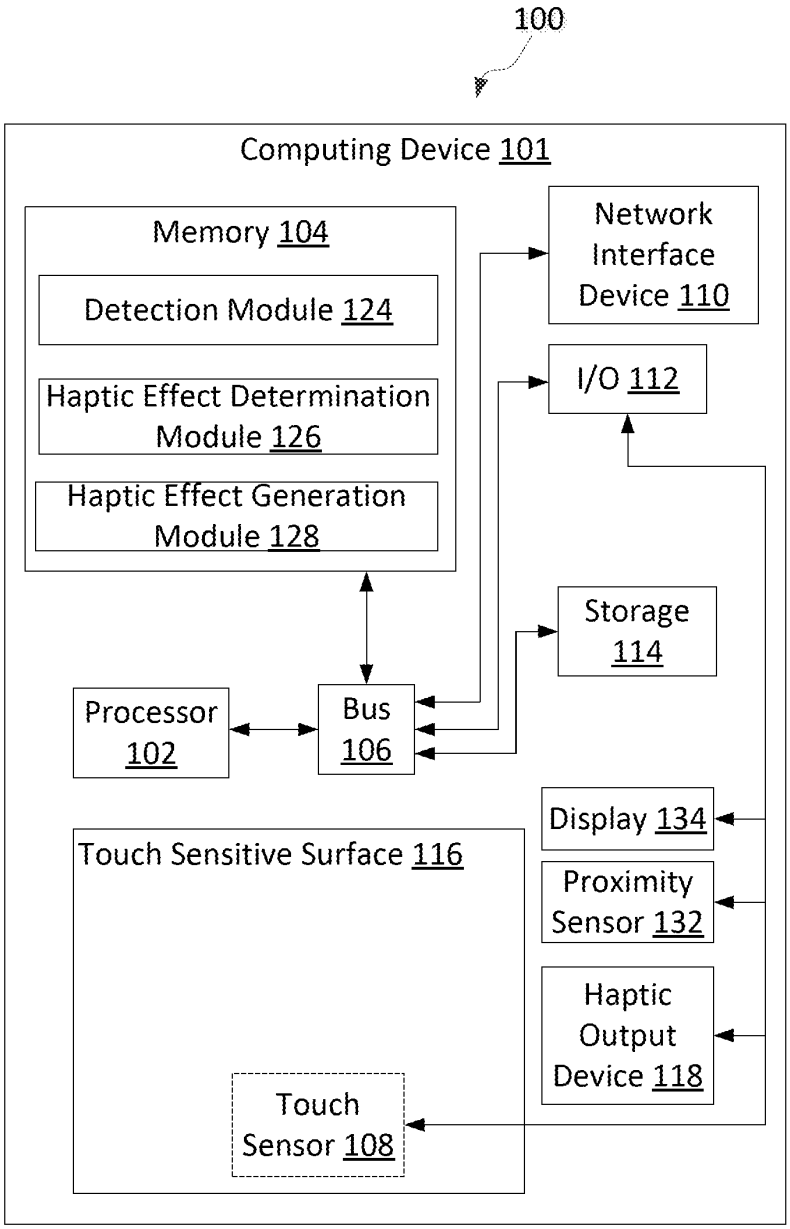

100
Computing Device 101
Memory 104
Detection Module 124
Haptic Effect Determination Module 126
Haptic Effect Generation Module 128
Network Interface Device 110
I/O 112
Storage 114
Processor 102
Bus 106
Display 134
Touch Sensitive Surface 116
Proximity Sensor 132
Haptic Output Device 118
Touch Sensor 108

FIG. 1

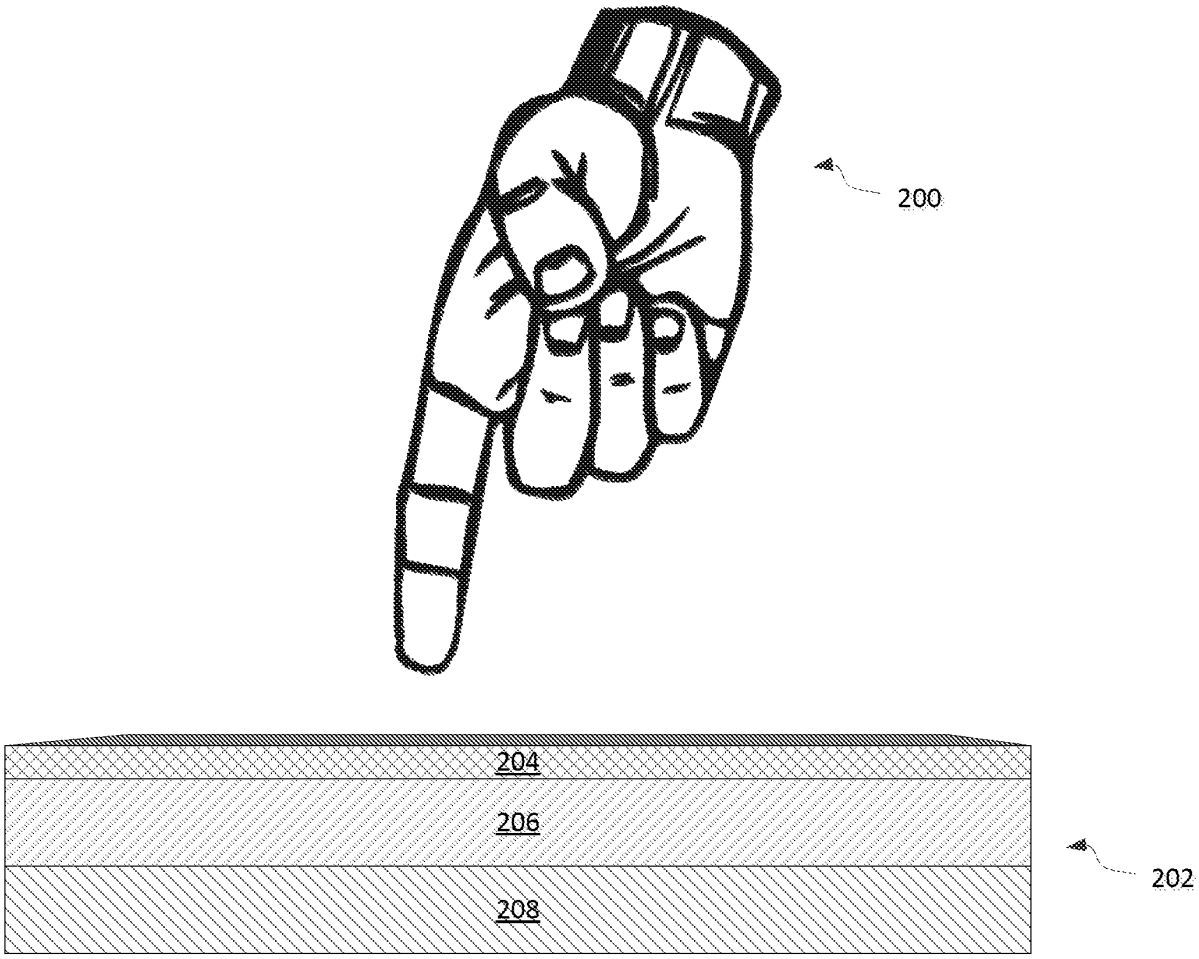


FIG. 2A

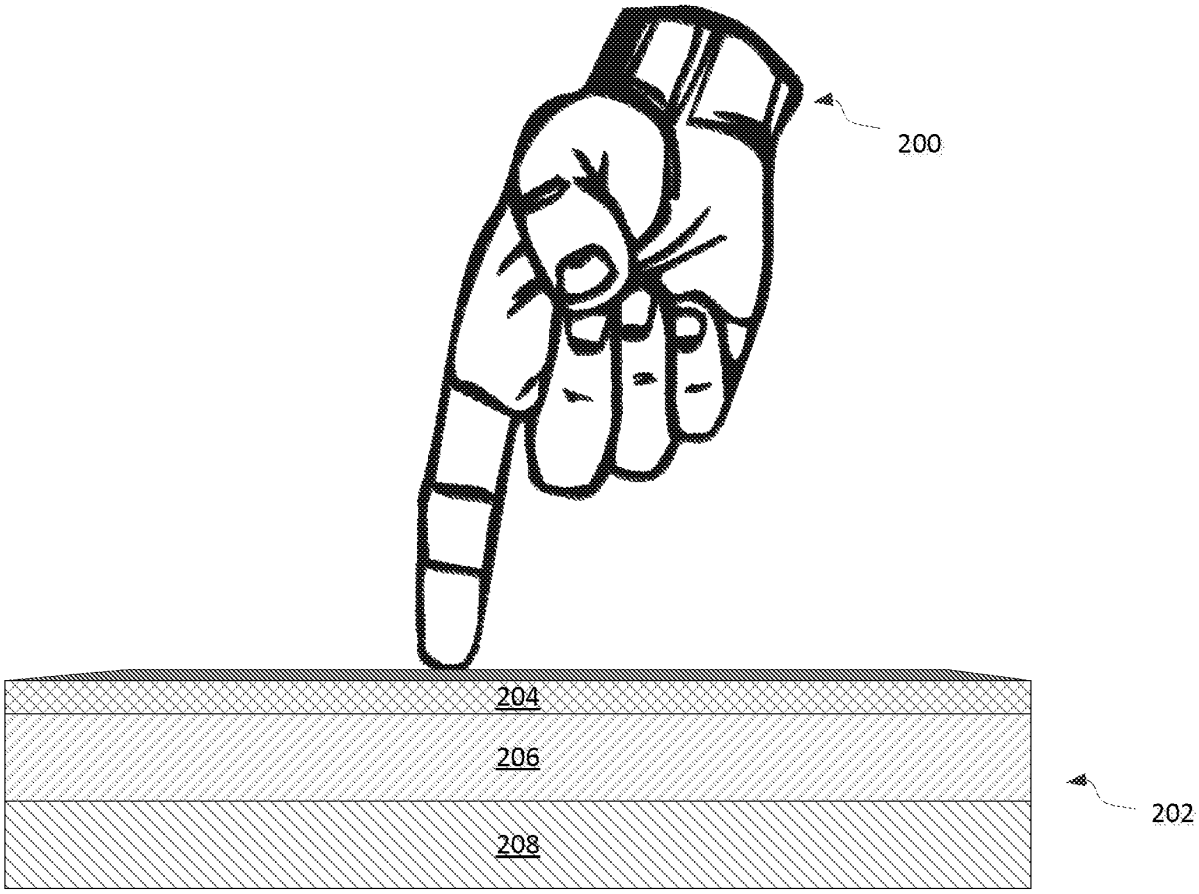


FIG. 2B

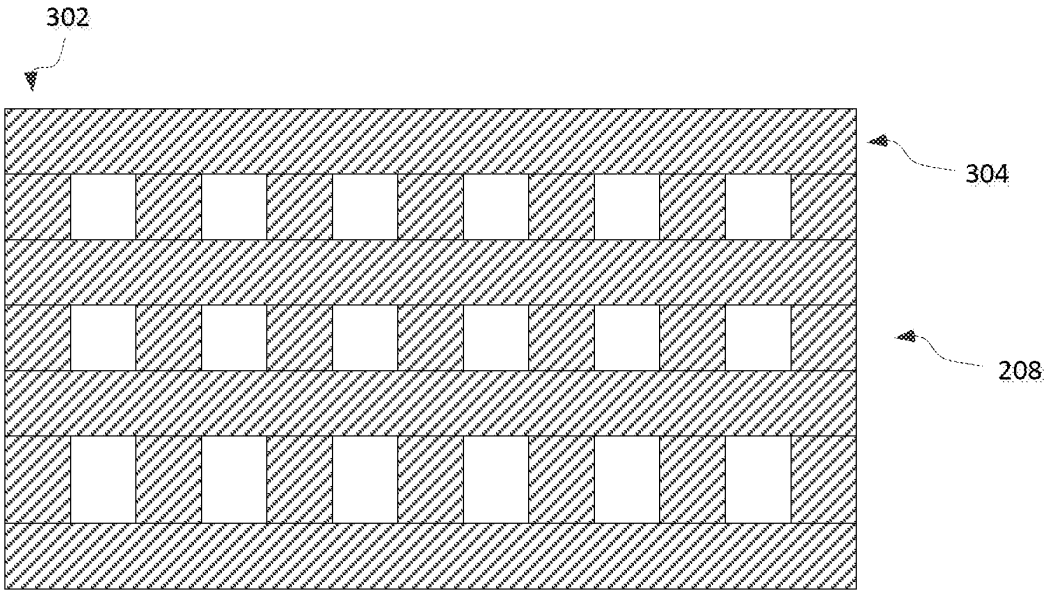


FIG. 3

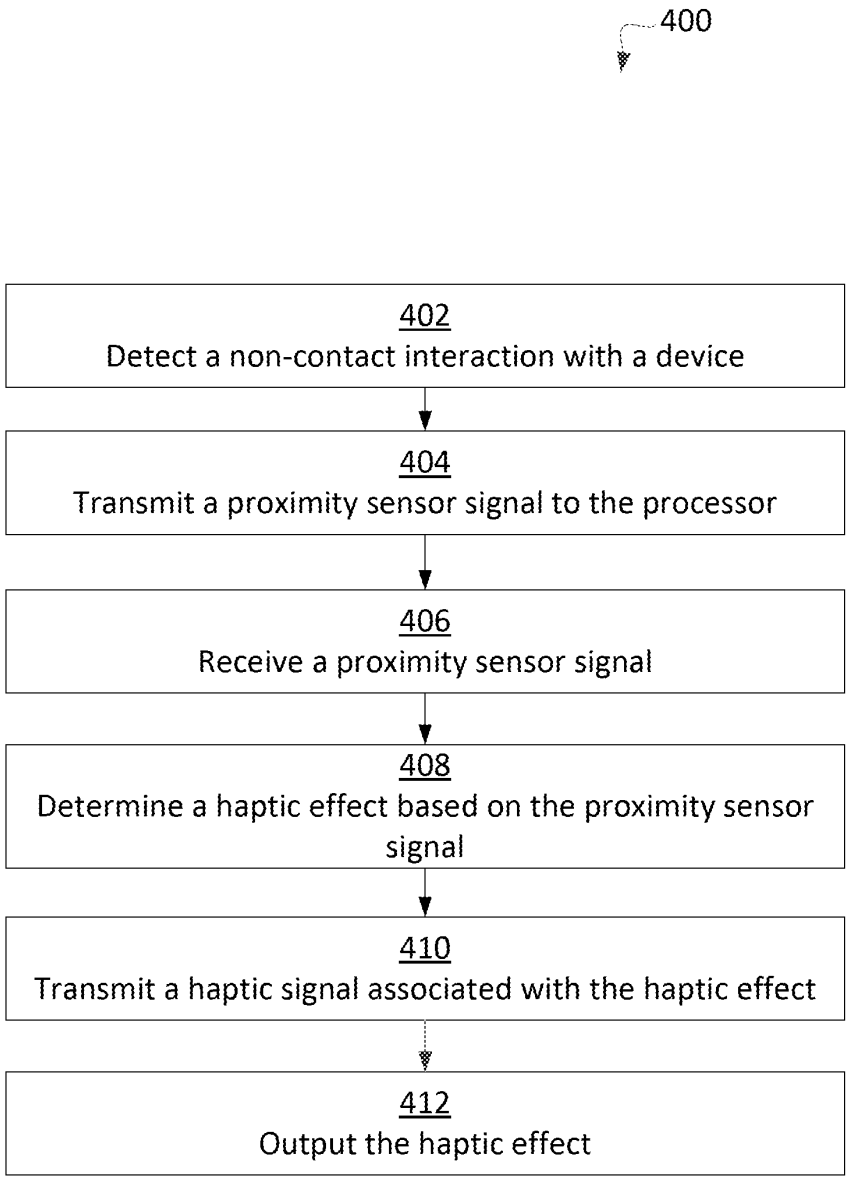

400
402
Detect a non-contact interaction with a device
404
Transmit a proximity sensor signal to the processor
406
Receive a proximity sensor signal
408
Determine a haptic effect based on the proximity sensor signal
410
Transmit a haptic signal associated with the haptic effect
412
Output the haptic effect

FIG. 4

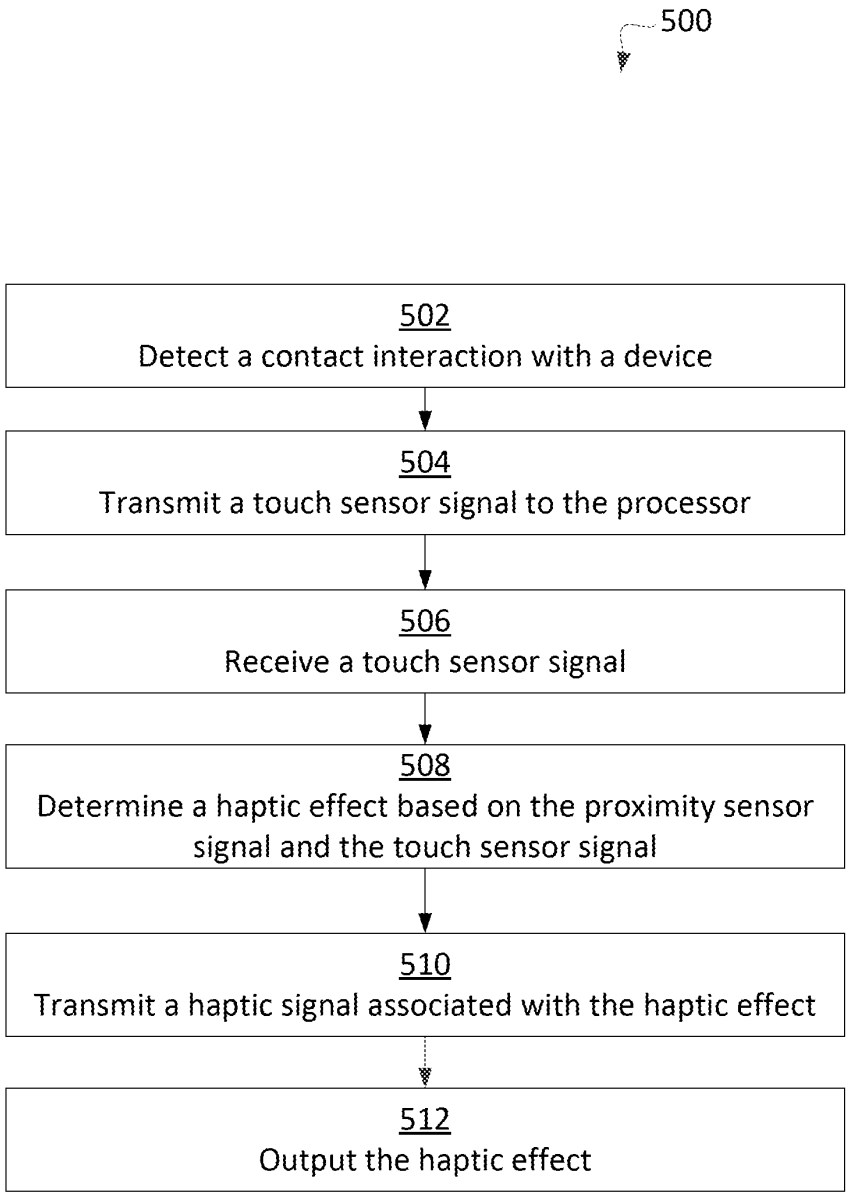

500
502
Detect a contact interaction with a device
504
Transmit a touch sensor signal to the processor
506
Receive a touch sensor signal
508
Determine a haptic effect based on the proximity sensor signal and the touch sensor signal
510
Transmit a haptic signal associated with the haptic effect
512
Output the haptic effect

FIG. 5

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

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Inventor 2 Remove

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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

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☐ **An Address is being provided for the correspondence Information of this application.**			
Customer Number	34300		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Systems and Methods for Proximity-Based Haptic Feedback		
Attorney Docket Number	IMM637 (051851-0971162)	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	34300		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

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1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

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NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Immersion Corporation

Mailing Address Information For Applicant:

Address 1	50 Rio Robles		
Address 2			
City	San Jose	**State/Province**	CA
Country	US	Postal Code	95134
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/John C. Alemanni/			Date (YYYY-MM-DD)	2016-12-12
First Name	John C	Last Name	Alemanni	Registration Number	47,384

Additional Signature may be generated within this form by selecting the Add button.

PTO/AIA/14 (11-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM637 (051851-0971162)
	Application Number	
Title of Invention	Systems and Methods for Proximity-Based Haptic Feedback	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/01 (06-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Systems and Methods For Proximity-Based Haptic Feedback

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____

  filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Abdelwahab Haman Date (Optional) : _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/01 (06-12)
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U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Systems and Methods For Proximity-Based Haptic Feedback

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Vahid Khoshkava Date (Optional): 18 Nov 2016

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Filer:	John Charles Alemanni/Amber Johnson
Attorney Docket Number:	IMM637 (051851-0971162)

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1600**

Electronic Acknowledgement Receipt	
EFS ID:	27777573
Application Number:	15377096
International Application Number:	
Confirmation Number:	4030
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Customer Number:	34300
Filer:	John Charles Alemanni/Amber Johnson
Filer Authorized By:	John Charles Alemanni
Attorney Docket Number:	IMM637 (051851-0971162)
Receipt Date:	13-DEC-2016
Filing Date:	
Time Stamp:	14:15:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1600
RAM confirmation Number	121416INTEFSW14164300
Deposit Account	201430
Authorized User	IPPayments KilpatrickTownsend
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	UtilityTransmittal.pdf	583216 1fb1b69ea1ef78ada4d16abd26b2e8eec6f72b75	no	1
Warnings:					
Information:					
2		Specification.pdf	169706 60b2b764ab00a4ea17d6a0856431ff60a2b35c60	yes	23

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	19
	Claims	20	22
	Abstract	23	23

Warnings:					
Information:					
3	Drawings-only black and white line drawings	Figures.pdf	855911 e145d5a84d7976b913a164bfacb6cb20b298adb6	no	6
Warnings:					
Information:					
4	Application Data Sheet	ADS.pdf	1408274 898ed1bbc49b8a9dbe37bf9582b677e8acbb687d	no	8
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					

5	Oath or Declaration filed	HamamDec.pdf	240143 58c2e9a922bb7f5f671d2789d123aaf034d049d3	no	1
Warnings:					
Information:					
6	Oath or Declaration filed	KhoshkavaDec.pdf	1526708 59cbbf341aadb905087595ee6e9a8d0ce7966845	no	1
Warnings:					
Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	35604 d5872e8b7380c6b559cfe6dbdde7de2b8ce6d4eb	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	4819562		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

SCORE Placeholder Sheet for IFW Content

Application Number: 15377096 Document Date: 12/13/2016

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions below.

At the time of document entry (noted above):

- Examiners may access SCORE content via the eDAN interface.
- Other USPTO employees can bookmark the current SCORE URL (http://Score.uspto.gov/ScoreAccessWeb/).
- External customers may access SCORE content via the Public and Private PAIR interfaces.

Form Revision Date: September 30, 2013

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/377,096

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/377,096	12/13/2016	2621	1600	IMM637 (051851-0971162)	19	3

CONFIRMATION NO. 4030

34300
Kilpatrick Townsend and Stockton, LLP
1001 W Fourth Street
Winston-Salem, NC 27101

FILING RECEIPT

OC000000088011983

Date Mailed: 12/22/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Vahid Khoshkava, Montreal, CANADA;
Abdelwahab Hamam, Montreal, CANADA;

Applicant(s)

Immersion Corporation, San Jose, CA;

Power of Attorney: None

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 12/20/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/377,096**

Projected Publication Date: 06/14/2018

Non-Publication Request: No

Early Publication Request: No
Title

Systems and Methods for Proximity-Based Haptic Feedback

Preliminary Class

345

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/377,096	12/13/2016	Vahid Khoshkava	IMM637 (051851-0971162)	4030

34300 7590 04/04/2018

Kilpatrick Townsend and Stockton/Immersion
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1100 Peachtree Street
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Atlanta, GA 30309

EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

NOTIFICATION DATE	DELIVERY MODE
04/04/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

eofficeaction@appcoll.com
kts_imm_docketing@kilpatricktownsend.com
ipefiling@kilpatricktownsend.com

Office Action Summary	Application No. 15/377,096	Applicant(s) KHOSHKAVA ET AL.	
	Examiner Bryan Earles	Art Unit 2625	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 December 2016*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-19* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *13 December 2016* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

Claim Objections

Claims 2, 5 and 9 are objected to because of the following informalities:

As to claim 2, this claim refers back to the term “the touch-sensitive input device,” however claim 1 defines “a touch-sensitive device.”

As to claim 5, the recitation “the an integrated sensor” needs revision.

As to claim 9, this claim recites “network pattern electrode layer,” however, claim 8 recites “network electrode pattern layer.”

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

Claims 1-4, 11-13 and 15-19 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Choe et al. (US 2010/0004033, hereinafter "Choe").

With respect to **claim 1**, Choe teaches a device comprising:

a proximity sensor (Choe: Fig. 1, proximity sensor 141) capable of detecting a non-contact interaction with a touch-sensitive device (Choe: Para. [0045]; the mobile terminal 100 as the touch-sensitive device) and outputting a first sensor signal (Choe: Para. [0076]);

a touch sensor (Choe: Fig. 1, user input unit 130 and the display module 151, collectively referred to as a touch screen) capable of detecting a touch with the touch-sensitive input device (Choe: Para. [0043]) and outputting a second sensor signal (Choe: Para. [0048]);

a haptic output device (Choe: Fig. 1, haptic module 157) configured to receive a haptic output signal and output a haptic effect in response to the haptic output signal (Choe: Paras. [0052] and [0076]); and

a processor (Choe: Fig. 1, controller 180) configured to:

receive the first sensor signal and the second sensor signal (Choe: Fig. 1, controller 180 receives I/O signals from the proximity sensor 141, user input unit 130 and the display module 151);

generate a haptic output signal based at least in part on the first and second sensor signals (Choe: Paras. [0076] – [0078]); and

transmit the haptic output signal to the haptic output device (Choe: Fig. 1; Paras. [0083] and [0136] – [0137]).

With respect to **claim 2**, Choe teaches the device of claim 1, wherein the proximity sensor is integrated into the touch-sensitive input device (Choe: Fig. 1, the sensing unit 140 including the proximity sensor 141 is integrated into the mobile terminal 100).

With respect to **claim 3**, Choe teaches the device of claim 1, wherein the proximity sensor comprises one of a capacitive sensor or an optical sensor (Choe: Para. [0045]).

With respect to **claim 4**, Choe teaches the device of claim 1, wherein the haptic output signal is designed to direct a user to contact the touch-sensitive device at a particular location (Choe: Figs. 16(a)-16(c); Para. [0137]).

With respect to **claim 11**, Choe teaches the device of claim 3, wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor (Choe: Para. [0045]).

With respect to **claim 12**, Choe teaches the device of claim 1, wherein the haptic output device comprises an electrostatic friction actuator (Choe: Para. [0053]).

With respect to **claim 13**, Choe teaches the device of claim 1, wherein the haptic output device comprises an air puff actuator (Choe: Para. [0053]).

Method claims (15, 16, 17 & 18) are drawn to the method of using the corresponding apparatus claimed in claims (1, 4, 12 & 13). Therefore, method claims (15, 16, 17 & 18) correspond to apparatus claims (1, 4, 12 & 13) and are rejected for the same reasons of anticipation as used above.

Apparatus claim (19) is drawn to an apparatus substantially analogous to the apparatus as claimed in claim (1). Therefore, apparatus claim (19) corresponds to apparatus claim (1), and is rejected for the same reasons of anticipation as used above.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 5 and 7-10 are rejected under 35 U.S.C. 103 as being unpatentable over Choe in view of Rosenberg et al. (US 2017/0300166, hereinafter "Rosenberg").

With respect to **claim 5**, Choe teaches the device of claim 1.

Choe does not expressly disclose:

wherein the an integrated sensor comprises the proximity sensor and the touch sensor.

However, Rosenberg teaches:

wherein the an integrated sensor comprises the proximity sensor and the touch sensor (Rosenberg: Abstract, Paras. [0028] and [0046]; Figs. 1-2).

Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was filed to modify the device, as taught by Choe, to incorporate the system 100, sensitive to both proximity and force inputs, with multipurpose shield electrodes, as taught by Rosenberg, in order to use the shield electrodes for a shielding effect during a resistance measurement, and a high-resolution surface capacitance measurement (Rosenberg: Para. [0022]).

With respect to **claim 7**, the combination of Choe as modified by Rosenberg teaches the device of claim 5, wherein the integrated sensor comprises an electro-active polymer (Rosenberg: Para. [0025] Figs. 1-2, integrated sensor 100 includes a force-sensitive material 131).

With respect to **claim 8**, the combination of Choe as modified by Rosenberg teaches the device of claim 7, wherein the electro-active polymer comprises a first side with a uniform electrode pattern layer affixed thereto (Rosenberg: Figs. 1-2, sense/drive electrode pairs 121 of the resistive touch sensor 120 formed on a surface of the force-sensing layer 130) and a second side with a network electrode pattern layer affixed thereto (Rosenberg: Para. [0038]; Figs. 1-2, shield electrode 151 formed on a surface of the force-sensing layer 130. Please note, also, the claimed "uniform electrode pattern layer" and "network electrode pattern layer" treated as distinct electrode layers.).

With respect to **claim 9**, the combination of Choe as modified by Rosenberg teaches the device of claim 8, further comprising an elastomer layer having a first side with a network pattern electrode layer affixed thereto and a second side configured adjacent to the second side of the electro-active polymer (Rosenberg: Paras. [0035] – [0038]; Figs. 1-2, the force sensitive layer 130, the buffer layer 140, and the cover layer 142 are elastically deformable).

With respect to **claim 10**, the combination of Choe as modified by Rosenberg teaches the device of claim 9, further comprising an insulator layer adjacent to the first side of the electro active polymer (Rosenberg: Para. [0033]; Fig. 2, non-conductive buffer layer 140 applied across the force-sensing layer 130).

Claim 6 is rejected under 35 U.S.C. 103 as being unpatentable over Choe in view of Rosenberg, as applied to claims 5, 7-10 and 14 above, and further in view of Rosenberg et al. (US 2017/0285848, hereinafter "Rosenberg848").

With respect to **claim 6**, the combination of Choe as modified by Rosenberg teaches the device of claim 5.

Choe and Rosenberg does not expressly disclose:

wherein the integrated sensor further comprises the haptic output device.

However, Rosenberg848 teaches:

wherein the integrated sensor further comprises the haptic output device (Rosenberg848: Fig. 1; Para. [0091]).

Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was filed to modify the device, as taught by Choe and Rosenberg, to incorporate the haptic output device as an integrated portion of the device, as taught by Rosenberg848, in order to provide distinct haptic feedback sensations based on the extent of user input force detected (Rosenberg848: Paras. [0022] and [0049]).

Claim 14 is rejected under 35 U.S.C. 103 as being unpatentable over Choe in view of Rosenberg848.

With respect to **claim 14**, Choe teaches the device of claim 1.

Choe does not expressly disclose:

wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure.

However, Rosenberg teaches:

wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure (Rosenberg848: Paras. [0022] and [0049]).

Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was filed to modify the device, as taught by Choe and Rosenberg, to incorporate the haptic output device as an integrated portion of the device, as taught by Rosenberg848, in order to provide distinct haptic feedback sensations based on the extent of user input force detected (Rosenberg848: Paras. [0022] and [0049]).

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Please see the attached PTO-892 Notice of References Cited.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Bryan E. Earles whose telephone number is (571)272-4628. The examiner can normally be reached on Monday-Friday at 7:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Will Boddie can be reached on (571)272-0666. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Bryan Earles/

Primary Examiner, Art Unit 2625

Notice of References Cited	Application/Control No. 15/377,096	Applicant(s)/Patent Under Reexamination KHOSHKAVA ET AL.	
	Examiner Bryan Earles	Art Unit 2625	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2009/0322497 A1	12-2009	KU; Ja Hoon	G06F1/1624	340/407.2
*	B	US-2010/0004033 A1	01-2010	CHOE; Min Wook	G06F1/1626	455/567
*	C	US-2015/0293592 A1	10-2015	CHEONG; Cheol Ho	G06F3/016	345/173
*	D	US-2017/0090576 A1	03-2017	Peterson; Carl R.	G06F3/016	1/1
*	E	US-2017/0285848 A1	10-2017	Rosenberg; Ilya Daniel	G06F3/0416	1/1
*	F	US-2017/0300166 A1	10-2017	Rosenberg; Ilya Daniel	G06F3/045	1/1
	G	US-				
	H	US-				
	I	US-				
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	K	US-				
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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
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	P					
	Q					
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	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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BIB DATA SHEET

CONFIRMATION NO. 4030

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/377,096	12/13/2016 RULE	345	2625	IMM637 (051851-0971162)

APPLICANTS
Immersion Corporation, San Jose, CA;

INVENTORS
Vahid Khoshkava, Montreal, CANADA;
Abdelwahab Hamam, Montreal, CANADA;

** CONTINUING DATA **********

** FOREIGN APPLICATIONS **********

** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **
12/20/2016

Foreign Priority claimed		STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Met after Allowance	CANADA	6	19	3
Verified and Acknowledged /BRYAN E EARLES/ Examiner's Signature	Initials				

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Suite 2800
Atlanta, GA 30309
UNITED STATES

TITLE

Systems and Methods for Proximity-Based Haptic Feedback

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BIB (Rev. 05/07).

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	29	(("KHOSHKAVA") near3 ("Vahid")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/03/27 15:47
S2	28	(("HAMAM") near3 ("Abdelwahab")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/03/27 15:47
S3	225	(("IMMERSION") near3 ("CORPORATION")).AANM.	USPAT	OR	ON	2018/03/27 15:47
S4	30998	(G06F3/0412; G06F3/0414; G06F3/044; H01L27/323; G06F2203/04105; G06F2203/04107).cpc.	US-PGPUB; USPAT	OR	ON	2018/03/27 15:47
S5	38966	(G06F3/016 or G06F3/0416 or G06F3/044 or G06F3/0421 or G06F2203/04108).cpc.	US-PGPUB; USPAT	OR	ON	2018/03/27 15:49
S6	0	propinquity near9 haptic	US-PGPUB; USPAT	OR	ON	2018/03/27 15:51
S7	2735	(propinquit$3 proximit$3 hover$3) near9 (haptic tactile)	US-PGPUB; USPAT	OR	ON	2018/03/27 15:52
S8	622	S7 and S5	US-PGPUB; USPAT	OR	ON	2018/03/27 15:53
S9	622	S7 and S5	US-PGPUB; USPAT	OR	ON	2018/03/27 15:53
S11	7967	345/174.ccls.	US-PGPUB; USPAT	OR	ON	2018/03/27 15:55
S12	2	"20140218317"	US-PGPUB; USPAT	OR	ON	2018/03/27 16:09
S13	1	"20170357315"	US-PGPUB; USPAT	OR	ON	2018/03/27 16:09
S14	1	"20160062464"	US-PGPUB; USPAT	OR	ON	2018/03/27 16:12
S15	0	(14/869829).APP.	USPAT; USOCR	OR	ON	2018/03/27 16:18
S16	2254	(propinquit$3 proximit$3 hover$3) near6 (haptic haptical$3 tactile)	US-PGPUB; USPAT	OR	ON	2018/03/27 16:20
S17	2	"20120286944"	US-PGPUB;	OR	ON	2018/03/27 16:21

			USPAT			
S18	551	S16 and S5	US-PGPUB; USPAT	OR	ON	2018/03/27 16:22
S19	558	S16 and (S5 S11)	US-PGPUB; USPAT	OR	ON	2018/03/27 16:22
S20	558	S16 and (S5 S11)	US-PGPUB; USPAT	OR	ON	2018/03/27 16:23
S21	2500	(("20170178470") or ("20150268724") or ("9875625") or ("20170168630") or ("20140320431") or ("9921650") or ("20160103489") or ("20150009168") or ("20170257492") or ("9729730") or ("20160147333") or ("20170357316") or ("20160004309") or ("20170136350") or ("9632581") or ("20140362014") or ("20170192510") or ("20170269693") or ("9535550") or ("20170269690") or ("20160004308") or ("20170256144") or ("20160018891") or ("9696806") or ("9606624") or ("20160334871") or ("20170277263") or ("9898903") or ("9710063") or ("9645647") or ("20180039302") or ("9921609") or ("20170242488") or ("20140139452") or ("20160054799") or ("20170357315") or ("20160179199") or ("20180052556") or ("20150185841") or ("9836150") or ("20170083096") or ("20150355710") or ("20170228122") or ("9658693") or ("20130113715") or ("20170131776") or ("9690381") or ("20140320435") or ("20170364154") or ("20170364155") or ("20160306426") or ("20140320436") or ("20140139451") or ("9335823") or ("9582178") or ("20160187988") or ("20160216767") or ("20160216765") or ("9405369") or ("9715281") or ("20140139450") or ("20170285752") or ("9851805") or ("9330544") or ("20160179198") or ("20120127088") or ("20170269689") or ("9600076") or ("9639158") or ("20160246375") or ("20170269686") or ("20170100666") or ("20150072789") or ("20140267065") or ("20120229400") or ("9558637") or ("9878239") or ("20170364190") or ("20150145657") or ("20160342208") or ("20150070147") or ("9436282") or ("20130300683") or ("20140184497") or ("9576445") or ("20120223880") or ("20140218317") or ("20150042573") or ("20150070146") or ("20170270756") or ("8493354") or ("20140333565") or ("20160162032") or ("20150035780") or ("8279193") or ("20170162009") or ("9898119") or ("9711014") or ("8659571") or ("8823674") or ("20170220115") or ("20100231550") or ("9619033") or ("9268403") or ("8866788") or ("9529435") or ("20170255268") or ("20150268725") or	US-PGPUB; USPAT	OR	OFF	2018/03/27 16:25

		("20180082552") or ("20150199024") or ("20160062464") or ("9696803") or ("20160063827") or ("20160063825") or ("20160063828") or ("20130222310") or ("20140104165") or ("20160062465") or ("20120229401") or ("20160259411") or ("20160062466") or ("20170322631") or ("20140347270") or ("20150070148") or ("9542820") or ("9746923") or ("9928699")).PN. or (("20140062682") or ("8847741") or ("20150253848") or ("8624864") or ("20170162010") or ("20150338921") or ("20160334901") or ("9619980") or ("20150316985") or ("20170365139") or ("8981915") or ("20140267076") or ("9830784") or ("9116546") or ("20120286944") or ("20170255255") or ("8570296") or ("20170052594") or ("20120038582") or ("20100231367") or ("8717151") or ("9886829") or ("20100231539") or ("20140098043") or ("9501149") or ("20140002346") or ("9501147") or ("20160189492") or ("9690370") or ("20150185842") or ("20180074694") or ("9846485") or ("20120327006") or ("20150248163") or ("20160313840") or ("20180074592") or ("9063570") or ("8576171") or ("9134797") or ("9466188") or ("20160321880") or ("20170199569") or ("20140098038") or ("20160246378") or ("9348416") or ("20100231508") or ("9405368") or ("20170358181") or ("20180027520") or ("20150084875") or ("20150097786") or ("20140320396") or ("20150253855") or ("9756604") or ("20170031444") or ("20150185849") or ("20150169056") or ("20170017310") or ("20120056825") or ("20150277559") or ("20160306427") or ("9715278") or ("20150185848") or ("20150268722") or ("20150362994") or ("20120249474") or ("8232969") or ("20060109256") or ("20180074585") or ("20140071079") or ("20150234493") or ("20110261021") or ("20130207904") or ("20120299857") or ("20140145994") or ("20060119586") or ("20120086564") or ("8264465") or ("20140281950") or ("9489048") or ("9645643") or ("7890863") or ("20100156818") or ("20170186286") or ("20150070265") or ("9182820") or ("9430106") or ("8710968") or ("20100231540") or ("9678569") or ("20160019762") or ("20160224115") or ("20110264491") or ("8854331") or ("8898564") or ("9235267") or ("20170308169") or ("8593409") or ("8686952") or ("8711118") or ("20110285667") or ("20160018890") or ("20180011539") or ("20110285666") or ("20110193824") or ("9898086") or ("20150116205") or ("9501145") or ("20170291104") or ("9477306") or						

		("8654524") or ("20150227280") or ("20140145836") or ("20110038114") or ("20140267013") or ("9927887") or ("20160162031") or ("20140035736") or ("20100231541") or ("20140267069") or ("9600075") or ("20150355713") or ("9600083") or ("9874935") or ("20180074591") or ("20090106655") or ("9389688") or ("9041647")).PN. or (("9354704") or ("9870053") or ("20170351331") or ("9189098") or ("20110025609") or ("20160098085") or ("20160259542") or ("20110138277") or ("9910494") or ("20140306904") or ("20170185151") or ("20160018920") or ("20140253302") or ("9245428") or ("20170083092") or ("20140281954") or ("20110216013") or ("20170069180") or ("20170301193") or ("9753540") or ("9927873") or ("8730182") or ("20170087459") or ("9035899") or ("20170352356") or ("20160048210") or ("20100013761") or ("20130201141") or ("20170068318") or ("20170336903") or ("20150268727") or ("20170168579") or ("9202351") or ("9727182") or ("9547366") or ("8462125") or ("20180011538") or ("9625991") or ("9063571") or ("9448713") or ("20150054768") or ("20120068957") or ("20130009892") or ("9612662") or ("8749495") or ("20170192541") or ("8982068") or ("20110140870") or ("20130250500") or ("20110267181") or ("20140340209") or ("20170357317") or ("20110267294") or ("20180081441") or ("20160162030") or ("20170357319") or ("20130250502") or ("20170357320") or ("20160238402") or ("20100073304") or ("20170053654") or ("20150005039") or ("9574896") or ("20100177050") or ("9891709") or ("20140340316") or ("20130016042") or ("20150130730") or ("20160189494") or ("9519346") or ("9545568") or ("20170160098") or ("20160091972") or ("8773247") or ("20170357318") or ("20120229402") or ("20180000429") or ("9928696") or ("20180066636") or ("20170255266") or ("9772688") or ("9786287") or ("9857872") or ("9600037") or ("20170336869") or ("20140218853") or ("20080062144") or ("20090167704") or ("20080062145") or ("20150370475") or ("20170147087") or ("20150224394") or ("20170344115") or ("20120235942") or ("20080062143") or ("20180033262") or ("8345013") or ("20050017947") or ("9829981") or ("20050052430") or ("20170357376") or ("9763628") or ("20150205353") or ("20160378187") or ("20160378189") or ("20020033795") or ("9921652") or ("20160062541") or ("9864509") or ("20110115709") or ("20130002587") or ("20080060856") or ("9471143") or						

		("6822635") or ("9535501") or ("20150370779") or ("8059104") or ("20170168707") or ("20120268412") or ("20180081483") or ("7450110") or ("20150138155") or ("20150331517") or ("20180067560") or ("20160103488") or ("20160259416") or ("8063892")).PN. or (("20150007025") or ("20150169059") or ("20150185885") or ("9864508") or ("20150149964") or ("20110260990") or ("9335822") or ("8188981") or ("20130307786") or ("9788298") or ("20180024681") or ("20150149899") or ("20140160050") or ("7548232") or ("20160321882") or ("20140208204") or ("20140139328") or ("20140306938") or ("9557843") or ("20150070290") or ("20120249462") or ("20160246376") or ("20150227207") or ("9778771") or ("20160349842") or ("8698766") or ("20150035757") or ("9864432") or ("20160066149") or ("9489081") or ("9606625") or ("9811202") or ("20150067495") or ("20150138126") or ("9733746") or ("20150067496") or ("20150072738") or ("20140320402") or ("20170131805") or ("20170090569") or ("20130207917") or ("20090250267") or ("20170068371") or ("20150331488") or ("20160248897") or ("20170046059") or ("RE42064") or ("20090128503") or ("20150067497") or ("20170285748") or ("9600120") or ("9285905") or ("9423874") or ("9448631") or ("8937603") or ("20140139329") or ("20140347323") or ("9880623") or ("20170131777") or ("20140267911") or ("20160062574") or ("20140139436") or ("20170092270") or ("20160332072") or ("20160342212") or ("20110227872") or ("20160357389") or ("20180039331") or ("20130222303") or ("20120327025") or ("9619034") or ("9886184") or ("20070236450") or ("20170242484") or ("9704358") or ("9164586") or ("20150070289") or ("8648829") or ("9857897") or ("20160378070") or ("20160378071") or ("20160282970") or ("20170102770") or ("20160378069") or ("20160195989") or ("9349552") or ("20140055358") or ("20170046058") or ("20170046060") or ("9880628") or ("20150103015") or ("8157650") or ("20160058375") or ("20140140551") or ("9910495") or ("9866924") or ("20140191973") or ("20150355714") or ("9390598") or ("20170357390") or ("9053617") or ("20130009882") or ("20170212589") or ("9829977") or ("20170364246") or ("20160062630") or ("9104285") or ("20150370455") or ("20170045944") or ("20170364167") or ("9690382") or ("20160019817") or ("20130198625") or ("20150070144") or ("20170092085") or						

		("20160062590") or ("20120319987") or ("20150370323") or ("8836664") or ("20170090572") or ("9727143") or ("9691270") or ("20150097791") or ("9170650") or ("9152264") or ("20140085247") or ("20140267362")).PN. or (("9830048") or ("8721416") or ("8896524") or ("20120229407") or ("20130044049") or ("20100079264") or ("20160041597") or ("20120287068") or ("20160259536") or ("20170357358") or ("20170285781") or ("20120105333") or ("20160357391") or ("9030308") or ("9678571") or ("8842086") or ("20120113008") or ("20140320276") or ("7348968") or ("9916007") or ("9513706") or ("20110018697") or ("9804724") or ("20130127767") or ("8405618") or ("20170123520") or ("20180039388") or ("20160291858") or ("20040164971") or ("9357312") or ("20080251364") or ("20150378434") or ("20160357375") or ("20150370529") or ("9846508") or ("20160103530") or ("20130328814") or ("9110536") or ("20140180582") or ("20140035735") or ("8836643") or ("20180004290") or ("20160357257") or ("20170168573") or ("20130127607") or ("9373233") or ("20180067557") or ("20140085253") or ("20170333788") or ("9811194") or ("9646471") or ("20120133494") or ("20160048207") or ("20170357335") or ("20130057509") or ("20130002570") or ("7336266") or ("9035918") or ("9773409") or ("9443501") or ("20160202763") or ("20150346973") or ("20170315716") or ("20110304550") or ("20150067513") or ("20170193760") or ("20180067596") or ("20160357429") or ("8502651") or ("9443401") or ("20140085213") or ("20130106758") or ("8780060") or ("9760241") or ("9910524") or ("20140362274") or ("20160170624") or ("20140247227") or ("20080111788") or ("20150022466") or ("9400557") or ("20070229483") or ("20130127755") or ("9753541") or ("20150370328") or ("20140002386") or ("8890666") or ("9323326") or ("20160231814") or ("20140267363") or ("7769417") or ("8125453") or ("20160066277") or ("20120056806") or ("9495011") or ("20180074690") or ("20080068351") or ("20150067563") or ("20170024013") or ("20040075676") or ("20070040815") or ("20070229478") or ("9355472") or ("9904366") or ("9195350") or ("20150293592") or ("20170293360") or ("7339572") or ("20160216794") or ("20170359302") or ("20080068348") or ("20080068350") or ("20030038776") or ("20080068349") or ("8073501") or ("9183710") or ("20010035854") or ("9122325") or ("20160170625") or ("20170277498") or ("20160373631") or					

		("9671866") or ("20110021272") or ("20120056839") or ("7808488") or ("20140056461") or ("9489047") or ("20160139670")).PN. or (("20180011571") or ("8059105") or ("20140009273") or ("9449476") or ("20130311881") or ("20170251268") or ("9235969") or ("20150067602") or ("8469806") or ("20160259516") or ("20160349913") or ("20130027324") or ("20130201115") or ("20170269687") or ("20120229424") or ("20080062122") or ("20140253303") or ("20120056733") or ("20070013677") or ("20160259530") or ("20090160763") or ("9792018") or ("20170357323") or ("20180081438") or ("20180067622") or ("20150153828") or ("20160252959") or ("8760413") or ("20060119589") or ("8325144") or ("20150054633") or ("20150323993") or ("20180067555") or ("20150135109") or ("7148875") or ("20160357388") or ("8049734") or ("7768504") or ("8156809") or ("7978183") or ("20130162579") or ("20160253552") or ("20160041648") or ("20060187215") or ("8773356") or ("20140368445") or ("9202352") or ("20170046039") or ("6429846") or ("20130234972") or ("20080303782") or ("9280205") or ("8063893") or ("20100045619") or ("20140139327") or ("20130100008") or ("20150301673") or ("20160334924") or ("7777716") or ("9740290") or ("7982720") or ("20020044132") or ("9921655") or ("7944435") or ("9411423") or ("20160195931") or ("20160070404") or ("9823828") or ("9900518") or ("6819312") or ("9690383") or ("20140101545") or ("20160103542") or ("20150097796") or ("20130106765") or ("8674961") or ("20160004430") or ("8031181") or ("20160202760") or ("20160246396") or ("20100265191") or ("20150143273") or ("20170308163") or ("20160062497") or ("20120194466") or ("20160259480") or ("9489046") or ("8878806") or ("9823833") or ("6337678") or ("20120194463") or ("20170021762") or ("20160004427") or ("20120081327") or ("9846535") or ("20160357381") or ("20160139671") or ("20170344143") or ("8638301") or ("8590379") or ("9862099") or ("20160187977") or ("20110148607") or ("20100060568") or ("20140232534") or ("20160259471") or ("9690380") or ("20160004311") or ("20160098131") or ("9671865") or ("9122330") or ("20060192771") or ("20160070351") or ("20150058723") or ("20080064499") or ("8395587") or ("9733706") or ("9772721") or ("20150277562") or ("20170003744") or ("20180067554") or ("20130321262") or ("20160344972") or ("RE44277") or ("20160065708") or ("9594429") or						

		("20140085065") or ("20140028592")).PN. or					
		(("20120249461") or ("20180078182") or					
		("20150070145") or ("20150370396") or					
		("20160065650") or ("9305374") or					
		("20140167942") or ("7728820") or					
		("20160004431") or ("8570161") or					
		("20160306423") or ("20160004428") or					
		("9082270") or ("20150261264") or					
		("20110310028") or ("20090085878") or					
		("20160162127") or ("20120081326") or					
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		("20170212591") or ("20150077324") or					
		("20170277262") or ("20110043454") or					
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		("20140256438") or ("20120019373") or					
		("20100277430") or ("20150097793") or					
		("20130207793") or ("20170310874") or					
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		("9887949") or ("20130135218") or					
		("20170046035") or ("20120081337") or					
		("8976112") or ("8892162") or					
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		("20140320393") or ("20020054060") or					
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		("20180067712") or ("20100188327") or					
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		("20160313875") or ("20170060248") or					
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		("20120326989") or ("9547430") or					
		("8519982") or ("20100017759") or					
		("9715300") or ("9164584") or ("8542216")					
		or ("20120126959") or ("9785238") or					
		("20160065831") or ("20130154933") or					
		("20160070348") or ("20120196664") or					
		("20170315770") or ("20170123498") or					
		("20170329446") or ("8451245") or					
		("20150054773") or ("9665177") or					
		("9293015") or ("20120206248") or					
		("8004391") or ("20090189749") or					
		("20180053385") or ("20180039366") or					
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		("20150347075") or ("20170083188") or					
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		("20180059849") or ("20180059792") or					
		("20160065707") or ("20160259472") or					
		("9207764") or ("20050116940") or					
		("7910843") or ("20110095994") or					
		("20080143693") or ("20170357389") or					
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		("20170068402") or ("20170075878") or					
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		("20130215079") or ("9507459") or					
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		("20110310126") or ("9665198") or					
		("20150062052") or ("20130314354") or					
		("20090096746")).PN. or (("8686839") or					

		("20160063850") or ("8830188") or ("20160021168") or ("9524030") or ("20130155018") or ("9659482") or ("20150022224") or ("20150350147") or ("20170068425") or ("9811066") or ("20160357357") or ("9542037") or ("9740381") or ("9898904") or ("20130106741") or ("20150097799") or ("9733880") or ("20150067601") or ("20160292989") or ("20150199013") or ("20140354570") or ("20070146317") or ("20150324049") or ("20060209037") or ("8390439") or ("8330061") or ("20160062498") or ("9778744") or ("20150241970") or ("20160316349") or ("20150067519") or ("9742977") or ("20170032630") or ("20130215038") or ("20160259470") or ("20170337804") or ("20120274599") or ("20140327531") or ("20160328017") or ("20140380156") or ("7679611") or ("20140118127") or ("9860436") or ("20110102340") or ("20170249812") or ("20170212673") or ("20170357568") or ("20090243997") or ("8378979") or ("9430042") or ("20180004295") or ("20170084408") or ("20150122621") or ("8159461") or ("20140362056") or ("9766702") or ("9557857") or ("20160041750") or ("20120293464") or ("20100027854") or ("20070152974") or ("20150097794") or ("20090231271") or ("20090184923") or ("20160054826") or ("20130147728") or ("20140365956") or ("9703406") or ("8963882") or ("20180024516") or ("20170357321") or ("9513707") or ("20140273992") or ("20160179264") or ("20160231815") or ("20150067559") or ("20160154544") or ("8963885") or ("20120319827") or ("20180074693") or ("20110169667") or ("20150109220") or ("20130118879") or ("9261963") or ("20130229271") or ("20150067596") or ("20160011771") or ("20170160803") or ("20170357398") or ("20140230575") or ("9753639") or ("20170147067") or ("20170243452") or ("20150067605") or ("20170357401") or ("8405612") or ("9514902") or ("20160370862") or ("9691238") or ("20170351334") or ("20160349970") or ("20120293415") or ("20100123588") or ("20150080060") or ("9823839") or ("9513704") or ("20140253305") or ("20170357430") or ("8917249") or ("9930157") or ("8400410") or ("20160062572") or ("20100283731") or ("20150130599") or ("20120028577") or ("20140292668") or ("9886091") or ("20160085307") or ("20160011666") or ("8593420") or ("20140189506") or ("20120001749") or ("8310444") or ("20170300118") or ("9547419") or ("7511706")).PN. or (("9632664") or ("20150293590") or ("8482381") or						

		("20030184574") or ("9710061") or ("20180004293") or ("8773403") or ("20100214243") or ("8441790") or ("8031172") or ("9930287") or ("20160188103") or ("9898087") or ("20170046034") or ("20160005278") or ("20090002328") or ("9329721") or ("9740289") or ("20110102162") or ("9881467") or ("9063594") or ("20150084900") or ("20130135262") or ("20140062684") or ("20110102326") or ("20160291771") or ("20180059914") or ("20170168571") or ("9626087") or ("20150370425") or ("8798534") or ("20170052593") or ("9035752") or ("20150070269") or ("20140267139") or ("20160274662") or ("20100141407") or ("8749507") or ("20150169058") or ("9196134") or ("20090322496") or ("20170249024") or ("20150370920") or ("8749533") or ("20140365883") or ("9836929") or ("20130155020") or ("9718193") or ("9791930") or ("20120293463") or ("9131035") or ("20140365953") or ("20110095877") or ("20100250071") or ("20160089569") or ("20080202824") or ("20110128239") or ("20170357325") or ("20160351190") or ("9529447") or ("20100116562") or ("20150347358") or ("20160259497") or ("20170090592") or ("20160062598") or ("9652041") or ("20150378519") or ("20150153929") or ("9063591") or ("20090313542") or ("20130135220") or ("20120295709") or ("20170090577") or ("9612741") or ("20130225261") or ("8994518") or ("20110248838") or ("20160188066") or ("20100033426") or ("20120096351") or ("20160259535") or ("20180061191") or ("20160259415") or ("9880627") or ("20070232348") or ("20170336871") or ("9058728") or ("20040110527") or ("20160357367") or ("20160170504") or ("9886093") or ("20160004432") or ("20110248947") or ("20120112894") or ("20140365945") or ("20160357354") or ("8665241") or ("20180059789") or ("8441444") or ("20050248549") or ("9841876") or ("20170315618") or ("20120075198") or ("8310351") or ("20160269645") or ("20110037734") or ("20170045982") or ("9569055") or ("9342149") or ("8362882") or ("20160195932") or ("9715280") or ("8890668") or ("20170045981") or ("8174372") or ("20110141052") or ("20120256848") or ("8674941") or ("20150293631") or ("20170038856") or ("20150049055") or ("20170131772") or ("20150049034") or ("8681130") or ("20170277367") or ("20160104356") or ("20160259413")).PN. or (("20170045983") or ("20160259517") or ("20160259498") or ("8654106") or ("20170357438") or						

		("20140139448") or ("20160210025") or ("20130154938") or ("9535594") or ("20150160773") or ("20170357387") or ("9645646") or ("20100267424") or ("20060061545") or ("20160291770") or ("8956230") or ("20100309142") or ("20160378190") or ("20100309141") or ("20170357478") or ("20170357402") or ("20170220173") or ("20150049056") or ("20150332566") or ("20140009441") or ("20160048705") or ("20150149967") or ("8633916") or ("8760273") or ("20070145857") or ("20160358600") or ("9335844") or ("9619076") or ("20170075563") or ("9178509") or ("20180059787") or ("20030174121") or ("20170003876") or ("20170115791") or ("20140092003") or ("9454881") or ("20150077373") or ("20100013653") or ("20170046025") or ("20140049505") or ("20160259518") or ("20150065046") or ("8884884") or ("9008730") or ("8797295") or ("9886092") or ("20140091914") or ("9652069") or ("20170220118") or ("20100153845") or ("20170357411") or ("20160259527") or ("20070146316") or ("20100045612") or ("20160062540") or ("9280248") or ("20150048846") or ("9891708") or ("20180067561") or ("20160012690") or ("9823767") or ("20160349912") or ("9294914") or ("9911553") or ("20150346957") or ("20160259528") or ("20170046024") or ("20170068410") or ("9400582") or ("20090167508") or ("20140266647") or ("20150205352") or ("9880735") or ("20150070151") or ("20180005497") or ("9645709") or ("20090225043") or ("20170147197") or ("20150302709") or ("20160004429") or ("8866602") or ("20150220199") or ("8373549") or ("20170075520") or ("9733704") or ("20160065505") or ("20140139454") or ("20160296838") or ("9110545") or ("20100085169") or ("20140092064") or ("20140125471") or ("20170075562") or ("20170091169") or ("20160358598") or ("20150378437") or ("7205978") or ("20160259499") or ("9612685") or ("20150347179") or ("20170220117") or ("20150123775") or ("20110248916") or ("20160259412") or ("20110115754") or ("20170173262") or ("9740388") or ("9520037") or ("20160259519") or ("20140206451") or ("9886953") or ("20160065509") or ("8858335") or ("20150002280") or ("20160260436") or ("7755607") or ("9575591") or ("20160196935") or ("20160049265") or ("20040178989") or ("20080024459")).PN. or (("20140049491") or ("9836124") or ("9092954") or ("9274660") or ("20160107570") or ("8587417") or ("7535454") or ("20150033167") or						

		("7843277") or ("20160259489") or ("20090189873") or ("20170358301") or ("20170249012") or ("20080158149") or ("20140232662") or ("7084854") or ("9177452") or ("20140218330") or ("9134803") or ("20170090599") or ("20160239087") or ("9395817") or ("9736345") or ("20160363997") or ("9477393") or ("9417695") or ("9811250") or ("9477313") or ("20150346933") or ("20170352233") or ("20140365882") or ("9030446") or ("20130194219") or ("20150177838") or ("9179066") or ("20160342214") or ("20110090070") or ("8462116") or ("7710399") or ("20140091857") or ("20120327009") or ("9229532") or ("20170315678") or ("9508236") or ("9827904") or ("8269731") or ("20170177054") or ("20150054727") or ("9104271") or ("7952566") or ("9798388") or ("20170168576") or ("9849379") or ("20140092055") or ("9280206") or ("9513709") or ("20150070149") or ("20170046038") or ("20180056867") or ("20160062582") or ("20140354553") or ("9158379") or ("9851838") or ("20170091168") or ("20140139486") or ("20040012560") or ("20170357632") or ("20150220148") or ("20170192627") or ("20160259623") or ("6707443") or ("20110163946") or ("9235299") or ("20140333564") or ("20160103544") or ("7623114") or ("8803795") or ("20160328023") or ("20170108928") or ("20150084752") or ("6906697") or ("9189932") or ("20160259495") or ("20080266273") or ("9881468") or ("8330590") or ("20170329953") or ("20170285848") or ("20170346999") or ("9891759") or ("20140270681") or ("20160139716") or ("20100053087") or ("20160357422") or ("20160259496") or ("20140139422") or ("7688310") or ("8913027") or ("20170354876") or ("20180033431") or ("20180081453") or ("8610549") or ("20160284173") or ("20090207129") or ("20150061846") or ("20130215005") or ("8316166") or ("20170053443") or ("20120081276") or ("9746968") or ("20100302199") or ("20150355711") or ("20160260414") or ("20160187979") or ("20170031495") or ("6995744") or ("20160349974") or ("20090135142") or ("20170357436") or ("20150347532") or ("20150355712") or ("20170168572") or ("20170060244") or ("20160357421") or ("20140198068") or ("20160260431") or ("20120274578") or ("20180052540")).PN. or (("9275653") or ("20180046251") or ("9436280") or ("20160162025") or ("9721566") or ("9836931") or ("20130021278") or ("20110260988") or ("20170144063") or ("20170031445") or ("20160282942") or						

		("9886179") or ("9665206") or ("20140143784") or ("20140327653") or ("8564535") or ("6693626") or ("20150002469") or ("20170094636") or ("20170285753") or ("20160062530") or ("20060256090") or ("20110128250") or ("8059088") or ("9477309") or ("20170263249") or ("20180046249") or ("20170083095") or ("6717573") or ("20140002340") or ("20130335209") or ("20140210756") or ("20120326999") or ("20140092052") or ("20080132313") or ("9678570") or ("20170344156") or ("20030122779") or ("20150350134") or ("20100079379") or ("20130106774") or ("9678605") or ("20150350448") or ("7423631") or ("20160162027") or ("9245429") or ("20160266682") or ("20160306422") or ("20170221325") or ("20160062589") or ("20140143678") or ("20140340208") or ("8928582") or ("9910496") or ("20070119698") or ("20170285750") or ("20170235368") or ("20160132114") or ("20130194082") or ("20060192760") or ("20130201010") or ("20140368323") or ("20150370376") or ("20170076564") or ("8884901") or ("20160357296") or ("9880619") or ("20170010672") or ("20170153795") or ("20180004294") or ("20150338919") or ("20100017489") or ("9733710") or ("7106305") or ("9495010") or ("20130227411") or ("20170089736") or ("20170040129") or ("20170075423") or ("20130227410") or ("20160224116") or ("9891738") or ("9182837") or ("20110133910") or ("9081542") or ("20140225718") or ("20160357297") or ("20140143737") or ("9645732") or ("20150324116") or ("8754759") or ("8860563") or ("20120249475") or ("20140232646") or ("8994827") or ("20140210758") or ("20110109423") or ("20100092267") or ("20140062892") or ("20150348551") or ("20140143785") or ("20170220182") or ("20170269786") or ("20170011354") or ("20140285453") or ("20120139844") or ("20150347534") or ("7825903") or ("20170131775") or ("8605053") or ("20060267949") or ("9886086") or ("20090167509") or ("20170322628") or ("20140253504") or ("9070262") or ("9606706") or ("8400283") or ("9448628") or ("20120249312") or ("9785281") or ("20140139637") or ("20150181087") or ("20060049920") or ("20160109950") or ("9257022")).PN. or (("20160357281") or ("20170010769") or ("9235274") or ("20160216830") or ("20140198130") or ("20170358300") or ("9887943") or ("9715279") or ("20110267182") or ("20150185843") or ("20150070150") or ("9588586") or ("8138896") or ("8500534") or						

		("20100328251") or ("20170206755") or ("9833907") or ("9846484") or ("20150097803") or ("20150309536") or ("20160195930") or ("20150347985") or ("9659468") or ("20170011355") or ("9182824") or ("20140274398") or ("20140160034") or ("20160259656") or ("20160313801") or ("9720515") or ("8416066") or ("20140240289") or ("20150248235") or ("20160334912") or ("20130147748") or ("20150347010") or ("20150350296") or ("9652945") or ("20160349880") or ("20140198069") or ("20160195928") or ("20150205357") or ("20160217778") or ("9459728") or ("9595250") or ("9690377") or ("20180050454") or ("20170090749") or ("6703550") or ("9358689") or ("20110012717") or ("20160070466") or ("20130154814") or ("8378794") or ("20150350297") or ("20150002477") or ("20150347007") or ("20160019360") or ("20070236474") or ("20120194472") or ("8976141") or ("20170346317") or ("6686901") or ("20150332031") or ("20170242506") or ("20170308165") or ("9024908") or ("9244562") or ("20150277596") or ("8378797") or ("20110205446") or ("20120268285") or ("20130191741") or ("20140292635") or ("8723824") or ("9244532") or ("20150277735") or ("8451240") or ("9928701") or ("20160149426") or ("20170348595") or ("8061182") or ("9916003") or ("9741216") or ("20100090813") or ("20180074588") or ("20130076649") or ("9804675") or ("20140143682") or ("7148789") or ("20060284849") or ("20160034092") or ("9542014") or ("20180046252") or ("20160086456") or ("6563487") or ("9037455") or ("20180011540") or ("8866766") or ("9711980") or ("20180039376") or ("20090213066") or ("20160163165") or ("8803671") or ("20170203206") or ("8294557") or ("20180061192") or ("20160018894") or ("20120105364") or ("20120084467") or ("20180075715") or ("20150212578") or ("20050151720") or ("20140135631") or ("6750877") or ("20090184921") or ("20150362993") or ("20170076361") or ("9042971") or ("20150334292") or ("20170357950") or ("20140245139") or ("9898084") or ("20170357640") or ("20170052624") or ("20170293361") or ("20080303797") or ("20130104040")).PN. or (("20100141408") or ("20160063826") or ("20120249315") or ("20140281958") or ("20140208333") or ("8803797") or ("9466187") or ("20150277617") or ("7886621") or ("9804692") or ("20140292706") or ("8339250") or ("20170092084") or ("9612661") or						

		("20140208128") or ("20150339001") or ("20170192730") or ("7561141") or ("20140267136") or ("8519948") or ("20120038568") or ("9632583") or ("20080055244") or ("20170358304") or ("20160299634") or ("9727217") or ("9791949") or ("20130335454") or ("20140142403") or ("20080073131") or ("8164573") or ("20140049475") or ("9612690") or ("20140327637") or ("20150205367") or ("20120299839") or ("20150316986") or ("9049998") or ("9201538") or ("9841839") or ("20180061195") or ("8416198") or ("20170315694") or ("9041669") or ("20170109039") or ("9044150") or ("20150130767") or ("20110080350") or ("20170165566") or ("20150268723") or ("9703378") or ("20160307566") or ("9174344") or ("20170269688") or ("20150178038") or ("20160061623") or ("9007302") or ("20150194165") or ("20150040005") or ("20160187976") or ("9405371") or ("20150230761") or ("9895607") or ("20160357305") or ("20110285637") or ("20140320400") or ("9110663") or ("20170354845") or ("20150116231") or ("20150227227") or ("20150346958") or ("20170068373") or ("20160349845") or ("9335824") or ("20170359461") or ("20150347379") or ("20140375580") or ("20090002199") or ("9829987") or ("9507420") or ("8436806") or ("20090141046") or ("20170010846") or ("20160357728") or ("20110260996") or ("20130222280") or ("20160048256") or ("9411451") or ("20150062078") or ("9564029") or ("8745284") or ("20160364962") or ("9836270") or ("20170357439") or ("9665213") or ("9123258") or ("20150261378") or ("20160342781") or ("9367150") or ("20170357637") or ("8022933") or ("20170068513") or ("20170300117") or ("7667687") or ("20160239090") or ("20150339024") or ("20160117034") or ("20160048261") or ("9400525") or ("20140218184") or ("20150153830") or ("8549892") or ("20160054798") or ("20140378787") or ("7742036") or ("9746945") or ("8866780") or ("8352643") or ("20170357633") or ("20170092278") or ("20020084982") or ("20170185375") or ("9557830") or ("9842105") or ("20060288137") or ("9164598") or ("9891723") or ("9448613") or ("20170357343")).PN. or (("9448632") or ("20170173457") or ("20130093702") or ("20150070261") or ("20160378747") or ("20140313021") or ("20160357368") or ("20130141396") or ("20160077591") or ("20140092057") or ("8797153") or ("20160085311") or ("9684410") or ("9830782") or ("8169402") or ("9917991")				

		or ("20160375354") or ("9916080") or ("20070146336") or ("7336260") or ("8830161") or ("20150186031") or ("8542193") or ("20170189803") or ("20150363019") or ("20160357358") or ("20170092259") or ("9557833") or ("9842476") or ("9928354") or ("20170116457") or ("9495009") or ("9411467") or ("20160320845") or ("20090272201") or ("20120194483") or ("20160096276") or ("9158387") or ("7656388") or ("20170068430") or ("20130241718") or ("20170229095") or ("20090021473") or ("20140125467") or ("20160119517") or ("20120326982") or ("20110074694") or ("9099971") or ("20110102462") or ("20100207882") or ("20170189824") or ("20140365919") or ("20090229892") or ("9804673") or ("8707195") or ("20170192576") or ("20140307179") or ("8502792") or ("20160147320") or ("9891811") or ("20170052640") or ("20090091479") or ("20150082401") or ("9360937") or ("9417696") or ("20100139418") or ("8441437") or ("20140315642") or ("20160357390") or ("9613245") or ("9501167") or ("20170243453") or ("20140002248") or ("20130194223") or ("8519947") or ("20160360256") or ("20140168124") or ("8547333") or ("20150199025") or ("20170090574") or ("20100156843") or ("20140281956") or ("20080150891") or ("9619052") or ("20170285749") or ("8599162") or ("20120019440") or ("20150062086") or ("20170132019") or ("20040227721") or ("20160370909") or ("20060066569") or ("20090219252") or ("20110205161") or ("9189121") or ("20120223824") or ("20090289779") or ("20150169118") or ("20100058251") or ("9772772") or ("9658704") or ("20170280397") or ("7649526") or ("20150102918") or ("9250719") or ("20140015862") or ("20160110038") or ("20140327530") or ("20160189427") or ("9208662") or ("9875019") or ("20170153703") or ("20160132118") or ("8181540") or ("20140368440") or ("9046922") or ("20160231819") or ("9841850") or ("9857913") or ("20170308075") or ("9697820") or ("20170351332") or ("20170010743") or ("8272278") or ("20150363012") or ("9182823") or ("20160070353") or ("20150373441")).PN. or (("20070057913") or ("20160364025") or ("20150379476") or ("20090303175") or ("20140365895") or ("8988386") or ("20160004329") or ("20120268368") or ("20160357404") or ("9613262") or ("9454256") or ("8570273") or ("20100225340") or ("20110302519") or ("8384679") or ("20160004310") or						

		("20150268785") or ("20160009317") or ("20160364091") or ("20090278798") or ("20130100030") or ("20130342451") or ("20160370906") or ("8531485") or ("20170068511") or ("20160364027") or ("20170024011") or ("20130141364") or ("20110227841") or ("7324094") or ("9712577") or ("20160148353") or ("20110115751") or ("8947216") or ("9229530") or ("9202354") or ("20150002438") or ("8917244") or ("9898085") or ("20170357520") or ("20180081439") or ("8884927") or ("20140365912") or ("9664902") or ("20040183782") or ("9606680") or ("20130127738") or ("9411420") or ("20120200520") or ("20140340204") or ("20140234009") or ("9239622") or ("9274635") or ("8739033") or ("9789896") or ("20120133615") or ("20160091971") or ("20150268784") or ("20120112999") or ("9632598") or ("9778840") or ("9329685") or ("20040130526") or ("20120056838") or ("8026906") or ("20070005835") or ("20020054011") or ("9329767") or ("9405383") or ("20040174340") or ("20110102160") or ("20140253522") or ("20170010847") or ("20100090814") or ("6864877") or ("20150138156") or ("20160154468") or ("20090167701") or ("20150350118") or ("9411442") or ("9710065") or ("8020095") or ("20120075210") or ("20170302831") or ("20130142362") or ("20160188101") or ("8542105") or ("9019088") or ("20170354795") or ("20060103634") or ("20130194084") or ("20090066673") or ("9851798") or ("20100283727") or ("20170161482") or ("20160044463") or ("9396630") or ("20070193436") or ("9069390") or ("20160062608") or ("9632597") or ("20170162203") or ("20140025750") or ("9644984") or ("8368641") or ("20080133648") or ("20160359771") or ("20160260433") or ("20060136630") or ("20140188561") or ("7567232") or ("20090002315") or ("20160357403") or ("20170075569") or ("20180046250") or ("20160357430") or ("20160062487") or ("20100182241") or ("20160117299") or ("20160054797") or ("20180081437") or ("20170371432") or ("20070279401") or ("20170027514") or ("8436825") or ("20170372524") or ("20140125470")).PN. or (("20150022328") or ("8125461") or ("20140320489") or ("20130088340") or ("9778743") or ("20150350507") or ("20170024014") or ("8547328") or ("9483120") or ("20080024457") or ("20160209925") or ("9766705") or ("20110102161") or ("20160224117") or ("9182822") or ("8928581") or ("9535552") or ("8378968") or ("8368662") or ("20150234518") or					

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S27	30	(ilya near rosenberg).in. and (haptic tactile force) near3 (respons$3 feedback)	US-PGPUB; USPAT	OR	ON	2018/03/28 16:15
S28	15	(ilya near rosenberg).in. and (haptic tactile force) near3 (sensation effect feedback)	US-PGPUB; USPAT	OR	ON	2018/03/28 16:17

EAST Search History (Interference)

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15377096	KHOSHKAVA ET AL.
	Examiner	Art Unit
	BRYAN EARLES	2625

CPC- SEARCHED		
Symbol	Date	Examiner
G06F3/016; G06F3/0416; G06F3/044; G06F3/0421; G06F2203/04108; G06F3/0412; G06F3/0414; H01L27/323; G06F2203/04105; G06F2203/04107	3/30/2018	BE

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

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SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Search	3/30/2018	BE
G06F3/016; G06F3/0416; G06F3/044; G06F3/0421; G06F2203/04108; G06F3/0412; G06F3/0414; H01L27/323; G06F2203/04105; G06F2203/04107	3/30/2018	BE
EAST Text Search (see search history printout)	3/30/2018	BE

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/BRYAN EARLES/ Primary Examiner.Art Unit 2625

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/377,096
	Filing Date	December 13, 2016
	First Named Inventor	Vahid Khoshkava
	Art Unit	2625
	Examiner Name	Bryan E. Earles
	Attorney Docket Number	051851-0971162 (IMM637)

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Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

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Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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	2	2 141 580	EP	A2	Jan 6, 2010	Lg Electronics Inc.		
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	4	2 887 187	EP	A1	Jun 24, 2015	LG Display Co., Ltd		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	5	EP17206294.5 , "Extended European Search Report", April 25, 2018, 8 pages	

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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Remarks:
This application was filed on 19-04-2010 as a divisional application to the application mentioned under INID code 62.

(54) Haptic effects with proximity sensing

(57) A method of generating haptic effects on a device includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

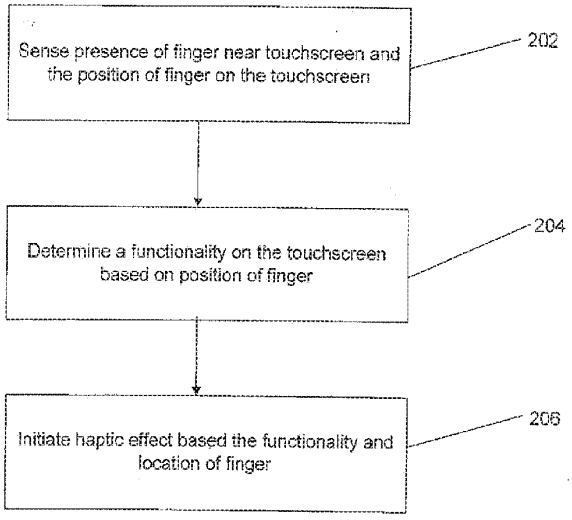


Fig. 3

EP 2 209 060 A2

Description

FIELD OF THE INVENTION

[0001] One embodiment of the present invention is directed to a haptic feedback system. More particularly, one embodiment of the present invention is directed to a haptic feedback system that utilizes proximity sensing.

BACKGROUND INFORMATION

[0002] Electronic device manufacturers strive to produce a rich interface for users. Conventional devices use visual and auditory cues to provide feedback to a user. In some interface devices, kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, texture, and heat) is also provided to the user, more generally known collectively as "haptic feedback." Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, vibration effects, or vibrotactile haptic effects, may be useful in providing cues to users of electronic devices to alert the user to specific events, or provide realistic feedback to create greater sensory immersion within a simulated or virtual environment.

[0003] Haptic feedback has also been increasingly incorporated in portable electronic devices, such as cellular telephones, personal digital assistants (PDAs), portable gaming devices, and a variety of other portable electronic devices. For example, some portable gaming applications are capable of vibrating in a manner similar to control devices (e.g., joysticks, etc.) used with larger-scale gaming systems that are configured to provide haptic feedback. Additionally, devices such as cellular telephones and PDAs are capable of providing various alerts to users by way of vibrations. For example, a cellular telephone can alert a user to an incoming telephone call by vibrating. Similarly, a PDA can alert a user to a scheduled calendar item or provide a user with a reminder for a "to do" list item or calendar appointment.

[0004] Increasingly, portable devices are moving away from physical buttons in favor of touchscreen-only interfaces. This shift allows increased flexibility, reduced parts count, and reduced dependence on failure-prone mechanical buttons and is in line with emerging trends in product design. When using the touchscreen input device, a mechanical confirmation on button press or other user interface action can be simulated with haptics.

[0005] For portable devices, cost is an important driving factor. Therefore, to generate haptic effects a single low cost actuator is generally used, for example an eccentric rotating mass ("ERM") motor or an electromagnetic motor. These actuators are able to produce strong magnitude haptic outputs. However, they also require a certain amount of time to achieve their peak haptic output (e.g., approximately 50 ms). These actuators are also used to provide feedback to the user when operating a touch sensitive input of a touchscreen device. For example when the user presses a button on a touchscreen a haptic effect is output to give the sensation of pressing a mechanical button. It is desired to output the haptic effect at the same time the user has selected the button in the interface. However, due to the time it takes to have actuator reach a desired magnitude, the haptic effect lags behind the button press event. If this lag becomes too long the user will not perceive the button press and the haptic effect as a single event.

[0006] Based on the foregoing, there is a need for an improved system and method for generating haptic effects for a touchscreen.

SUMMARY OF THE INVENTION

[0007] One embodiment is a method of generating haptic effects on a device. The method includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

The invention also relates to:

[0008]

1. A method of generating haptic effects on a device, said method comprising:

   detecting the presence of an object near an input area of the device; and
   generating a haptic effect on the device in response to the presence detection.

2. The method of point 1, further comprising:

   determining the approximate time when the object will touch the input area; and
   generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

3. The method of point 2, wherein said generating comprises energizing an actuator before the object touches the input area.

4. The method of point 1, wherein said haptic effect comprises generating a vibration on the input area.

5. The method of point 1, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

6. The method of point 1, wherein said device is a cellular telephone.

7. The method of point 1, wherein said input area is a touch sensitive surface.

8. The method of point 1, further comprising:

determining a position of the object relative to the input area; and
determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

9. The method of point 8, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

10. A haptically enabled device comprising:

an input area;
a proximity sensor coupled to said input area; and
a haptic feedback system coupled to said input area.

11. The device of point 10, wherein said proximity sensor is adapted to detect the presence of an object near the input area and said haptic feedback system is adapted to generate a haptic effect on the device in response to the presence detection.

12. The device of point 11, wherein said haptic feedback system is adapted to determine the approximate time when the object will touch the input area; and generate the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

13. The device of point 12, wherein said haptic feedback system comprises an actuator, and said system energizes said actuator before the object touches the input area.

14. The device of point 10, wherein said input area comprises a touch sensitive surface.

15. The device of point 14, wherein said touch sensitive surface is a touchscreen.

16. A computer readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate haptic effects on a device, said processor:

detecting the presence of an object near an input area of the device; and
generating a haptic effect on the device in response to the presence detection.

17. The computer readable medium of point 16, said processor further:

determining the approximate time when the object will touch the input area; and
generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

18. The computer readable medium of point 17, wherein said generating comprises energizing an actuator before the object touches the input area.

19. The computer readable medium of point 16, wherein said haptic effect comprises generating a vibration on the input area.

20. The computer readable medium of point 16, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

21. The computer readable medium of point 16, wherein said device is a cellular telephone.

22. The computer readable medium of point 16, wherein said input area is a touch sensitive surface.

23. The computer readable medium of point 16, said processor further:

determining a position of the object relative to the input area; and
determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

24. The computer readable medium of point 23, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality,
wherein said second type is different than said first type.

25. A haptically enabled device comprising:

means for detecting the presence of an object near an input area of the device; and
means for generating a haptic effect on the device in response to the presence detection.

26. A haptically enabled device of point 25, further comprising:

means for determining the approximate time

when the object will touch the input area; and
means for generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1 is a block diagram of a cellular telephone in accordance with one embodiment.

[0010] Fig. 2 is a flow diagram of the functionality performed by a telephone when generating haptic effects in response to the proximity of a user to a touchscreen in accordance with one embodiment.

[0011] Fig. 3 is a flow diagram of the functionality performed by the telephone when generating haptic effects in response to the proximity of a user to the touchscreen in accordance with one embodiment.

DETAILED DESCRIPTION

[0012] One embodiment is a portable device that includes a haptic feedback system with proximity sensing. The haptic system initiates the haptic feedback before a user actually touches a touchscreen or other input area based on the proximity information.

[0013] Fig. 1 is a block diagram of a cellular telephone 10 in accordance with one embodiment. Telephone 10 includes a screen 11 and an input area, touchscreen 13, that includes "keys" and can include other types of user interfaces, including menus, etc. In another embodiment, the keys of telephone 10 can be mechanical type keys. Internal to telephone 10 is a haptic feedback system that generates vibrations on telephone 10. In one embodiment, the vibrations are generated on the entire telephone 10. In other embodiments, specific portions of telephone 10 can be haptically enabled by the haptic feedback system, including the entire touchscreen 13 or individual keys of touchscreen 13.

[0014] The haptic feedback system includes a processor 12. Coupled to processor 12 is a memory 20 and an actuator drive circuit 16, which is coupled to a vibration actuator 18. Although the embodiment of Fig. 1 is a cellular telephone, embodiments can be implemented with any type of handset or mobile/portable device, or any device that uses an actuator to generate vibrations. For example, other embodiments may not include touchscreens but are haptic devices with other types of input areas. Other input areas besides touchscreens may be a mini-joystick, scroll wheel, d-Pad, keyboard, touch sensitive surface, etc. As with a cellular telephone, for these devices there is a desire for a haptic effect to be generated on the input area and/or the entire device.

[0015] Processor 12 may be any type of general purpose processor, or could be a processor specifically designed to provide haptic effects, such as an application-specific integrated circuit ("ASIC"). Processor 12 may be the same processor that operates the entire telephone 10, or may be a separate processor. Processor 12 can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters. In general, the high level parameters that define a particular haptic effect include magnitude, frequency and duration. Low level parameters such as streaming motor commands could also be used to determine a particular haptic effect.

[0016] Processor 12 outputs the control signals to drive circuit 16 which includes electronic components and circuitry used to supply actuator 18 with the required electrical current and voltage to cause the desired haptic effects. Actuator 18 is a haptic device that generates a vibration on telephone 10. Actuator 18 can include one or more force applying mechanisms which are capable of applying a vibrotactile force to a user of telephone 10 (e.g., via the housing of telephone 10). Memory device 20 can be any type of storage device, such as random access memory ("RAM") or read-only memory ("ROM"). Memory 20 stores instructions executed by processor 12. Memory 20 may also be located internal to processor 12, or any combination of internal and external memory.

[0017] A proximity sensor 14 is coupled to processor 12. Proximity sensor 14 detects when a finger (or stylus) is in close proximity to but not in contact with touchscreen 13. Proximity sensor 14 may also detect location (e.g., x, y, z), direction, speed and acceleration, orientation (e.g., roll, pitch, yaw), etc. of the finger relative to touchscreen 13. Proximity sensor 14 provides its information as an input to processor 12 when a finger is placed above touchscreen 13. This input can be used by processor 12 when generating haptic feedback for telephone 10.

[0018] Proximity sensor 14 may use any technology that allows the proximity of a finger or other object to touchscreen 13 to be sensed. For example, it may be based on sensing technologies including capacitive, electric field, inductive, hall effect, reed, eddy current, magneto resistive, optical shadow, optical visual light, optical IR, optical color recognition, ultrasonic, acoustic emission, radar, heat, sonar, conductive or resistive and the like.

[0019] In one embodiment, proximity sensor 14 includes one or more proximity sensors that each generate a sensing field above touchscreen 13 and that produce signals when an object disturbs or intercepts the sensing field(s). Each sensing field typically generates its own signals when disturbed. In one embodiment, a single sensing field is used to cover the entire touchscreen 13 surface. In another embodiment, a single sensing field only covers a portion of the touchscreen 13 surface. In another embodiment, multiple sensing fields are used to cover the entire touchscreen 13 surface. Any number of sensing fields may be used. In some cases, in order to perform tracking, the sensing fields may even be distributed as a pixelated array of nodes.

[0020] Fig. 2 is a flow diagram of the functionality performed by telephone 10 when generating haptic effects in response to the proximity of a user to touchscreen 13 in accordance with one embodiment. In one embodiment,

the functionality of Fig. 2 is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0021] At 102, proximity sensor 14 senses the presence of a finger, stylus, or other object above or in some other manner near touchscreen 13 or other input area of telephone 10.

[0022] At 104, proximity sensor 14 determines the position, speed and/or acceleration of the finger relative to the surface of touchscreen 13. This enables processor 12 to determine whether the user's finger will actually contact touchscreen 13. For example, if the proximity signal is increasing at a certain rate, it is highly likely that the user will contact touchscreen 13 and press a button.

[0023] At 106, based on the determination at 104, processor 12 can calculate when the finger is expected to contact touchscreen 13. In anticipation of this contact, processor 12 initiates the haptic effect before the actual contact, thus avoiding the lag time caused by actuator 18. Processor 12 may use the acceleration of the finger and the starting time required by actuator 18 to determine how far in advance to initiate the haptic effect and energize actuator 18. Therefore, the haptic effect will be implemented at approximately the exact time that the finger actually contacts touchscreen 13 and result in better synchrony of the haptic effect with the button press event. In another embodiment, processor 12 may initiate the haptic effect upon sensing the mere presence of the finger at 102.

[0024] In typical use of cell phones or PDA's, the user generally holds the device in one hand and uses the other hand to interact with the user interface such as touchscreen 13. For handheld haptic devices with proximity sensing this means that the user can sense the haptic feedback with the hand holding the device even though the finger has not yet touched the surface. Therefore, useful haptic effects can be created as a function of the proximity even when a finger never touches touchscreen 13.

[0025] In one embodiment, if a user is hovering a finger over the touchscreen and moving over a grid of displayed buttons, a first haptic effect can be played when the user is moving from over one button to over the next button. The first haptic effect can be a short soft haptic effect in order to simulate the feel of moving over the edge of one button to the next. This first haptic effect will give the user an indication of the button locations without the user activating the buttons. A second haptic effect can be played when the user actually touches the screen and acts to select the button. The second haptic effect can be a strong haptic effect simulating a sharp button click.

[0026] Fig. 3 is a flow diagram of the functionality performed by telephone 10 when generating haptic effects in response to the proximity of a user to touchscreen 13 in accordance with one embodiment. In one embodiment, the functionality of Fig. 3 is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0027] At 202, proximity sensor 14 senses the presence and position of a finger, stylus, or other object above or in some other manner near touchscreen 13. The sensed position may include the x and y coordinates of the finger relative to touchscreen 13.

[0028] At 204, the functionality on the touchscreen is determined based on position of the finger. For example, if a multiple button graphical user interface on touchscreen 13 is displayed, the closest button that the finger is above and the functionality of that button is determined.

[0029] At 206, processor 12 initiates a haptic effect based the functionality and location of finger. Depending on the functionality on the touchscreen, a different haptic effect may be generated by processor 12. Because the finger does not actually touch touchscreen 13 in this embodiment, the haptic effect is felt by the other hand that is holding telephone 10.

[0030] In one embodiment, haptic effects can be applied to various menu navigation steps. For a user holding a hand held haptic enabled device, the haptics can be directed to the housing such that the user's hand holding the device will experience the haptic effect. For example, when using a touchscreen, if the user hovers over a top level menu choice and a sub-menu exists for that choice, then a light haptic effect simulating a soft button click (first haptic effect) can be played as the graphics display the preview sub-menu items. If there is no sub-menu attached to that particular menu item (or no valid choices exist) then a second haptic effect can be generated, for example a buzz created by series of pulses. If the user then selects the top level menu item, a strong haptic effect simulating a sharp button click (third haptic effect) can be played. If the user decides to move to another top-level menu a fourth haptic effect can be played when entering the new menu. The fourth haptic effect can be the same as the first haptic effect if it is a similar menu item. These haptic effects, resulting while a user finger is still hovering over a surface, i.e., before contract has been made, would be directed to the other hand that is holding the haptic device.

[0031] In one embodiment, different haptic effects can be applied depending on the intended use of the touchscreen area. For example, when a user's finger is hovering over a touch screen integrated into a cell phone or PDA, different haptic effects can be produced in the cell phone when in a map/GPS navigation mode than when managing climate control or when entering hand written notes.

[0032] In one embodiment, during typical operation of a cell phone, the user can have many different proximity relationships to the device. For example the cell phone could be in the user's hand, in the user's pocket, or right next to the user's face. These different operating conditions required different levels of haptic feedback to the user. A proximity sensor could be used to detect these different operating conditions. It is also possible to detect

these user conditions through the use of acceleration and/or orientation measurements. Once the current operating condition of the device is known, for example holding the phone next to an ear, a global haptic volume adjustment could be made for the different operating states. In one example, the user could have a specific vibration pattern set for a reminder event. If the user has the phone attached to a belt clip the vibration pattern could contain strong haptic effects in order to signal the reminder event. If the user is actually using the phone and has the phone pressed up next to the user's face where the user will be more sensitive to the haptic effects, when the reminder event is triggered, it would be useful to have the haptic magnitude reduced for that event.

[0033] In one embodiment, gestures can be recognized such as a virtual jog dial. A jog dial recognizes rotation and when performed above a proximity active surface can be recognized without the surface being touched. A movement in the x, y and/or z direction can also be recognized. As an example, haptic effects can be attached to the use of the virtual jog wheel. A first haptic effect can be played at regular intervals of the jog wheel to give the user an indication and confirmation of progress in moving the wheel. A second haptic effect can be output when the user reaches the end of a list that the jog wheel is controlling. These jog and/or x, y, z motions can be recognized even when performed with proximity sensing, over a mechanical alpha/numeric keypad such as which exists on most cell phones today.

[0034] Several embodiments disclosed are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

Claims

1. A method of generating haptic effects on a device, said method comprising:

   detecting the presence of an object near an input area of the device;
   determining a position of the object relative to the input area;
   determining a functionality on the input area based on the position; and
   generating a haptic effect on the device in response to the presence detection,

   wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

2. The method of claim 1, further comprising:

   determining the approximate time when the object will touch the input area; and
   generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

3. The method of claim 2, wherein said generating comprises energizing an actuator (18) before the object touches the input area.

4. The method of claim 1, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

5. The method of claim 1, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

6. A haptically enabled device comprising:

   an input area;
   a proximity sensor (14) coupled to said input area, wherein said proximity sensor (14) is adapted to detect the presence of an object near the input area; and
   a haptic feedback system coupled to said input area, wherein said haptic feedback system is adapted to determine a position of the object relative to the input area, determine a functionality on the input area based on the position, and generate a haptic effect on the device in response to the presence detection, wherein said generation of the haptic effect comprises a selection of a first type of the haptic effect based on the functionality.

7. The device of claim 6, wherein said haptic feedback system is adapted to determine the approximate time when the object will touch the input area; and generate the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

8. The device of claim 7, wherein said haptic feedback system comprises an actuator (18), and said system energizes said actuator (18) before the object touches the input area.

9. A computer readable medium having instructions stored thereon that, when executed by a processor (12), cause the processor (12) to generate haptic effects on a device, said processor (12):

   detecting the presence of an object near an input area of the device;
   determining a position of the object relative to the input area;
   determining a functionality on the input area

based on the position; and
generating a haptic effect on the device in response to the presence detection, wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

10. The computer readable medium of claim 9, said processor (12) further:

determining the approximate time when the object will touch the input area; and
generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

11. The computer readable medium of claim 10, wherein said generating comprises energizing an actuator (18) before the object touches the input area.

12. The computer readable medium of claim 9, wherein said haptic effect comprises generating a vibration on the input area.

13. A method of generating haptic effects on a device, comprising:

detecting a presence of an object near an input area of the device;
generating a first type of haptic effect on the device in response to the presence detection;
detecting an actual touch of the input area; and
generating a second type of haptic effect on the device based on the actual touch.

14. A method of generating haptic effects on a device, comprising:

detecting a hovering of an object over a first button of an input area of the device to a second button of the input area of the device; and
generating a first type of haptic effect on the device in response to the detected hovering,

wherein the first type of haptic effect provides an indication of the first and second buttons without a user activating the first and second buttons.

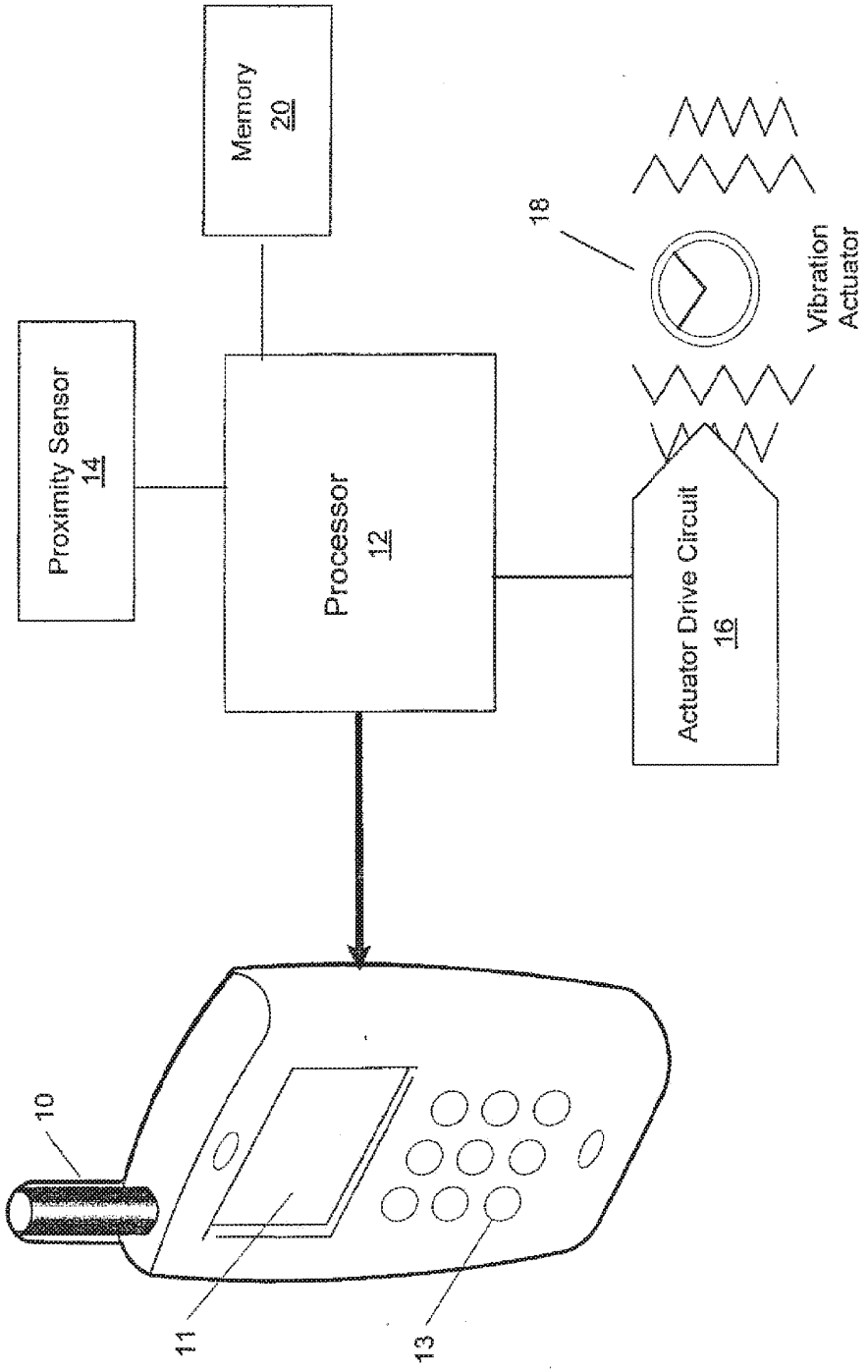

Memory
20
18
Vibration
Actuator
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
10
11
13

Fig. 1

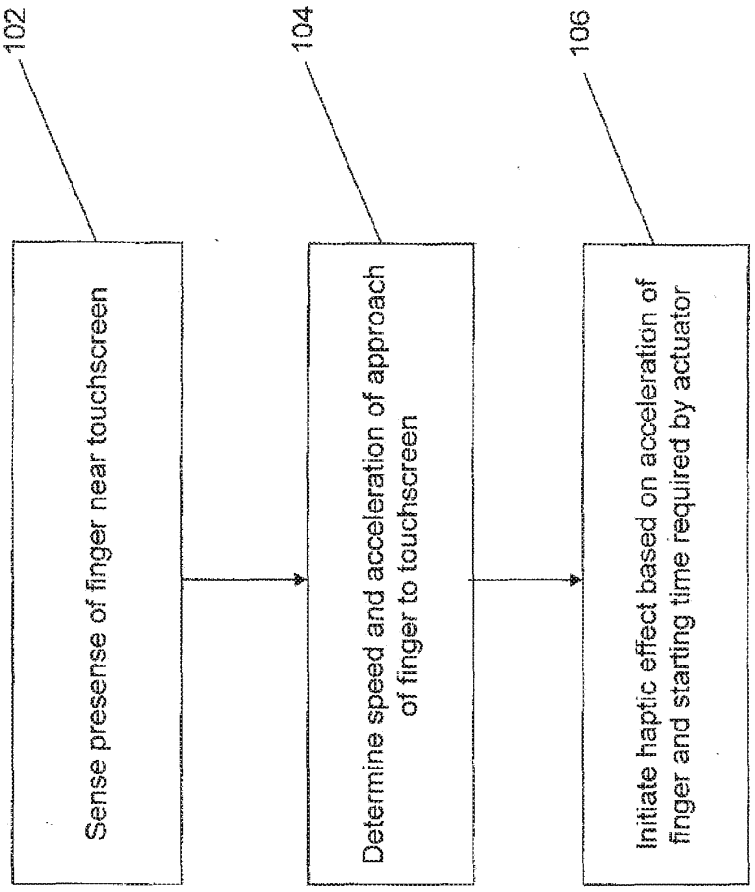

102
Sense presense of finger near touchscreen
104
Determine speed and acceleration of approach of finger to touchscreen
106
Initiate haptic effect based on acceleration of finger and starting time required by actuator

Fig. 2

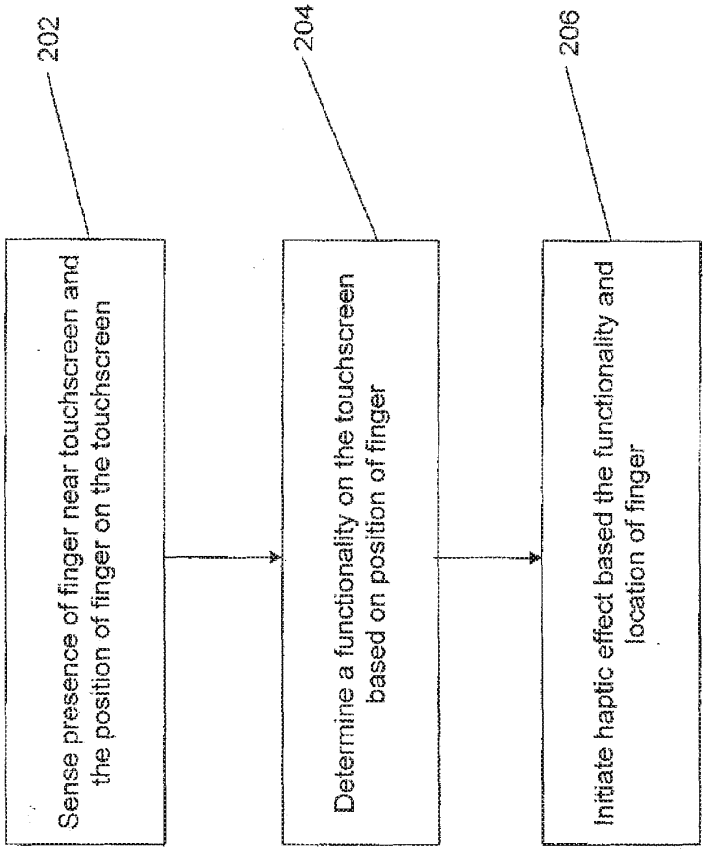

202
Sense presence of finger near touchscreen and the position of finger on the touchscreen
204
Determine a functionality on the touchscreen based on position of finger
206
Initiate haptic effect based the functionality and location of finger

Fig. 3

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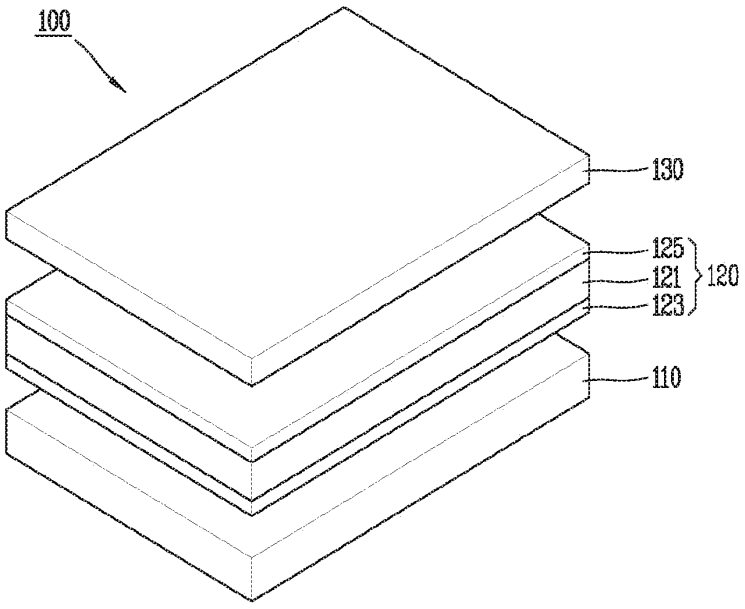
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(54) **Monolithic haptic type touch screen, manufacturing method thereof, and display device including the same**

(57) A monolithic haptic-type touch screen (120) capable of performing both touch recognition and haptic feedback are provided. The monolithic haptic-type touch screen includes an insulating film (121) formed by doping ferroelectric material in an electroactive polymer (EAP), an upper electrode (125) formed on an upper surface of the insulating film, and a lower electrode (123) formed on a lower surface of the insulating film and corresponding to the upper electrode.

FIG. 2



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Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to a touch screen and, more particularly, to a monolithic haptic-type touch screen integrating a touch function and a haptic function, a manufacturing method thereof, and a display device including the same.

2. Background

[0002] A touch screen is an input device for recognizing a particular position when a user's hand or an object touches the particular position, and executing a particular function, without using an input device such as a keyboard or a mouse.

[0003] Touch screens are used in various display devices, for example, electronic products having various screen sizes, such as an automated teller (ATM) machine of a bank, a personal digital assistant (PDA), a portable multimedia player (PMP), a touch pad of a notebook computer, a navigation device, and the like, as well as a cellular phone.

[0004] Recently, beyond providing mere touch and direct manipulation functionality, haptic functionality has been added to the touch screen to provide touch sensation to users. Haptic technology is technology that allows users to feel the sense of touch, a force, a motion, and the like.

[0005] A haptic function is implemented together with a touch screen in a display device, and when a user touches a touch screen as an input device, the haptic function may provide a tactile feedback to the user through vibrations, or the like.

[0006] FIG. 1 is a view illustrating a structure of a related art display device including a touch screen and a haptic device.

[0007] Referring to FIG. 1, a related art display device 1 includes a cover glass 3, a touch screen 4, a display panel 2, and a haptic feedback unit 5.

[0008] The display panel 2 is a part where an image is substantially displayed, and an organic light emitting panel, a plasma panel, and the like, is used as the display panel 2.

[0009] The touch screen is positioned above the display panel 2 and senses a touch input applied by a user through the cover glass 3.

[0010] The touch screen 4 includes an insulating film 4b, and an upper electrode 4a and a lower electrode 4c respectively formed above and below the insulating film 4b.

[0011] When the user applies a touch input through the cover glass 3, the touch screen 4 recognizes the touch input by capacitance generated between the upper electrode 4a and the lower electrode 4c, and performs a corresponding operation.

[0012] The cover glass 3 is positioned above the touch screen 4 to protect the touch screen 4 and the display panel 2. The cover glass 3 is formed as tempered glass having a predetermined thickness.

[0013] The haptic feedback unit 5 is positioned below the display panel 2 and provides a haptic feedback such as vibrations or the like, to the user.

[0014] The haptic feedback unit 5 operates together with the touch screen 4, and thus, when the user touches the touch screen 4, the haptic feedback unit 5 provides a haptic feedback to the user. The haptic feedback unit 5 is configured as a vibration motor or formed of piezoelectric ceramic.

[0015] Here, since the related art display device 1 having the foregoing configuration is configured to include the touch screen 4 and the haptic feedback unit 5, an overall thickness of the display device 1 increases.

[0016] Also, since the haptic feedback unit 5 is positioned in the lowermost portion, namely, below the display panel 2, haptics such as vibrations generated by the haptic feedback unit 5 may not properly be delivered to the user.

[0017] For example, in a case in which the haptic feedback unit 5 is configured as a vibration motor, it may be difficult to promptly provide a haptic feedback to the user due to a low response speed of the vibration motor, and in order to deliver uniform vibrations to the front surface of the display device, a large number of vibration motors should be used, which results in an increase in the thickness and size of the display device 1.

[0018] Also, in a case in which the haptic feedback unit 5 is formed of piezoelectric ceramic, a response speed may be enhanced, compared with the vibration motor, but manufacturing cost of the display device 1 increases due to high-priced piezoelectric ceramic. In addition, due to opaque characteristics of piezoelectric ceramic, the haptic feedback unit 5 needs to be disposed in the lowermost portion of the display panel 2, like the vibration motor, and thus, it is challenging to accurately deliver a haptic feedback to the user.

SUMMARY

[0019] Therefore, an aspect of the detailed description is to provide a monolithic haptic-type touch screen capable of performing both a touch recognition and providing a haptic feedback, a manufacturing method thereof, and a display device including the monolithic haptic-type touch screen.

[0020] To achieve these and other advantages and in accordance with the purpose of this specification, as embodied and broadly described herein, a monolithic haptic-type touch screen may include: an insulating film including doped ferroelectric material in an electroactive polymer (EAP); an upper electrode formed on an upper surface of the insulating film; and a lower electrode formed on a lower surface of the insulating film and correspond-

ing to the upper electrode. The upper electrode and the lower electrode operate as electrodes for both touch recognition and haptic feedback.

[0021] To achieve these and other advantages and in accordance with the purpose of this specification, as embodied and broadly described herein, a method for manufacturing a monolithic haptic-type touch screen may include: immersing a ferroelectric material in a liquid polymer to form an insulating film; forming an upper electrode on an upper surface of the insulating film; and forming a lower electrode, which corresponds to the upper electrode, on a lower surface of the insulating film.

[0022] According to one or more embodiments, a display device comprises a display panel configured to display an image and a haptic touch-sensitive structure. The haptic touch-sensitive structure comprises a first electrode disposed proximal to a user-facing side of the display device, a second electrode disposed distal to the user-facing side of the device, and an insulating film formed between the first electrode and the second electrode. In some embodiments, the haptic touch-sensitive structure is configured to generate a touch signal responsive to a touch input from a user detected by the first electrode and the second electrode and the haptic touch-sensitive structure is further configured to generate a haptic output responsive to a vibration signal applied to the first electrode and the second electrode. In some embodiments, the haptic touch-sensitive structure is configured to generate the haptic output at a location of the touch input, responsive to the vibration signal including the location of the touch input applied to the first electrode and the second electrode.

[0023] According to embodiments of the present disclosure, the monolithic haptic-type touch screen, the manufacturing method thereof, and the display device including the same, since the monolithic haptic-type touch screen capable of performing both touch recognition and haptic feedback is manufactured by using an electroactive polymer (EAP), an overall thickness of a display device configured to execute a touch and haptic function by including the monolithic haptic-type touch screen can be reduced, and thus, manufacturing cost can be reduced.

[0024] Also, since the monolithic haptic-type touch screen is positioned above a display panel, an accurate and prompt haptic feedback may be provided to a user.

[0025] In addition, since a haptic feedback is selectively provided limitedly for a user's touch point, rather than the entire region of the touch screen, various haptic outputs can be provided to a user.

[0026] Further scope of applicability of the present application will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments, are given by way of illustration only, since various changes and modifications within the spirit and scope will become apparent to those skilled in the art from the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The accompanying drawings, which are included to provide a further understanding and are incorporated in and constitute a part of this specification, illustrate exemplary embodiments and together with the description serve to explain the principles.

[0028] In the drawings:

FIG. 1 is view illustrating a structure of the related art display device including a touch screen and a haptic device.

FIG. 2 is a view illustrating a structure of a display device including a monolithic haptic-type touch screen according to an embodiment of the present disclosure.

FIG. 3 is a flow chart illustrating a process of a method for manufacturing a monolithic haptic-type touch screen.

FIG. 4 is a view illustrating an electric structure of the monolithic haptic-type touch screen according to an embodiment of the present disclosure.

FIG. 5 is a view illustrating an electric structure of the monolithic haptic-type touch screen according to another embodiment of the present disclosure.

FIG. 6 is a view illustrating a driving unit of the display device including the monolithic haptic-type touch screen illustrated in FIG. 2.

FIG. 7 is a view illustrating a display device including a monolithic haptic-type touch screen.

DETAILED DESCRIPTION

[0029] Description will now be given in detail of the exemplary embodiments, with reference to the accompanying drawings. For the sake of brief description with reference to the drawings, the same or equivalent components will be provided with the same reference numbers, and description thereof will not be repeated.

[0030] Hereinafter, a monolithic haptic-type touch screen, a manufacturing method thereof, and a display device including the same according to embodiments of the present disclosure will be described with reference to the accompanying drawings.

[0031] FIG. 2 is a view illustrating a structure of a display device including a monolithic haptic-type touch screen according to an embodiment of the present disclosure.

[0032] Referring to FIG. 2, a display device 100 according to the present embodiment may include a pro-

tective cover 130, a monolithic haptic-type touch screen 120, and a display panel 110.

[0033] The display panel 110 is a part where an image is substantially displayed, and a liquid crystal panel, an organic light emitting panel, a plasma panel, and the like, may be used as the display panel 110, but the present disclosure is not limited thereto. An image displayed on the display panel 110 may be provided to a user through the monolithic haptic-type touch screen 120 and the protective cover 130.

[0034] The monolithic haptic-type touch screen 120 may be disposed on the display panel 110. The monolithic haptic-type touch screen 120 may include a transparent insulating film and transparent electrodes, namely, an upper electrode 125 and a lower electrode 123, respectively disposed on upper and lower surfaces of the insulating film 121.

[0035] The insulating film 121 may be formed by using an electroactive polymer (EAP) material.

[0036] The EAP material may have a structure in which an electrode, a polymer, and an electrode are vertically arranged in this order, and may generate vibrations according to a signal, for example, a voltage, applied from the outside.

[0037] For example, the insulating film 121 formed of an EAP material may continuously contract and expand according to a voltage applied thereto to stably generate vibrations, and since the insulating film 121 has a high response speed, it may generate vibrations having various frequency bands.

[0038] As the EAP, dielectric elastomer such as silicone, acryl, urethane, and the like, may be used. The dielectric elastomer may have high transparency and elasticity.

[0039] However, the foregoing dielectric elastomer requires a relatively high voltage and is excessively deformed due to a low Young's modulus thereof, having low durability. Thus, the insulating film 121 according to the present embodiment may be formed by doping a material having a high Young's modulus and ferroelectricity characteristics in an EAP.

[0040] Since the insulating film 121 is formed by doping a material having a high Young's modulus and ferroelectricity in an EAP, the insulating film 121 requires a low driving voltage and has enhanced durability, compared with the related art insulating film formed using an EAP, or the like.

[0041] Here, the insulating film 121 may be formed to have a thickness ranging from about 50 μm to 200 μm, and a voltage applied to the insulating film 121 may be in inverse proportion to a thickness of the insulating film 121.

[0042] Also, the insulating film 121 may have high transmittance equal to or greater than 85%, Young's modulus ranging from about 300 to 700, and strain of 5% or less.

[0043] The upper electrodes 125 and the lower electrode 123 may be positioned on upper and lower surfaces of the insulating film 121.

[0044] The upper electrode 125 and the lower electrode 123 may operate as an electrode of a touch sensor sensing a touch input applied by the user and an electrode of a haptic actuator providing a haptic feedback to the user.

[0045] For example, when the user performs a touch operation on an upper surface of the protective cover 130, capacitance in the upper electrode 125 and the lower electrode 123 with the insulating film 121 interposed therebetween is changed in the portion touched by the user. The display device 100 senses the change in capacitance to recognize the user's touch.

[0046] Also, in order to provide a haptic feedback, for example, vibrations, to the user, a predetermined voltage may be applied to the upper electrode 125 and the lower electrode 123. Accordingly, the insulating film 121 may generate vibrations by the voltage applied to the upper electrode 125 and the lower electrode 123, and the generated vibrations may be provided to the user through the protective cover 130.

[0047] In consideration of the fact that the monolithic haptic-type touch screen 120 is disposed on the display panel 110, the upper electrode 125 and the lower electrode 123 may be formed of a transparent material, for example, indium tin oxide (ITO) or indium zinc oxide (IZO).

[0048] However, in consideration of the fact that the upper electrode 125 and the lower electrode 123 operate as electrodes for a haptic feedback, the upper electrode 125 and the lower electrode 123 may be formed of a transparent electrode material resistant to vibrations, such as carbon nanotube (CNT), an organic conductive polymer (PEDOT/PSS), graphene, a silver nanowire, or metal mesh.

[0049] The protective cover 130 may be disposed on the monolithic haptic-type touch screen 120. The protective cover 130 may protect the touch screen 120 and the display panel 110.

[0050] Also, the protective cover 130 may operate as a medium delivering vibrations generated in the monolithic haptic-type touch screen 120 to the user.

[0051] In other words, the protective cover 130 may amplify vibrations generated in the monolithic haptic-type touch screen 120 toward the user.

[0052] Meanwhile, the protective cover 130 may be formed of tempered glass, or the like. However, in consideration of the fact that the monolithic haptic-type touch screen 120 provides localized vibrations to the user, the protective cover 130 may be formed of transparent plastic such as polymethacrylate, polycarbonate, and the like.

[0053] Meanwhile, although not shown, an insulating sheet (not shown) formed of an insulating material may be disposed between the monolithic haptic-type touch screen 120 and the display panel 110.

[0054] The insulating sheet may prevent malfunction of the display panel 110 due to a high voltage generated when the monolithic haptic-type touch screen 120 per-

forms a touch and haptic operation. Also, according to circumstances, a conductive sheet, instead of an insulating sheet, may be disposed, and in this case, the conductive sheet may be connected to a ground GND.

[0055] Hereinafter, a method for manufacturing the monolithic haptic-type touch screen according to an embodiment of the present disclosure will be described in detail.

[0056] FIG. 3 is a flow chart illustrating a process of a method for manufacturing the monolithic haptic-type touch screen illustrated in FIG. 2.

[0057] Referring to FIGS. 2 and 3, the method for manufacturing a monolithic haptic-type touch screen according to the present embodiment may include an insulating film manufacturing step (S10), an upper electrode forming step (S20), and a lower electrode forming step (S30).

[0058] Also, the insulating film manufacturing step (S10) may include sub-steps of immersing (S11), dispersing (S13), and drying (S15).

[0059] First, a ferroelectric material may be immersed in a liquid EAP, namely, a liquid polymer matrix (S11).

[0060] The ferroelectric material may be a material having high permittivity, and a ceramic compound may be used as the ferroelectric material. For example, the ferroelectric material may be a ceramic compound having a perovskite structure such as barium titanate ($BaTiO_3$), lead titanate ($PbTiO_3$), lead zirconate ($PbZrO_3$), or niobium potassium oxide ($KNbO_3$) having high permittivity characteristics.

[0061] The ferroelectric material may be immersed in an amount of about 1.0 wt% to 4.5 wt% in a liquid polymer. If the ferroelectric material is immersed by less than 1.0 wt%, it may be difficult to obtain an effect of requiring a low driving voltage due to high permittivity, and if the ferroelectric material is immersed in excess of 4.0 wt%, transmissivity may be reduced.

[0062] Also, the ferroelectric material may be immersed in the form of powder in a liquid polymer. In this case, particles of the ferroelectric material may have a size ranging from 50 to 150 nm. If a size of the particle of ferroelectric powder is less than 50 nm, considerable particle aggregation occurs, and thus, ferroelectric powder is not properly mixed with the liquid polymer, and if a size of the particle of ferroelectric powder exceeds 150 nm, transmissivity is reduced due to opaqueness of particle.

[0063] Subsequently, the immersed ferroelectric material may be dispersed in a liquid polymer (S13). For example, the after the ferroelectric material is immersed, the ferroelectric material may be dispersed in the polymer matrix by using a high-speed rotary machine or an extractor.

[0064] Subsequently, liquid polymer in which the ferroelectric material is dispersed may be left at room temperature for a predetermined time and dried to form the insulating film 121 (S15).

[0065] Here, the liquid polymer may be left for about two to four hours at room temperature. Also, the liquid polymer may be dried for more than four hours at a temperature ranging from 100°C to 200°C to form the insulating film 121.

[0066] After the insulating film 121 is formed, the upper electrode 125 may be formed on an upper surface of the insulating film 121 (S20). Also, the lower electrode 123 is formed on a lower surface of the insulating film 121, thus manufacturing the monolithic haptic-type touch screen 120 (S30).

[0067] Meanwhile, the upper electrode 125 and the lower electrode 123 may be formed in various shapes on the upper and lower surfaces of the insulating film 121, respectively.

[0068] For example, the upper electrode 125 and the lower electrode 123 may be formed in a flat shape, a bar shape, or a checkerboard shape including a plurality of sub-electrodes on the upper and lower surfaces of the insulating film 121, respectively.

[0069] FIG. 4 is a view illustrating an electric structure of the monolithic haptic-type touch screen according to an embodiment of the present disclosure, and FIG. 5 is a view illustrating an electric structure of the monolithic haptic-type touch screen according to another embodiment of the present disclosure.

[0070] Referring to FIG. 4, a plurality of upper electrode 125 may be arranged in one direction on the upper surface of the insulating film 121, having a bar shape.

[0071] Also, a plurality of lower electrodes 123 may be arranged in the other direction on the lower surface of the insulating film 121 such that the lower electrodes 123 correspond to the upper electrodes 125. Here, the upper electrodes 125 and the lower electrodes 123 may cross each other in the arrangement directions.

[0072] As capacitance is changed in an intersection of the upper electrode 125 and the lower electrode 123 according to a user's touch, the user's touch input may be recognized.

[0073] The upper electrode 125 and the lower electrode 123 may be provided with a predetermined voltage from the outside such that the insulating film 121 vibrates at the recognition point.

[0074] The upper electrode 125 and the lower electrode 123 may be formed by depositing an electrode material on the upper and lower surfaces and patterning the same, respectively.

[0075] Meanwhile, in order to more precisely recognize a touch and provide a haptic feedback, the upper electrode 125 and the lower electrode 123 may have a checkerboard structure including a plurality of sub-electrodes.

[0076] Referring to FIG. 5, the upper electrode 125 may have a checkerboard shape including a plurality of sub-electrodes on the upper surface of the insulating film 121. Here, the plurality of sub-electrodes of the upper electrode 125 may be individually connected to an external circuit, for example, a touch and haptic control circuit.

[0077] The lower electrode 123 may be formed to have a flat shape on the lower surface of the insulating film 121. However, the present disclosure is not limited there-

to and the lower electrode 123 may also have a checkerboard shape identical to that of the upper electrode 125.

[0078] The upper electrode 125 and the lower electrode 123 as described above may cause capacitance to be changed in an intersection thereof by a user's touch, whereby the user's touch input can be recognized.

[0079] The upper electrode 125 and the lower electrode 123 may be provided with a predetermined voltage such that the insulating film 121 vibrates at the recognition point.

[0080] In this case, since the upper electrode 125 includes a plurality of sub-electrodes, the user's touch input may be more accurately recognized and a corresponding haptic feedback may be provided, relative to the upper electrode 125 described above with reference to FIG. 4.

[0081] The upper electrode 125 and the lower electrode 123 may be formed by depositing an electrode material on upper and lower surfaces of the insulating film 121 and pattering the same, respectively.

[0082] FIG. 6 is a view illustrating a driving unit of the display device including the monolithic haptic-type touch screen illustrated in FIG. 2.

[0083] Referring to FIGS. 2 and 6, a driving unit 200 of the display device 100 may include a touch control unit 210, a haptic control unit 220, and a main control unit 230.

[0084] Here, the touch control unit 210 may include a touch input unit 211 and a touch controller 213. Also, the haptic control unit 220 may include a haptic controller 221, an amplifier 223, and a haptic operating unit 225.

[0085] The touch control unit 210 may sense a touch input of the user and control the display panel 110 of the display device 100 to perform a corresponding operation.

[0086] In some embodiments, the touch input unit 211 may sense a user's touch input, and the touch controller 213 may generate touch coordinates of the user and a corresponding command according to the sensing result.

[0087] For example, the user may touch a predetermined icon on a screen visible through the protective cover 130 of the display device 100, namely, on a screen displayed on the display panel 110.

[0088] The touch input unit 211 may sense the user's touch input through a change in capacitance of the monolithic haptic-type touch screen 120. The touch input unit 211 may output the sensing result to the touch controller 213.

[0089] The touch controller 213 may generate touch coordinates of the user, namely, a position of the icon on the screen of the display panel 110 and a command signal to be performed by the icon according to the sensing results output from the touch input unit 211. The touch controller 213 may output the touch coordinates and the command, as a touch signal, to the main control unit 230.

[0090] According to the touch signal output from the touch controller 213, the main control unit 230 may process the corresponding command and control the display unit 110 to display the processing result to allow the user to recognize it.

[0091] At the same time, in order to provide a haptic feedback, the main control unit 230 may generate a predetermined haptic signal and output the generated haptic signal to the haptic control unit 220. The haptic signal may include the touch coordinates of the user included in the touch signal which has been provided from the touch control unit 210.

[0092] The haptic control unit 220 may generate a signal, namely, a vibration signal, for providing a haptic feedback for the user. The vibration signal may include the touch coordinates of the user and a predetermined voltage, for example, a voltage for using the monolithic haptic-type touch screen 120 as a haptic actuator.

[0093] The voltage signal of the vibration signal output from the haptic control unit 220 may be amplified by the amplifier 223. This is because, a high voltage, for example, a voltage ranging from 500 to 700V, needs to be applied to the upper electrode 125 and the lower electrode 123 of the monolithic haptic-type touch screen 120 for the haptic feedback operation.

[0094] Subsequently, the voltage signal amplified by the amplifier 223 according to the touch coordinates of the vibration signal may be output to the upper electrode 125 and the lower electrode 123 of the monolithic haptic-type touch screen 120.

[0095] Accordingly, vibrations are generated in a portion of the insulating film 121 of the monolithic haptic-type touch screen 120 corresponding to the upper electrode 125 and the lower electrode 123 to which the voltage signal has been applied, and the vibrations may be provided as a haptic feedback for the user through the protective cover 130.

[0096] Here, the haptic feedback operation of the monolithic haptic-type touch screen 120 may be performed immediately when the touch sensing operation is finished, namely, almost simultaneously with the touch sensing operation.

[0097] The monolithic haptic-type touch screen 120 may vibrate with strength ranging from about 0.5 to 1.0G, and a frequency when the monolithic haptic-type touch screen 120 vibrations may range from about 10 to 400 Hz.

[0098] Meanwhile, when the upper electrode 125 of the monolithic haptic-type touch screen 120 has a checkerboard structure including a plurality of sub-electrodes as illustrated in FIG. 5, a touch input may be more precisely sensed and a more accurate haptic feedback may be provided.

[0099] For example, when the upper electrode 125 includes a plurality of individually operating sub-electrodes, the touch control unit 210 may more precisely sense touch coordinates of the user by the plurality of sub-electrodes. The haptic control unit 220 may allow the insulating film to vibrate at the touch coordinates sensed by the touch control unit 210, providing selective vibrations for the user.

[0100] FIG. 7 is a view illustrating a display device including a monolithic haptic-type touch screen.

[0101] As illustrated in FIG. 7, since the display device according to the present disclosure includes a monolithic

haptic-type touch screen, the display device has a small thickness. Also, since the display device according to the present disclosure does not use a haptic device such as a vibration motor, or the like, the display device according to the present disclosure is light in weight and has high transparency.

[0102] Thus, the display device including a monolithic haptic-type touch screen according to the present disclosure may be used as a display of a portable device such as a smartphone, a PDA, a navigation device, a tablet, or the like.

[0103] As described above, the monolithic haptic-type touch screen may operate as a touch sensor when the user applies a touch input, and may be used as a haptic actuator when it provides a haptic feedback, namely, vibrations, for the user.

[0104] Also, since the monolithic haptic-type touch screen has high transparency, it may be disposed above the display panel, thus providing a prompt and accurate haptic feedback for the user.

[0105] In addition, the monolithic haptic-type touch screen may provide vibrations for the user through the entire region thereof or may selectively provide vibrations only in a user's touch portion.

[0106] The foregoing embodiments and advantages are merely exemplary and are not to be considered as limiting the present disclosure. The present teachings can be readily applied to other types of apparatuses. This description is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. The features, structures, methods, and other characteristics of the exemplary embodiments described herein may be combined in various ways to obtain additional and/or alternative exemplary embodiments.

[0107] As the present features may be embodied in several forms without departing from the characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be considered broadly within its scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the appended claims.

Claims

1. A monolithic haptic-type touch screen comprising:

   an insulating film including doped ferroelectric material in an electroactive polymer (EAP);
   an upper electrode disposed on an upper surface of the insulating film; and
   a lower electrode disposed on a lower surface of the insulating film and corresponding to the upper electrode,
   wherein the upper electrode and the lower electrode operate as electrodes for both touch recognition and haptic feedback.

2. The monolithic haptic-type touch screen of claim 1, wherein the EAP is one selected from a group consisting of dielectric elastomers of silicon, acryl, and urethane.

3. The monolithic haptic-type touch screen of claim 1, wherein the ferroelectric material is one selected from a ceramic compound group consisting of barium titanate, lead titanate, lead zirconate, and niobium potassium oxide.

4. The monolithic haptic-type touch screen of claim 1, wherein the upper electrode and the lower electrode include one selected from a group consisting of carbon nanotube (CNT), an organic conductive polymer, graphene, silver nanowire, and metal mesh.

5. A display device comprising:

   a display panel configured to display an image;
   a monolithic haptic-type touch screen disposed on the display panel and configured to recognize a user's touch and provide a haptic feedback to the user, and include an insulating film composed of doped ferroelectric material in an electroactive polymer (EAP), an upper electrode disposed on an upper surface of the insulating film, and a lower electrode disposed on a lower surface of the insulating film and corresponding to the upper electrode, the upper electrode and the lower electrode operating as electrodes for both touch recognition and haptic feedback; and
   a protective cover disposed on the monolithic haptic-type touch screen.

6. The display device of claim 5, wherein the protective cover includes transparent plastic of polymethacrylate or polycarbonate.

7. The display device of claim 5, further comprising:

   an insulating sheet disposed between the monolithic haptic-type touch screen and the display panel.

8. A display device comprising:

   a display panel configured to display an image; and
   a haptic touch-sensitive structure including:

      a first electrode disposed proximal to a user-facing side of the display device;

a second electrode disposed distal to the user-facing side of the device; and
an insulating film formed between the first electrode and the second electrode,
wherein the haptic touch-sensitive structure is configured to generate a touch signal responsive to a touch input from a user detected by the first electrode and the second electrode, and
wherein the haptic touch-sensitive structure is further configured to generate a haptic output responsive to a vibration signal applied to the first electrode and the second electrode.

9. The display device of claim 8, wherein the haptic touch-sensitive structure is configured to generate the haptic output at a location of the touch input, responsive to the vibration signal including the location of the touch input applied to the first electrode and the second electrode.

10. The display device of claim 8, wherein the insulating film includes doped ferroelectric material in an electroactive polymer (EAP), and the vibration signal is a voltage signal applied to both the first electrode and the second electrode to generate the haptic output.

11. The display device of claim 10, wherein the insulating film is substantially transparent to visible light and configured to expand or contract responsive to the vibration signal applied to the first electrode and the second electrode.

12. The display device of claim 10, wherein the EAP is one selected from a group consisting of dielectric elastomers of silicon, acryl, and urethane.

13. The display device of claim 10, wherein the ferroelectric material is one selected from a ceramic compound group consisting of barium titanate, lead titanate, lead zirconate, and niobium potassium oxide.

14. The display device of claim 1 or claim 10, wherein a thickness of the insulating film ranges from 50 μm to 200 μm.

15. The display device of claim 10, wherein the first electrode and the second electrode include one selected from a group consisting of carbon nanotube (CNT), an organic conductive polymer, graphene, silver nanowire, and metal mesh.

FIG. 1

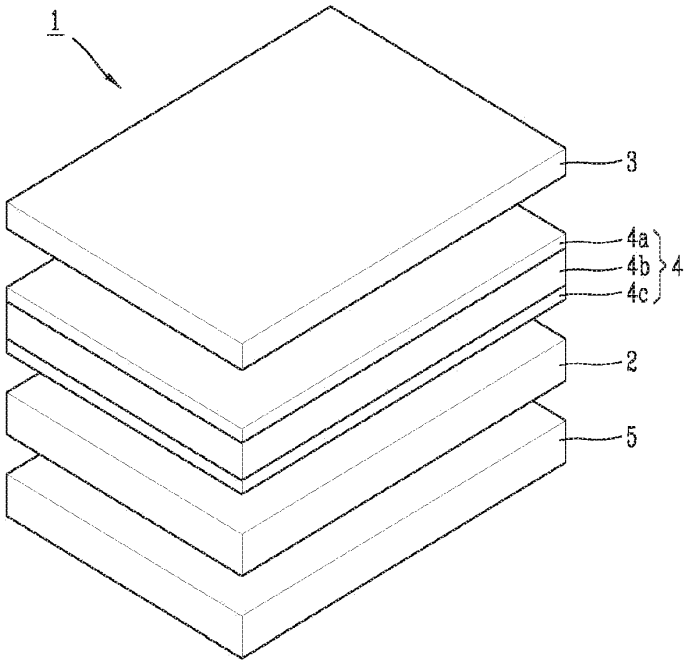


FIG. 2

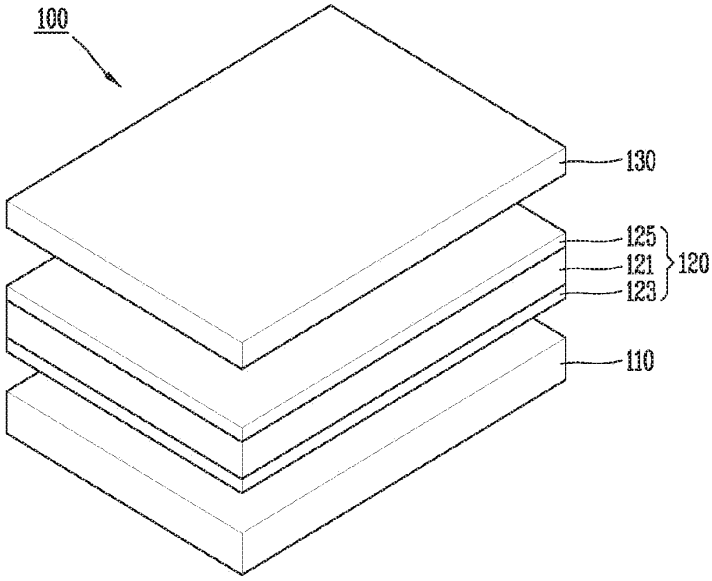


FIG. 3

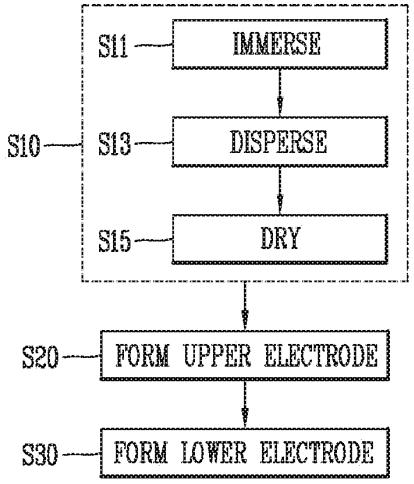

S11
IMMERSE
S10
S13
DISPERSE
S15
DRY
S20
FORM UPPER ELECTRODE
S30
FORM LOWER ELECTRODE

FIG. 4

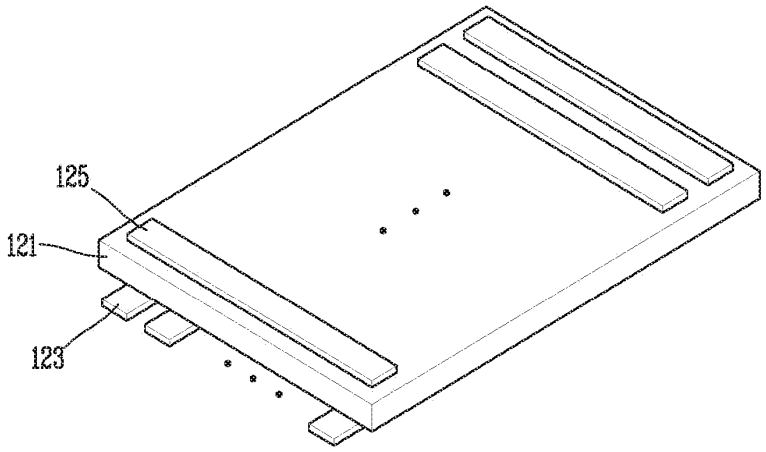

125
121
123

FIG. 5

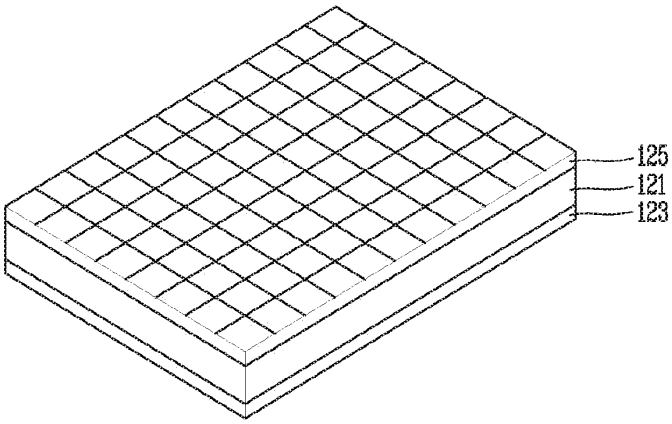

125
121
123

FIG. 6

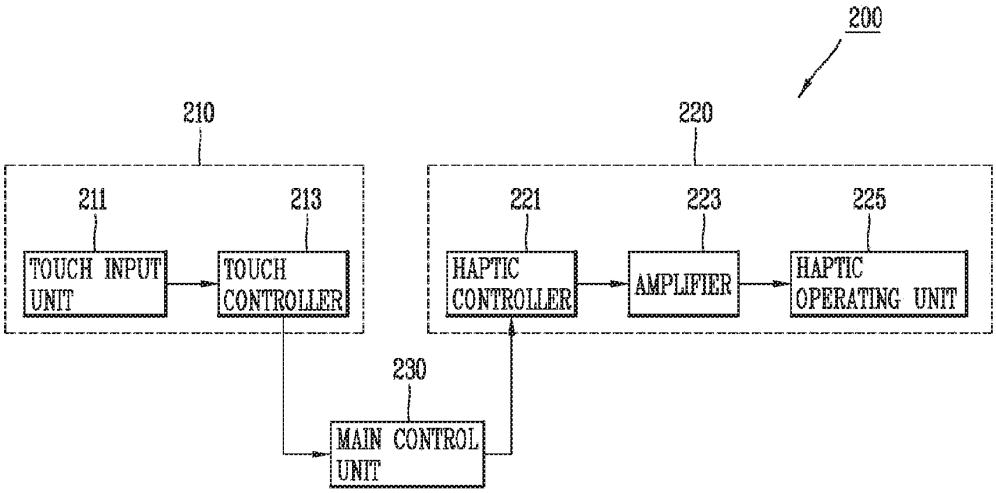
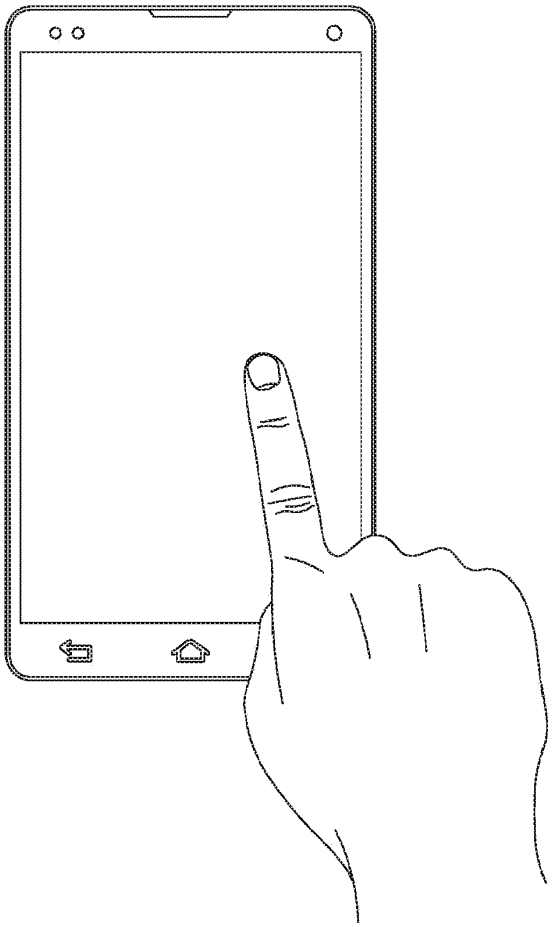

200
210
220
211
213
221
223
225
TOUCH INPUT UNIT
TOUCH CONTROLLER
HAPTIC CONTROLLER
AMPLIFIER
HAPTIC OPERATING UNIT
230
MAIN CONTROL UNIT

FIG. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 7453

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	US 2012/229400 A1 (BIRNBAUM DAVID [US] ET AL) 13 September 2012 (2012-09-13) * abstract * * paragraph [0043] - paragraph [0053]; figure 7 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 May 2015	Bravo, Piero

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 19 7453

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15-05-2015

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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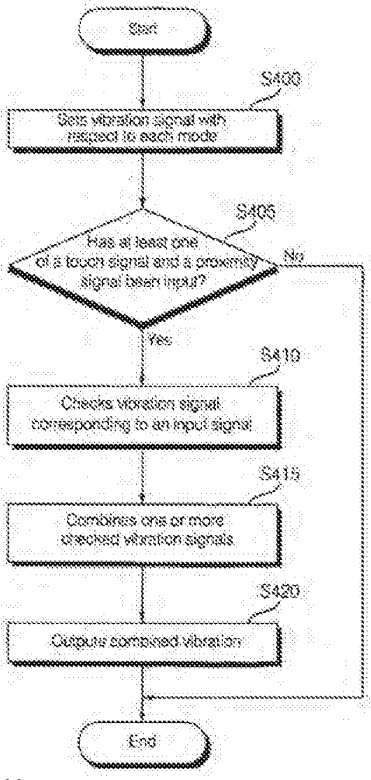
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(54) Distinguishing input signals detected by a mobile terminal

(57) A method of distinguishing input signals detected by a mobile terminal is provided. The method comprises detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and outputting a combined vibration signal corresponding to at least the first and second input signals. The first and second input signals may be proximity signals, touch signals, or a combination thereof. The combined vibration signal may be outputted according to a characteristic of at least the first and second input signals.

FIG. 6



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Description

CROSS-REFERENCE TO RELATED APPLICATION

TECHNICAL FIELD

[0001] The present invention relates generally to mobile terminals, and, more particularly, to distinguishing input signals detected by a mobile terminal.

BACKGROUND

[0002] A mobile terminal is a portable device capable of performing voice and video communication, inputting and outputting information, storing data, or other functions. In order to enable complex multimedia functions, a mobile terminal may be modified using hardware or software to output vibration signals, in addition to audio and video signals.

[0003] Usually, a mobile terminal outputs a vibration signal in response to receiving touch signal or a proximity signal. Unfortunately, there are a limited number of vibration signals, and the same vibration signal may be outputted for different types of touch signals and proximity signals.

[0004] Accordingly, systems and methods are needed to easily distinguish between different types of touch signals and proximity signals that are detected by a mobile terminal.

SUMMARY

[0005] The present disclosure is directed to systems and corresponding methods that facilitate detecting potential deadlocks across different test runs in an execution environment.

[0006] For purposes of summarizing, certain aspects, advantages, and novel features have been described herein. It is to be understood that not all such advantages may be achieved in accordance with any one particular embodiment. Thus, the claimed subject matter may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages without achieving all advantages as may be taught or suggested herein.

[0007] In accordance with one embodiment, a method of distinguishing input signals detected by a mobile terminal is provided. The method comprises detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and outputting a combined vibration signal corresponding to at least the first and second input signals. The first and second input signals may be proximity signals, touch signals, or a combination thereof. The combined vibration signal may be outputted according to type or characteristic of at least the first and second input signals.

[0008] In accordance with another embodiment, a method of distinguishing input signals detected by a mobile terminal is provided. The method comprises detecting a proximity signal and a touch signal inputted to the mobile terminal, wherein a first vibration signal is associated with the proximity signal and a second vibration is associated with the touch signal; determining a first location through which the proximity signal is inputted and a second location through which the touch signal is inputted; and outputting a combined vibration signal corresponding to the proximity signal and the touch signal, in response to determining that the first and second locations are the same.

[0009] In accordance with yet another embodiment, a method of distinguishing proximity signals detected by a proximity sensor of a mobile terminal is provided. The method comprises detecting a first proximity signal at a first proximity distance from the proximity sensor and a second proximity signal at a second proximity distance from the proximity sensor, wherein a first vibration signal is associated with the first proximity signal and a second vibration signal is associated with the second proximity signal; and outputting a combined vibration signal corresponding to the first and second proximity signals.

[0010] In accordance with yet another embodiment, method of distinguishing touch signals detected by a touch screen of a mobile terminal is provided. The method comprises detecting a first touch signal inputted at a first area of the touch screen and a second touch signal inputted at a second area of the touch screen, wherein a first vibration signal is associated with the first touch signal and a second vibration signal is associated with the second touch signal; and outputting a combined vibration signal corresponding to the first and second touch signals.

[0011] In accordance with yet another embodiment, a system comprising one or more logic units is provided. The one or more logic units are configured to perform the functions and operations associated with the above-disclosed methods.

[0012] In accordance with yet another embodiment, a computer program product comprising a computer useable medium having a computer readable program is provided. The computer readable program when executed on a computer causes the computer to perform the functions and operations associated with the above-disclosed methods.

[0013] One or more of the above-disclosed embodiments in addition to certain alternatives are provided in further detail below with reference to the attached figures. The invention is not, however, limited to any particular embodiment disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments of the present invention are understood by referring to the figures in the attached drawings, as provided below.

[0015] Fig. 1 is a block diagram of a mobile terminal, in accordance with one embodiment.

[0016] Fig. 2 is a front perspective view of a mobile terminal, in accordance with one embodiment.

[0017] Fig. 3 is a rear perspective view of a mobile terminal, in accordance with one embodiment.

[0018] Fig. 4 illustrates operation of a proximity sensor, in accordance with one embodiment.

[0019] Figs. 5a and 5b illustrate a proximity area and a haptic area, in accordance with one embodiment.

[0020] Fig. 6 is a flowchart illustrating a method of distinguishing input signals detected by the mobile terminal, in accordance with one embodiment.

[0021] Fig. 7 is a flowchart illustrating a method of distinguishing input signals inputted from different display locations, in accordance with one embodiment.

[0022] Fig. 8 is a flowchart illustrating a method of distinguishing input signals inputted from different distances from a proximity sensor, in accordance with one embodiment.

[0023] Fig. 9 is a flowchart illustrating a method of distinguishing input signals inputted from different display areas, in accordance with one embodiment.

[0024] Figs. 10 and 11 are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0025] Figs. 12 and 13 are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0026] Figs. 14 and 15 are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0027] Figs. 16 to 18 are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0028] Figs. 19 to 22 are diagrams to which reference is made to illustrate a method of distinguishing signals received by the mobile terminal, in accordance with one or more embodiments.

[0029] Features, elements, and aspects of the invention that are referenced by the same numerals in different figures represent the same, equivalent, or similar features, elements, or aspects, in accordance with one or more embodiments.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0030] In the following, numerous specific details are set forth to provide a thorough description of various embodiments of the invention. Certain embodiments of the invention may be practiced without these specific details or with some variations in detail. In some instances, certain features are described in less detail so as not to obscure other aspects of the invention. The level of detail associated with each of the elements or features should not be construed to qualify the novelty or importance of one feature over the others.

[0031] As used herein, the terms "module," "unit," and "part" are used for purposes of facilitating disclosure. Therefore, significant meanings or roles should not be imputed to the terms themselves and it should be understood that the terms "module," "unit," and "part" may be used together or interchangeably.

[0032] By way of non-limiting example only, the embodiments are described with reference to the mobile terminal 100 shown in Fig. 1. However, such teachings apply equally to mobile phones, smart phones, notebook computers, terminals for digital broadcasting, personal digital assistants (PDAs), portable multimedia players (PMPs), navigation devices for GPS, and other types of terminals. Also, Fig. 1 shows the mobile terminal 100 having various components, but it should be understood that implementing all of the illustrated components is not a requirement. Greater or fewer components may alternatively be implemented.

[0033] Referring to Fig. 1, a mobile terminal 100 may comprise a wireless communication unit 110, an audio/video (A/V) input unit 120, a user input unit 130, a sensing unit 140, an output unit 150, memory 160, an interface unit 170, a controller 180, and a power supply unit 190. When the constituent elements are implemented in actual applications, two or more of the constituent elements may be combined into one constituent element or one constituent element may be divided into two or more constituent elements, if appropriate.

[0034] The wireless communication unit 110 may comprise a broadcasting receiving module 111, a mobile communication module 113, a wireless internet module 115, a local area communication module 117, a global positioning system (GPS) module 119, or other communication module.

[0035] The broadcasting receiving module 111 receives at least one of broadcasting signals and broadcasting-related information from an external broadcasting management server through broadcasting channels. The broadcasting channels can include a satellite channel, a terrestrial wave channel and the like. The broadcasting management server may refer to a server for creating and transmitting at least one of broadcasting signals and broadcasting-related information or a sever for receiving at least one of previously generated broadcasting signals and previously generated broadcasting-related information and transmitting it to a terminal.

[0036] The broadcasting-related information may refer to information pertinent to a broadcasting channel, a broadcasting program and/or a broadcasting service provider. The broadcasting signal may comprise not only TV broadcasting signals, radio broadcasting signals, and data broadcasting signals, but also broadcasting signals in which TV broadcasting signals or radio broadcasting signals are combined with data broadcasting signals. The broadcasting-related information may be provided over a mobile communication network. In this case, the broadcasting-related information can be received by the mobile communication module 113. The broadcasting-related

information may exist in various forms. For example, the broadcasting-related information may exist in the form of the electronic program guide (EPG) of the digital multimedia broadcasting (DMB), the electronic service guide (ESG) of the digital video broadcast-handheld (DVB-H) or the like.

[0037] The broadcasting receiving module 111 receives broadcasting signals using various broadcasting systems. In particular, the broadcasting receiving module 111 can receive broadcasting signals using a digital broadcasting system, such as the digital multimedia broadcasting-terrestrial (DMB-T), the digital multimedia broadcasting-satellite (DMB-S), the media forward link only (MediaFLO), the digital video broadcast-handheld (DVB-H), and the integrated services digital broadcast-terrestrial (ISDB-T). The broadcasting receiving module 111 may be constructed to be suitable for not only the digital broadcasting systems, but also all broadcasting systems providing broadcasting signals. At least one of broadcasting signals and/or broadcasting-related information, received through the broadcasting receiving module 111, may be stored in the memory 160.

[0038] The mobile communication module 113 transmits and receives radio signals to and from at least one of a base station, an external terminal, and a server over a mobile communication network. Here, the radio signals may comprise voice call signals, video call signals, or various forms of data according to transmission/reception of text/multimedia messages.

[0039] The wireless Internet module 115 refers to a module for wireless Internet access. The wireless Internet module 115 may be built in the mobile terminal 100 or external to the mobile terminal 100. Wireless Internet technologies may employ wireless LAN (WLAN) (Wi-Fi), wireless broadband (Wibro), world interoperability for microwave access (Wimax), high-speed downlink packet access (HSDPA), and so on.

[0040] The local area communication module 117 refers to a module for local area communication. Local area communication technology can employ Bluetooth, radio frequency identification (RFID), infrared data association (IrDA), ultra wideband (UWB), ZigBee or the like. The GPS module 119 receives position information from a plurality of GPS satellites.

[0041] The AN input unit 120 is adapted to input audio signals or video signals and can include a camera 121, a microphone 123, and so on. The camera 121 processes image frames, such as still images or motion images, which are captured by an image sensor in the video call mode or the capturing mode. The processed image frames may be displayed on a display unit 151.

[0042] The image frames processed by the camera 121 may be stored in the memory 160 or transmitted to the outside through the wireless communication unit 110. The camera 121 may be provided in plural numbers according to the configuration of a terminal.

[0043] The microphone 123 receives external sound signals in the call mode, the recording mode, the voice recognition mode, etc. and converts the received sound signals into electrical voice data. In the call mode, the processed voice data may be converted into a format, which can be transmitted to a mobile communication base station through the mobile communication module 113, and then output. The microphone 123 may employ a variety of noise removal algorithms for removing noise occurring in the process of receiving external sound signals.

[0044] The user input unit 130 generates key entry data, which is input by a user in order to control the operation of the terminal. The user input unit 130 may comprise the keypad, the dome switch, the touch pad (static pressure/constant electricity), the jog wheel, the jog switch, the finger mouse or the like. In particular, a mutually layered structure of the touch pad and the display unit 151, which will be described later on, may be referred to as a touch screen.

[0045] The sensing unit 140 senses a current status of the mobile terminal 100, such as a closed state of the mobile terminal 100, the position of the mobile terminal 100, whether a user touches the mobile terminal 100 or not, and so on and generates a sensing signal for controlling the operation of the mobile terminal 100. For example, when the mobile terminal 100 is a slide phone type, the sensing unit 140 can sense whether the slide phone is opened or not. The sensing unit 140 may also have the functions of sensing whether the power supply unit 190 supplies power or not, whether the interface unit 170 is connected to an external device, and so on.

[0046] The sensing unit 140 can include a proximity sensor 141. The proximity sensor 141 may detect an approaching object, whether objects exist nearby, etc. without mechanical contact. The proximity sensor 141 may detect neighboring objects by employing a change of AC magnetic field, a change of static magnetic field, the rate of capacitance or the like. Two or more proximity sensors 141 may be used according to the aspect of a configuration.

[0047] The output unit 150 is constructed to output audio signals, video signals or alarm signals and may comprise the display unit 151, a sound output module 153, an alarm unit 155, a haptic module 157, and so on.

[0048] The display unit 151 displays information processed in the mobile terminal 100. For example, when the mobile terminal is in the call mode, the display unit 151 displays a user interface (UI) or a graphic user interface (GUI), which is pertinent to a call. When the mobile terminal 100 is in the video call mode or the capturing mode, the display unit 151 displays captured or received images individually or simultaneously and also displays a UI or a GUI.

[0049] Meanwhile, in the case in which the display unit 151 and the touch pad form the mutually layered structure and construct a touch screen as described above, the display unit 151 may also be used as an input device as well as the output device. If the display unit 151 comprises a touch screen, the display unit 151 may also comprise

a touch screen panel, a touch screen panel controller, or other touch screen component. In one embodiment, the touch screen panel is a transparent panel attached to the outside and may be connected to an internal bus within the mobile terminal 100. The touch screen panel continues to monitor whether there is a touch input and, when there is a touch input, sends corresponding signals to the touch screen panel controller. The touch screen panel controller processes the corresponding signals received from the touch screen panel and transmits the corresponding data to the controller 180, so that the controller 180 may determined whether there has been a touch input or which area of the touch screen has been touched.

[0050] The display unit 151 may comprise at least one of a liquid crystal display, a thin film transistor-liquid crystal display, an organic light-emitting diode, a flexible display, and a 3D display. Two or more display units 151 may exist according to the implementation type of the mobile terminal 100. For example, the mobile terminal 100 may be equipped with both an external display unit (not shown) and an internal display unit (not shown).

[0051] The sound output module 153 outputs audio data, which is received from the wireless communication unit 110 in the incoming call mode, the call mode, the record mode, the voice recognition mode, the incoming broadcasting mode or the like or stored in the memory 160. The sound output module 153 also outputs sound signals pertinent to the functions performed in the mobile terminal 100, for example, sound of a received call signal and sound of a received message. The sound output module 153 can include a speaker, a buzzer or the like.

[0052] The alarm unit 155 outputs signals to inform the occurrence of events in the mobile terminal 100. For example, the events occurring in the mobile terminal 100 may comprise an incoming call signal, a received message, an entered key signal input and so on. The alarm unit 155 may also output signals to inform the occurrence of events in different ways other than the audio or video signals. For example, the alarm unit 155 can output the signals in vibration form.

[0053] When a call signal is received or a message is received, the alarm unit 155 may generate a signal in order to inform the reception of the call signal or message. Alternatively, when a key signal is input, the alarm unit 155 may generate a signal as a feedback to the input key signal. A user may notice the occurrence of an event through the output of the signal. It should be understood that signals, informing the occurrence of events, from the mobile terminal 100 may also be output through the display unit 151 or the sound output module 153.

[0054] The haptic module 157 generates a variety of haptic effects which may be felt by a user. A representative example of the haptic effects, which are generated by the haptic module 157, is a vibration signal. When the haptic module 157 generates a vibration signal, the intensity, pattern, or other characteristic of the vibration signal generated by the haptic module 157 may be converted, and different pieces of vibration signals may be composed or output or sequentially output.

[0055] The haptic module 157 may generate various haptic effects, such as an effect caused by a stimulus of the arrangement of pins, which move vertically to a contact skin surface, an effect caused by a stimulus through spraying force or suction force by the air through an injection nozzle or an inlet, an effect caused by a stimulus passing over the skin surface, an effect caused by a stimulus through the contact of an electrode, an effect caused by a stimulus employing electrostatic force, and an effect caused by the reappearance of a feeling of cold and warmth employing an element that may absorb or generate heat, as well as a vibration signal.

[0056] The haptic module 157 may be implemented to not only transfer the haptic effects through a direct contact, but also make the haptic effects felt through myasthenia such as a user's finger, arm, etc. In one embodiment, the mobile terminal 100 may comprise a plurality of haptic modules 157. The memory 160 may store programs necessary to process and control the controller 180 and also function to temporarily store input or output data (for example, a phonebook, messages, still images, motion images and the like).

[0057] The memory 160 may comprise at least one type of storage media, including a flash memory type, a hard disk type, a multimedia card micro type, card type memory (for example, SD memory, XD memory, and so on), RAM, and ROM. The mobile terminal 100 may also manage a web storage serving as the storage function of the memory 160 on an Internet.

[0058] The interface unit 170 functions as an interface with all external devices connected to the mobile terminal 100. Examples of the external devices connected to the mobile terminal 100 can include a wired/wireless headset, an external charger, wired/wireless data ports, a memory card, a card socket such as subscriber identification module (SIM) /user identity module (UIM) cards, an audio input/output (I/O) terminal, a video I/O terminal, an earphone, and so on. The interface unit 170 can receive data or can be supplied with power from the external devices, transfer the data or power to respective constituent elements of the mobile terminal 100, and transmit data of the mobile terminal 100 to the external devices.

[0059] The interface unit 170 may become a passage in which power source from external cradles is supplied to the mobile terminal 100 when the mobile terminal 100 is coupled to the cradles or a passage in which a variety of command signals input from cradles by a user are transferred to the mobile terminal 100.

[0060] The controller 180 typically controls the operation of each of the elements and controls an overall operation of the mobile terminal 100. For example, the controller 180 may perform pertinent controls and processes for voice call, data communication, video telephony, and so on. The controller 180 may comprise a multimedia play module 181 for playing multimedia. The multimedia play module 181 may be constructed in hardware within the controller 180 or constructed in software separately

from the controller 180.

[0061] The power supply unit 190 is supplied with external power source or internal power source and supplies power source necessary for the operation of the each constituent element under the control of the controller 180. The mobile terminal 100 may be configured to be operable in a communication system, which transmits data through frames or packets, including a wired/wireless communication system and a satellite-based communication system.

[0062] The mobile terminal pertinent to the present invention has been described so far from a viewpoint of the constituent elements according to its functions. Hereinafter, the mobile terminal pertinent to the present invention is further described from a viewpoint of the constituent elements according to its external shape with reference to Figs. 2 and 3. Hereinafter, of several types of mobile terminals such as the folding type, the bar type, the swing type, and the sliding type, a sliding type mobile terminal equipped with a touch screen is described as an example, for convenience of description. However, it should be understood that the present invention is not limited to the sliding type mobile terminal, but instead may be applied to all types of mobile terminals, including the above types.

[0063] Fig. 2 is a front perspective view of the mobile terminal 100, in accordance with an embodiment. Referring to Fig. 2, the mobile terminal 100 comprises a first body 100A, and a second body 100B configured to slide in at least one direction in the first body 100A.

[0064] A state where the first body 100A is overlapped with the second body 100B can be called a closed configuration, and a state where at least part of the second body 100B is exposed through the first body 100A, as shown in FIG. 2, may be called an open configuration.

[0065] In the closed configuration of the mobile terminal 100, the mobile terminal 100 generally operates in a standby mode, but the standby mode may be released by user interaction with the mobile terminal 100. In the open configuration of the mobile terminal 100, the mobile terminal 100 generally operates in a call mode, etc., but the call mode may be switched to the standby mode through user interaction with the mobile terminal 100 or after a lapse of a certain time period.

[0066] A casing constituting an external shape of the first body 100A is comprised of a first front casing 100A-1 and a first rear casing 100A-2. A variety of electronic components are embedded in space formed by the first front casing 100A-1 and the first rear casing 100A-2. At least one middle casing can be further disposed between the first front casing 100A-1 and the first rear casing 100A-2. The casings may be formed by injecting synthetic resin or can be formed from metal, such as stainless steel (STS) or titanium (Ti).

[0067] The display unit 151, a first sound output module 153a, a first camera 121a, and a first user input unit 130 may be further disposed in the first body 100A, more particularly, the first front casing 100A-1.

[0068] The display unit 151 includes a liquid crystal display (LCD), an organic light emitting diode (OLED) and the like, which visually display information. A touch pad may be overlapped with the display unit 151 in a layered structure and, therefore, the display unit 151 operates as a touch screen, enabling the input of information by a user's touch. The first sound output module 153a may be implemented in the form of a receiver or speaker. The first camera 121 a may be implemented appropriately to capture still images or motion images of a user, etc.

[0069] In the same manner as the first body 100A, a casing, constituting an external appearance of the second body 100B, is constituted by a second front casing 100B-1 and a second rear casing 100B-2. A second user input unit 130b may be disposed on the front face of the second body 100B, more particularly, the second front casing 100B-1. Third and fourth user input units 130c and 130d, the microphone 123, and the interface unit 170 may be disposed in at least one of the second front casing 100B-1 and the second rear casing 100B-2.

[0070] The first to fourth user input units 130a, 130b, 130c, and 130d may be collectively called the user input unit 130 and may adopt any kind of a method as long as it is a tactile manner, which allows a user to manipulate the user input unit 130 while feeling a tactile sense.

[0071] For example, the user input unit 130 may be implemented using a dome switch or a touch pad, which is able to receive commands or information through a user's push or touch manipulation, or may be implemented using a wheel or jog method of rotating a key or a method using a joystick.

[0072] From a viewpoint of the function, the first user input unit 130a is adapted to input commands such as start, end, and scrolling. The second user input unit 130b is adapted to input numbers, text, symbols and so on. Further, the third and fourth user input units 130c and 130d may operate as hot keys for activating special functions within the mobile terminal 100.

[0073] The microphone 123 may be implemented in an adequate fashion, which is appropriate to receive a user's voice, other sound and so on. The interface unit 170 becomes a passage through which the mobile terminal according to the present invention may exchange data, etc. with external devices. For example, the interface unit 170 may be at least one of a connector for connecting to an earphone in a wired or wireless manner, a port for local area communication, and a power supply terminal for supplying power source to the mobile terminal 100. The interface unit 170 may be a card socket for accommodating external cards, such as a subscriber identification module (SIM), a user identity module (UIM), and a memory card for information storage.

[0074] The power supply unit 190 for supplying power source to the mobile terminal is disposed on the part of the second rear casing 100B-2. The power supply unit 190 may be, for example, a rechargeable battery, and may be detachably attached to the second body 100B

for recharging, and so on.

[0075] Fig. 3 is a rear perspective view of the mobile terminal 100, in accordance with one embodiment. Referring to Fig. 3, a fifth user input unit 130e of a wheel type and a second camera 121 b may be further disposed on the rear face of the second rear casing 100B-2 of the second body 100B. A sixth user input unit 130f may be arranged on the side of the second body 100B.

[0076] The second camera 121b has a photographing direction substantially opposite to that of the first camera 121a and may have different pixels from that of the first camera 121a. For example, the first camera 121a may have low pixels sufficiently enough to capture an image of a user's face and transmit the captured image to a counterpart in a video call or the like. The second camera 121b may have high pixels since general subjects are photographed and are not generally transmitted immediately.

[0077] A flash 125 and a mirror 126 may be further disposed adjacent to the second camera 121b. The flash 125 illuminates light to a subject when the subject is photographed by the second camera 121b. The mirror 126 reflects a user's face, etc. when the user tries to have his picture taken (self-photographing) using the second camera 121b.

[0078] A second sound output module (not shown) may be further disposed in the second rear casing 100B-2. The second sound output module may implement a stereo function together with the first sound output module 153a and may also be used for a call in a speaker-phone mode.

[0079] An antenna (not shown) for receiving broadcasting signals as well as an antenna for a call, etc., may be disposed on one side of the second rear casing 100B-2. The antenna may be drawn out from the second body 100B. A part of a sliding module 100C, which slidingly couples the first body 100A and the second body 100B, may be disposed on the part of the first rear casing 100A-2 of the first body 100A. The other part of the sliding module 100C may be disposed on the part of the second front casing 100B-1 of the second body 100B and may not be exposed to the outside, as shown in FIG 3.

[0080] It has been described above that the second camera module 121 b, and so on are disposed in the second body 100B, but the present invention is not necessarily limited to the above arrangement. For example, at least one of the constituent elements, which are described to be arranged in the second rear casing 100B-2, such as the second camera module 121b, may be disposed in the first body 100A, mainly, in the first rear casing 100A-2.

[0081] In this configuration, the closed configuration has an advantage in that the constituent elements arranged in the first rear casing 100A-2 are protected by the second body 100B. Further, although the second camera module 121b is not separately included, the first camera module 121 a may be rotatably disposed in such a way as to photograph even photographing directions of the second camera module 121b.

[0082] The power supply unit 190 for supplying power source to the mobile terminal is mounted on the part of the rear casing 100A-2. The power supply unit 190 may be, for example, a rechargeable battery and may be detachably coupled to the rear casing 100A-2 for charging, and so on.

[0083] Fig. 4 illustrates operation of a proximity sensor 141, in accordance with one embodiment. As shown in Fig. 4, when a user's finger approaches the display unit 151, the proximity sensor 141 senses such approach and outputs a proximity signal. In one embodiment, the proximity sensor 141 may output different proximity signals when the user's finger is placed at a location D3 and when the user's finger is located at a location D2 or D1.

[0084] In other words, assuming that a distance in which the proximity sensor approaches a detection object and outputs a proximity signal is a detection distance Sn, if proximity signals output from a plurality of the proximity sensors having different detection distances are compared with each other, it may be known how near the object approaches the proximity sensors 141.

[0085] Further, if a plurality of proximity sensors 141 having different detection areas is disposed and which proximity signal is output from which one of the proximity sensors 141 is understood, it may be known that a detection object approaches which area of the display unit 151, whether a detection object moves close to the display unit 151, and so on. Accordingly, the controller 180 may perform a variety of operation controls according to a degree in which a user's finger, etc. approaches the display unit 151, a proximity location thereof, and so on.

[0086] Figs. 5a and 5b are diagrams illustrating a proximity area in which the proximity sensor outputs a proximity signal and a haptic area in which a haptic effect is generated. In the case in which an object, such as an icon or menu item as shown in (a) of Fig. 5a, is displayed in the display unit 151, an area in which the object is displayed may be divided into a first area A at the center of the display unit 151 and a second area B adjacent to the boundary of the display unit 151, and haptic effects with different intensity and patterns may be generated from the first area A and the second area B. For example, the proximity sensor may be configured to output a vibration signal when the first area A is touched rather than when the second area B is touched.

[0087] In the case in which a proximity signal is used together with a haptic effect, a haptic area from which the haptic effect is generated and a proximity area in which the proximity signal is sensed may be defined differently. In other words, the haptic area may be set to be narrower than the proximity area, or the haptic area may be set to be wider than the proximity area. For example, in (a) of Fig. 5a, an area, including the first area A and the second area B, may be defined as the proximity area, and the first area A may be defined as the haptic area.

[0088] Further, an area in which an object is displayed may be divided into three areas A, B, and C as shown in

(b) of Fig. 5a and may be divided into n areas as shown in (c) of Fig. 5a such that haptic effects with different intensity and patterns may be generated from the respective areas. Even in the case in which the area is divided as described above, the proximity area and the haptic area may be defined differently.

[0089] The size of the proximity area may be constructed to vary according to a degree in which an object approaches the display unit 151. In other words, as shown in (a) of Fig. 5b, the size of the proximity area may be constructed to gradually decrease in order of C, B, and A or gradually increase in order of A, B, and C according to a degree in which an object approaches the display unit 151. Even in this case, as in an area 'H' shown in (b) of Fig. 5b, a haptic area from which a haptic effect has been generated may be constructed to have a constant size irrespective of a degree in which an object approaches the display unit 151.

[0090] Fig. 6 is a flowchart illustrating a method of distinguishing signals received by the mobile terminal 100, in accordance with one embodiment.

[0091] As shown in Fig. 6, the controller 180 assigns vibration signals to touch signals and proximity signals (S400). The vibration signals may be automatically assigned by the controller 180 or may be generated by a user. In one embodiment, a first vibration signal may be assigned to touch signals and a second vibration signal may be assigned to proximity signals. In another embodiment, vibration signals may be assigned according to characteristics of touch signals and proximity signals.

[0092] For example, different vibration signals may be assigned to touch signals input within a certain area, touch signals input with a specific pressure, and touch signals input through multiple points. Further, different vibration signals may be assigned to proximity signals input within a certain area, proximity signals input within a certain distance, proximity signals input at a certain speed, and proximity signals input at multiple points.

[0093] Next, the controller 180 determines whether at least one of a touch signal and a proximity signal has been input (S405). For example, one or more touch signals may be inputted, one or more proximity signals may be inputted, or one or more proximity signals and touch signals may be inputted simultaneously. Touch signals may be determined based on values detected in a touch screen, and proximity signals may be determined based on values detected by the proximity sensor 141. If, as a result of the determination in S405, at least a touch signal or a proximity signal has not been inputted, the controller 180 does not output a vibration signal.

[0094] On the other hand, if, as a result of the determination in step S405, at least one of a touch signal and a proximity signal has been inputted, the controller 180 analyzes the inputted signal and looks up the vibration signal assigned to the input signal (S410). If there is more than one inputted signal, the controller 180 combines the vibration signals assigned to the inputted signals (S415).

[0095] The controller 180 may combine one or more vibration signals through addition and subtraction. The combination method of the vibration signals may be automatically defined by the controller 180 according to an analyzed signal, or a user may select the combination method. Next, the controller 180 outputs the combined vibration signals through the haptic module 157 (S420).

[0096] Fig. 7 is a flowchart illustrating a method of distinguishing input signals associated with different display locations, in accordance with one embodiment.

[0097] As shown in Fig. 7, a screen, including one or more menu icons, is displayed on the display unit 151 (S500). The menu icon may be a menu icon that may be selected to enter a down menu, an icon for performing a specific function or one or more images.

[0098] Next, the controller 180 determines whether a proximity signal has been detected at the location of a specific one of the one or more menu icons through the proximity sensor 141 (S505). If, as a result of the determination in S505, the proximity signal has not been detected at the location of a specific menu icon, the controller 180 does not output a vibration signal.

[0099] On the other hand, if, as a result of the determination in S505, the proximity signal has been detected at the location of a specific menu icon, the controller 180 outputs a vibration signal, corresponding to the detected proximity signal, through the haptic module 157 (S510). Here, a single vibration signal corresponding to the detected proximity signal is output as vibration. Next, the controller determines whether a touch signal has been input through the specific menu icon of the location where the proximity signal was detected in step S505 (S515). Here, the touch signal may be input through a touch screen.

[0100] If, as a result of the determination in S515, the touch signal has not been input through the specific menu icon, the controller 180 determines whether the touch signal has been input through a menu icon different from the specific menu icon (S525). If, as a result of the determination in S525, the touch signal has not been input through the different menu icon, the controller 180 does not output a vibration signal.

[0101] Meanwhile, if, as a result of the determination in step S525, the touch signal has been input through the different menu icon, the controller 180 outputs a vibration signal, corresponding to the input touch signal, through the haptic module 157 (S530). Next, the controller 180 displays a screen, corresponding to the menu icon through which the touch signal has been input, on the display unit 151 (S535).

[0102] On the other hand, if, as a result of the determination in S515, the touch signal has been input through the specific menu icon, the controller 180 outputs vibration in which a vibration signal corresponding to the proximity signal, which has been detected in step S505, and a vibration signal corresponding to the touch signal, which has been input in step S515, are combined through the haptic module 157 (S520). The respective vibration signals may be added or subtracted and then output as

vibration. The controller 180 then displays a screen corresponding to the menu icon through which the touch signal has been input on the display unit 151 (S535).

[0103] Fig. 8 is a flowchart illustrating a method of distinguishing input signals associated with different distances from the proximity sensor 141, in accordance with one embodiment. As shown in Fig. 8, the controller 180 displays a screen, including one or more menu icons, on the display unit 151 (S600).

[0104] The controller 180 determines whether a proximity signal whose distance from the proximity sensor 141 is a first proximity distance has been detected through the proximity sensor 141 (S605). If, as a result of the determination in S605, the proximity signal having the first proximity distance has not been detected, the controller 180 does not output a vibration signal.

[0105] On the other hand, if, as a result of the determination in S605, the proximity signal having the first proximity distance has been detected, the controller 180 outputs a vibration signal, corresponding to the detected proximity signal having the first proximity distance, through the haptic module 157 (S610). Next, the controller 180 determines whether a proximity signal whose distance from the proximity sensor 141 is a second proximity distance has been detected (S615). If, as a result of the determination in S615, the proximity signal having the second proximity distance has not been detected, the controller 180 does not output a vibration signal.

[0106] On the other hand, if, as a result of the determination in S615, the proximity signal having the second proximity distance has been detected, the controller 180 outputs vibration in which a vibration signal, corresponding to the proximity signal of the first proximity distance, which has been detected in S605, and a vibration signal corresponding to the proximity signal of the second proximity distance, which has been detected in S615, are combined through the haptic module 157.

[0107] Fig. 9 is a flowchart illustrating a method of distinguishing input signals associated with different display areas, in accordance with one embodiment. As shown in Fig. 9, the controller 180 displays a screen, including one or more areas, on the display unit 151 (S700). Each of the one or more areas may comprise of an image, a document, a keypad or a menu icon. The areas may be set by a user, and the screen may be divided equally and then designated as specific areas. As a touch signal or a proximity signal is input through two or more areas, vibration may be output through multi-touch.

[0108] A touch signal is input through a first area (S705). Here, a signal input through the first area and a second area may be not only a touch signal, but also a proximity signal detected through the proximity sensor 141.

[0109] Next, the controller 180 determines whether a touch signal has been input through the second area (S710). If, as a result of the determination in step S710, the touch signal has not input through the second area, the controller 180 outputs a vibration signal, corresponding to the touch signal of the first area, through the haptic module 157. A touch signal input through the first area and a touch signal input through the second area may be performed at the same time.

[0110] On the other hand, if, as a result of the determination in S710, the touch signal has input through the second area, the controller 180 outputs vibration in which a vibration signal corresponding to the touch signal of the first area and a vibration signal corresponding to the touch signal of the second area are combined through the haptic module 157.

[0111] The combined vibration signal may be output differently depending on a method in which a touch signal is input through the first area and a touch signal is input through the second area. For example, the combined vibration signal may be output differently according to a distance between the first area and the second area. When a distance between the first area and the second area is less than a specific distance, vibration may be output by subtracting respective vibration signals. When a distance between the first area and the second area is larger than a specific distance, vibration in which respective vibration signals are summed may be output.

[0112] Further, in the case in which a distance between areas in which respective touch signals are input is changed in real time, vibration may be output differently according to the changed distance. For example, in the case in which, after touch signals are input through a first area and a second area, touch signals are input through a third area and a fourth area, it is assumed that the first area and the third area are entered using the same finger and the second area and the fourth area are entered using the same finger.

[0113] It corresponds to a case where multi-touch with different distances is repeatedly generated using a thumb and a index finger. This is because a case where multi-touch is entered using two fingers is general. At this time, in the case in which a distance between the third area and the fourth area becomes wider than a distance between the first area and the second area, a last vibration signal in which first vibration, wherein a vibration signal corresponding to a touch signal in the first area and a vibration signal corresponding to a touch signal in the second area are combined, and second vibration.

[0114] In one embodiment, a vibration signal corresponding to a touch signal in the third area and a vibration signal corresponding to a touch signal in the fourth area are combined, have been added may be output. In the case in which a distance between the third area and the fourth area becomes narrower than a distance between the first area and the second area, a last vibration signal in which the first vibration has been subtracted from the second vibration may be output.

[0115] As another embodiment, vibration may be output differently according to a speed in which a distance between areas through which respective touch signals are input is changed. In the case in which, after touch signals are input through a first area and a second area,

touch signals are input through a third area and a fourth area, it is assumed that the first area and the third area are entered using the same finger and the second area and the fourth area are entered using the same finger. In other words, it corresponds to a case where multi-touch with different speeds is repeatedly generated using a thumb and a index finger.

[0116] The speed is calculated in relation to the time and distance from where the touch signals are input through the first area and the second area to where the touch signals are input through the third area and the fourth area. When the speed is greater than a specific speed, a vibration signal corresponding to the touch signal in the first area and a vibration signal corresponding to the touch signal in the second area are combined.

[0117] In some embodiments, a vibration signal corresponding to the touch signal in the third area and a vibration signal corresponding to the touch signal in the fourth area are combined, and outputed. When the speed is lower than a specific speed, a last vibration signal in which the first vibration has been subtracted from the second vibration may be output.

[0118] As still another embodiment, in the case in which a distance between respective touch signals, which may be input through a touch screen, becomes a maximum, it is necessary to inform information about the distance. Here, a maximum distance of the each touch signal may be identical to or shorter than a maximum straight-line distance in which a touch signal may be input in a touch screen.

[0119] For example, in the case in which an image is enlarged by each input touch signal and then displayed as a maximum size that may be displayed on the display unit 151, information, indicating that further enlargement of the image is difficult, should be known. Accordingly, first alarm vibration other than vibration in which vibration signals corresponding to touch signals are combined in respective areas may be further output, and vibration in which vibration signals corresponding to touch signals are combined in respective areas may not be output, but only first alarm vibration may be output.

[0120] Further, in the case in which a distance between respective touch signals, which may be input through a touch screen, becomes a minimum, it is necessary to inform information about the distance. Here, a minimum distance of the each touch signal may be identical to or longer than a minimum straight-line distance in which a touch signal may be input in a touch screen.

[0121] For example, in the case in which an image is reduced by each input touch signal and then displayed as a minimum size that may be displayed on the display unit 151, information, indicating that further reduction of the image is difficult, should be known. Accordingly, second alarm vibration other than vibration in which vibration signals corresponding to touch signals are combined in respective areas may be further output.

[0122] Touch signals used in the multi-touch may be applicable to proximity signals detected by the proximity sensor. That is, even in the event of a distance difference between areas in which the proximity signals are detected, a distance change of an area, and a speed change, the various vibration patterns may be output.

[0123] The controller 180 may display an execution screen of a menu icon displayed in a first area on the display unit 151 according to a touch signal input in the first area, and may display an enlargement screen of an image displayed in a second area on the display unit 151 according to a touch signal input in the second area.

[0124] Figs. 10 and 11 are diagrams showing vibration signals outputted by the mobile terminal 100, in accordance with one or more embodiments.

[0125] As shown in (a) of Fig. 10, there appear a screen 505, displaying a vibration signal with respect to vibration type1, which may be selected when a touch signal is input, and a screen 510 displaying a vibration signal with respect to vibration type3. In other words, one of vibration signals with respect to vibration type1 to vibration typen may be set as a vibration signal with respect to an input touch signal according to classification 500 of a vibration type. Here, the pressure and area of an input touch signal and whether the touch signal has been input through multi-touch are not taken into consideration. Further, a vibration signal newly generated by a user may be selected.

[0126] As shown in (b) of Fig. 10, there appear a screen 520, displaying a vibration signal in the case of proximityA, which may be selected when a proximity signal is input, and a screen 525 displaying a vibration signal in the case of proximity B. In other words, one of vibration signals with respect to proximityA to proximityN may be set as a vibration signal with respect to an input proximity signal according to vibration type classification 515 of the proximity signal. Here, a proximity speed, a proximity area, and a proximity distance of an input proximity signal, and whether the proximity signal has been input through multi-touch are not taken into consideration.

[0127] In the case in which a proximity distance of a proximity signal is considered, there appear a screen 605, displaying a vibration signal with respect to a proximity distance D1, and a screen 610 displaying a vibration signal with respect to a proximity distance D2 as shown in (a) of Fig. 11. In other words, vibration signals with respect to proximity distances D1 to D4 are set as vibration signals with respect to the respective proximity distances according to classification 600 of the proximity distances. Here, the classification 600 with respect to the proximity distances D1 to D4 may be set automatically or set by a user. For example, the proximity distance D1 may be set to 0 to 10 meters, and the proximity distance D2 may be set to 10 to 20 meters. Alternatively, the proximity distance D1 may be set to 0 to 20 meters, and the proximity distance D2 may be set to 20 to 40 meters.

[0128] In the case in which multi-touch of a proximity signal is taken into consideration, there appears a screen 620, displaying an area in which a proximity signal is input in the display unit 151, that is, a multi-touch area is

divided into plural areas, as shown in (b) of Fig. 11. Since an area in which a proximity signal is input into plural areas, an area in which a proximity signal may be input in the display unit 151 is divided into plural areas.

[0129] In other words, vibration signals with respect to multi-touch areas P1 to P9 are set as vibration signals with respect to the respective multi-touch areas according to classification 615 of multi-touch. Here, the classification 615 with respect to the multi-touch areas P1 to P9 may be set automatically or set by a user. For example, the multi-touch areas P1 to P9 may be set by dividing an area in which a proximity signal is input into nine equal areas or may be set by randomly dividing the area.

[0130] In the case in which a proximity speed of a proximity signal is taken into consideration, there appear a screen 630 displaying a vibration signal with respect to a proximity speed V1, a screen 635 displaying a vibration signal with respect to a proximity speed V2, and a screen 640 displaying a vibration signal with respect to a proximity speed V3, as shown in (c) of Fig. 11.

[0131] That is, vibration signals with respect to proximity speeds V1 to V9 are set as vibration signals with respect to the respective proximity speeds according to classification 625 of the proximity speeds. Here, the classification 625 with respect to the proximity speeds V1 to V9 may be set automatically or set by a user. For example, the proximity speed V1 may be set to 0 to 10 cm/s and the proximity speed V2 may be set to 10 to 20cm/s. Alternatively, the proximity speed V1 may be set to 0 to 20 cm/s, and the proximity speed V2 may be set to 20 to 40 cm/s.

[0132] Figs. 12 and 13 are diagrams showing vibration signals outputted by the mobile terminal 100, in accordance with one or more embodiments. As shown in (a) of Fig. 12, there appears a screen 700 displaying a plurality of menu icons for menu selection. In the case in which a signal for selecting a menu is input, the controller 180 analyzes the input signal. As a result of the analysis, the input signal may have a type, which includes a proximity signal and a touch signal and in which after the proximity signal is detected, the touch signal is input.

[0133] A vibration signal set with respect to the touch signal is a vibration signal 705 with respect to vibration type3, as shown in (b) of Fig. 12, and a vibration signal set with respect to the proximity signal is a vibration signal 710 with respect to proximity B, as shown in (c) of Fig. 12.

[0134] Accordingly, in the case in which, after the proximity signal is maintained for a specific period of time, a menu icon is touched, vibration 715 in which the vibration signal 705 with respect to the vibration type3 and the vibration signal 710 with respect to the proximity B have been added is output, as shown in (d) of Fig. 12. Here, the vibration may be output by subtracting the respective vibration signals, and a combination method of the vibration signals may be set automatically or set by a user.

[0135] As shown in (a) of Fig. 13, there is displayed a screen 800, displaying a brightness control menu for controlling the brightness of the display unit 151. When a signal for selecting brightness is input, the controller 180 analyzes the input signal. As a result of the analysis, the input signal may have a type which includes a proximity signal and a touch signal and in which, after the proximity signal is detected, the touch signal is input.

[0136] A vibration signal set with respect to the touch signal is a vibration signal 805 regarding vibration type1 as shown in (b) of Fig. 13, and a vibration signal set with respect to the proximity signal is a vibration signal 810 regarding proximity A as shown in (c) of Fig. 13. Accordingly, in the case in which the proximity signal is maintained for a specific period of time and a menu icon is then touched, vibration 815 in which the vibration signal 805 regarding the vibration type1 has been subtracted from the vibration signal 810 regarding the proximity A is output as shown in (d) of Fig. 13.

[0137] Figs. 14 and 15 are diagrams showing vibration signals outputted by the mobile terminal 100, in accordance with one or more embodiments. As shown in (a) of Fig. 14, in the case in which a user's hands, ear or face becomes gradually close to or distant from a screen 900 displayed on the display unit 151, the proximity sensor 141 detects a proximity signal, and the controller 180 analyzes the detected proximity signal.

[0138] As a result of the analysis, the input signal includes a proximity signal input at a proximity distance D1 and a proximity signal input at a proximity distance D3. As shown in (b) of Fig. 14, a vibration signal 905 with respect to the proximity distance D1 and a vibration signal 910 with respect to the proximity distance D3 are set. In the case in which a distance from the screen 900 is changed from the proximity distance D3 to the proximity distance D1, vibration 910 in which the vibration signal 905 with respect to the proximity distance D1 has been subtracted the vibration signal 910 with respect to the proximity distance D3 is output, as shown in (c) of Fig. 14.

[0139] Meanwhile, in the case in which a distance from the screen 900 is changed from the proximity distance D1 to the proximity distance D3, vibration 920 in which the vibration signal 910 with respect to the proximity distance D3 and the vibration signal 905 with respect to the proximity distance D1 have been added is output, as shown in (d) of Fig. 14. A combination method of adding or subtracting the vibration signals may be exchanged.

[0140] In (a) of Fig. 15, a signal, including a proximity signal input at a first proximity distance and a proximity signal input at a second proximity distance, is input and a vibration signal is output by combining vibration signals with respect to the respective proximity distances, when an operation button is selected through the display unit 151 to play music.

[0141] Since a vibration signal is output separate from audio output, the a user may determine that the operation button has been entered correctly through the vibration signal without being hindered by the music play. The same applies to motion image play, as shown in (b) of Fig. 15. A user may check that that the operation button has been entered correctly through the vibration signal

without being hindered by the motion image play.

[0142] Figs. 16 to 18 are diagrams showing vibration signals outputted by the mobile terminal 100, in accordance with one or more embodiments. As shown in (a) of Fig. 16, in the case in which a touch signal is input as a multi-touch signal through several areas on a screen 1100 displaying an image, the controller 180 analyzes the input touch signal.

[0143] As a result of the analysis, the input signal includes a touch signal input through an area P1 of the multi-touch area and a touch signal input through an area P9 of the multi-touch area. As shown in (b) of Fig. 16, a vibration signal 1105 with respect to the multi-touch area P1 and a vibration signal 1110 with respect to the multi-touch area P9 are set. Accordingly, as shown in (c) of Fig. 16, vibration 1115 in which the vibration signal 1105 with respect to the multi-touch area P1 has been subtracted from the vibration signal 1110 with respect to the multi-touch area P9 is output.

[0144] Another embodiment in which a touch signal is input as a multi-touch signal through several areas of a multi-touch area is described with reference to Figs. 17 and 18.

[0145] As shown in (a) of Fig. 17, upon receipt of radio, an area of the display unit 151, displaying twelve operation buttons, may be set as nine multi-touch areas. In the case in which touch signals are input through an area P1 and an area P9 of the nine areas, vibration 1210 in which a vibration signal 1201 with respect to the multi-touch area P1 has been subtracted from a vibration signal 1209 with respect to the multi-touch area P9 is output.

[0146] In the case in which an area of the display unit 151, displaying a keypad through which numerals may be input, is set as nine multi-touch areas and touch signals are input through areas P2 and P8, vibration 1220 in which a vibration signal 1202 with respect to the multi-touch area P2 and a vibration signal 1206 with respect to the multi-touch area P6 have been added is output, as shown in (b) of Fig. 17. In the case in which an area of the display unit 151, displaying a keypad through which numerals and text may be input, is set as nine multi-touch areas and touch signals are input through areas P2 and P8, vibration 1230 in which a vibration signal 1202 with respect to the multi-touch area P2 and a vibration signal 1206 with respect to the multi-touch area P8 have been added is output, as shown in (c) of Fig. 17.

[0147] Meanwhile, in the case in which the touch signal as shown in (c) of Fig. 17 is input right after the touch signal as shown in (b) of Fig. 17, it corresponds to a case where a distance between the areas in which the touch signals have been input is changed. Accordingly, vibration in which the vibration 1220 shown in (b) of Fig. 17 and the vibration 1230 shown in (c) of Fig. 17 are combined may be output. Further, in the case in which, after the touch signal as shown in (b) of Fig. 17 is input, the touch signal as shown in (c) of Fig. 17 is input, different vibrations may be output according to a speed of the input touch signal.

[0148] As shown in (a) of Fig. 18, in the case in which an area of the display unit 151 on which an image list indicated by thumbnail is displayed is set as nine multi-touch areas and touch signals are input through an area P1 and an area P9, vibration 1240 in which a vibration signal 1201 with respect to the multi-touch area P1 has been subtracted from a vibration signal 1209 with respect to the multi-touch area P9 is output.

[0149] In the case in which an area of the display unit 151 on which a plurality of menus is displayed is set as nine multi-touch areas and touch signals are input through an area P1 and an area P9, vibration 1250 in which a vibration signal 1209 with respect to the multi-touch area P9 and a vibration signal 1201 with respect to the multi-touch area P1 have been added is output, as shown in (b) of Fig. 18.

[0150] In the case in which an area of the display unit 151 on which at least thirty date menus are displayed is set as nine multi-touch areas and touch signals are input through an area P2 and an area P8, vibration 1260 in which a vibration signal 1202 with respect to the multi-touch area P2 and a vibration signal 1208 with respect to the multi-touch area P8 have been added is output, as shown in (c) of Fig. 18.

[0151] That is, in the case in which a plurality of menu icons is displayed in a specific area of the display unit 151, a multi-touch area may be set in the specific area of the display unit 151, and the number of the multi-touch areas may be decided independently from the number of a plurality of menu icons. Accordingly, even though different menu icons are multi-touched, the same vibration signal may be output.

[0152] Figs. 19 to 22 are diagrams to which reference is made to illustrate a method of distinguishing input signals received by the mobile terminal 100, in accordance with one or more embodiments.

[0153] As shown in (a) of Fig. 19, in the case in which a user's hands, ear or face becomes gradually close to or distant from a screen 1400 of the display unit 151 at a different speed, the proximity sensor 141 detects a proximity signal and the controller 180 analyzes the detected proximity signal. As a result of the analysis, an input signal includes a proximity signal input at a proximity speed V1 and a proximity signal input at a proximity speed V9.

[0154] As shown in (b) of Fig. 19, a vibration signal 1405 with respect to the proximity speed V1 and a vibration signal 1410 with respect to the proximity speed V9 are set. Accordingly, in the case in which the proximity speed of the proximity signal is changed from the proximity speed V9 to the proximity speed V1, vibration 1415 in which the vibration signal 1405 with respect to the proximity speed V1 has been subtracted from the vibration signal 1410 with respect to the proximity speed V9 is output, as shown in (c) of Fig. 19.

[0155] Another embodiment in which proximity signals with different speeds are detected is described below with reference to Fig. 20. In the case in which a proximity

speed of a proximity signal with respect to a menu button for multi-tasking is changed from a proximity speed V9 to a proximity speed V1, vibration 1510 in which a vibration signal 1501 with respect to the proximity speed V1 has been subtracted from a vibration signal 1508 with respect to the proximity speed V9 is output, as shown in (a) of Fig. 20.

[0156] In the case in which a proximity speed of a proximity signal with respect to a menu button for multi-tasking for image enlargement is changed from a proximity speed V1 to a proximity speed V9, vibration 1520 in which the vibration signal 1509 with respect to the proximity speed V9 and the vibration signal 1501 with respect to the proximity speed V1 have been added is output, as shown in (b) of Fig. 20. In the case in which a proximity speed of a proximity signal with respect to a menu button for setting environments of the display unit 151 is changed from a proximity speed V2 to a proximity speed V8, vibration 1530 in which a vibration signal 1508 with respect to the proximity speed V8 and a vibration signal 1502 with respect to the proximity speed V2 have been added is output, as shown in (c) of Fig. 20.

[0157] Meanwhile, in the case in which a signal for selection is input in a screen 1600 on which menu buttons are displayed as shown in (a) of Fig. 21, the controller 180 analyzes an input signal. As a result of the analysis, the input signal includes a proximity signal input through a proximity area M9 and a proximity signal input through a proximity area M1.

[0158] As shown in (b) of Fig. 21, a vibration signal 1610 with respect to the proximity area M9 and a vibration signal 1605 with respect to the proximity area M1 are set. In the case in which a proximity area of an input proximity signal is changed from the proximity area M9 to the proximity area M1, vibration 1615 in which the vibration signal 1605 with respect to the proximity area M1 has been subtracted from the vibration signal 1610 with respect to the proximity area M9 is output, as shown in (c) of Fig. 21.

[0159] As still another embodiment in which proximity signals with different proximity areas are detected is described below with reference to Fig. 22. As shown in (a) of Fig. 22, in the case in which a proximity area of a proximity signal is changed from a proximity area M9 to a proximity area M1 in a menu button for playing motion images, vibration 1710 in which a vibration signal 1701 with respect to the proximity area M1 has been subtracted from a vibration signal 1709 with respect to the proximity area M9 is output.

[0160] In the case in which a proximity area of a proximity signal is changed from a proximity area M1 to a proximity area M9 in a menu button for enlarging images, vibration 1720 in which a vibration signal 1709 with respect to the proximity area M9 and a vibration signal 1701 with respect to the proximity area M1 have been added is output, as shown in (b) of Fig. 22.

[0161] In the case in which a proximity area of a proximity signal with respect to a menu button for the world-wide time is changed from M2 to M8, vibration 1730 in which a vibration signal 1702 with respect to the proximity area M2 and a vibration signal 1708 with respect to the proximity area M9 have been added is output, as shown in (c) of Fig. 22.

[0162] In an alternative embodiment, the invention may be implemented as computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any instruction execution system. For the purposes of this description, a computer-usable or computer-readable medium may be any apparatus that can contain, store, communicate, propagate or transport the program for use by or in connection with the instruction execution system, apparatus or device.

[0163] The computer-readable medium may be an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. Examples of a computer-readable medium include a semiconductor or solid-state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk and an optical disk. Current examples of optical disks include compact disk read only memory (CD-ROM), compact disk read/write (CD-R/W) and digital video disk (DVD).

[0164] It should also be understood that the logic code, programs, modules, processes, methods and the order in which the respective steps of each method are performed are purely exemplary. Depending on implementation, the steps can be performed in any order or in parallel, unless indicated otherwise in the present disclosure. Further, the logic code is not related, or limited to any particular programming language, and may comprise of one or more modules that execute on one or more processors in a distributed, non-distributed or multiprocessing environment.

[0165] The present invention has been described above with reference to one or more features or embodiments. Those skilled in the art will recognize, however, that changes and modifications may be made to these embodiments without departing from the scope of the present invention. These and various other adaptations and combinations of the embodiments disclosed are within the scope of the invention and are further defined by the claims and their full scope of equivalents.

Claims

1. A method of distinguishing input signals detected by a mobile terminal, the method comprising:

   detecting a proximity signal and a touch signal inputted to the mobile terminal, wherein a first vibration signal is associated with the proximity signal and a second vibration is associated with the touch signal;

   determining a first location through which the

proximity signal is inputted and a second location through which the touch signal is inputted; and

outputting a combined vibration signal that is a mix of the first and the second vibration signals, in response to determining that the first and second locations are the same.

2. The method of claim 1, further comprising outputting the first vibration signal, in response to determining that the first and second locations are different.

3. A method of distinguishing proximity signals detected by a proximity sensor of a mobile terminal, the method comprising:

detecting a first proximity signal at a first proximity distance from the proximity sensor and a second proximity signal at a second proximity distance from the proximity sensor, wherein a first vibration signal is associated with the first proximity signal and a second vibration signal is associated with the second proximity signal; and

outputting a combined vibration signal corresponding to the first and second proximity signals.

4. A method of distinguishing touch signals detected by a touch screen of a mobile terminal, the method comprising:

detecting a first touch signal inputted at a first area of the touch screen and a second touch signal inputted at a second area of the touch screen, wherein a first vibration signal is associated with the first touch signal and a second vibration signal is associated with the second touch signal; and

outputting a combined vibration signal corresponding to the first and second touch signals.

5. The method of claim 4, wherein the combined vibration signal is outputted according to a distance between the first area and the second area.

6. The method of claim 4, further comprising detecting a third touch signal inputted at a third area of the touch screen and a fourth touch signal inputted at a fourth area of the touch screen, wherein the combined vibration signal is outputted according to a change in a distance between the first and second areas and a distance between the third and fourth areas.

7. The method of claim 4, further comprising detecting a third touch signal inputted at a third area of the touch screen and a fourth touch signal inputted at a fourth area of the touch screen, wherein the combined vibration signal is outputted according to a speed difference between the first and second touch signals inputted through the first and second areas and the third and fourth touch signals inputted through the third and fourth areas.

8. A method of distinguishing input signals detected by a mobile terminal, the method comprising:

detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and

outputting a combined vibration signal corresponding to at least the first and second input signals.

9. The method of claim 8, wherein the first and second input signals are proximity signals detected by a proximity sensor of the mobile terminal.

10. A mobile terminal comprising:

a proximity sensor for detecting a proximity signal and a touch signal inputted to the mobile terminal, wherein a first vibration signal is associated with the proximity signal;

a touch screen for detecting touch signal inputted to the mobile terminal, wherein a second vibration is associated with the touch signal;

a controller for determining a first location through which the proximity signal is inputted and a second location through which the touch signal is inputted; and

a haptic module for outputting a combined vibration signal corresponding to the proximity signal and the touch signal, in response to determining that the first and second locations are the same.

11. The mobile terminal of claim 10, wherein the controller is further for displaying an execution screen corresponding to the first location, in response to determining that the first and second locations are the same.

12. A mobile terminal comprising:

a proximity sensor for detecting a first proximity signal at a first proximity distance from the proximity sensor and a second proximity signal at a second proximity distance from the proximity sensor, wherein a first vibration signal is associated with the first proximity signal and a second vibration signal is associated with the second proximity signal; and

a haptic module for outputting a combined vi-

bration signal corresponding to the first and second proximity signals.

13. A mobile terminal comprising:

a touch screen for detecting a first touch signal inputted at a first area of the touch screen and a second touch signal inputted at a second area of the touch screen, wherein a first vibration signal is associated with the first touch signal and a second vibration signal is associated with the second touch signal; and
a haptic module for outputting a combined vibration signal corresponding to the first and second touch signals.

14. A mobile terminal comprising:

a detection unit for detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and
a haptic module for outputting a combined vibration signal corresponding to at least the first and second input signals.

15. The mobile terminal of claim 14, wherein the first and second input signals are touch signals inputted through a touch screen.

FIG. 1

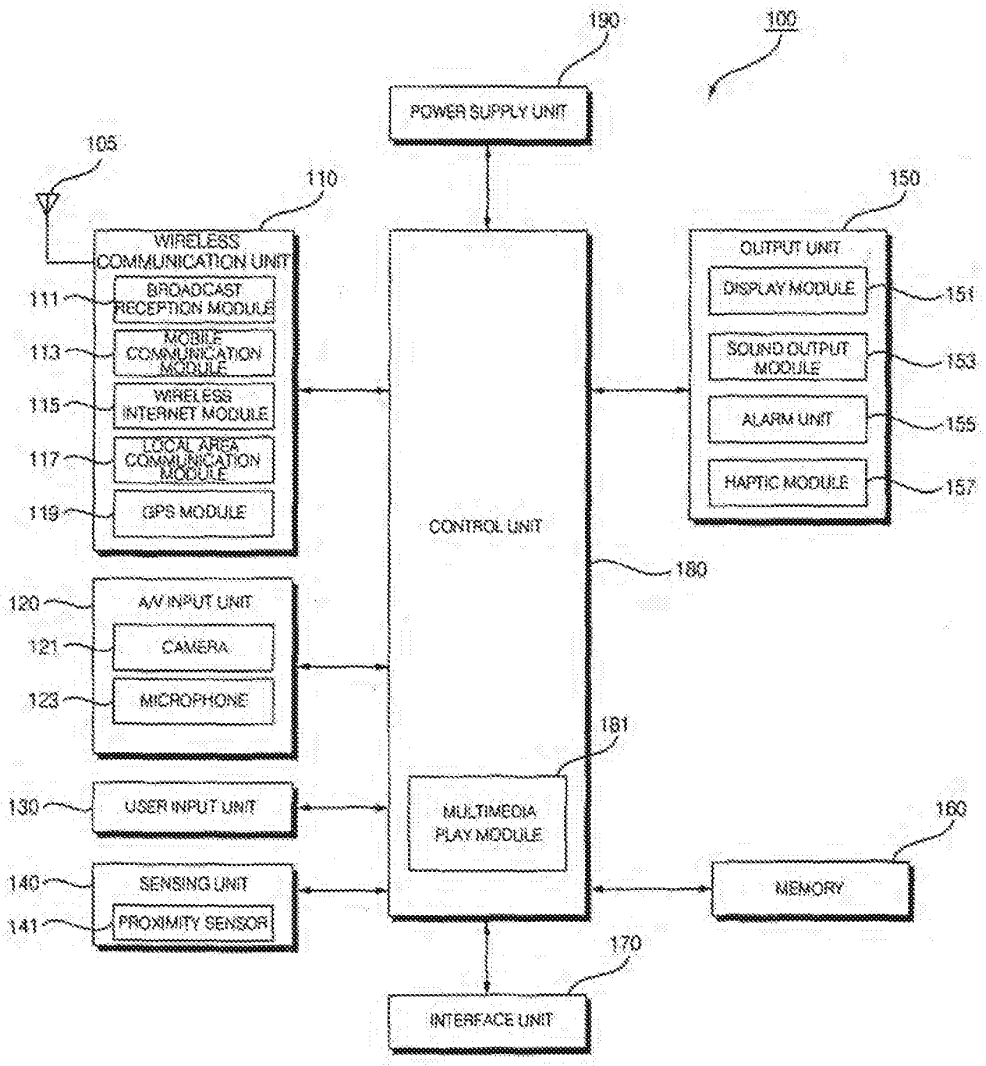

190
100
POWER SUPPLY UNIT
105
110
150
WIRELESS COMMUNICATION UNIT
OUTPUT UNIT
111
BROADCAST RECEPTION MODULE
DISPLAY MODULE
151
113
MOBILE COMMUNICATION MODULE
SOUND OUTPUT MODULE
153
115
WIRELESS INTERNET MODULE
ALARM UNIT
155
117
LOCAL AREA COMMUNICATION MODULE
HAPTIC MODULE
157
119
GPS MODULE
CONTROL UNIT
180
120
A/V INPUT UNIT
121
CAMERA
123
MICROPHONE
181
130
USER INPUT UNIT
MULTIMEDIA PLAY MODULE
160
140
SENSING UNIT
MEMORY
141
PROXIMITY SENSOR
170
INTERFACE UNIT

FIG. 2

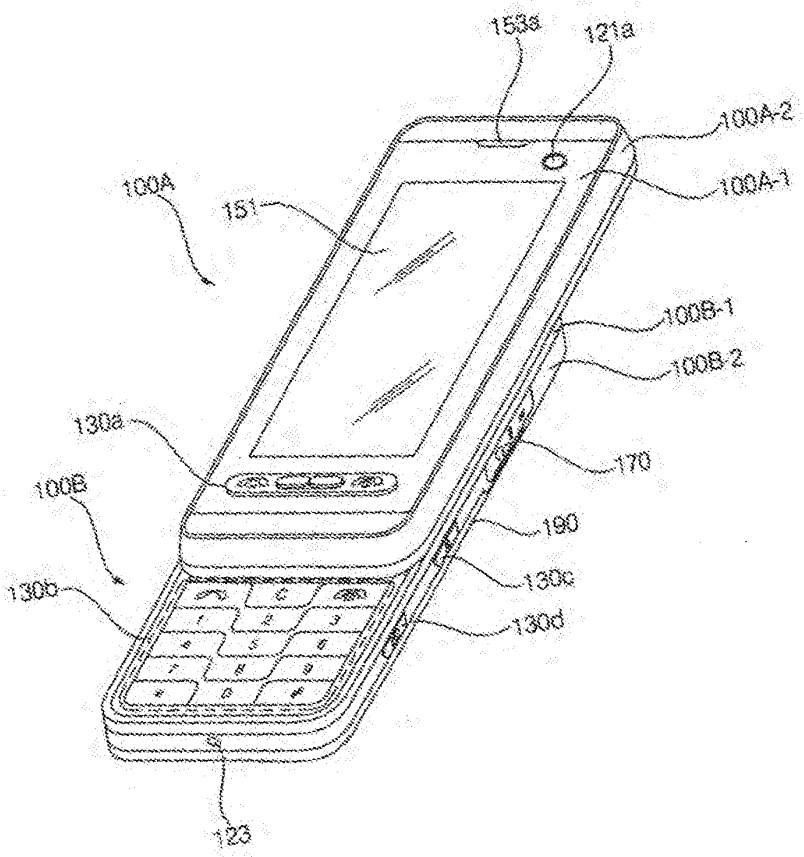

153a
121a
100A-2
100A-1
100A
151
100B-1
100B-2
130a
170
100B
190
130b
130c
130d
123

FIG. 3

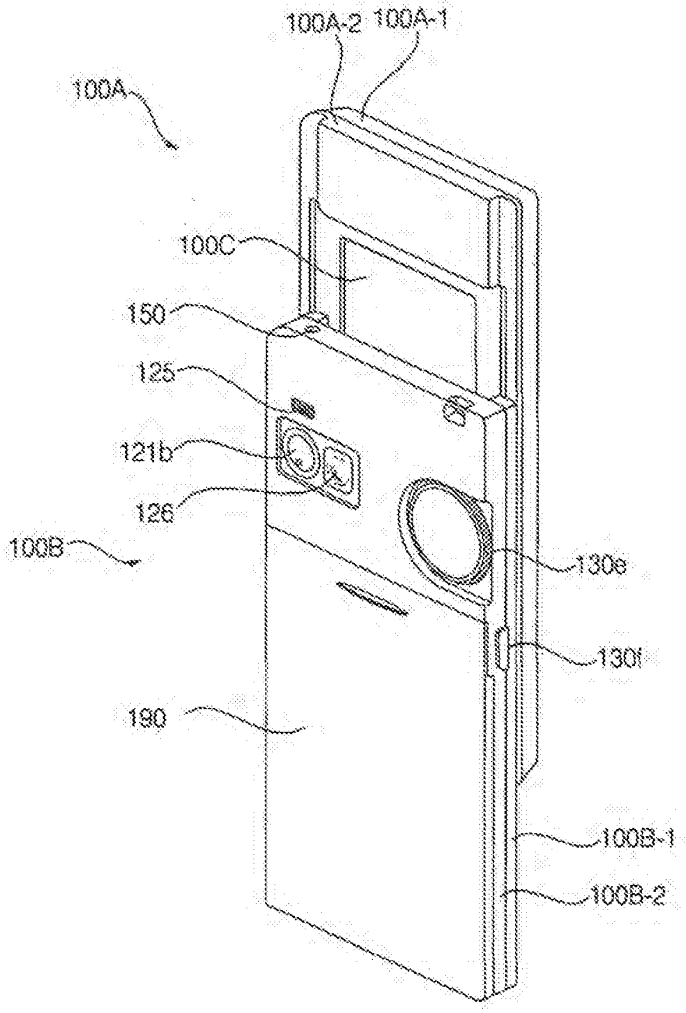

100A-2
100A-1
100A
100C
150
125
121b
126
100B
130e
130f
190
100B-1
100B-2

FIG. 4

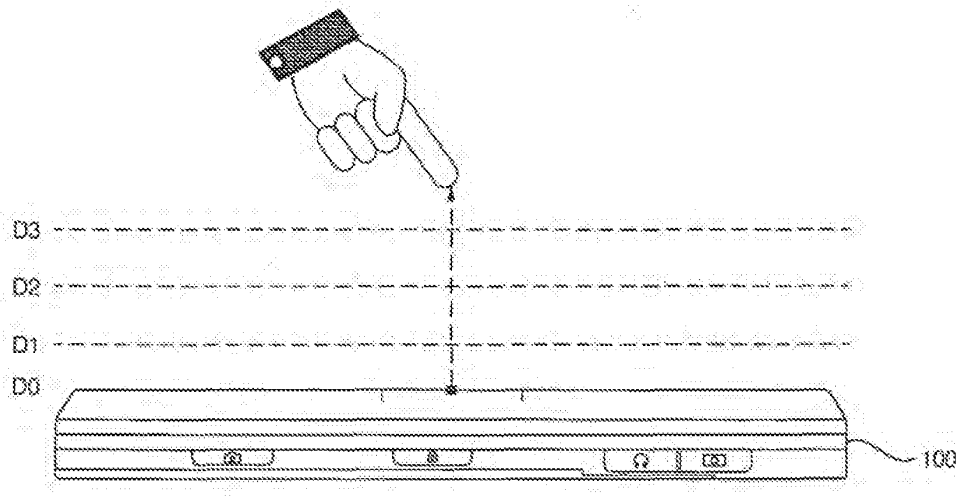

D3
D2
D1
D0
100

FIG. 5a

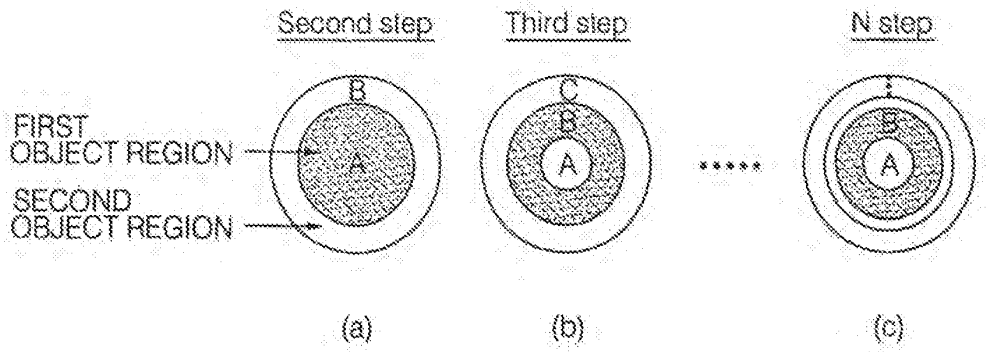

Second step
Third step
N step
FIRST OBJECT REGION
SECOND OBJECT REGION
B
A
C
B
A
B
A
(a)
(b)
(c)

FIG. 5b

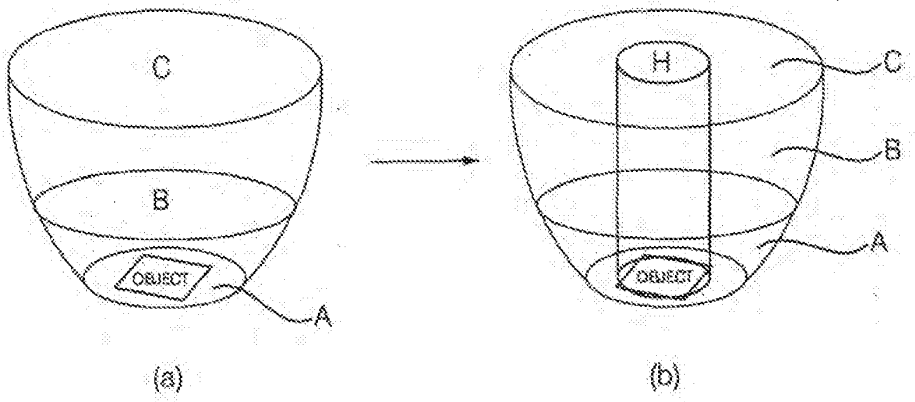


FIG. 6

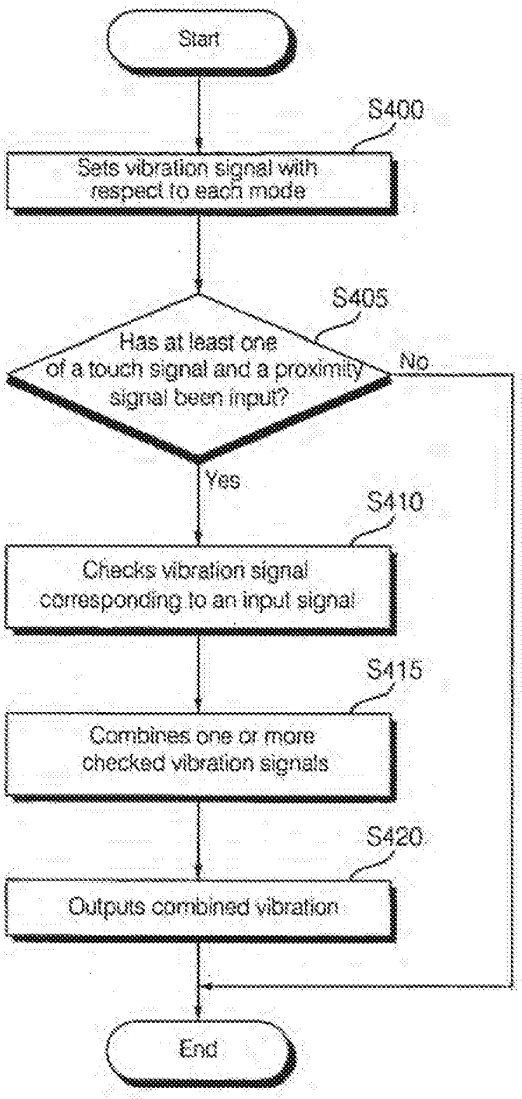

Start
S400
Sets vibration signal with respect to each mode
S405
Has at least one of a touch signal and a proximity signal been input?
No
Yes
S410
Checks vibration signal corresponding to an input signal
S415
Combines one or more checked vibration signals
S420
Outputs combined vibration
End

FIG. 7

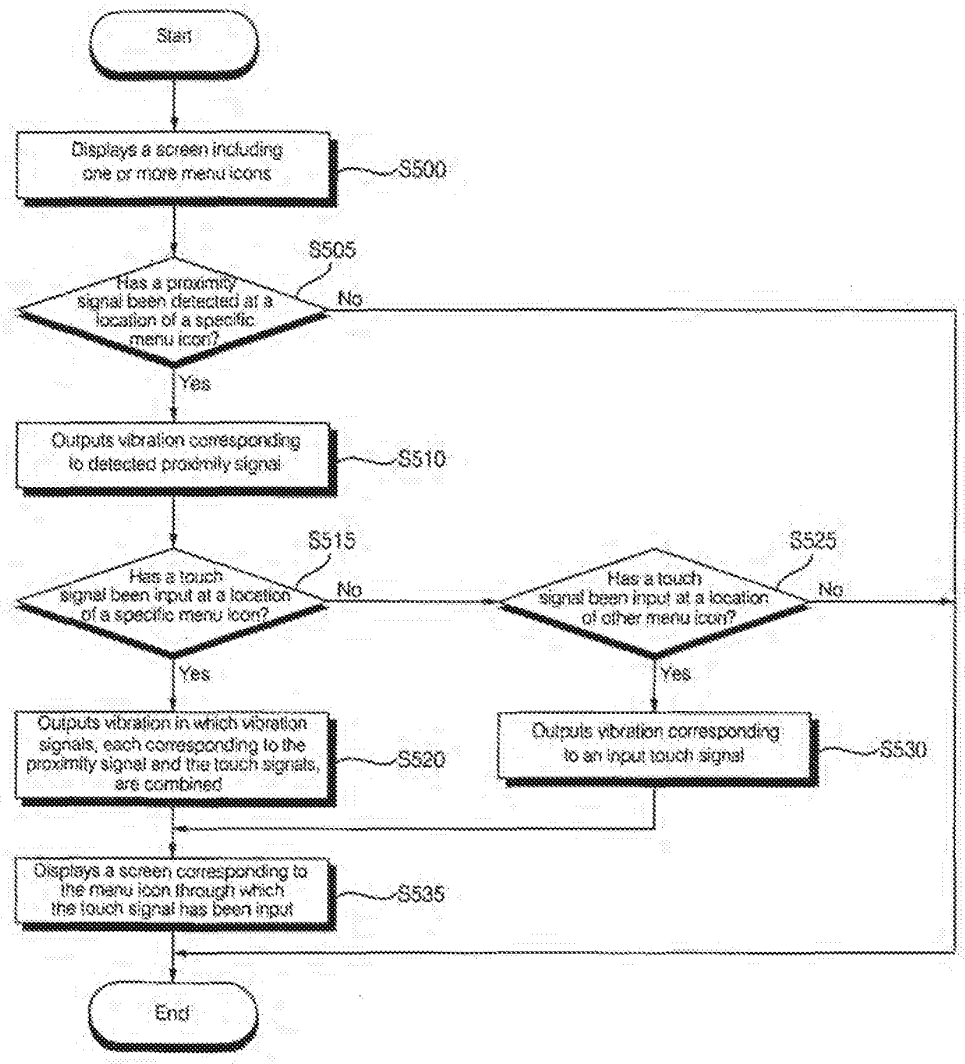

Start
Displays a screen including one or more menu icons
S500
Has a proximity signal been detected at a location of a specific menu icon?
S505
No
Yes
Outputs vibration corresponding to detected proximity signal
S510
Has a touch signal been input at a location of a specific menu icon?
S515
No
Yes
Has a touch signal been input at a location of other menu icon?
S525
No
Yes
Outputs vibration in which vibration signals, each corresponding to the proximity signal and the touch signals, are combined
S520
Outputs vibration corresponding to an input touch signal
S530
Displays a screen corresponding to the menu icon through which the touch signal has been input
S535
End

FIG. 8

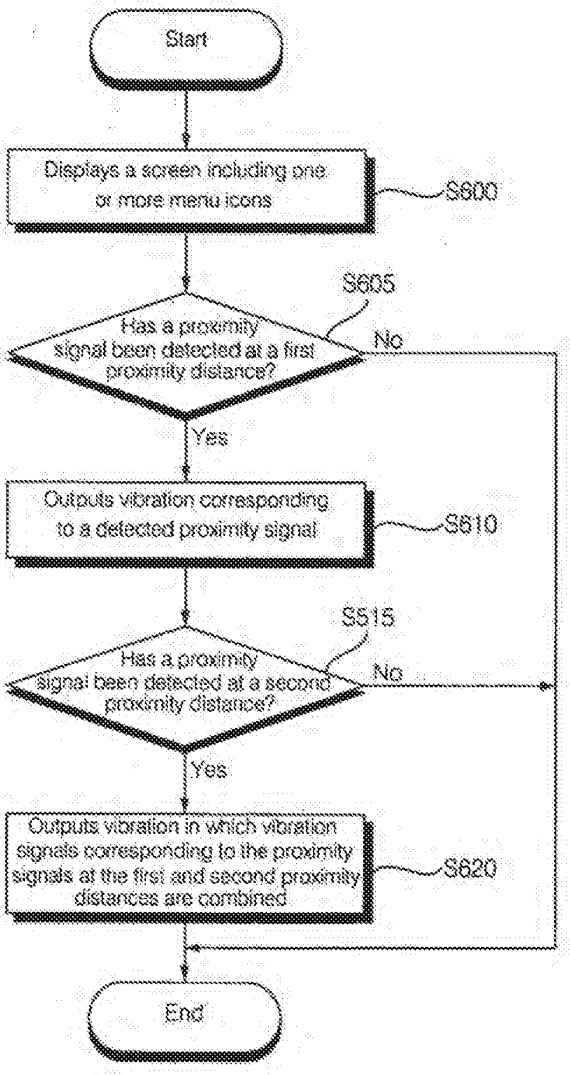

Start
Displays a screen including one or more menu icons
S600
S605
Has a proximity signal been detected at a first proximity distance?
No
Yes
Outputs vibration corresponding to a detected proximity signal
S610
S615
Has a proximity signal been detected at a second proximity distance?
No
Yes
Outputs vibration in which vibration signals corresponding to the proximity signals at the first and second proximity distances are combined
S620
End

FIG. 9

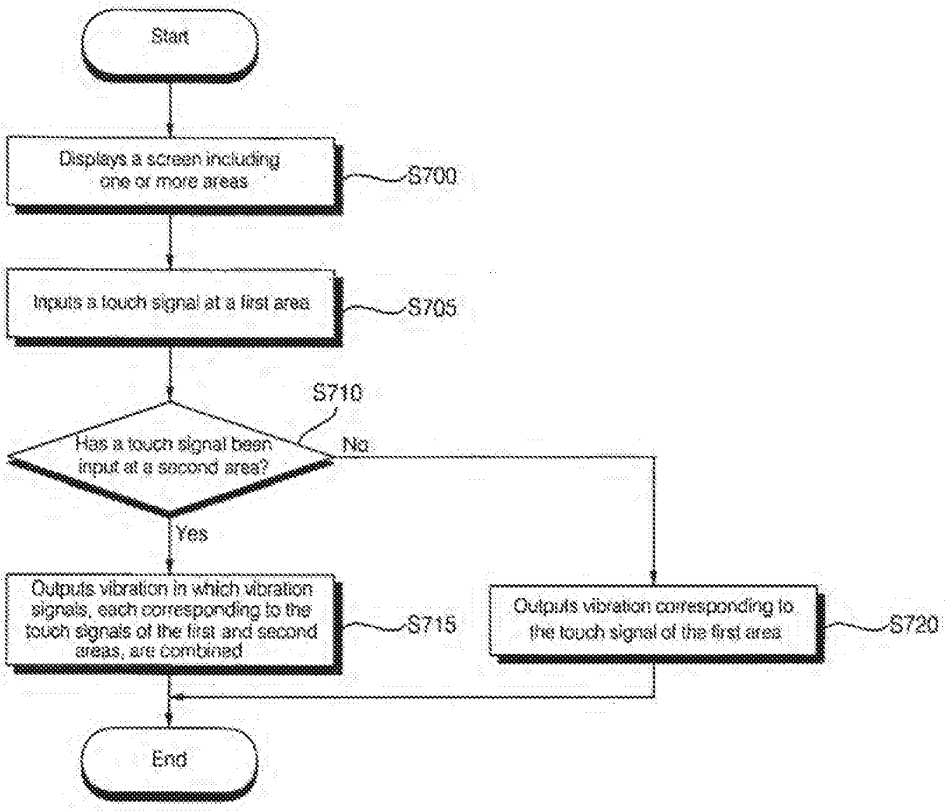

Start
Displays a screen including one or more areas
S700
Inputs a touch signal at a first area
S705
S710
Has a touch signal been input at a second area?
No
Yes
Outputs vibration in which vibration signals, each corresponding to the touch signals of the first and second areas, are combined
S715
Outputs vibration corresponding to the touch signal of the first area
S720
End

FIG. 10

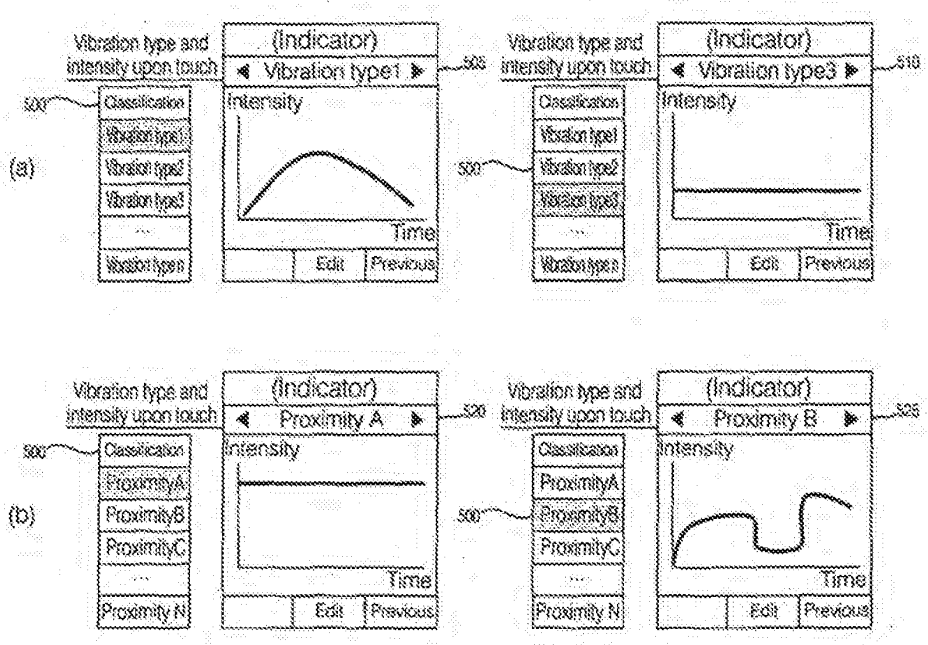

(a)
Vibration type and intensity upon touch
(Indicator)
Vibration type1
Classification
Vibration type1
Vibration type2
Vibration type3
...
Vibration type n
Intensity
Time
Edit
Previous
500
505
Vibration type and intensity upon touch
(Indicator)
Vibration type3
510
(b)
Proximity A
ProximityA
ProximityB
ProximityC
Proximity N
520
Proximity B
525

FIG. 11

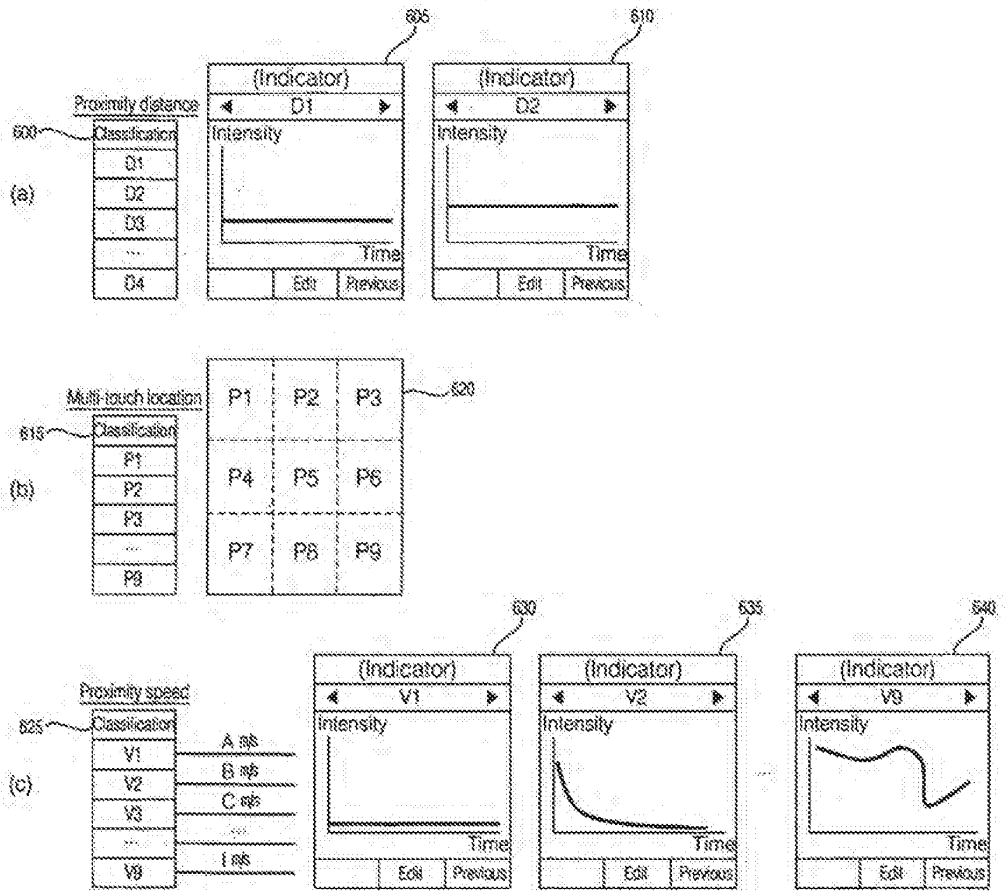

605
610
(Indicator)
D1
Intensity
Time
Edit
Previous
(Indicator)
D2
Intensity
Time
Edit
Previous
Proximity distance
600
Classification
D1
D2
D3
...
D4
(a)
Multi-touch location
615
Classification
P1
P2
P3
...
P8
(b)
P1
P2
P3
P4
P5
P6
P7
P8
P9
620
630
635
640
(Indicator)
V1
Intensity
Time
Edit
Previous
(Indicator)
V2
Intensity
Time
Edit
Previous
(Indicator)
V9
Intensity
Time
Edit
Previous
Proximity speed
625
Classification
V1
V2
V3
...
V9
A m/s
B m/s
C m/s
...
I m/s
(c)

FIG. 12

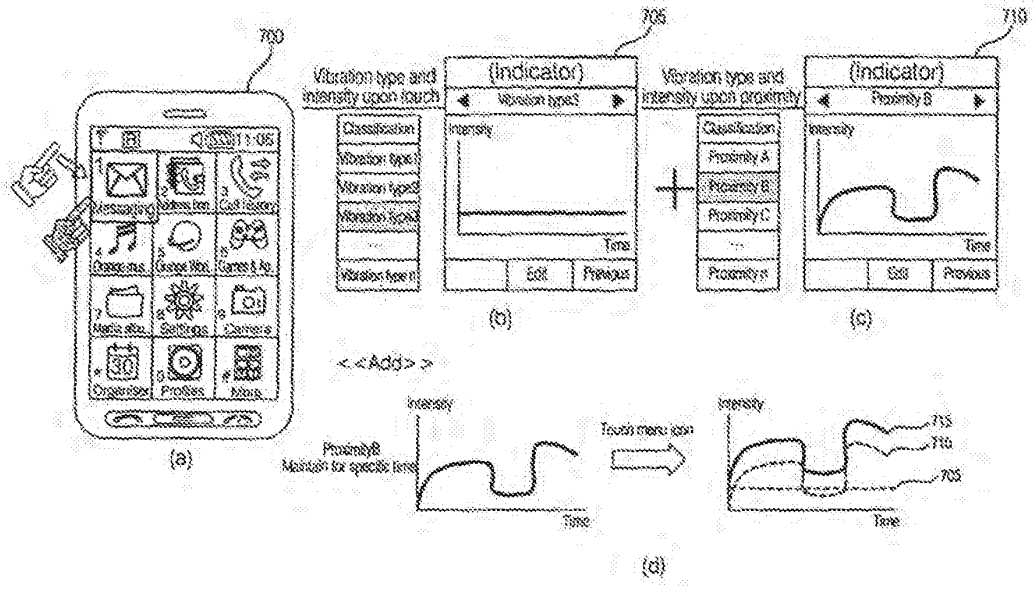

700
(a)
Vibration type and intensity upon touch
(indicator)
Vibration type1
Classification
Vibration type1
Vibration type2
Vibration type3
Vibration type n
Intensity
Time
Edit
Previous
705
(b)
Vibration type and intensity upon proximity
(indicator)
Proximity B
Classification
Proximity A
Proximity B
Proximity C
Proximity n
Intensity
Time
Edit
Previous
710
(c)
<<Add>>
Proximity B
Maintain for specific time
Intensity
Time
Touch menu icon
Intensity
715
710
705
Time
(d)

FIG. 13

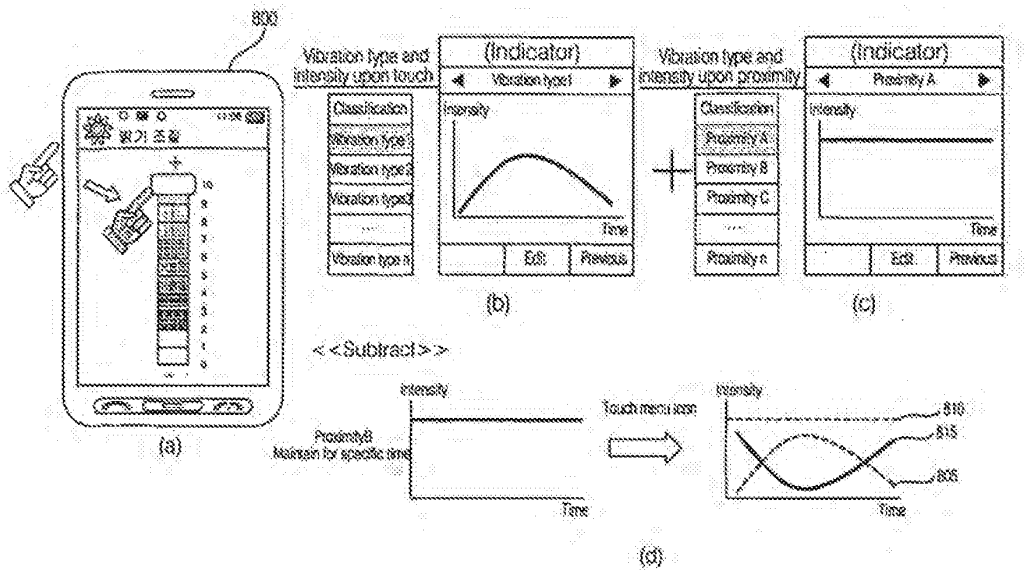

800
Vibration type and intensity upon touch
(Indicator)
Vibration type1
Classification
Vibration type 1
Vibration type 2
Vibration type3
Vibration type n
Intensity
Time
Edit
Previous
(b)
Vibration type and intensity upon proximity
(Indicator)
Proximity A
Classification
Proximity A
Proximity B
Proximity C
Proximity n
Intensity
Time
Edit
Previous
(c)
(a)
<<Subtract>>
Intensity
Proximity B
Maintain for specific time
Time
Touch recognition
Intensity
810
815
805
Time
(d)

FIG. 14

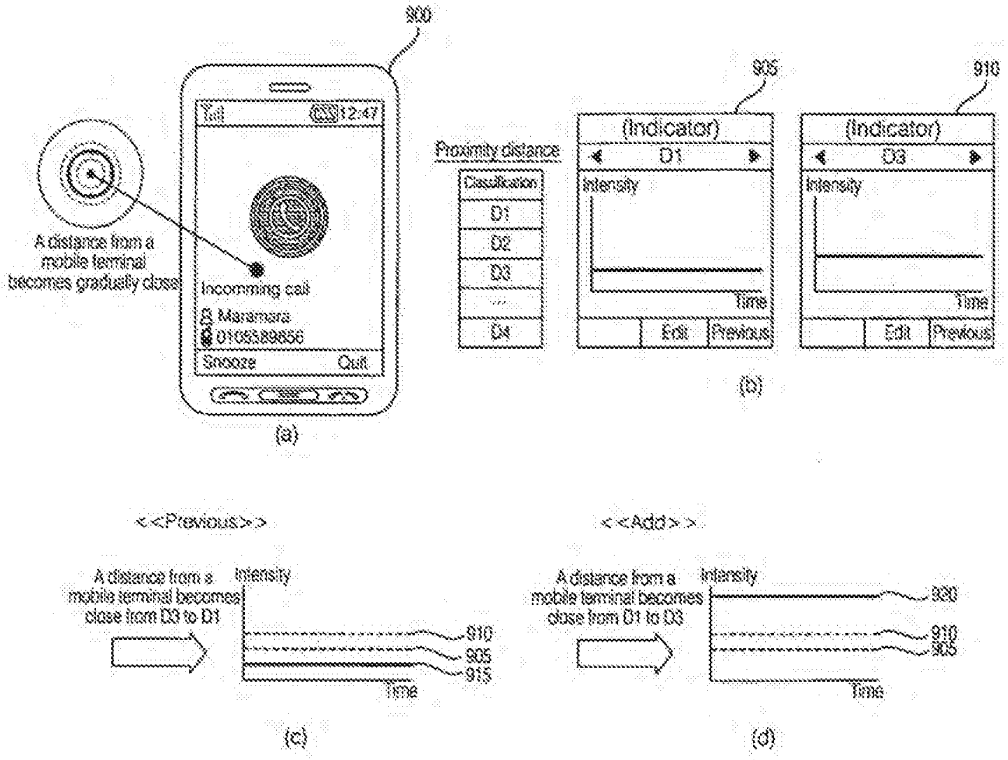

900
12:47
A distance from a mobile terminal becomes gradually close
Incomming call
Maramara
01033289856
Snooze
Quit
(a)
Proximity distance
Classification
D1
D2
D3
...
D4
905
(Indicator)
D1
Intensity
Time
Edit
Previous
910
(Indicator)
D3
Intensity
Time
Edit
Previous
(b)
<<Previous>>
A distance from a mobile terminal becomes close from D3 to D1
Intensity
910
905
915
Time
(c)
<<Add>>
A distance from a mobile terminal becomes close from D1 to D3
Intensity
900
910
905
Time
(d)

FIG. 15

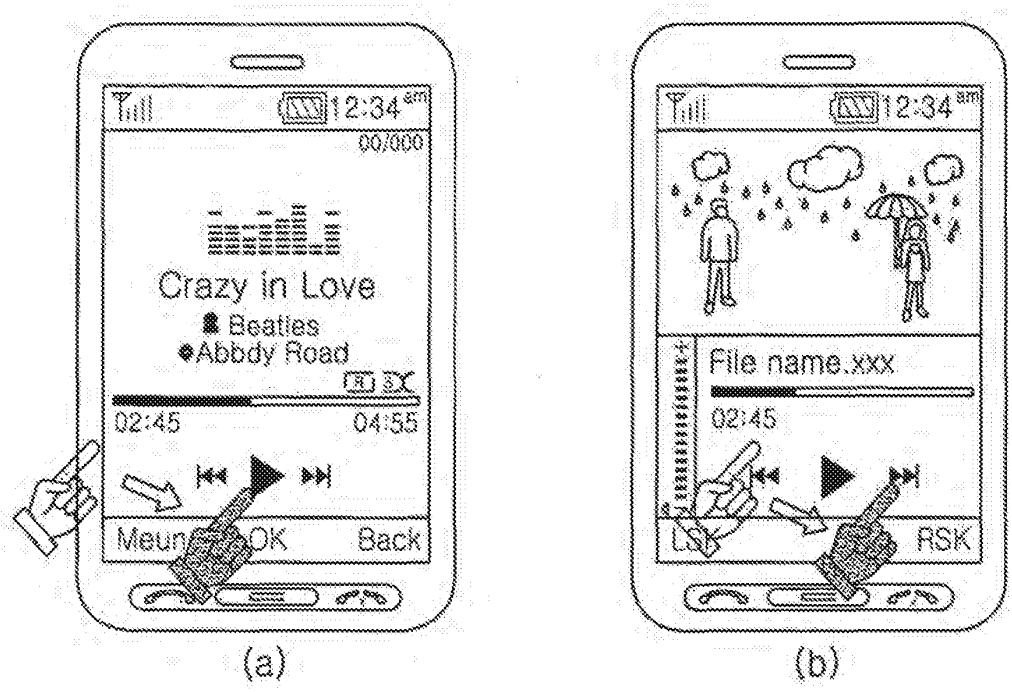

12:34 am
00/000
Crazy in Love
Beatles
Abbdy Road
02:45
04:55
Menu
OK
Back
(a)
12:34 am
File name.xxx
02:45
LSK
RSK
(b)

FIG. 16

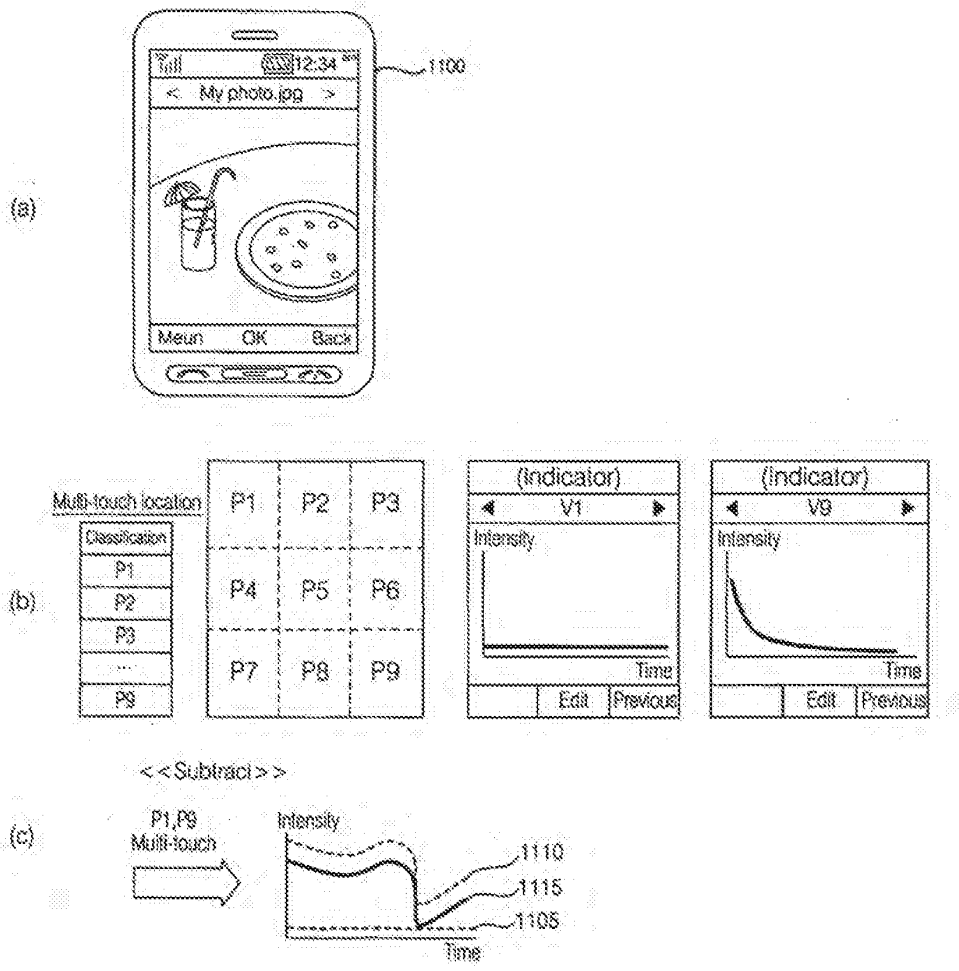

(a)
12:34
< My photo.jpg >
1100
Menu
OK
Back
(b)
Multi-touch location
Classification
P1
P2
P3
...
P9
P1
P2
P3
P4
P5
P6
P7
P8
P9
(indicator)
V1
Intensity
Time
Edit
Previous
(indicator)
V9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
P1,P9
Multi-touch
Intensity
1110
1115
1105
Time

FIG. 17

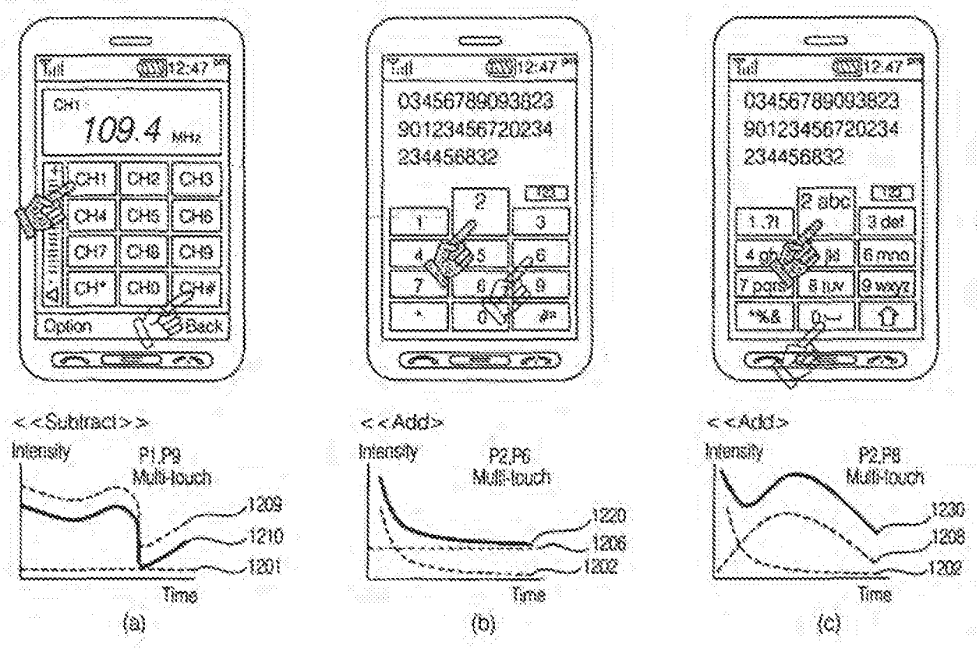

<<Subtract>>
Intensity
P1,P9
Multi-touch
1209
1210
1201
Time
(a)
<<Add>>
Intensity
P2,P6
Multi-touch
1220
1206
1202
Time
(b)
<<Add>>
Intensity
P2,P8
Multi-touch
1230
1208
1209
Time
(c)

FIG. 18

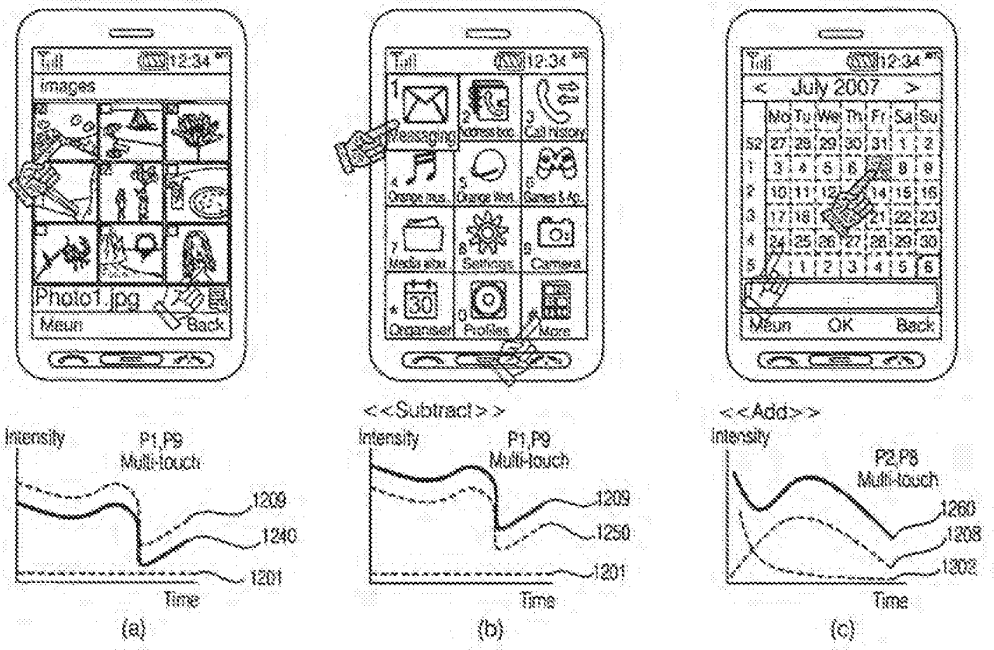

Images
Photo1.jpg
Menu
Back
<<Subtract>>
Messaging
Call history
Media app.
Settings
Camera
Organiser
Profiles
More
<<Add>>
July 2007
Menu
OK
Back
Intensity
P1,P9
Multi-touch
1209
1240
1201
Time
(a)
Intensity
P1,P9
Multi-touch
1209
1250
1201
Time
(b)
Intensity
P2,P8
Multi-touch
1260
1208
1202
Time
(c)

FIG. 19

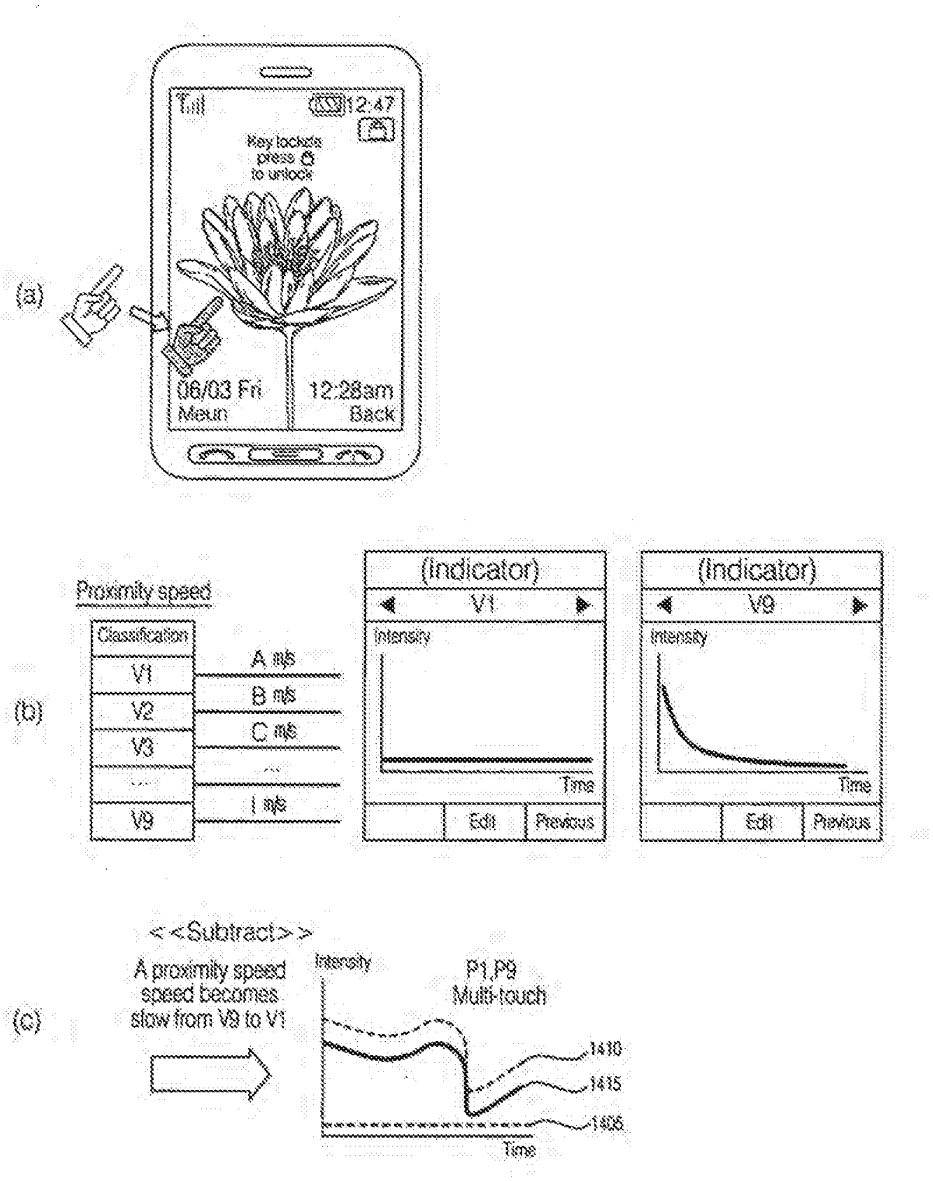

(a)
12:47
Key locked
press
to unlock
06/03 Fri
Menu
12:28am
Back
(b)
Proximity speed
Classification
V1
V2
V3
...
V9
A m/s
B m/s
C m/s
...
I m/s
(Indicator)
V1
Intensity
Time
Edit
Previous
(Indicator)
V9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
A proximity speed
speed becomes
slow from V9 to V1
Intensity
P1,P9
Multi-touch
1410
1415
1405
Time

FIG. 20

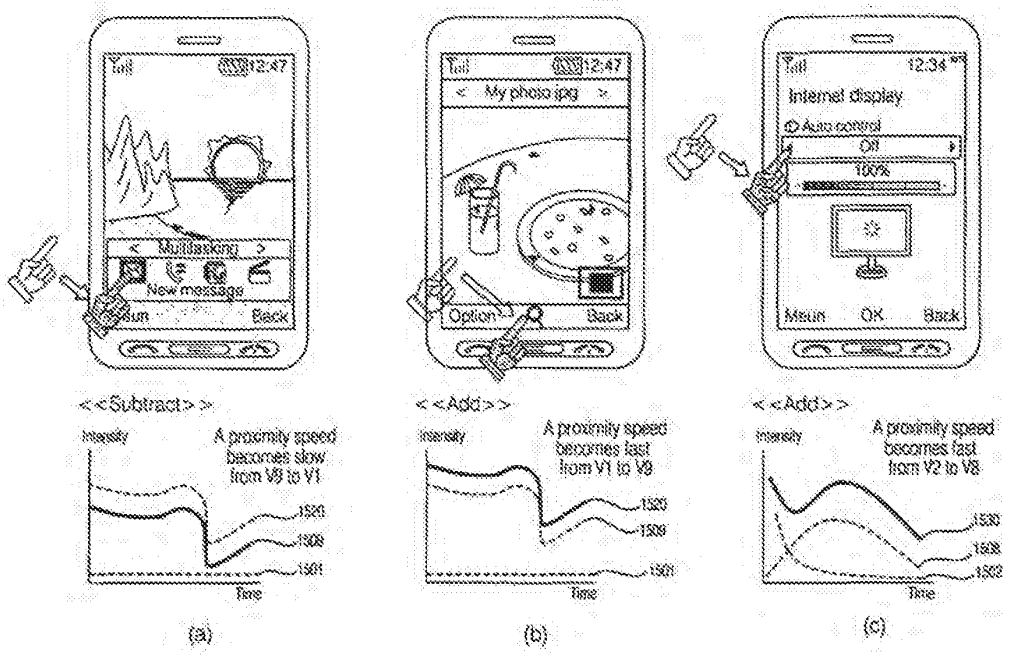

<<Subtract>>
Intensity
A proximity speed becomes slow from V8 to V1
Time
(a)
<<Add>>
Intensity
A proximity speed becomes fast from V1 to V8
Time
(b)
<<Add>>
Intensity
A proximity speed becomes fast from V2 to V8
Time
(c)

FIG. 21

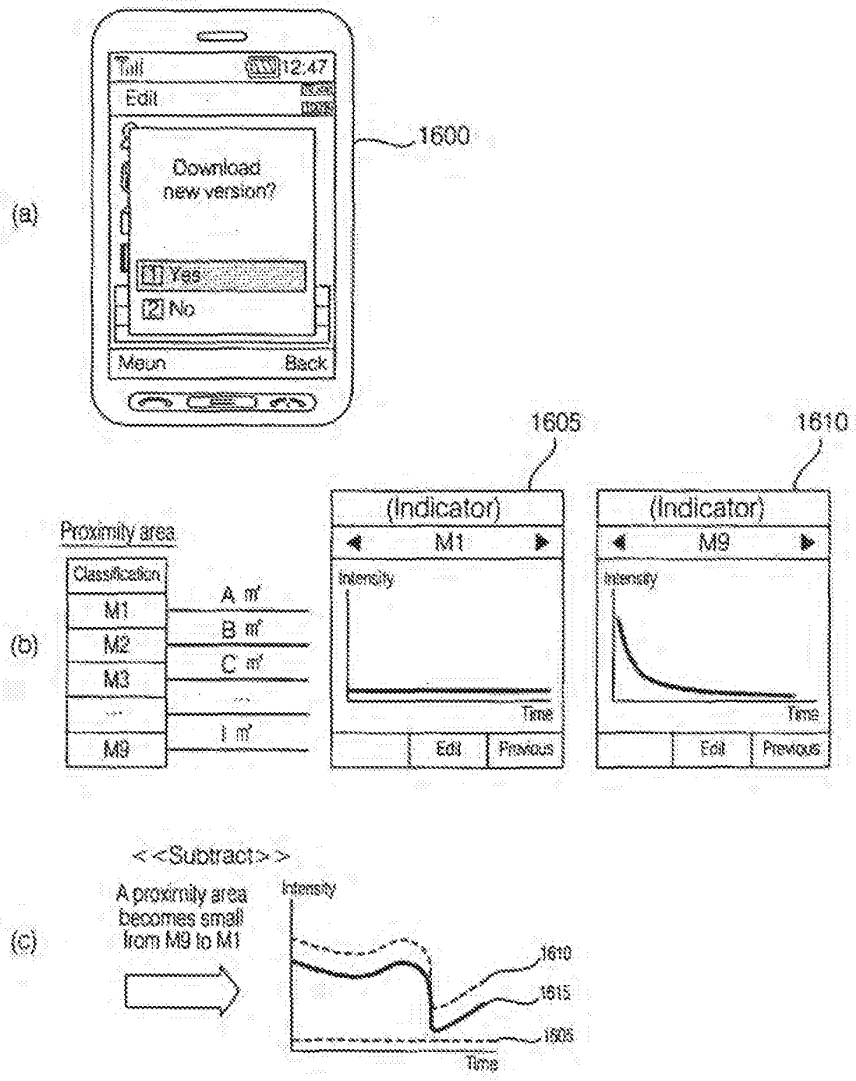
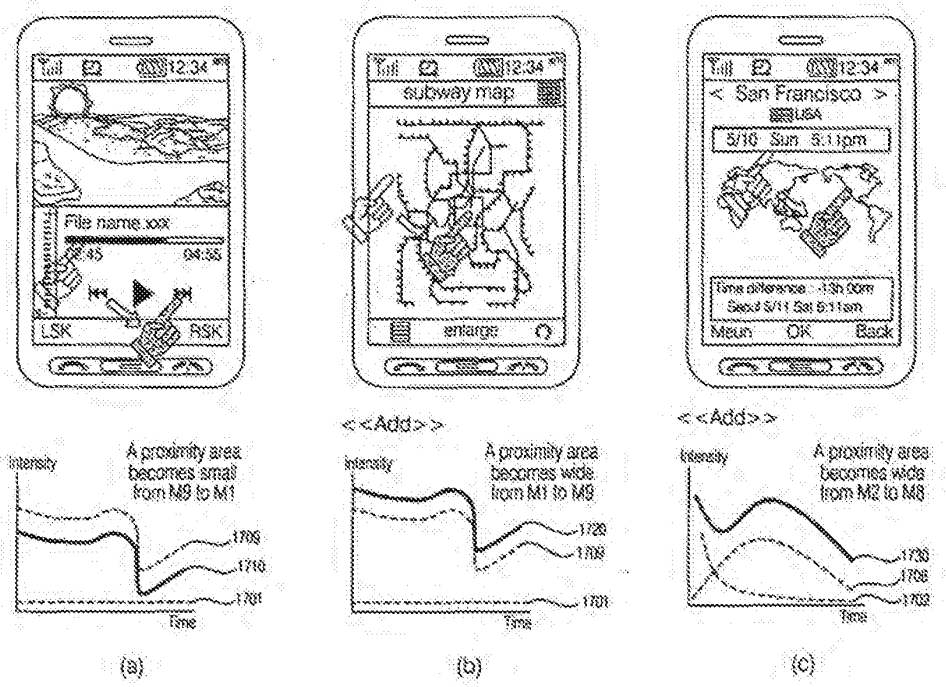

(a)
12:47
Edit
Download new version?
1 Yes
2 No
Menu
Back
1600
(b)
1605
1610
Proximity area
Classification
M1
M2
M3
M9
A m
B m
C m
1 m
(Indicator)
M1
Intensity
Time
Edit
Previous
(Indicator)
M9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
A proximity area becomes small from M9 to M1
Intensity
1610
1615
1605
Time

FIG. 22


12:34
File name.xxx
LSK
RSK
subway map
enlarge
< San Francisco >
USA
5/10 Sun 5:11pm
Menu
OK
Back
<<Add>>
<<Add>>
Intensity
A proximity area becomes small from M9 to M1
A proximity area becomes wide from M1 to M9
A proximity area becomes wide from M2 to M8
Time
(a)
(b)
(c)

Electronic Acknowledgement Receipt

EFS ID:	32561395
Application Number:	15377096
International Application Number:	
Confirmation Number:	4030
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Customer Number:	34300
Filer:	Michael T. Morlock/Kay Farmer
Filer Authorized By:	Michael T. Morlock
Attorney Docket Number:	IMM637 (051851-0971162)
Receipt Date:	08-MAY-2018
Filing Date:	13-DEC-2016
Time Stamp:	12:27:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IMM637Transmittal.pdf	94276 c06e194fc52dac4d42ba749c6d02d08456e9651d	no	2

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IMM63708a.pdf	119520 5cbdd93bb7b20cbb70155ed60ffc03dfdae362e0	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	EP_2209060_A2.pdf	11462092 ec02a1161abf8f42845a0462f86c321cb81741d0	no	10
Warnings:					
Information:					
4	Foreign Reference	EP_2887187_A1.pdf	15719895 b74937a60b7f097834b50035be0f4aef66925b0e	no	14
Warnings:					
Information:					
5	Non Patent Literature	EPEESR_04252018.pdf	7264446 d96d87ca63223e33866635ebc13148773d768eed	no	8
Warnings:					
Information:					
6	Foreign Reference	EP2141580A2.pdf	12848280 c32792ccdb0c80408a5b9d978e31caa889161fbf	no	37
Warnings:					
Information:					
			Total Files Size (in bytes):	47508509	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 8, 2018.
KILPATRICK TOWNSEND & STOCKTON LLP
By: /Kay Farmer/
Kay Farmer

PATENT
Attorney Docket No.: 051851-0971162
Client Ref. No.: IMM637

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Vahid Khoshkava	Confirmation No.: 4030
Application No.: 15/377,096	Examiner: Bryan E. Earles
Filed: December 13, 2016	Technology Center/Art Unit: 2625
For: SYSTEMS AND METHODS FOR PROXIMITY-BASED HAPTIC FEEDBACK	
Customer No.: 34300	INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the references are not enclosed.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This IDS is being filed after the mailing of the first Office Action on the merits, but before the mailing date of the final Office Action, Notice of Allowance, or any other action that closes prosecution.

I hereby certify under 37 CFR §1.97(e)(1) that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

Date: 5/8/2018

By: /Michael Morlock/
Michael T. Morlock
Registration No. 62,245

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Attachment(s):

- ☒ PTO/SB/08
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/377,096	12/13/2016	Vahid Khoshkava	IMM637 (051851-0971162)

CONFIRMATION NO. 4030

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PUBLICATION NOTICE

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Publication No.US-2018-0164886-A1
Publication Date:06/14/2018

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Attorney Docket IMM637 (051851-0971162)
Application No. 15/377,096

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Catherine A. Anderson/
Catherine A. Anderson

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Vahid Khoshkava
Application No.	:	15/377,096
For	:	**Systems and Methods for Proximity-Based Haptic Feedback**
Filed	:	December 13, 2016
Examiner	:	EARLES, BRYAN E
Art Unit	:	2625
Confirmation No.	:	4030

Mail Stop **Amendment**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO OFFICE ACTION

The following Amendment and Remarks are submitted in response to the Office Action mailed April 4, 2018.

Listing of the Claims begin on page 2 of this paper.

Remarks begin on page 5 of this paper.

LISTING OF THE CLAIMS

1. (Currently Amended) A device comprising:

a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device and outputting a first sensor signal;

a touch sensor capable of detecting a touch with the touch-sensitive ~~input~~ device and outputting a second sensor signal;

a haptic output device configured to receive a haptic output signal and output a haptic effect in response to the haptic output signal; and

a processor configured to:

receive the first sensor signal and the second sensor signal;

generate a haptic output signal based at least in part on the first and second sensor signals; and

transmit the haptic output signal to the haptic output device.

2. (Currently Amended) The device of claim 1, wherein the proximity sensor is integrated into the touch-sensitive ~~input~~ device.

3. (Original) The device of claim 1, wherein the proximity sensor comprises one of a capacitive sensor or an optical sensor.

4. (Original) The device of claim 1, wherein the haptic output signal is designed to direct a user to contact the touch-sensitive device at a particular location.

5. (Currently Amended) The device of claim 1, wherein ~~the~~ an integrated sensor comprises the proximity sensor and the touch sensor.

6. (Original) The device of claim 5, wherein the integrated sensor further comprises the haptic output device.

7. (Original) The device of claim 5, wherein the integrated sensor comprises an electro-active polymer.

8. (Original) The device of claim 7, wherein the electro-active polymer comprises a first side with a uniform electrode pattern layer affixed thereto and a second side with a network electrode pattern layer affixed thereto.

9. (Currently Amended) The device of claim 8, further comprising an elastomer layer having a first side with a second network electrode pattern ~~electrode~~ layer affixed thereto and a second side configured adjacent to the second side of the electro-active polymer.

10. (Original) The device of claim 9, further comprising an insulator layer adjacent to the first side of the electro active polymer.

11. (Original) The device of claim 3, wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor.

12. (Original) The device of claim 1, wherein the haptic output device comprises an electrostatic friction actuator.

13. (Original) The device of claim 1, wherein the haptic output device comprises an air puff actuator.

14. (Original) The device of claim 1, wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure.

15. (Currently Amended) A method comprising:

detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device;

detecting, by a touch sensor, a touch on the touch-sensitive ~~input~~ device;

transmitting a first sensor signal associated with the non-contact interaction to a processor;

transmitting a second sensor signal associated with the touch to a processor;

receiving, by the processor, the first and second sensor signals;

generating, by the processor, a haptic output signal based at least in part on the

first and second sensor signals;

transmitting, by the processor, the haptic output signal to a haptic output device; and

outputting, by the haptic output device, a haptic effect in response to the haptic output signal.

16. (Original) The method of claim 15, wherein the haptic output signal designed to direct a user to contact the touch-sensitive device at a particular location.

17. (Original) The method of claim 15, wherein outputting a haptic effect comprises outputting, by an electrostatic friction actuator, an electrostatic friction haptic effect.

18. (Original) The method of claim 15, wherein outputting a haptic effect comprises outputting, by an air puff actuator, an air puff haptic effect.

19. (Currently Amended) A computer-readable non-transitory medium encoded with executable program code, the computer-readable medium comprising:

program code for detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device;

program code for detecting, by a touch sensor, a touch on the touch-sensitive ~~input~~ device;

program code for transmitting a first sensor signal associated with the non-contact interaction to a processor;

program code for transmitting a second sensor signal associated with the touch to a processor;

program code for receiving, by the processor, the first and second sensor signals;

program code for generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals; and

program code for transmitting the haptic output signal to a haptic output device.

REMARKS

I. General

This paper is filed in response to the Non-Final Office Action mailed April 4, 2018 (the "Office Action"). The Office Action rejects all pending claims.

The Office Action objects to claims 2, 5, and 9. The Office Action rejects claims 1-4, 11-13, and 15-19 under 35 U.S.C. 102 as allegedly anticipated by U.S. 2010/0004033 to Choe *et al.* ("Choe"). The Office Action rejects claims 5 and 7-10 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and U.S. 2017/0300166 to Rosenberg ("Rosenberg"). The Office Action rejects claim 6 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe, Rosenberg, and U.S. 2017/0285848 to Rosenberg ("Rosenberg848"). The Office Action rejects claim 14 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and Rosenberg848.

Applicants respectfully request reconsideration and allowance of all pending claims.

II. Objections – Claims 2, 5, and 9

The Office Action objects to claims 2, 5, and 9 for informalities. This paper amends claims 2, 5, and 9, and Applicants request withdrawal of these objections.

III. 35 U.S.C. § 102 – Claims 1-4, 11-13, and 15-19

The Office Action rejects claims 1-4, 11-13, and 15-19 under 35 U.S.C. 102 as allegedly anticipated by Choe. The Office Action has not established that Choe anticipates the claims. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP § 2131, quoting *Verdegaal Bros. v. Union Oil Co. of Cal.*, 814 F.2d 628, 631 (Fed. Cir. 1987).

The Office Action does not establish that Choe discloses or suggests "generate a haptic output signal based at least in part on the first and second sensor signals," as is

required by claim 1. The Office Action cites to Choe paragraphs [0076]-[0078]. Office Action at 3. These paragraphs do not disclose this limitation. The claim requires "generat[ing] a haptic output signal based at least in part on the *first and second sensor signals*." Thus, the claim requires determining a haptic effect based on signals from the proximity sensor and the touch sensor. The cited paragraphs of Choe do not disclose such an embodiment. Indeed, Choe paragraph [0076] makes clear that the haptic effect is determined based only on proximity. Choe [0076] ("it may be determined what part of the display module 151 is being approached by the detected object and whether the detected object is being moved within the close vicinity of the display module 15 by determining *which of the plurality of proximity sensors 141 is outputting a proximity sensor* .... controller 180 may control the haptic module 157 to generate a haptic-effect signal corresponding to a touch key currently *being approached by the detected object*." (emphasis added)).

For the foregoing reasons the Office Action has failed to establish that claim 1 is anticipated by Choe. Independent claims 15 and 19 recite similar elements and are thus allowable for at least the same reasons as claim 1. Dependent claims 2-4, 11-13, and 16-18 each depend from and further limit one of claims 1 or 15, and thus are allowable for at least the same reasons as claims 1 and 15. Applicants request withdrawal of these rejections.

IV. 35 U.S.C. § 103 – Claims 5 and 7-10

The Office Action rejects claims 5 and 7-10 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and to Rosenberg. Applicants traverse this rejection, the Office Action fails to establish *prima facie* obviousness. *See* MPEP §§ 2141 and 2143; *Graham v. John Deere Co.*, 383 U.S. 1 (1966); *KSR Int'l Co. v. Teleflex, Inc.*, 82 U.S.P.Q.2d at 1395-96.

Claims 5 and 7-10 each depend from and further limit claim 1. As discussed above, the Office Action does not establish that Choe discloses each and every element of claim 1. The Office Action introduces Rosenberg as allegedly disclosing other limitations. But regardless of whether these limitations are disclosed by Rosenberg, the Office Action does not establish that Rosenberg cures the deficiency above. Thus, the

Office Action does not establish that claim 1 is obvious over the combination of Choe and Rosenberg, and does not establish that claims 5 and 7-10 are obvious. Applicants request withdrawal of these rejections.

V. 35 U.S.C. § 103 – Claim 6

The Office Action rejects claim 6 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe, Rosenberg, and Rosenberg848

Claim 6 depends from and further limits claim 1. As discussed above, the Office Action does not establish that Choe and Rosenberg discloses each and every element of claim 1. The Office Action introduces Rosenberg848 as allegedly disclosing other limitations. But regardless of whether these limitations are disclosed by Rosenberg848, the Office Action does not establish that Rosenberg848 cures the deficiency above. Thus, the Office Action does not establish that claim 1 is obvious over the combination of Choe, Rosenberg, and Rosenberg848 and does not establish that claim 6 is obvious. Applicants request withdrawal of this rejection.

VI. 35 U.S.C. § 103 – Claim 14

The Office Action rejects claim 14 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and Rosenberg848.

Claim 14 depends from and further limit claim 1. As discussed above, the Office Action does not establish that Choe discloses each and every element of claim 1. The Office Action introduces Rosenberg848 as allegedly disclosing other limitations. But regardless of whether these limitations are disclosed by Rosenberg848, the Office Action does not establish that Rosenberg848 cures the deficiency above. Thus, the Office Action does not establish that claim 1 is obvious over the combination of Choe and Rosenberg848, and does not establish that claim 14 is obvious. Applicants request withdrawal of this rejection.

CONCLUSION

Applicants respectfully assert that in view of the amendments and remarks above, all pending claims are allowable and Applicants respectfully request the allowance of all claims.

Should the Examiner have any comments, questions, or suggestions of a nature necessary to expedite the prosecution of the application, or to place the case in condition for allowance, the Examiner is courteously requested to telephone the undersigned at the number listed below.

Respectfully submitted,

Date: 7/24/2018

/Michael Morlock/

Michael Morlock
Reg. No. 62,245

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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) IMM637 (051851-0971162)
Application Number 15/377,096	Filed December 13, 2016
For Systems and Methods for Proximity-Based Haptic Feedback	
Art Unit 2625	Examiner Bryan E. Earles

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☑	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$ 200
☐	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
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☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

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I am the

☐ applicant.

☑ attorney or agent of record. Registration number 62245.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Michael Morlock/	7/24/2018
Signature	Date
Michael Morlock	(414) 815-6500
Typed or printed name	Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

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This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Electronic Patent Application Fee Transmittal

Application Number:	15377096
Filing Date:	13-Dec-2016
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Filer:	Michael T. Morlock/Catherine Anderson
Attorney Docket Number:	IMM637 (051851-0971162)

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
		Total in USD ($)		**200**

Electronic Acknowledgement Receipt	
EFS ID:	33261927
Application Number:	15377096
International Application Number:	
Confirmation Number:	4030
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Customer Number:	34300
Filer:	Michael T. Morlock/Catherine Anderson
Filer Authorized By:	Michael T. Morlock
Attorney Docket Number:	IMM637 (051851-0971162)
Receipt Date:	24-JUL-2018
Filing Date:	13-DEC-2016
Time Stamp:	10:16:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$200
RAM confirmation Number	072418INTEFSW10172801
Deposit Account	201430
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1		0971162response.pdf	156229 4f6166a94d21507c58d103303eddfcb9afea9839	yes	8
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	4	
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Warnings:					
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2	Extension of Time	0971162EOT.pdf	140924 7731eb6f01b8276e3088b667d464b25ad46d7e92	no	2
Warnings:					
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3	Fee Worksheet (SB06)	fee-info.pdf	30822 aff0cee5eeb968e823e148d88295e59a82befe44	no	2
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/377,096	Filing Date 12/13/2016	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	07/24/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/377,096	12/13/2016	Vahid Khoshkava	IMM637 (051851-0971162)	4030

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Kilpatrick Townsend and Stockton/Immersion
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1100 Peachtree Street
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Atlanta, GA 30309

EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

NOTIFICATION DATE	DELIVERY MODE
11/21/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 15/377,096	Applicant(s) Khoshkava et al.	
	Examiner BRYAN EARLES	Art Unit 2625	AIA Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 24 July 2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-19 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-19 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

The Office acknowledges the amendment dated 24 July 2018, in which:

Claims **1-19** are currently pending.

Claims **1, 2, 5, 9, 15 and 19** are amended.

Response to Arguments/Amendments/Remarks

Applicant's arguments filed 24 July 2018 have been fully considered but they are not persuasive.

On pages 5-6 of the Remarks, Applicant argues "the Office action does not establish that Choe discloses or suggests 'generate a haptic output signal based at least in part on the first and second sensor signals,' as required by claim 1."

The Office respectfully disagrees. The Office points to a more applicable portion of the Choe disclosure which was also cited in the previous office action. Figures 16(a)-16(c) and the corresponding paragraphs [0136] – [0138] detail an example of providing a haptic effect using the sensing signals of both the proximity sensor 141 and the touch sensor 130. As the user's finger approaches the touchscreen surface the haptic feedback effect changes to indicate the current displacement between the user's finger and the touchscreen surface. Once the user's finger contacts the key 224 of the touchscreen surface the haptic feedback effect changes to provide confirmation to the

user that a command was issued. Accordingly, Choe's disclosure fully meets the BRI of all claim limitations. Therefore, the Office maintains the rejection to claims 1-4, 11-13 and 15-19 under 35 U.S.C. 102(a)(1) as being anticipated by Choe.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

Claims 1-4, 11-13 and 15-19 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Choe et al. (US 2010/0004033, hereinafter "Choe").

With respect to **claim 1** (Currently Amended), Choe teaches a device comprising:

a proximity sensor (Choe: Fig. 1, proximity sensor 141) capable of detecting a non-contact interaction with a touch-sensitive device (Choe: Para. [0045]; the mobile terminal 100 as the touch-sensitive device) and outputting a first sensor signal (Choe: Para. [0076]);

a touch sensor (Choe: Fig. 1, user input unit 130 and the display module 151, collectively referred to as a touch screen) capable of detecting a touch with the touch-sensitive device (Choe: Para. [0043]) and outputting a second sensor signal (Choe: Para. [0048]);

a haptic output device (Choe: Fig. 1, haptic module 157) configured to receive a haptic output signal and output a haptic effect in response to the haptic output signal (Choe: Paras. [0052] and [0076]); and

a processor (Choe: Fig. 1, controller 180) configured to:

receive the first sensor signal and the second sensor signal (Choe: Fig. 1, controller 180 receives I/O signals from the proximity sensor 141, user input unit 130 and the display module 151);

generate a haptic output signal based at least in part on the first and second sensor signals (Choe: Paras. [0076] – [0078]); and

transmit the haptic output signal to the haptic output device (Choe: Fig. 1; Paras. [0083] and [0136] – [0138]).

With respect to **claim 2** (Currently Amended), Choe teaches the device of claim 1, wherein the proximity sensor is integrated into the touch-sensitive device (Choe: Fig. 1, the sensing unit 140 including the proximity sensor 141 is integrated into the mobile terminal 100).

With respect to **claim 3**, Choe teaches the device of claim 1, wherein the proximity sensor comprises one of a capacitive sensor or an optical sensor (Choe: Para. [0045]).

With respect to **claim 4**, Choe teaches the device of claim 1, wherein the haptic output signal is designed to direct a user to contact the touch-sensitive device at a particular location (Choe: Figs. 16(a)-16(c); Para. [0137]).

With respect to **claim 11**, Choe teaches the device of claim 3, wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor (Choe: Para. [0045]).

With respect to **claim 12**, Choe teaches the device of claim 1, wherein the haptic output device comprises an electrostatic friction actuator (Choe: Para. [0053]).

With respect to **claim 13**, Choe teaches the device of claim 1, wherein the haptic output device comprises an air puff actuator (Choe: Para. [0053]).

Method claims (15, 16, 17 & 18) are drawn to the method of using the corresponding apparatus claimed in claims (1, 4, 12 & 13). Therefore, method claims (15, 16, 17 & 18) correspond to apparatus claims (1, 4, 12 & 13) and are rejected for the same reasons of anticipation as used above.

Apparatus claim (19) is drawn to an apparatus substantially analogous to the apparatus as claimed in claim (1). Therefore, apparatus claim (19) corresponds to apparatus claim (1), and is rejected for the same reasons of anticipation as used above.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 5 and 7-10 are rejected under 35 U.S.C. 103 as being unpatentable over Choe in view of Rosenberg et al. (US 2017/0300166, hereinafter "Rosenberg").

With respect to **claim 5** (Currently Amended), Choe teaches the device of claim 1.

Choe does not expressly disclose:

wherein an integrated sensor comprises the proximity sensor and the touch sensor.

However, Rosenberg teaches:

wherein an integrated sensor comprises the proximity sensor and the touch sensor (Rosenberg: Abstract, Paras. [0028] and [0046]; Figs. 1-2).

Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was filed to modify the device, as taught by Choe, to incorporate the system 100, sensitive to both proximity and force inputs, with multipurpose shield electrodes, as taught by Rosenberg, in order to use the shield electrodes for a shielding effect during a

resistance measurement, and a high-resolution surface capacitance measurement (Rosenberg: Para. [0022]).

With respect to **claim 7**, the combination of Choe as modified by Rosenberg teaches the device of claim 5, wherein the integrated sensor comprises an electro-active polymer (Rosenberg: Para. [0025] Figs. 1-2, integrated sensor 100 includes a force-sensitive material 131).

With respect to **claim 8**, the combination of Choe as modified by Rosenberg teaches the device of claim 7, wherein the electro-active polymer comprises a first side with a uniform

electrode pattern layer affixed thereto (Rosenberg: Figs. 1-2, sense/drive electrode pairs 121 of the resistive touch sensor 120 formed on a surface of the force-sensing layer 130) and a second side with a network electrode pattern layer affixed thereto (Rosenberg: Para. [0038]; Figs. 1-2, shield electrode 151 formed on a surface of the force-sensing layer 130. Please note, also, the claimed “uniform electrode pattern layer” and “network electrode pattern layer” treated as distinct electrode layers.).

With respect to **claim 9** (Currently Amended), the combination of Choe as modified by Rosenberg teaches the device of claim 8, further comprising an elastomer layer having a first side with a second network electrode pattern layer affixed thereto and a second side configured adjacent to the second side of the electro-active polymer

(Rosenberg: Paras. [0035] – [0038]; Figs. 1-2, the force sensitive layer 130, the buffer layer 140, and the cover layer 142 are elastically deformable).

With respect to **claim 10**, the combination of Choe as modified by Rosenberg teaches the device of claim 9, further comprising an insulator layer adjacent to the first side of the electro active polymer (Rosenberg: Para. [0033]; Fig. 2, non-conductive buffer layer 140 applied across the force-sensing layer 130).

Claim 6 is rejected under 35 U.S.C. 103 as being unpatentable over Choe in view of Rosenberg, as applied to claims 5, 7-10 and 14 above, and further in view of Rosenberg et al. (US 2017/0285848, hereinafter "Rosenberg848").

With respect to **claim 6**, the combination of Choe as modified by Rosenberg teaches the device of claim 5.

Choe and Rosenberg does not expressly disclose:

wherein the integrated sensor further comprises the haptic output device.

However, Rosenberg848 teaches:

wherein the integrated sensor further comprises the haptic output device (Rosenberg848: Fig. 1; Para. [0091]).

Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was filed to modify the device, as taught by Choe and Rosenberg, to incorporate the haptic output device as an integrated portion of the device, as taught by

Rosenberg848, in order to provide distinct haptic feedback sensations based on the extent of user input force detected (Rosenberg848: Paras. [0022] and [0049]).

Claim 14 is rejected under 35 U.S.C. 103 as being unpatentable over Choe in view of Rosenberg848.

With respect to **claim 14**, Choe teaches the device of claim 1.

Choe does not expressly disclose:

wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure.

However, Rosenberg teaches:

wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure (Rosenberg848: Paras. [0022] and [0049]).

Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was filed to modify the device, as taught by Choe and Rosenberg, to incorporate the haptic output device as an integrated portion of the device, as taught by Rosenberg848, in order to provide distinct haptic feedback sensations based on the extent of user input force detected (Rosenberg848: Paras. [0022] and [0049]).

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BRYAN EARLES whose telephone number is (571)272-4628. The examiner can normally be reached on Monday - Thursday at 7:30am - 5:00pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William Boddie can be reached on 571-272-0666. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.

Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BRYAN EARLES/
Primary Examiner, Art Unit 2625

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Vahid Khoshkava
Application No.	:	15/377,096
For	:	**Systems and Methods for Proximity-Based Haptic Feedback**
Filed	:	December 13, 2016
Examiner	:	EARLES, BRYAN E
Art Unit	:	2625
Confirmation No.	:	4030

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO OFFICE ACTION

The following Amendment and Remarks are submitted in response to the Office Action mailed November 21, 2018.

Listing of the Claims begin on page 2 of this paper.

Remarks begin on page 5 of this paper.

LISTING OF THE CLAIMS

1. (Previously Presented) A device comprising:

a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device and outputting a first sensor signal;

a touch sensor capable of detecting a touch with the touch-sensitive device and outputting a second sensor signal;

a haptic output device configured to receive a haptic output signal and output a haptic effect in response to the haptic output signal; and

a processor configured to:

receive the first sensor signal and the second sensor signal;

generate a haptic output signal based at least in part on the first and second sensor signals; and

transmit the haptic output signal to the haptic output device.

2. (Previously Presented) The device of claim 1, wherein the proximity sensor is integrated into the touch-sensitive device.

3. (Original) The device of claim 1, wherein the proximity sensor comprises one of a capacitive sensor or an optical sensor.

4. (Original) The device of claim 1, wherein the haptic output signal is designed to direct a user to contact the touch-sensitive device at a particular location.

5. (Previously Presented) The device of claim 1, wherein an integrated sensor comprises the proximity sensor and the touch sensor.

6. (Original) The device of claim 5, wherein the integrated sensor further comprises the haptic output device.

7. (Original) The device of claim 5, wherein the integrated sensor comprises an electro-active polymer.

8. (Original) The device of claim 7, wherein the electro-active polymer comprises a first side with a uniform electrode pattern layer affixed thereto and a second side with a network electrode pattern layer affixed thereto.

9. (Previously Presented) The device of claim 8, further comprising an elastomer layer having a first side with a second network electrode pattern layer affixed thereto and a second side configured adjacent to the second side of the electro-active polymer.

10. (Original) The device of claim 9, further comprising an insulator layer adjacent to the first side of the electro active polymer.

11. (Original) The device of claim 3, wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor.

12. (Original) The device of claim 1, wherein the haptic output device comprises an electrostatic friction actuator.

13. (Original) The device of claim 1, wherein the haptic output device comprises an air puff actuator.

14. (Original) The device of claim 1, wherein the touch sensor is capable of detecting a pressure and wherein the haptic output signal is based at least in part on the detected pressure.

15. (Previously Presented) A method comprising:

detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device;

detecting, by a touch sensor, a touch on the touch-sensitive device;

transmitting a first sensor signal associated with the non-contact interaction to a processor;

transmitting a second sensor signal associated with the touch to a processor;

receiving, by the processor, the first and second sensor signals;

generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals;

transmitting, by the processor, the haptic output signal to a haptic output device; and

outputting, by the haptic output device, a haptic effect in response to the haptic output signal.

16. (Original) The method of claim 15, wherein the haptic output signal designed to direct a user to contact the touch-sensitive device at a particular location.

17. (Original) The method of claim 15, wherein outputting a haptic effect comprises outputting, by an electrostatic friction actuator, an electrostatic friction haptic effect.

18. (Original) The method of claim 15, wherein outputting a haptic effect comprises outputting, by an air puff actuator, an air puff haptic effect.

19. (Previously Presented) A computer-readable non-transitory medium encoded with executable program code, the computer-readable medium comprising:

program code for detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device;

program code for detecting, by a touch sensor, a touch on the touch-sensitive device;

program code for transmitting a first sensor signal associated with the non-contact interaction to a processor;

program code for transmitting a second sensor signal associated with the touch to a processor;

program code for receiving, by the processor, the first and second sensor signals;

program code for generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals; and

program code for transmitting the haptic output signal to a haptic output device.

REMARKS

I. General

This paper is filed in response to the Final Office Action mailed November 21, 2018 (the "Office Action"). The Office Action rejects all pending claims.

The Office Action rejects claims 1-4, 11-13, and 15-19 under 35 U.S.C. 102 as allegedly anticipated by U.S. 2010/0004033 to Choe *et al.* ("Choe"). The Office Action rejects claims 5 and 7-10 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and U.S. 2017/0300166 to Rosenberg ("Rosenberg"). The Office Action rejects claim 6 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe, Rosenberg, and U.S. 2017/0285848 to Rosenberg ("Rosenberg848"). The Office Action rejects claim 14 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and Rosenberg848.

Applicants respectfully request reconsideration and allowance of all pending claims.

II. 35 U.S.C. § 102 – Claims 1-4, 11-13, and 15-19

The Office Action rejects claims 1-4, 11-13, and 15-19 under 35 U.S.C. 102 as allegedly anticipated by Choe. The Office Action has not established that Choe anticipates the claims. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP § 2131, quoting *Verdegaal Bros. v. Union Oil Co. of Cal.*, 814 F.2d 628, 631 (Fed. Cir. 1987).

As explained previously, the Office Action does not establish that Choe discloses or suggests "generate a haptic output signal based at least in part on the first and second sensor signals," as is required by claim 1. In the rejection of claim 1, the Office Action cites to only Choe at [0076]-[0078]. Office Action at 4 (Pasted below).

> generate a haptic output signal based at least in part on the first and second sensor signals (Choe: Paras. [0076] – [0078]); and

The claim requires "generat[ing] a haptic output signal based at least in part on the *first and second sensor signals*." Thus, the claim requires determining a haptic effect based on signals from two sensors. The cited paragraphs of Choe do not disclose such an embodiment. Indeed, Choe paragraph [0076] makes clear that the haptic effect is determined based only on proximity. Choe [0076] ("it may be determined what part of the display module 151 is being approached by the detected object and whether the detected object is being moved within the close vicinity of the display module 15 by determining *which of the plurality of proximity sensors 141 is outputting a proximity sensor* .... controller 180 may control the haptic module 157 to generate a haptic-effect signal corresponding to a touch key currently *being approached by the detected object*." (emphasis added)).

In the Response to Arguments section the Office Action introduces a new citation to Choe Figures 16(a) – 16(c) and cites to Choe paragraphs [0136]-[0138] and urges that these "detail an example of providing a haptic effect using the sensing signals of both the proximity sensor 141 and the touch sensor 130." Office Action at 2. This citation does not cure the deficiency discussed above. The newly cited paragraphs do not anticipate "generat[ing] a haptic output signal based at least in part on the *first and second sensor signals*," as is required by claim 1. Rather, at best these paragraphs describe determining a first haptic effect 225 based on proximity and a second haptic effect 226 based on contact. For example, Choe describes "if it is determined that the distance between the user's finger and the key 224 has gradually decreased, the controller 180 may control the haptic module 157 to generate a **haptic effect 225**...." Choe at [0137] (emphasis added). The next paragraph describes "once the key 224 is touched or approached by the user's finger, the controller 180 may control the haptic module 157 to generate a **haptic effect 226** ...." Choe at [0138] (emphasis added). This does not disclose "generat[ing] a haptic output signal based at least in part on the *first and second sensor signals*," as is required by claim 1. Rather at best it describes determining two distinct haptic effects, 225 and 226. That these haptic effects are distinct (and thus not based in part on two sensor signals) is emphasized by the fact that the specification uses different reference numerals. 37 C.F.R. § 1.84(p)(4) requires that "[t]he same part of an invention appearing in more than one view of the drawing must always be designated by the same reference character,

and the same reference character must never be used to designate different parts." *See also*, MPEP § 608.01(g) ("[N]o single reference character being used for two different parts or for a given part and a modification of such part"). Thus, the Office Action does not establish that Choe anticipates "generat[ing] a haptic output signal based at least in part on the *first and second sensor signals*," as is required by claim 1.

For the foregoing reasons the Office Action has failed to establish that claim 1 is anticipated by Choe. Independent claims 15 and 19 recite similar elements and are thus allowable for at least the same reasons as claim 1. Dependent claims 2-4, 11-13, and 16-18 each depend from and further limit one of claims 1 or 15, and thus are allowable for at least the same reasons as claims 1 and 15. Applicants request withdrawal of these rejections.

III. 35 U.S.C. § 103 – Claims 5 and 7-10

The Office Action rejects claims 5 and 7-10 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and to Rosenberg. Applicants traverse this rejection, the Office Action fails to establish *prima facie* obviousness. *See* MPEP §§ 2141 and 2143; *Graham v. John Deere Co.*, 383 U.S. 1 (1966); *KSR Int'l Co. v. Teleflex, Inc.*, 82 U.S.P.Q.2d at 1395-96.

Claims 5 and 7-10 each depend from and further limit claim 1. As discussed above, the Office Action does not establish that Choe discloses each and every element of claim 1. The Office Action introduces Rosenberg as allegedly disclosing other limitations. But regardless of whether these limitations are disclosed by Rosenberg, the Office Action does not establish that Rosenberg cures the deficiency above. Thus, the Office Action does not establish that claim 1 is obvious over the combination of Choe and Rosenberg, and does not establish that claims 5 and 7-10 are obvious. Applicants request withdrawal of these rejections.

IV. 35 U.S.C. § 103 – Claim 6

The Office Action rejects claim 6 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe, Rosenberg, and Rosenberg848

Claim 6 depends from and further limits claim 1. As discussed above, the Office Action does not establish that Choe and Rosenberg discloses each and every element of claim 1. The Office Action introduces Rosenberg848 as allegedly disclosing other limitations. But regardless of whether these limitations are disclosed by Rosenberg848, the Office Action does not establish that Rosenberg848 cures the deficiency above. Thus, the Office Action does not establish that claim 1 is obvious over the combination of Choe, Rosenberg, and Rosenberg848 and does not establish that claim 6 is obvious. Applicants request withdrawal of this rejection.

V. 35 U.S.C. § 103 – Claim 14

The Office Action rejects claim 14 as allegedly obvious under 35 U.S.C. 103 over the combination of Choe and Rosenberg848.

Claim 14 depends from and further limit claim 1. As discussed above, the Office Action does not establish that Choe discloses each and every element of claim 1. The Office Action introduces Rosenberg848 as allegedly disclosing other limitations. But regardless of whether these limitations are disclosed by Rosenberg848, the Office Action does not establish that Rosenberg848 cures the deficiency above. Thus, the Office Action does not establish that claim 1 is obvious over the combination of Choe and Rosenberg848, and does not establish that claim 14 is obvious. Applicants request withdrawal of this rejection.

CONCLUSION

Applicants respectfully assert that in view of the amendments and remarks above, all pending claims are allowable and Applicants respectfully request the allowance of all claims.

Should the Examiner have any comments, questions, or suggestions of a nature necessary to expedite the prosecution of the application, or to place the case in condition for allowance, the Examiner is courteously requested to telephone the undersigned at the number listed below.

Respectfully submitted,

Date: 1/16/2019

/Michael Morlock/

Michael Morlock
Reg. No. 62,245

KILPATRICK TOWNSEND & STOCKTON LLP
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Electronic Acknowledgement Receipt

EFS ID:	34872796
Application Number:	15377096
International Application Number:	
Confirmation Number:	4030
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Customer Number:	34300
Filer:	Michael T. Morlock/Emily Titus
Filer Authorized By:	Michael T. Morlock
Attorney Docket Number:	IMM637 (051851-0971162)
Receipt Date:	16-JAN-2019
Filing Date:	13-DEC-2016
Time Stamp:	14:44:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/377,096
	Filing Date	December 13, 2016
	First Named Inventor	Vahid Khoshkava
	Art Unit	2625
	Examiner Name	Bryan E. Earles
	Attorney Docket Number	051851-0971162 (IMM637)

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	5,311,175	A	May 10, 1994	Waldman	
	2	6,715,045	B2	Mar 30, 2004	Braun et al.	
	3	7,890,863	B2	Feb 15, 2011	Grant et al.	

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	4	20040257339	A1	Dec 23, 2004	Takashi	
	5	20060152497	A1	Jul 13, 2006	Rekimoto	
	6	20070070044	A1	Mar 29, 2007	Yeh et al.	
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Examiner Initial*	Cite No	Foreign Document Number [3]	Country Code [2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T [5]
	14	H00643998	JP	B2	Feb 18, 1994	NCR INT Inc.		
	15	2008042745	WO	A2	Apr 10, 2008	Immersion Corporation		
	16	2008123431	JP	A	May 29, 2008	Cannon KK		
	17	20100002776	KR	A	Jan 7, 2010	LG Electronics Inc.		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [5]

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT **(Not for submission under 37 CFR 1.99)**		
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	Examiner Name	Bryan E. Earles
	Attorney Docket Number	051851-0971162 (IMM637)

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

US005311175A

United States Patent [19]

Waldman

[11] Patent Number: 5,311,175

[45] Date of Patent: May 10, 1994

[54] METHOD AND APPARATUS FOR PRE-IDENTIFICATION OF KEYS AND SWITCHES

[76] Inventor: Herbert Waldman, 1739 52nd St., Brooklyn, N.Y. 11204

[21] Appl. No.: 607,715

[22] Filed: Nov. 1, 1990

[51] Int. Cl.[5] H03M 11/10

[52] U.S. Cl. 341/34; 341/22; 341/23; 341/27

[58] Field of Search ..... 341/21, 23, 27, 22, 341/24, 34; 200/5 A; 364/709.06, 709.12, 709.14, 709.15; 400/87, 476, 477, 479, 481, 485, 491.3; 178/17 C; 379/368, 52; 340/706, 711

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2016184 9/1979 United Kingdom 364/709

Primary Examiner—Donald J. Yusko
Assistant Examiner—Michael Horabik

[57] ABSTRACT

A method and apparatus for keypads, for conveying audible, visual or tactile information to a user regarding the identity, function, proper usage or potential utility of a given key or group of keys. The information being invoked by the user through superficial or proximal manipulation of the given key without having pressed or manipulated it in a way that would invoke its normal function. The primary concern of the system is as an informational adjunct to a more traditional keypad.

18 Claims, 8 Drawing Sheets

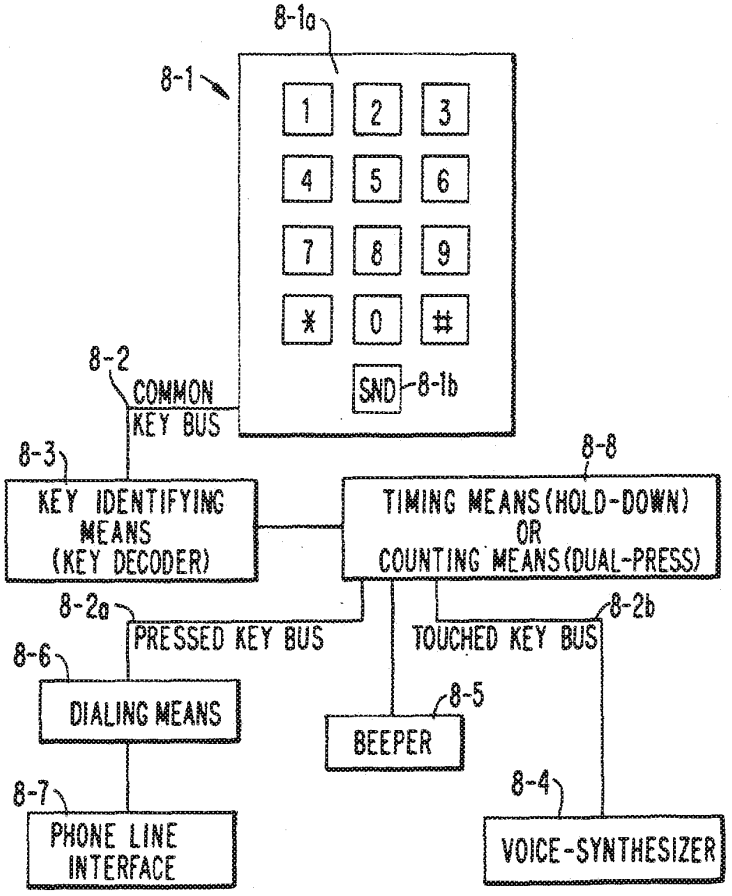


FIG. 1

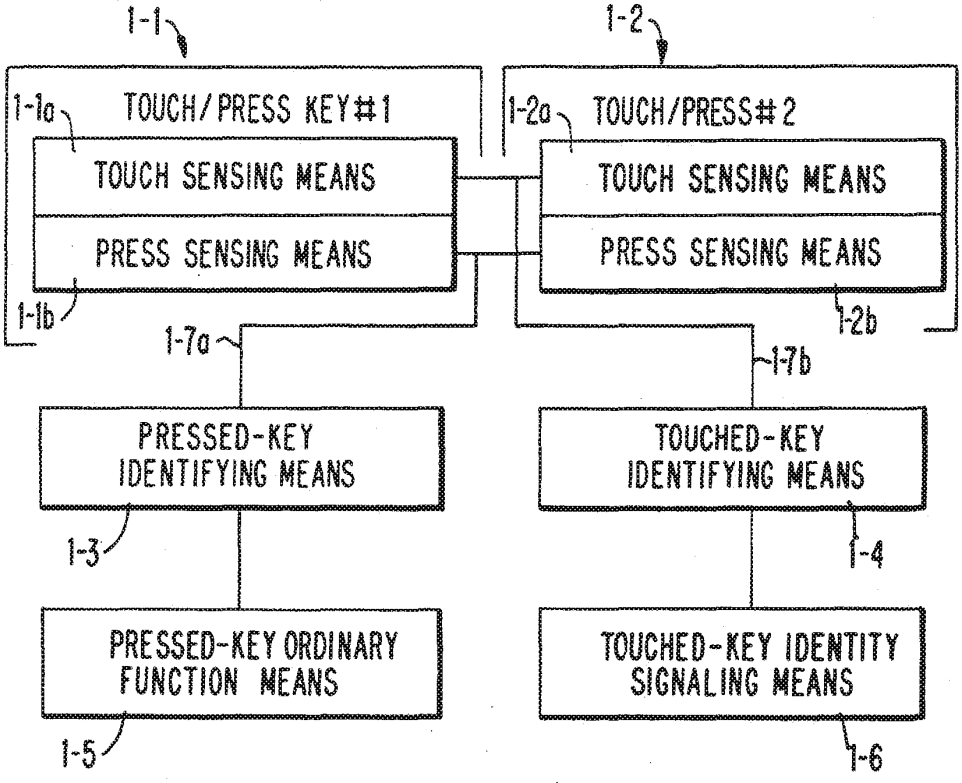

1-1
1-2
1-1a
TOUCH/PRESS KEY#1
1-2a
TOUCH/PRESS#2
TOUCH SENSING MEANS
PRESS SENSING MEANS
TOUCH SENSING MEANS
PRESS SENSING MEANS
1-1b
1-2b
1-7a
1-7b
PRESSED-KEY IDENTIFYING MEANS
TOUCHED-KEY IDENTIFYING MEANS
1-3
1-4
PRESSED-KEY ORDINARY FUNCTION MEANS
TOUCHED-KEY IDENTITY SIGNALING MEANS
1-5
1-6

FIG. 2

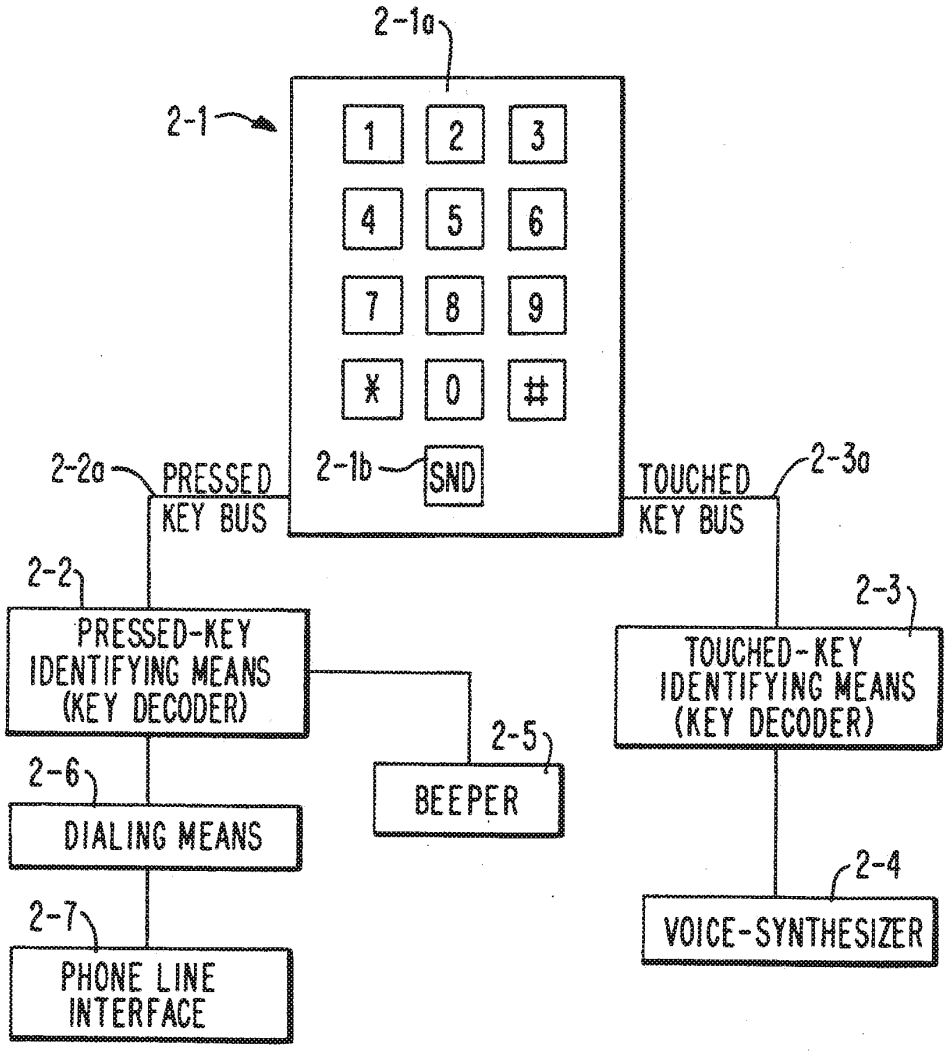

2-1a
2-1
1
2
3
4
5
6
7
8
9
*
0
#
2-1b
SND
2-2a
PRESSED KEY BUS
TOUCHED KEY BUS
2-3a
2-2
PRESSED-KEY IDENTIFYING MEANS (KEY DECODER)
2-3
TOUCHED-KEY IDENTIFYING MEANS (KEY DECODER)
2-5
BEEPER
2-6
DIALING MEANS
2-4
VOICE-SYNTHESIZER
2-7
PHONE LINE INTERFACE

FIG. 3a

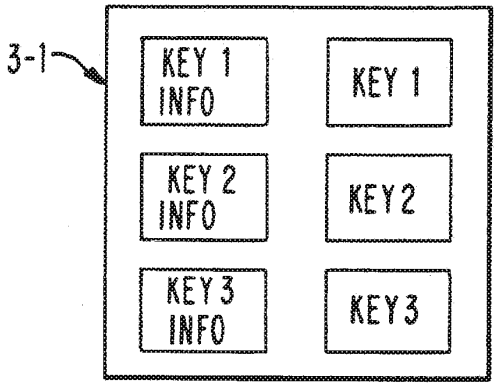


FIG. 3b

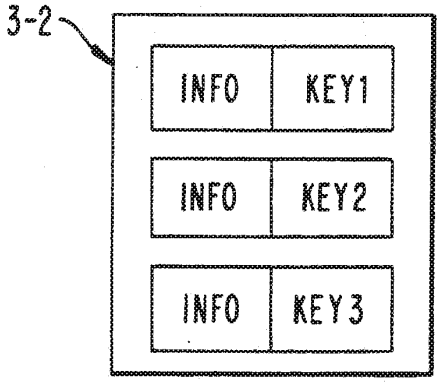


FIG. 3c

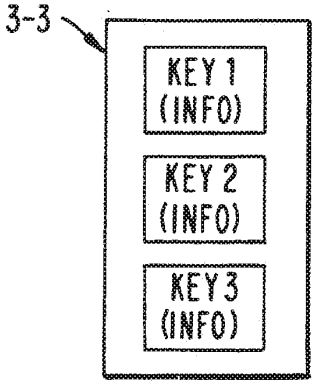


FIG. 4

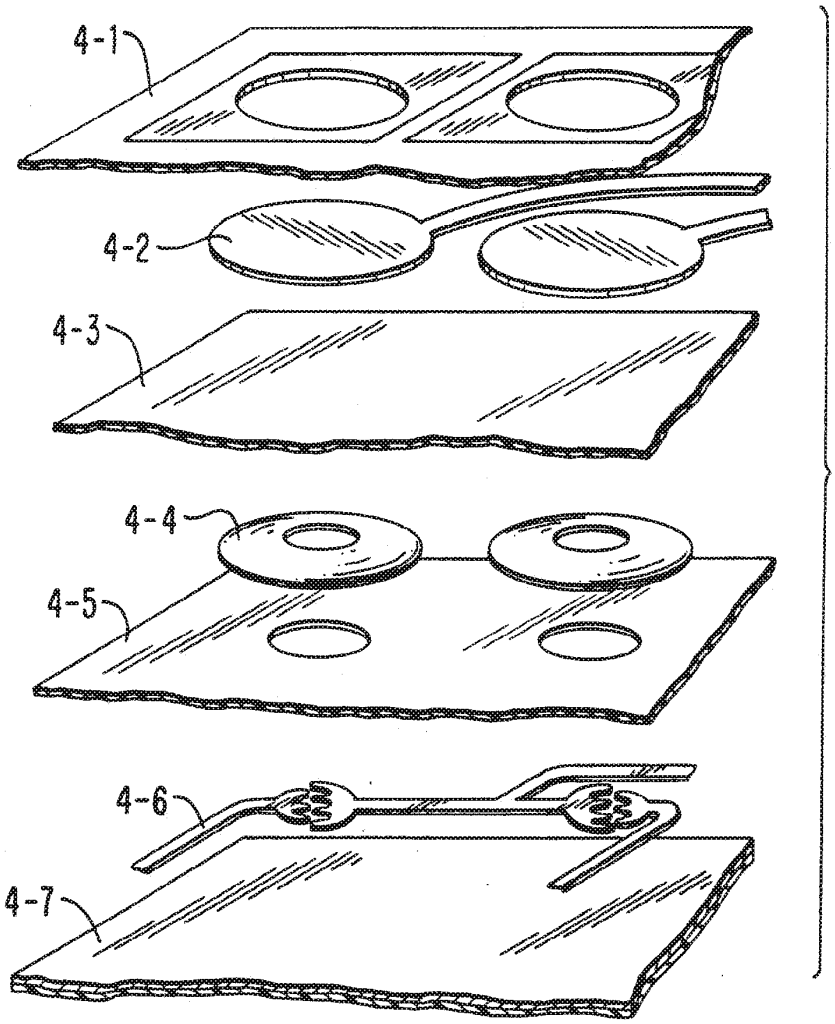


FIG. 5

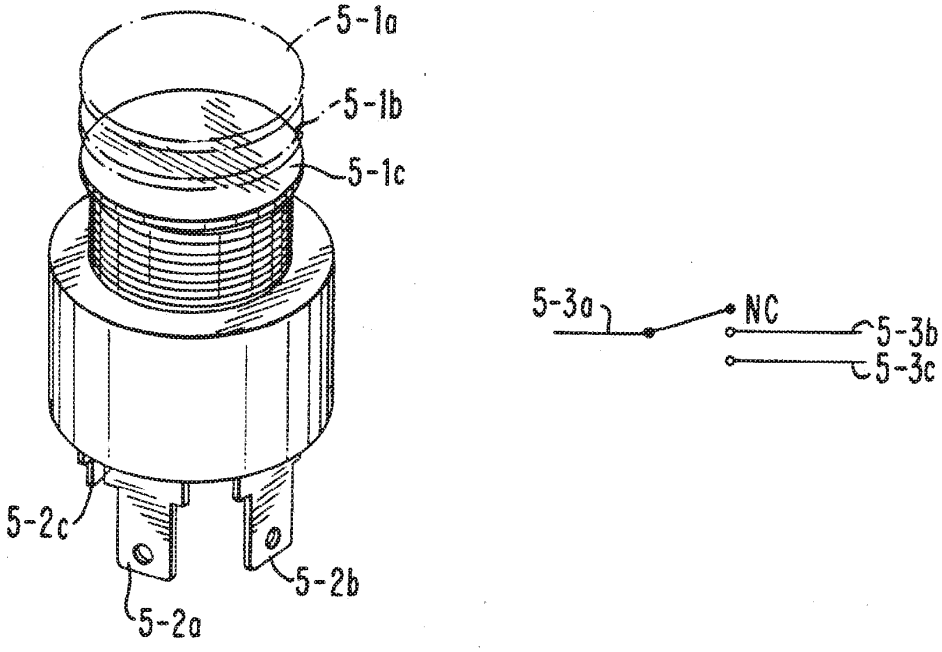


FIG. 6

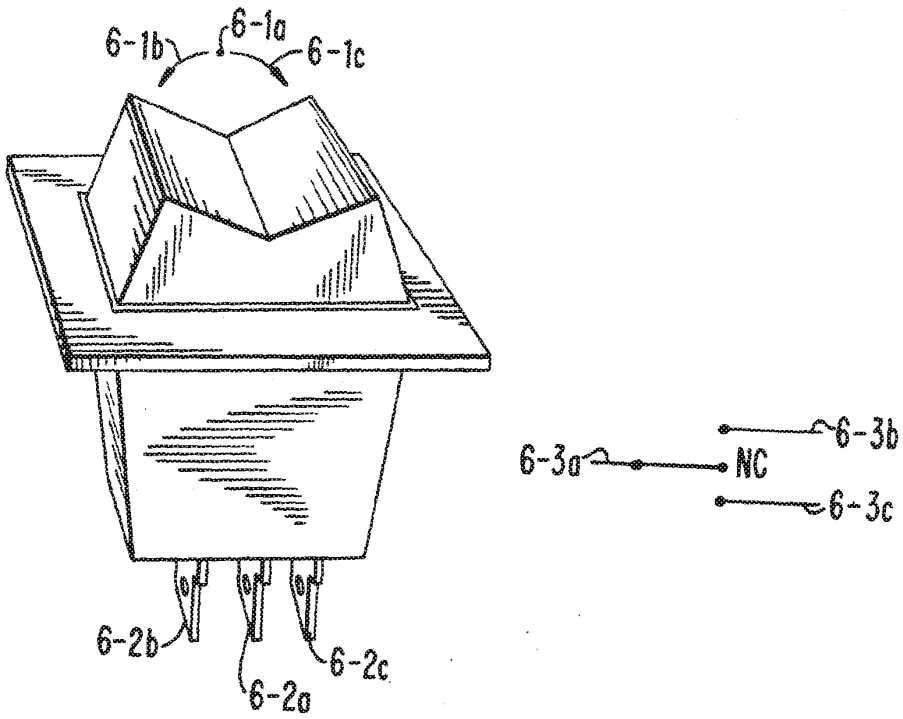


FIG. 7

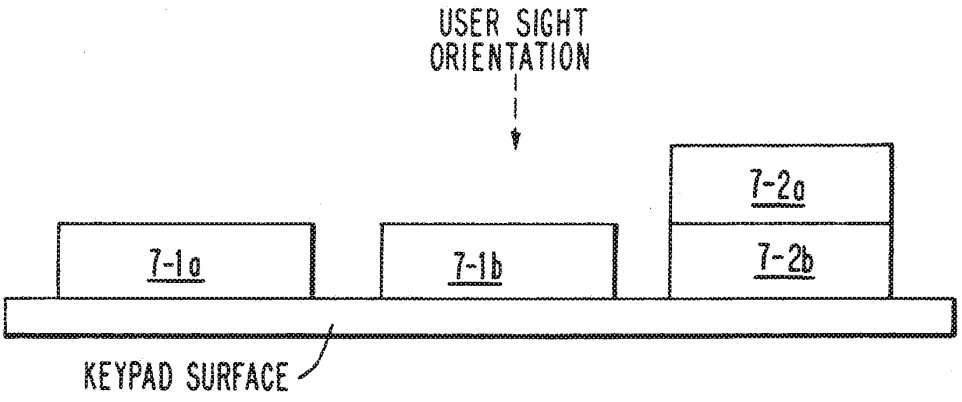
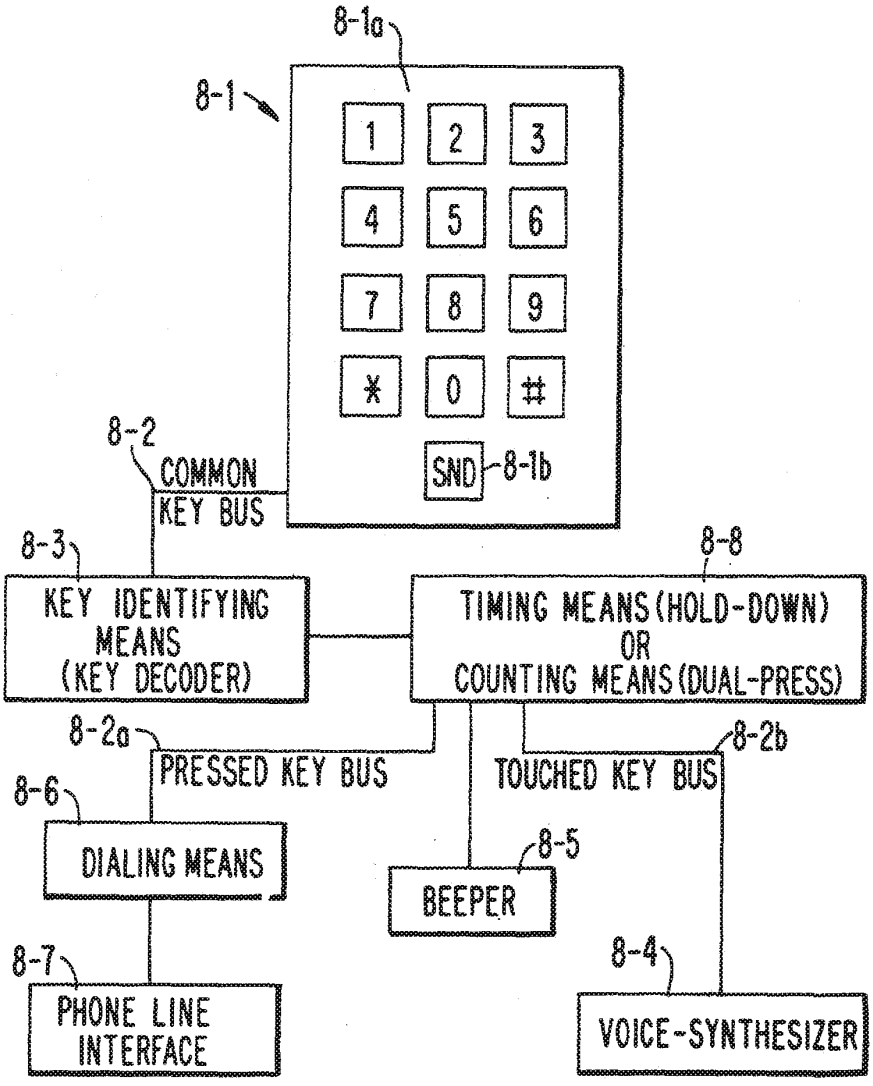


FIG. 8


8-1a
8-1
1
2
3
4
5
6
7
8
9
*
0
#
SND
8-1b
8-2
COMMON
KEY BUS
8-3
KEY IDENTIFYING MEANS (KEY DECODER)
8-8
TIMING MEANS (HOLD-DOWN) OR COUNTING MEANS (DUAL-PRESS)
8-2a
PRESSED KEY BUS
8-2b
TOUCHED KEY BUS
8-6
DIALING MEANS
8-5
BEEPER
8-7
PHONE LINE INTERFACE
8-4
VOICE-SYNTHESIZER

METHOD AND APPARATUS FOR PRE-IDENTIFICATION OF KEYS AND SWITCHES

The subject matter of this application is related to the following disclosure documents:

1. A Method for Proximity-Activated or Superficial-Contact-Activated Identification of Keys on a Pressure-Activated Keypad, Ser. No. 264,836, Sep. 7, 1990

2. A Method for Proximity-Activated or Superficial-Contact-Activated Identification of Keys on a Pressure-Activated Telephone Dialer or Keypad Particularly Adapted to Cellular and Mobile Telephones, Ser. No. 265,634, Sep. 7, 1990.

BACKGROUND OF THE INVENTION

This invention relates to key and pushbutton apparatus and a method of conveying identification, instruction, or description information about such keys or buttons, primarily when they are manipulated superficially by the user (touched) as opposed to being used in their normal fashion (pressed; i.e., having their normal functions invoked by the user). The preferred apparatus of the invention is embodied to serve this need most concisely by combining the informational key means above the ordinary functional key means in a vertical "layered" format rather than a horizontal "planar" format, such that it can be accessed informationally by a user (e.g., for identification of or instruction about the underlying ordinary function key) without actuating the (possibly erroneous or unknown) ordinary function. With audible informational means, this aspect the invention is particularly adaptable to numeric keypad/pushbutton systems with mixed functions such as modern telephone keypads, and especially suited to applications where visual distraction of the user is a problem, such as with cellular telephone keypads.

Over the past years great strides have been made in both voice-synthesis and keypad technology, and many present-day products and systems use one or both in some form. Many microprocessors and dedicated IC-circuits capable of voice-synthesis, keypad-handling, or both are available, as are many forms of matrix and pushbutton keypads utilizing both traditional (mechanical movement-and-contact) methods and more sophisticated electronic methods for non-mechanical detection of key usage. The latter include, among others, resistive and/or capacitive electrical systems using conductive or semiconductive keypad materials, low-pressure-contact matrix materials (a la LCD touch-screens), piezo-mechanical materials, as well as infra-red and other "touch-free" detection systems which detect proximity to a key rather than actual contact. Thus, as one will understand, a wide variety of such technologies is available to the present-day systems-designer for implementing both voice-synthesis and keys, and the prior art is cognizant of many techniques and applications thereof. Numerous products are also available which marry the two technologies, typically by emitting a synthesized voice message regarding the pressed key, given after a key is pressed and/or its function executes.

The prior art does not, however, disclose or anticipate the marriage of the two technologies in a form that allows a user to obtain information or instruction about a key prior to making normal use of the key by manipulating it in a superficial or characteristic manner that does not activate its normal function. The state of current electronics switching and keypad catalogs aptly

reveals this, as one can find only traditional rocker switches as a potential "off-the-shelf" embodiment of the switching needs of the invention. Even OFF-MOM-MOM mechanical pushbuttons, which are not unknown to the state of the art and could implement a system closer to the preferred embodiment than rockers, are semi-custom items not listed in short-form catalogs. No catalog hardware even approximating the preferred embodiment, which foresees a substantially zero-effort "touch-sensitive" key positioned above a substantially existent-effort "pressure-sensitive" key, is available even in semi-custom form.

It is understood, of course, that any technique which enables the user to obtain information or instruction about a key (or group of keys) before functional use of it would enhance the operation of complex keypad systems, and would particularly enhance the safe and accurate use of keypad systems (such as mobile telephones) wherein visual distraction of the user is unsafe or undesirable. There have been many articles written which describe the hazards imposed by dialing on a cellular system while manipulating an automobile, and it is obvious that any improvement or enhancement of the dialing procedure which will keep the driver's eyes on the road will be particularly advantageous and valuable. Likewise, such a device would be of immense value as a system for the handicapped, particularly the visually impaired for whom keypad use is literally a hit-or-miss affair. In both instances, the characteristic of giving identification information regarding a touched key before it is pressed and its function is executed would be of great value.

The apparatus and methods to be described enable information in a wide variety of forms to be passed to a user in a variety of ways prior to the pressing and functional invocation of a key.

The method and apparatus of the instant invention depend upon a two-level keypad system wherein a first (Touch) subsystem responds to an informational manipulation of a key and a second (Press) subsystem responds to a functional manipulation of the same key. This is accomplished most simply by vertically laminating a Touch-responsive keypad requiring little or no physical actuation pressure (such as a conductive-pad capacitive-discharge system) over the top of a traditional (mechanical throw-and-contact) Press-responsive system requiring significant actuation pressure. The former (Touch) system would then be linked to a voice-synthesizer or other information-giving means capable of decoding the Touch and passing appropriate information to the user regarding the underlying, functionally associated key.

It should be noted, however, that there are many alternative means by which the informational and keypad needs of the invention could be met. Some examples of the former are visual responses such as display messages giving help to the user regarding keypress function, or tactile feedback from the key itself for specialized identification purposes, while some examples of the latter are proximity-sensing systems rather than touch-sensing ones (e.g., infra-red), dual-throw mechanical keys wherein a moderate actuation-pressure results in the informational function while a harder pressure actuates a second throw resulting in the functional function, or even dual-press systems wherein keys are pressed once for informational use and a second time, perhaps within a given time-frame, to accomplish functional use. None of the above examples violate the spirit of the

invention, which is to provide some sort of information regarding a given key or key-group to a user without invoking the normal functionality of that key or key-group. Many implementations that would accomplish this are possible.

As one can understand, the main object of the invention is to advantageously utilize the characteristics of the many voice-generation and keypad technologies available at the present time. Numerous examples of appropriate technology are readily available in independent forms well known to the state of the art, and they can be married in a wide variety of ways to accomplish the precepts of the invention.

OBJECTIVES OF THE INVENTION

According to the concepts described above, the functional objectives of the invention is simply to provide information about a key or group of keys to the user, conveniently through the use of the key itself but without invoking the normal function of the key (and possibly suffering the consequences of incorrect usage). The simplest way to visualize the invention conceptually is as two separate but related keys adjacent to one another, wherein one is marked "Key X Information" and the adjacent key is marked "Key X." The type of information passed to the user upon invocation of "Key X Information," or the way and means by which it is passed, are inconsequential and would vary from one implementation to another. The idea is simply that some useful information regarding what will happen when "Key X" is invoked will be passed. This is a clear but awkward implementation of the concept of the invention, but not of the invention itself, which encompasses the simpler and more elegant means of associating "Key X Information" with "Key X" by combining them into a single physical key, which when used in an otherwise normal manner (e.g., touched with a fingertip) but not invoked through pressure provides "Key X Information," and when invoked through pressure executes the function of "Key X."

SUMMARY OF THE INVENTION

In a keypad system having at least one first key for effecting an ordinary function or functions when actuated in a prescribed manner by a user (such as a physically-applied pressure), at least one of said keys also having a functionally associated second key means actuated in a different prescribed manner (such as a contact with substantially zero physically-applied pressure), the system also having a user-signaling means capable of producing an informational indication to uniquely identify the associated ordinary function key to the user or likewise describe one or more useful characteristics thereof; a method wherein upon the prescribed actuation of said second key means, the system will present the associated information to the user without said first key means necessarily having been actuated or its ordinary function invoked. The apparatus of the invention accomplishes this most strongly by a vertical layering of the first and second means wherein they appear to the user as a single key, but with the second means requiring a lesser actuation effort than the first, allowing it to function informationally without actuating the second means located beneath it. The primary concern of the system of the instant invention is thus as an informational adjunct to a more traditional keypad, and the primary concern of the apparatus of the invention is to serve this need concisely by vertically associating access to both the information and ordinary function means.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a block representation of two keys incorporating Touch and Press functions.

FIG. **2** is a block representation of a simplified store & forward telephone keypad utilizing Touch and Press functions.

FIG. **3***a* is a plan view representation of a keypad employing separate informational keys.

FIG. **3***b* is a plan view representation of a keypad employing Satelite information keys.

FIG. **3***c* is a plan view representation of a keypad employing true Touch/Press combined keys.

FIG. **4** is an exploded section view of a standard "tactile-membrane" laminated keypad section including exposed conductors for Touch use.

FIG. **5** is a drawing and schematic representation of a dual-throw detente pushbutton switch with the first position requiring less effort than the second.

FIG. **6** is a drawing and schematic representation of a two-position rocker type switch suitable for use as a combined Press Key/Satellite Key.

FIG. **7** is a block side-view representation of two horizontally associated key contacts and two vertically associated key contacts on a planar surface.

FIG. **8** is an example representation of a store & forward telephone keypad & dialer with voice-synthesis key identification, capable of utilizing either a Dual-Press Protocol or a Hold-Down protocol for Touch detection with a single key bus.

STATE OF THE ART COMPONENTS

All the elements and modules of the system of the invention are well known individually in the state of the art, and are therefore shown in block form without delving into the details of their design and construction. This approach is used in order to facilitate the clarity and simplicity of the specification and to avoid undue cluttering of the drawings. Power supplies and external line or data interfaces (such as phone-line connections) are similarly not shown, except in block form where necessary.

DEFINITION OF TERMS USED

Key/Key means:

Any detection or switching means capable of signaling the occurrence of a specific mechanical user action with regard to itself, typically that of the proximity and/or contact and/or mechanical pressure of a user's finger.

Keypad:

Any arrangement of one or more keys on a substantially plar ar surface.

Press Function/Ordinary Function/Traditional Function/Execution Function:

The specific function performed by a given device in response to a specific key without regard to the invention.

Press:

Any use of a key which would invoke the ordinary function of that key.

Touch Function/Informational Function:

The function performed by a given key with regard to a functionally associated key according to the invention.

Touch:

Any use of a key which would invoke and provide for the conveyance of information about a functionally associated key, without necessarily invoking the ordinary function of said associated key.

Touch Means:

Any key or key protocol functional with regard to the above definition of a Touch.

Touch Capable Key:

Any vertically associated combination of Key means wherein layers farther from the source causing the detection or switching require a succeedingly greater effort or proximity on the part of the source to result in detection or switching.

Functionally associated:

A relationship between two keys wherein a substantially different functions are performed by each with regard to a substantially complementary purpose, e.g., a key which performs a function, associated with a key which provides information regarding said function-performing key.

Horizontally associated:

A relationship between keys primarily across a substantially planar attachment surface.

Vertically associated:

A relationship between keys primarily perpendicular to a substantially planar attachment surface.

Physically associated:

A relationship between keys consisting of having no key(s) intervening geographically between them on a given axis.

Proximally associated:

A relationship between physically and functionally associated keys consisting of having particular adjacency, coloring, labelling, or other characteristic designed to imply functional association.

(True) Touch/Press:

A vertically associated pair or set of keys wherein a key(s) upward or uppermost with regard to the user performs a Touch function(s) and the key(s) downward or lowermost with regard to the user perform a Press function(s).

Satellite Key:

A horizontally associated key or key-throw physically and proximally associated with another specific Pressable key or key-throw, performing informational actions specific to that key.

Hold-Down Protocol/Press-and-Hold Protocol:

A protocol whereby a user depresses a key uninterrupted for a given interval (or longer) in order to signify an action different from that of a depression shorter than the interval. In order to insure a positive delayed-release action of such a key, such a protocol may involve a delayed (or second) audible tone, audible phrase, or other type of system-acknowledgement of the alternate key function.

Dual-Press Protocol/Dual-Actuation Protocol:

A protocol whereby a user presses a key a second time in succession to accomplish a result different from that of a single press.

Multi-Press Protocol/Multi-Actuation Protocol:

A protocol whereby a user presses a key a predefined number of times in succession to accomplish a result different from that of a single or other number of presses.

DETAILED DESCRIPTION OF THE FIGURES

FIG. **1** is a block diagram showing Touch and Press functions residing in each of two individual keys (assemblies **1-1** and **1-2**), connected to common buses (**1-7***a* for Pressed keys and **1-7***b* for Touched Keys) that connect to means identifying the Touch source key (**1-4**) and producing a signal (**1-6**) on a Touch and identifying the Press source key (**1-3**) on a Press and executing the function(s) appropriate to it. Note that in this (preferred) embodiment the Touch sensing means (**1-1***a* and **1-2***a*), which respond to proximity or low or no finger pressure, are physically atop the Press sensing means, which respond to significant finger pressure. This, a Touch will respond in only a Touch detection, while a Press will result in both a Touch and a Press being detected. The circuitry in blocks **1-5** and **1-6** may handle this latter situation in any appropriate fashion, including aborting or altering the Touched key signal produced by **1-6**.

FIG. **2** is an exemplary system showing a simplified telephone dialing keypad (**2-1**) using a "store & forward" method whereby pressed digit keys (**2-1***a*) are buffered by a memory-equipped dialing means (**2-6**) or other memory circuit, then forwarded to the line-interface (**2-7**, including indirect interfaces such as a cellular RF-interface) by a SEND (SND, **2-1***b*) key. The illustrated system responds to a Touch (a la FIG. **1**) by decoding it (**2-3**) off the Touched Key Bus (**2-3***a*) and naming the Touched key audibly via the voice synthesizer (**2-4**), e.g., by speaking "one" when the top left-hand key is Touched, "star" if the bottom lefthand key is Touched, etc. It responds to a Press by executing the Touch functions above (since a Press implicitly causes a Touch), but also decoding the key as Pressed (**2-2**) off the Press Key Bus (**2-2***a*) and thereafter buffering the appropriate digit for dialing (**2-6**) and audibly emitting an acknowledging beep (**2-5**). Upon decoding a SND (**2-1***b*) Press, the system forwards the contents of the dialing means to the line interface (**2-7**). By confirming the identity of a Touched digit key before it is Pressed, a user can easily and consistently dial correct telephone numbers with no visual attention or input. Additionally, the system could be configured to identify the entire telephone number currently held in the dialing buffer on a SND Touch, thereby confirming the number before it is sent to the line interface by a SND Press. This latter function could also be applied to redial, memory, and other optional keys with complex functions based on previously-entered data, providing a good example of the kind of Functional and Objective Use information (described further elsewhere) that can be provided by the invention in addition to simple key-identification.

FIGS. **3***a*, **3***b* and **3***c* are a comparative plan view representation of three three-key keypads employing (respectively) separate informational keys (**3-1**), Satellite information keys (**3-2**), and true Touch/Press combined keys (**3-3**). Note that the separate key setup (**3-1**) requires a correspondi..g information key (marked "Info") for each function key, separately labelled as informational. This sort of system might be satisfactory for relaying functional or usage information, but has little utility for key-identification purposes, since the user is required to physically remove his finger from the information key and seek out the function key afterward. In contrast, although still separate, the Satellite key system (**3-2**) geographically associates the informational and functional keys more conveniently, and obviates some of the labelling requirements thereby. Note, however, that the user still has to move his finger (albeit slightly) to actuate the functional half of the pair, which makes such a system good but not foolproof for key-

identification purposes, much as blind keying can be accomplished (albeit even less reliably) on a standard telephone keypad, whose digit keys always occur in a fixed geographic relationship to one another and can be remembered. Note also that to be useful for key pre-identification purposes, the system would require either the same basic treatment as the preferred embodiment, (i.e., the "Info" half of the pair having a zero or markedly lesser actuation pressure and the functional half having a non-zero or markedly greater actuation pressure), or a distinguishable tactile (e.g., a roughened surface) or directional (e.g., a double-throw rocker-switch pad with the information-giving throws consistently to one side) characteristic allowing the information key to be readily and "blindly" recognized by the user. Some such identifying characteristic must be supplied to make such a system useful for blind keying as opposed to a traditional keypad setup.

FIG. 4 is an exploded section view of a "tactile-membrane" laminated keypad such as is commonly used and well-known to the state of the art, but additionally including conductors (4-2) exposed through holes in the face laminate (4-1) for Touch use. This example would be suitable, among others, for use with a one-conductor multiplexor-based system that responds (because of its own inherent port leakage) to the inherent capacitance of the conductor when sampled at a given frequency and sample-duration, a commonly used approach to touch-keys that requires little external circuitry. The preferred embodiments of the invention envision the principles of this type of keypad, which as represented requires a zero-effort contact for Touch purposes but a significant effort to Press. The exact mechanical effort required can be tailored by altering the semi-conical geometry of the flexible contact cup.

FIG. 5 is a drawing and schematic representation of a dual-throw OFF-MOM-MOM pushbutton switch with the first throw position 5-1*b* (which would serve the Touch purposes of the invention) requiring less mechanical throw (and therefore less total throw effort) than the second throw position 5-1*c* (which would serve the Press functions). The bottom of throw 1 would typically have a resistance type linear-detente well-known to the state of the art, used to define the actuation depth of throw 1 for the user, forced past which throw 2 would make contact. The switch could alternately be configured as an OFF-MOM1-MOM1+2 to avoid make-break-make signal conditions. For a keypad with few keys this type of switch would suffice well, but it might be an unwieldy and costly approach for more multi-key or space-critical applications, since it is larger and mechanically more complex than a typical molded or laminated unit.

FIG. 6 is a representative diagram of a two-position rocker type switch suitable for use as a combined Press Key/Satellite Key. Thrown in one direction the switch would serve the Touch purposes of the invention, while the other throw would serve the Press functions. In essence, for purposes of the invention this type of switch takes a "geographic" or "horizontally associated" approach to what the keys in FIGS. 4 and 5 do in a "stacked" or "vertically associated" fashion. This is a useable approach like the dual-throw pushbutton in FIG. 5, but might likewise prove unwieldy, costly, or space-inefficient for multi-key applications, since it is likewise larger and more mechanically complex than a typical molded or laminated unit.

FIG. 7 is a block side-view representation of two horizontally associated key contacts (7-1*a* and 7-1*b*) and two vertically associated key contacts (7-2*a* and 7-2*b*) on a planar surface, substantially indicating the difference between such associations. A user, in other words, would perceive 7-1*a* as adjacent (side-by-side) to 7-1*b*, and 7-2*a* as above (on-top-of) 7-2*b*. It can readily be seen that the user will perceive the latter as a single key, even though two separate contacts are involved. In this illustration, 7-2*a* would have a lesser (or contact or proximity) actuation pressure and provide information, while 7-2*b* would require a greater (or substantially existent) actuation pressure and would provide ordinary function. Note that without this differential actuation (i.e., if 7-2*a* and 7-2*b* had substantially the same actuation characteristics) the 7-2*a*/7-2*b* pair would essentially be nothing more than a single-throw double-pole (SPDT) switch. The superiority of a differential actuation with a functional association, however-encompassing the preferred embodiment of the invention-can readily be seen. If no tactile or geographic cue is provided to indicate to the user which of 7-1*a* and 7-1*b* provides each service, even the closest of proximal associations will not allow for pre-identification for blind keying. Such an arrangement (all else being equal) will also take up at least twice the planar area, while the extra vertical (height) differential required by 7-2*a*/7-2*b* could be negligible, using, for example, only a thin conductive film.

FIG. 8 is an example representation of a store & forward telephone keypad & dialer with voice-synthesis key identification, capable of utilizing either a Dual-Press Protocol or a Hold-Down protocol for Touch detection with a single key bus. As described elsewhere (and referring also to FIG. 2), these less preferred embodiments use timing (Hold-Down) or keypress counting (Dual Press) to discriminate between a Touch and a Press rather than separate Touch/Press contacts and buses. Note, however, that there is a single bus (8-2) only between the keypad (8-1) and the timing or keypress-counting means (8-8), since these means control the enabling flow to the Dialing (ordinary function) means (8-6 and 8-7) or the Voice-synthesizer (information) means (8-4) according to their own respective time associated or count associated parameters. Beyond this point, the system is functionally identical and equivalent to one using the preferred vertically associated embodiments, and one can easily visualize blocks 3-8 and 8-8 as constituting a transparent, time-associated bus linked to the keypad.

FORMAT OUTLINE

In order to present a clearer understanding of the specification, the following format will be used.

The implementation of the teachings of the invention will be described in connection with various device and keypad types.

At the outset we will set forth examples of some various types of information which might be generically conveyed to a user of a device incorporating the invention. We will then set forth, by way of example only, some combinations of sub-systems which might be used to implement the invention, and some exemplary embodiments in which these subsystems might be reasonably married and applied to accomplish the teachings of the invention. Finally, by way of example only, we will list and briefly discuss some common devices to which the invention might be beneficially applied.

INFORMATION TYPES

Identification Information

This is the primary and most useful sort of information with regard to the invention, since the differential key-actuation pressure under the teachings of the preferred embodiments allow quite literally for perfectly accurate "blind" keying, so long as some sort of non-visual identifying information is provided by a Touch. There are limitless types of keys with various functions which might provide apt illustration of the informational concepts of the invention, but perhaps the best and simplest is the familiar, 12-key numeric telephone keypad. Therein the invention would most likely serve to audibly pre-identify the key occupied by the user's finger prior to dialing of the digit. Thus, putting one's finger upon the "*" key without applying pressure (touching it) would result in an audible voice message saying "star," or putting it similarly on the "1" key would result in the message "one." If one simply thereafter pressed the "1" key (with one's finger already on it, having been informed), one would hear a DTMF signal or pulse-train go out onto the telephone line, accomplishing the ordinary function of the key (dialing "1" to the line) and also confirming that the ordinary function had been invoked. This is a simple form of an identification-only system that could be easily implemented according to the precepts of the invention.

Functional Help Information

Expanding upon the above example, one could likewise provide help to a user regarding the functionality of the key. Instead of simply identifying the key (e.g., saying "one"), the device might further say: "One. The one key will dial the digit one onto the telephone line." This provides the user with a description of the purpose of the key, rather than simply identifying it.

Usage Help Information

Again including the above examples, the same key might be made to say: "One. To dial a one onto the telephone line, press this key hard." This includes the identification and functionality information above, and further adds usage or "how-to" information regarding the key. This information, along with functional help, would be of significant assistance in complex key systems such as computer keypads or industrial controller keypads, wherein the functions and uses of individual keys are often not obvious and where it is likewise often difficult to make key functions "faceplate explanatory."

Objective Use Information

Expanding further, the same key might be made to say: "One. To dial a one onto the telephone line, press this key hard. Dialing this digit first will access your long-distance carrier." This includes all the preceding information, and further adds objective or "why-to" information regarding the key. This sort of information would be extremely useful in systems such as elevator keypads, wherein the contents of the floors of the building may not be obvious. In a department store, for instance, one might touch the "Floor 1" key and be given information about what is on Floor 1, e.g., "Floor 1. Lingerie, women's-wear, housewares." One could then Press the Floor 1 key to go there, or try Touching others to pre-locate other departments before Pressing the one desired. Another example of this would be objective confirmation of previously entered information, such as a telephone "memory" key configured to announce its "remembered" phone number on a touch without actually dialing or "recalling" it until it was pressed.

Informational Objectives

All of the above examples deal with a basic precept of the invention, which is to provide information about a particular key or group of keys prior to functional use or execution, the most basic and useful being simple identification. Many extant systems use and have used voice, visual display, and other feedback means during and/or post-usage, but such information (other than as a confirmation that the key's ordinary function has been actuated or accomplished) is of limited utility. To use the above elevator example, pressing the "Floor 1" key and being told, "Floor 1. Lingerie, women's-wear, housewares," while the elevator is descending is not useful if one wanted to go, say, to the Hardware department on Floor 3.

INFORMATIONAL SUBSYSTEMS

Any or all of the information discussed above could as easily be conveyed visually on a screen, and even (in either form) invoked selectively through a sub-menu invoked by the informational actuation. Other alternatives could also be used for specialized purposes, an example of which might be dynamic tactile feedback for the blind and deaf (e.g., the "1" key responding with one mechanically palpable motion or "bump" when touched, and the "2" key responding with two similar "bumps", etc.) Flashing lights could be used similarly (although the utility of doing so is more problematic), or any conventional or unconventional means which passes specific key-related information to the user.

Voice-using and display-using implementations would, however, be the most useful forms in most instances, the latter being of great benefit in devices wherein keys have complex or un-obvious functions requiring long-winded explanations, and the former being especially beneficial to the handicapped and in instances like cellular telephones wherein accurate "blind" keying is desirable because visual distraction of the user presents hazards. Many such systems, especially those conveying usage or functionality information for training or educational purposes, or those in which the invention might have limited utility to some users (e.g., a sighted person using a phone for the blind) would probably incorporate off- and/or limiting-switches to disable all or part of the invention's functions.

Various types of hardware are available for fulfilling any of the above requirements:

Voice: The archetypical modern implementation of this requires only a voice-capable IC hooked up to a audio speaker. Many such IC's and types of speakers are available, and some IC's include the subsidiary amplifier hardware necessary to drive a speaker directly. The data patterns to provide the selected words, sounds, or phonemes are often incorporated (or pre-incorporated in a manufacturer-determined format) into such IC's as a masked on-board ROM, but can also be suitably implemented using external memory components such as ROMs, PROMs or EPROMs according to the specific IC used. Many such IC's are software or firmware programmable microprocessors which could also handle keypad data acquisition and translation, as well as many other specific tasks required by particular devices. Ran-

dom-access data devices such as floppy- or hard-disks could also be used to store the necessary voice data digitally, or CD-disk systems could be employed for directly producing sounds and bypassing any on-board digital-translation steps, but random-access disks of any type could be gainfully used for very complex informational tasks or those requiring frequent changes. Even audio tapes could be employed, directly or as data-storage devices. It is also worthy of note that any such system could be made user-customizeable or configurable by including recording means as part of the hardware, allowing a user to change or tailor the informational messages according to his own needs.

Sound: In specialized applications wherein audible tones might be employed without resorting to speech, a plethora of buzzers, beepers, squawkers, tone generators and the like are available for various sounds and various purposes. Possible implementations might involve, for example, a beeper sounding a number of times indicative of the identity of the associated key (e.g., a key marked "3" could be identified by 3 short beeps), or a linear keypad might make an ascending/descending tone as one Touched the keys from left-to-right/right-to-left. In any case, such means might be easily and gainfully employed in addition to voice or display means as confirmation or warning devices, supplementing the primary Touch information in a variety of ways.

Visual: Generically we will use this term to mean the display of pictorial or alphanumeric data in a visual format, although many means for producing such are available. The simplest forms could be as rudimentary as a flashing, colored, or multi-colored light (similar to a sound-based implementation, see above), or an associated pre-printed transparency backlit only when the Touch key is invoked. For purely alphanumeric purposes, many types of traditional, segmented LED, VFD and LCD displays are available, as well as more exotic technologies for specific purposes. For more versatile (possibly pictorial) applications, a variety of pixel-matrix devices could be used, such as LCD or RGB matrix displays. It should be noted that specialized versions of the former can already be obtained for so-called "touch-screen" purposes, wherein a fixed or programmable key matrix is embedded transparently in or under the display screen. A Satellite Key, Dual-Press, or Press-and-Hold structure of the invention could be implemented using standard "touch-screen" technology, and a custom dual-level laminate with different actuation pressures could presently be used to implement the more preferred, vertically associated embodiments.

Tactile: Although the applications for this are limited (particularly to devices for the blind), many inexpensive piezo-mechanical devices are becoming available which could make a "pulse-count" tactile-feedback system practical for the purposes of the invention. Numerous temperature- and light-sensitive materials are also becoming available which change their shape or texture in response to stimulus, and which might be employed in a braille or braille-like fashion to provide more complex tactile information. A changeable "braille display" could also be conceived for use in conjunction with the operation of the invention for presenting detailed information in a purely tactile format, as for the blind and deaf.

TOUCH/PRESS KEYPAD SUBSYSTEMS

The preferred embodiment of the invention envisions what appears to the user as a single key, performing an informational function when contacted superficially and a traditional function-execution when actuated with significant finger pressure. Many hardware means could be used to effect such a system, which merely requires the superimposition of a keypad requiring no, little, or less pressure or proximity (typically contact-, proximity- or minimal-pressure-sensing) over the top of a keypad requiring some, more, or greater pressure or proximity (typically a traditional significant-pressure keypad). Both types are well known to the state of the art and have many variations, and since the concept of traditional, mechanical-pressure pushbuttons is so old and well-known as to have had its origins largely lost to history, we will not treat it here. Likewise, the concept of a minimal-pressure switch is only a technological extrapolation of a significant-pressure switch, and it can be readily seen that the former could be combined amiably with the latter. This could be approached technologically through the use of high-tech piezo-electrical components sensitive to exquisitely small pressures (also worth noting because of a lack of moving parts and because some can respond potentiometrically to mechanical stress), but the larger concept of pressure-actuated switching is still both traditional and obvious. True contact- and proximity-sensitive switches, however, are historically and technologically a more recent conceptual innovation which we will briefly exemplify:

Contact-Sensitive Switches: These types of keys are typically conductive, using the resistance, impedance, or capacitance changes caused in an exposed conductor by the contact of a finger to detect its presence. Typically they will detect an appropriate contacting surface with substantially zero pressure applied, and most are entirely insensitive to pressures above those necessary for minimal contact. Many types are well known, with the archetype perhaps being a multiplexor IC whose inherent port-leakage can be used at a specific frequency to charge a single-line conductor, which is then grounded by a touch. A less common (although still widely-used) approach is to detect contact through the electrical changes in a thermal-electric component caused by body heat.

Proximity-Sensitive Switches: These types of keys are typified by infra-red-sensitive keypads, which either passively detect the proximity of the infra-red component of body-heat, or actively generate infra-red frequencies and specifically detect occulations or reflections of their own signal. Other types of the latter could be conceived, since active-component systems can generate any sort of detectable emission for themselves-RF, for instance, or visible light or ultrasound-but infra-red types are the only ones now in common use for keypad applications.

EXEMPLARY EMBODIMENTS

The preferred embodiment of the invention envisions what appears to the user as a single key for both informational and functional purposes, performing its informational function when contacted superficially and executing its normal function when actuated with significant finger pressure. As described above, this merely requires the superimposition of a keypad requiring no, little, or less pressure or proximity over the top of a keypad requiring some, more, or greater pressure or

proximity, with the latter being actuated to perform whatever ordinary functional task is required by the user according to the device, and the former performing informationally regarding the use of that key, using whatever informational means is appropriate to the design of the device. Most of these embodiments are obvious in light of the invention's objectives, e.g., a conductive-capacitive contact-sensing pad laminated onto the surface of a pressure-activated key. Other, less obvious embodiments are possible technologically, such as a zero-pressure contact key above a minimal-pressure one, or even a completely "touchless" key operating according to a further proximity and a nearer one. The principle of a lighter-effort key functioning informationally layered vertically above a heavier-effort key functioning executionally remains the same.

There are, however, other embodiments which are both possible and practical by which the precept of supplying key-associated information prior to a function-executing keypress may be met. A few are listed below for example:

Press-and-Hold: This sort of embodiment is timing-dependent, and therefore requires only a one-contact key of any sort. The user would actuate it appropriately and hold it while the informational function was displayed or played-out, at the end of which he could either release the key (without yet having actuated its ordinary function) or continue to hold it down until the ordinary function was actuated, perhaps further indicated by a beep or other acknowledgement as determined by the designer.

Dual-Press: This type of embodiment is not necessarily timing-dependent, although practical implementations probably would be. Like the Press-and-Hold embodiment above, it likewise requires only a single-contact key, since its basis is a reliance on counting keypresses, with a first or initial press serving informationally and a second or subsequent press of the same key serving functionally. Multi-press protocols serving the purposes of the invention could likewise be devised for specific uses and devices.

Satellite Key: This type of embodiment is basically a horizontal (and less convenient) extrapolation of the dual functionality of keys according to the invention. Instead of combining the ordinary and informational functions in a laminated or vertical format, a Satellite Key structure would actually use two keys or contacts horizontally related to one another; one providing execution and the other the related information. Although this represents a possibly less-obvious association of two separate keys, less clumsy implementations can be envisioned, using, for instance, a well-known MOM-OFF-MOM or MOM-NONE-MOM rocker switch to provide the key's ordinary function when thrown in one direction and its informational function when thrown in the other. Albeit less straightforwardly, this use of two horizontally associated contacts in a single switch could allow consistent (e.g., all keys right-throw for information and left-throw for ordinary function) pre-identification of a key just as in the preferred embodiment, allowing a user to actuate either information or ordinary function without removing his finger from the key.

Stand-alones and Overlays: Since the primary concern of the instant invention is as an informational adjunct to a more traditional keypad, it is obvious that means could be devised for adding such informational capability to existing devices not so equipped. It would easily be possible, for instance, to retro-equip a flat, pressure-sensitive membrane keypad (such as those common on microwave ovens well-known in the state of the art) with a suitable touch-sensitive overlay equipped with its own self-contained informational means. Likewise, with the advent of microminiaturized piezo sound circuits (such as those used in "talking" greeting cards also well-known in the state of the art), it would be possible to make miniature, self-contained, touch-sensitive informational devices which could be post-applied to existing, separate keys, individually giving each such key the function of the invention. Such devices of any sort could contain any desired information, either particular to the device being enhanced, or for more general application (e.g., standard sets of numbers one-through-ten or zero-through-nine). Such devices could even be made to record user-decided messages into a RAM or PROM at the time of installation, making them highly versatile. With the present state of miniaturization of voice-capable memory, microcircuitry, and power supply systems (possibly including, for example, photo-voltaics where long life is desired), there are no major technological obstacles to such self-contained stand-alones and overlays.

PRACTICAL APPLICATIONS

It is obvious in light of the above that the instant invention has a broad range of potential applications in common use. For the sake of example, we will discuss several of the more obvious ones here:

Telephones: Any device with a basically numeric keypad would be an obvious candidate for enhancement with the invention (e.g., pocket or desktop calculators; microwave ovens and other home appliances; TV's VCR's, Stereos or Video Games with digitally-controlled tuning or functions; or remote controls for these and other common digitally-controlled devices) but none is more ubiquitous than the telephone and its familiar dozen keys. The benefits to the visually imparied should be obvious (and this might well include sighted people in a power blackout), but the most compelling application is in mobile use. Cellular-phone safety is currently being addressed in many ways—often propelled by a legislative push in the back—and most of the issues of talking while driving have been adequately addressed by the new generation of hands-free phones. These phones are typically only hands-free for conversation, however, with dialing remaining another matter, and with the split-attention problems involved only being compounded by the need for compactness in cellular keypads.

This aspect of the cellular-safety problem has been redressed only badly by the current generation of phones, and the necessity of removing one's concentration-if not one's eyes-from the road continues to be a problem. The only broad and current alternative to keypad dialing, voice-recognition, is still quite costly and suffers from enormous unreliability problems due to the constantly shifting ambient-noise characteristics of the mobile environment, requiring extensive and expensive (and often futile anyway) filtering systems. These systems also often require "training" for a particular user's voice, making them susceptible to vagaries (like headcolds) in the user's voice pattern, and are awkward to use in any case, having specialized protocols lacking the familiar, self-explanatory characteristics of a standard phone keypad. Most also do not allow full voice access to many of the useful special features of the base telephone unit, such as auto-redialers and repertory

memories. The invention therefore represents a viable, less expensive, and far less frustrating alternative to such marginally-useable systems, still requiring one hand of a driver, but audibly allowing him to quickly and accurately "blind-key" a number without removing his eyes from the road, and similarly not taxing his concentration to recall the rules of voice-recognition "phone-speak." With proper treatment, the invention could likewise identify and describe all the keys on the pad, allowing the user full and equally "blind" access to rapid-dialing and convenience features.

Finally, it should be noted in the latter regard that single-key telephone memories make an excellent example of how a non-prerecorded informational announcement might be used. With an on-board RAM or EEPROM and recording means to support it, a memory key might be programmed with both a number and a corresponding name. Thus, if "Memory 1" was programmed to dial Herb's number, the corresponding informational means would similarly be programmed to announce "Herb" rather than "Memory one" when Touched.

Elevators: As previously noted, a department-store elevator is an excellent example of how the invention might be used to give Touch information regarding the objective of a corresponding Press. This would more likely be implemented visually than audibly, since a great many people would use such an elevator, but with some sort of graphics capability such a display might easily depict not only the departments on the Touched floor, but also an overview of the floor itself, allowing users to quickly reference the exact location of any given department. An audible identification might also be included for visually-handicapped users unable to use the graphic data (a feature that would certainly apply to elevator keypads in any sort of building, or indeed any sort of keypad intended for public access, such as automated teller machines or (again) public telephones).

Home Appliances: The ubiquitous VCR that "only my kid can program" is an excellent example of a keypad system whose use might be enhanced and simplified by some on-the-keypad functional and usage information. This could be audible, or, since most modern units do their programming on-screen, could as easily be designed to use the television itself as the informational display. Such functions could also be applied to any of the raft of household devices which are drifting from analog knobs and dials to a keypad format, such as microwave ovens, dishwashers, and washers and driers. Again, the handicapped could also benefit from such incorporation, which could even be made available by manufacturers as an add-on overlay fitting existing keypad products.

Industrial Consoles: Many companies and industries make use of complex custom and semi-custom keypads for tasks ranging from design to process-control. Such systems are often complex and not functionally obvious, and in the worst cases the misuse of a single key might bring down an entire system or production line. Training employees to use such systems can be arduous as well, and the invention might be beneficially employed both to reduce this and manage the overwhelming "VCR-syndrome" complexity of the most complicated systems. Again, there are also many industrial applications wherein handicapped workers might benefit significantly from devices equipped with the invention.

Computers: The benefits of the invention for most computer users are neither great nor obvious, but the benefits for neophyte users (especially the very young) might be significant, and for visually handicapped users would be clear and manifold. Again, the invention could be applied easily in an overlay form to most PC's and common consoles, especially in a purely identificational form. Since form-fitting rubber dust covers which do not require removal are already available for most common layouts, the extrapolation to a conductive-rubber "talking-dust-cover" would be a short and happy one for the blind, especially since the data processing community is one of a very few high-paying areas where the handicapped in general have made significant employment inroads. Such specialty items could even be designed to interface with the main processor, and with appropriately sophisticated software might make even the complexities of rapid and accurate word-processing or spreadsheet use an attainable goal.

Likewise, the benefits of the invention might well be applied to most of the specialty computers, "how-to" software, and computer keyboards designed for the education of small children. Typing-tutor applications are one widespread and obvious possibility.

One skilled in the art will immediately understand that there are many, probably thousands, of ways in which the teachings of this invention could be implemented in various devices with various aims. All such ways are deemed to be within the spirit and scope of the claims appended to this specification.

I claim:

1. A system operable from at least one inputted signal, comprising

at least one switching means having first and second states, said first state being the default state while said second state being a partial requirement for producing a predetermined signal, said at least one switching means responsive to manual contact for changing its state from said first state to said second state for producing said predetermined signal regardless of the duration of the period of time in said second state after being in said second state continuously for at least a predetermined period of time,

pre-identification means coupled to said at least one switching means and operable for producing a pre-identification signal when the state of said at least one switching means has been changed from said first state to said second state, said pre-identification signal identifying said predetermined signal to an operator,

signal generating means operatively coupled to said at least one switching means for generating said predetermined signal after said at least one switching means has been maintained in said second state for said predetermined period of time, and

timing means operatively coupled to said at least one switching means for generating a timing signal for measuring a time period from when said at least one switching means is changed from its first state to its second state,

whereby, said at least one switching means initially informs an operator as to the predetermined signal and thereafter, produces its predetermined signal if it is maintained in its second state throughout the predetermined time period as measured by said timing means regardless of any additional time said second state is maintained.

2. The system as claimed in claim 1, further comprising indicating means operable for indicating that said at least one switching means has been maintained in said second state for the predetermined time.

3. The system as claimed in claim 1, wherein said pre-identification means generates an audible indication of said predetermined signal.

4. The system as claimed in claim 1, wherein said pre-identification means generates a visual indication of said predetermined signal.

5. The system as claimed in claim 1, wherein said at least one switching means includes a mechanical switch for changing between the states of said switching means.

6. The system as claimed in claim 5, wherein said mechanical switch has a single contact pair.

7. The system as claimed in claim 1, wherein there are a plurality of switching means, each switching means having an associated predetermined signal, an associated predetermined time period and an associated pre-identification means.

8. A system operable from at least one inputted signal, comprising

at least one switching means including first inputting means having first and second states and second inputting means having first and second states,

the first state of said first inputting means being a default state, said first inputting means being responsive to manual contact for changing its state from said first state to said second state,

the first state of said second inputting means being a default state and the second state of said second inputting means being operable for producing a predetermined signal, said second inputting means responsive to manual contact for changing its state from said first state to said second state,

pre-identification means coupled to said at least one switching means and operable for producing a pre-identification signal when the state of said first inputting means has been changed from its first state to its second state, and

signal generating means operatively coupled to said at least one switching means for generating said predetermined signal when said second inputting means is changed from its first state to its second state,

said second inputting means being operable independent of said first inputting means so that said second inputting means can be used to generate said predetermined signal without a pre-identification signal being produced first,

whereby an operator can first change the state of said first inputting means to its second state, learn from said pre-identification means the associated predetermined signal, and thereafter, change the state of said second inputting means from its first state to its second state to produce said predetermined signal or alternately, the operator can change the state of only the second inputting means to its second state to produce said predetermined signal.

9. The system as claimed in claim 8, wherein said pre-identification means generates an audible indication of said predetermined signal.

10. The system as claimed in claim 8, wherein said pre-identification means generates a visual indication of said predetermined signal.

11. The system as claimed in claim 8, wherein said first and second inputting means are positioned adjacent each other.

12. The system as claimed in claim 8, wherein said at least one switching means is in the form of a split dual section membrane type switch.

13. The system as claimed in claim 8, wherein said first and second inputting means are combined into a single mechanical switch.

14. The system as claimed in claim 8, wherein there are a plurality of switching means, each switching means having an associated predetermined signal, and an associated pre-identification means.

15. A method of operating a system comprising at least one switching means having first and second states, said first state being the default state while said second state being a partial requirement for producing a predetermined signal, said at least one switching means responsive to manual contact for changing its state from said first state to said second state for producing said predetermined signal regardless of the duration of the period of time in said second state after being in said second state continuously for at least a predetermined period of time,

said method comprising

changing said switching at least one means from its first state to its second state.

generating a pre-identification signal when the state of said at least one switching means has been changed from said first state to said second state, said pre-identification signal identifying said predetermined signal to an operator, and

generating said predetermined signal only after said at least one switching means has been maintained in its second state a predetermined period of time,

whereby, a single change in the state of said at least one switching means initially enables the operator to identify the associated predetermined signal and maintaining the change in state for at least the predetermined period of time generates said predetermined signal.

16. The method as claimed in claim 15, further comprising the step of indicating that said switching means has been maintained in said second state for the predetermined time.

17. The method as claimed in claim 15, wherein said pre-identification signal generates an audible indication of said predetermined signal.

18. The method as claimed in claim 15, wherein said pre-identification signal generates a visual indication of said predetermined signal.

* * * * *

US006715045B2

(12) **United States Patent**
Braun et al.

(10) **Patent No.: US 6,715,045 B2**
(45) **Date of Patent: *Mar. 30, 2004**

(54) **HOST CACHE FOR HAPTIC FEEDBACK EFFECTS**

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(73) Assignee: **Immersion Corporation**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **10/060,472**

(22) Filed: **Jan. 29, 2002**

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US 2002/0095224 A1 Jul. 18, 2002

Related U.S. Application Data

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(51) **Int. Cl.**[7] **G06F 12/00**

(52) **U.S. Cl.** **711/154**; 711/133; 711/159; 710/57; 345/701; 345/702; 341/27

(58) **Field of Search** 711/118, 133, 711/134, 135, 136, 167, 154, 159; 710/57; 341/20, 27; 345/701, 702

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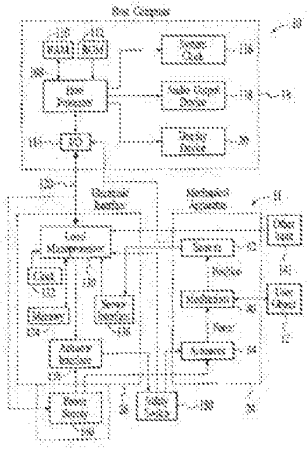
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(74) *Attorney, Agent, or Firm*—Kilpatrick Stockton LLP

(57) **ABSTRACT**

Methods and apparatus for efficient management of memory in a haptic feedback system including a host computer and a haptic feedback device. A representation of device memory is maintained on the host computer to allow the host computer knowledge of force effects stored in the device memory. A host cache for force effects is provided to allow larger numbers of force effects to be created for the device, where force effects not able to fit in device memory can be stored in the host cache.

20 Claims, 9 Drawing Sheets



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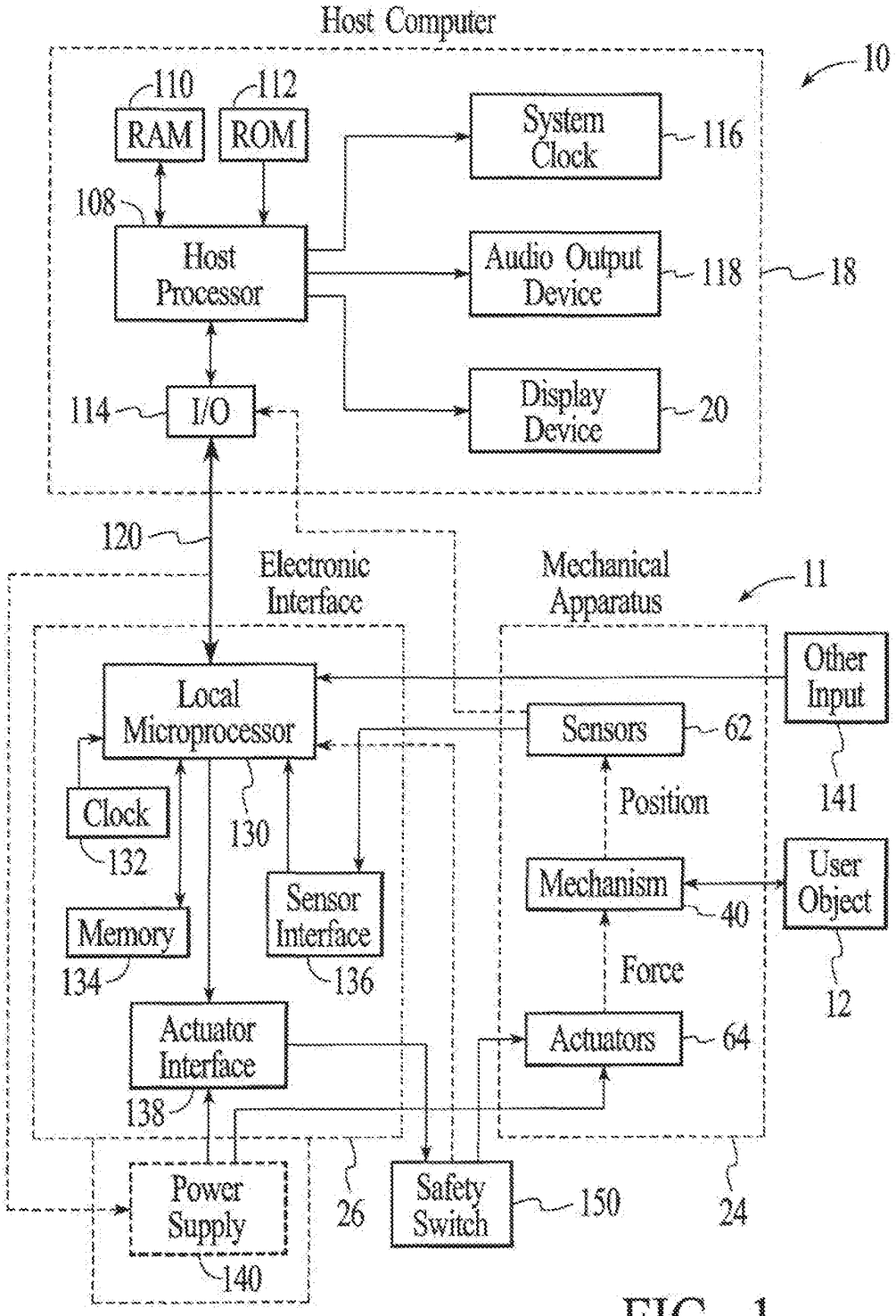

Host Computer
10
110
RAM
112
ROM
System Clock
116
108
Host Processor
Audio Output Device
118
18
114
I/O
Display Device
20
120
Electronic Interface
Mechanical Apparatus
11
Other Input
Local Microprocessor
Sensors
62
Clock
132
130
Position
141
Mechanism
User Object
Sensor Interface
40
Memory
134
136
Force
12
Actuator Interface
Actuators
64
138
Power Supply
140
26
Safety Switch
150
24

FIG. 1

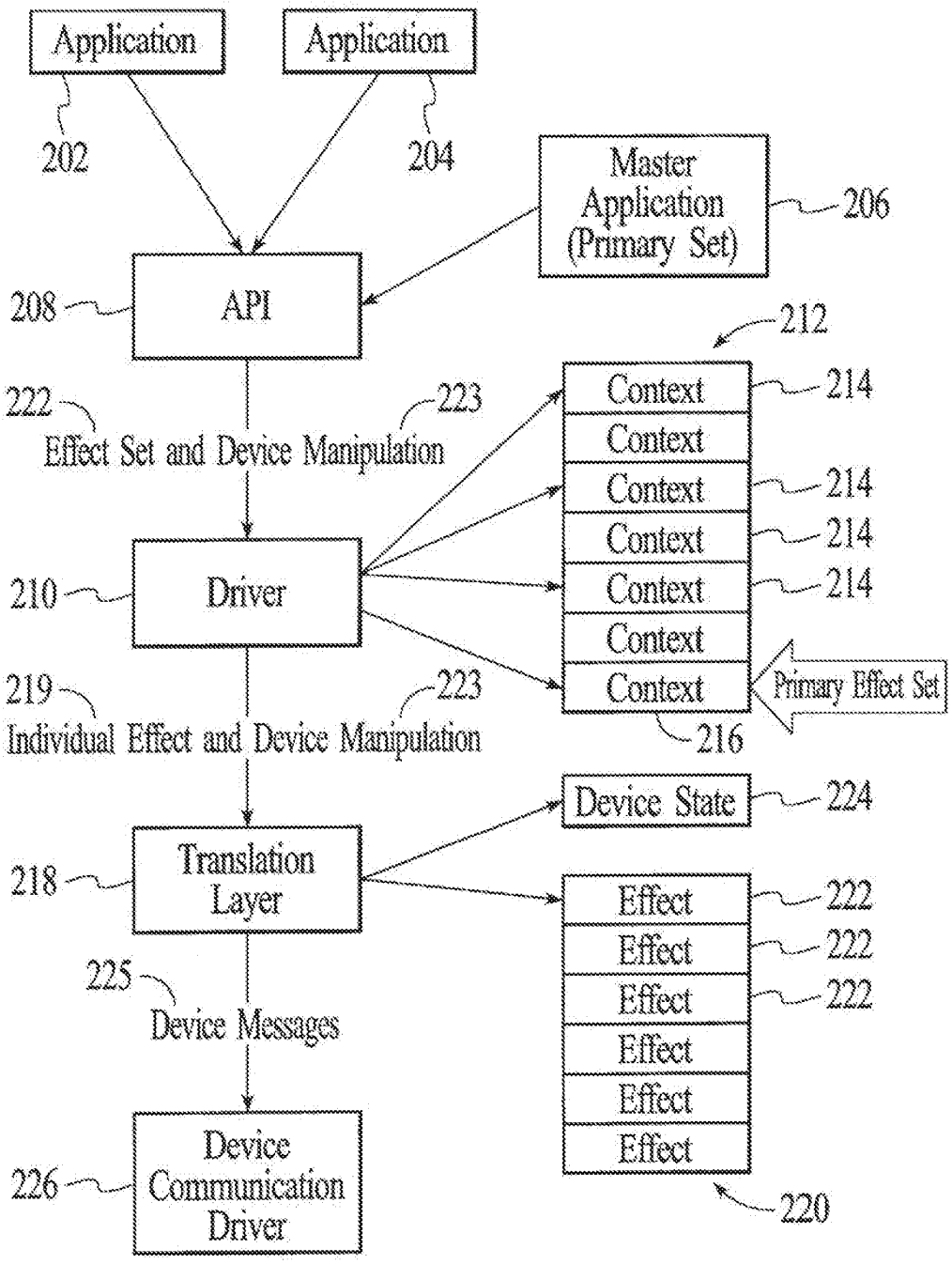

Application
Application
202
204
Master Application (Primary Set)
206
208
API
212
222
Effect Set and Device Manipulation
223
Context
214
Context
Context
214
Context
214
Context
214
Context
Context
Primary Effect Set
210
Driver
219
Individual Effect and Device Manipulation
223
216
Device State
224
218
Translation Layer
Effect
222
Effect
222
Effect
222
Effect
Effect
Effect
225
Device Messages
220
226
Device Communication Driver

FIG. 2

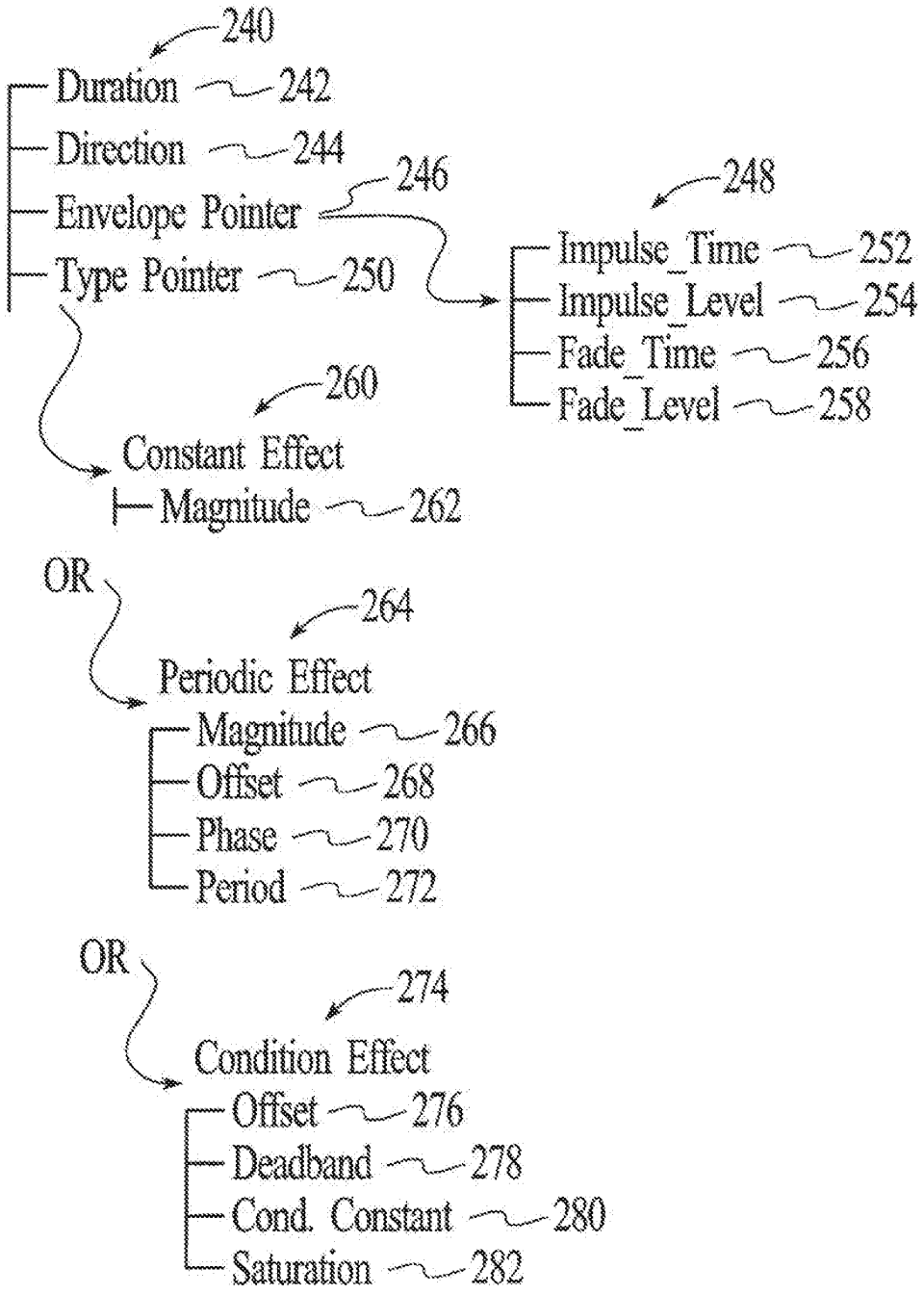

240
Duration 242
Direction 244
246
Envelope Pointer
248
Impulse_Time 252
Impulse_Level 254
Fade_Time 256
Fade_Level 258
Type Pointer 250
260
Constant Effect
Magnitude 262
OR
264
Periodic Effect
Magnitude 266
Offset 268
Phase 270
Period 272
OR
274
Condition Effect
Offset 276
Deadband 278
Cond. Constant 280
Saturation 282

FIG. 3

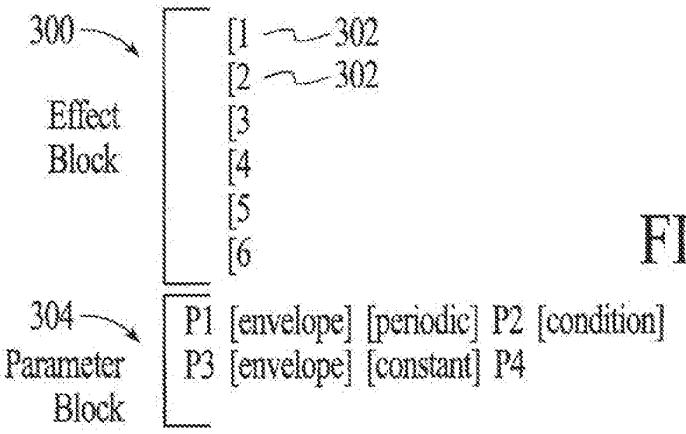


FIG. 4

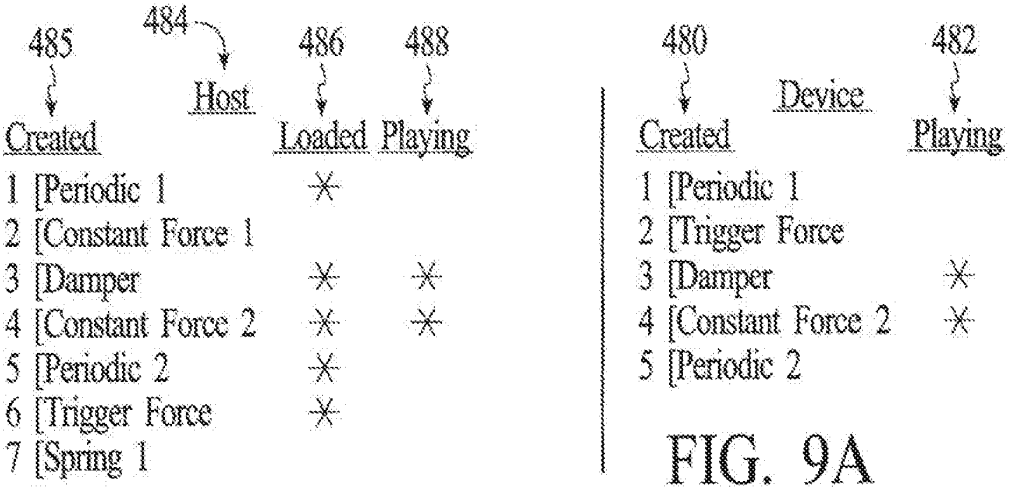


FIG. 9A

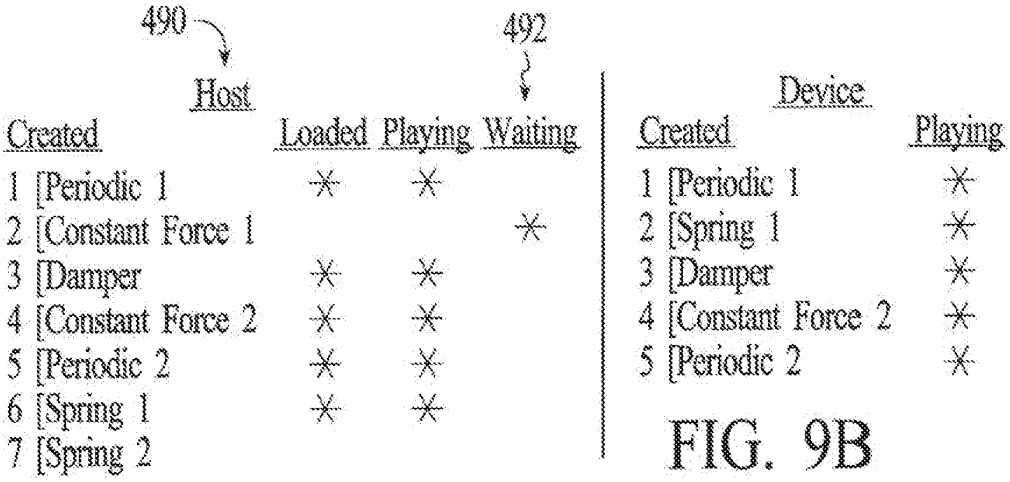


FIG. 9B

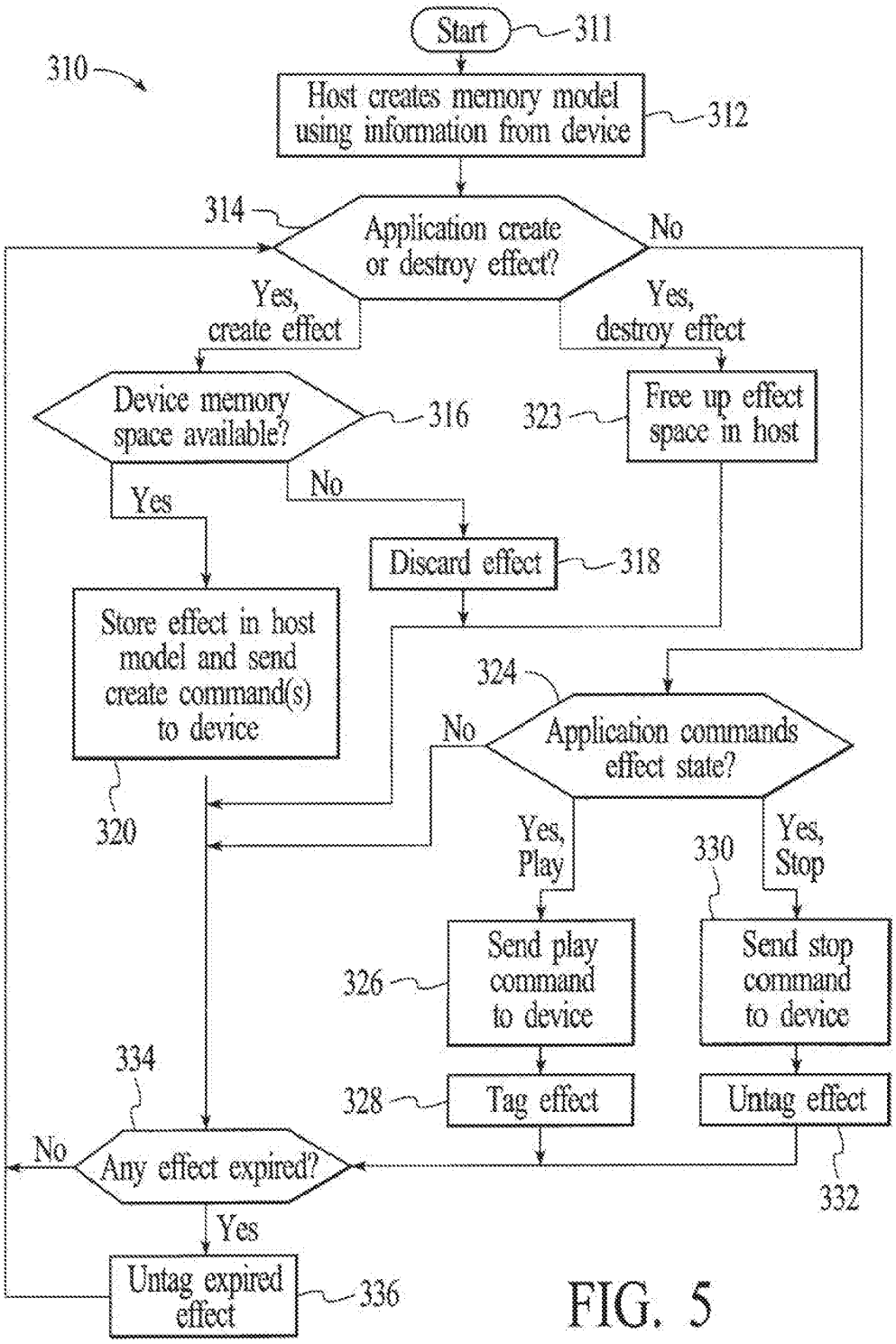

Start
311
310
Host creates memory model using information from device
312
314
Application create or destroy effect?
No
Yes, create effect
Yes, destroy effect
Device memory space available?
316
323
Free up effect space in host
Yes
No
Discard effect
318
Store effect in host model and send create command(s) to device
324
No
Application commands effect state?
320
Yes, Play
330
Yes, Stop
Send play command to device
326
Send stop command to device
334
328
Tag effect
Untag effect
No
Any effect expired?
332
Yes
Untag expired effect
336

FIG. 5

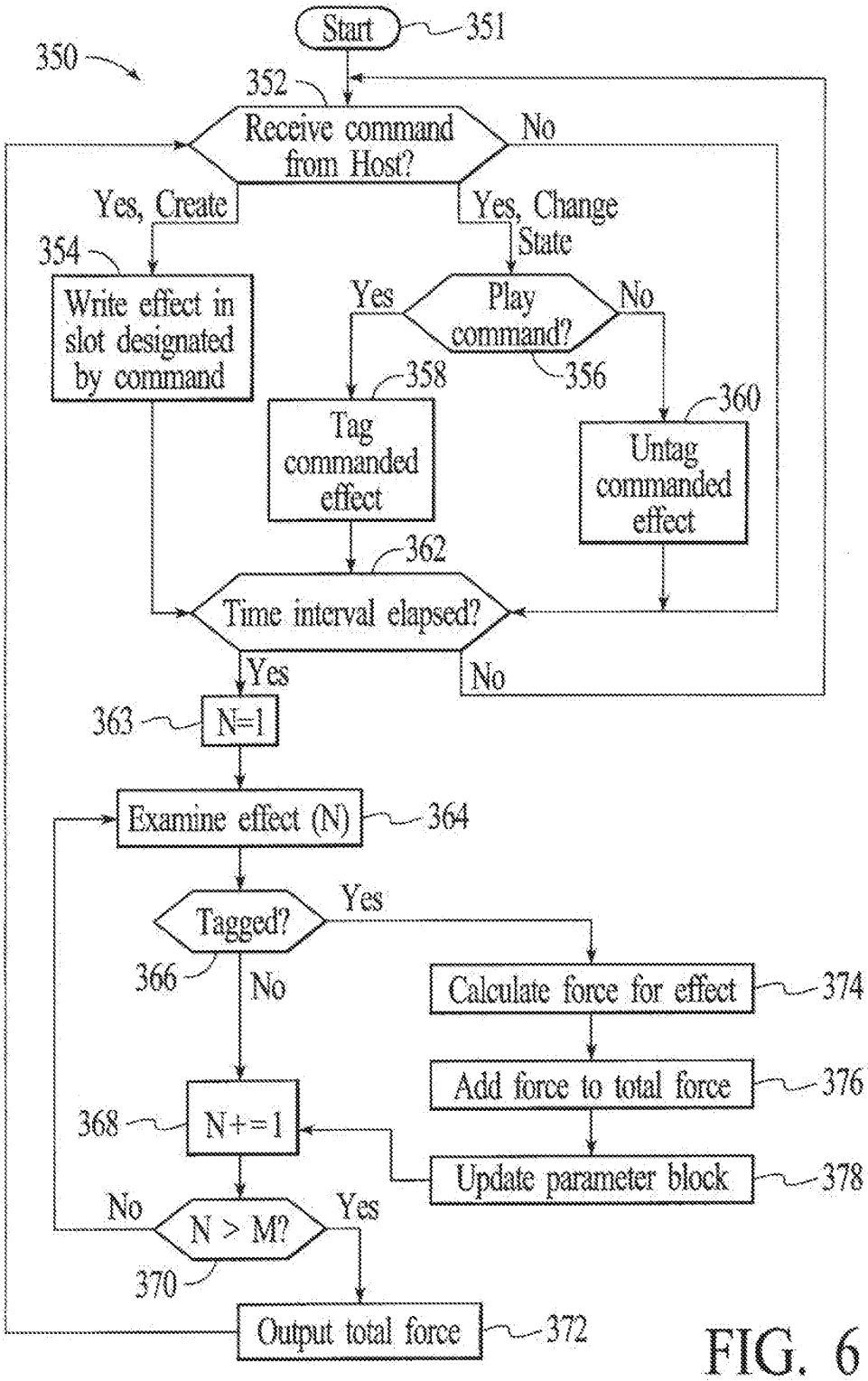

Start
351
350
352
Receive command from Host?
No
Yes, Create
Yes, Change State
354
Write effect in slot designated by command
Yes
Play command?
No
356
358
360
Tag commanded effect
Untag commanded effect
362
Time interval elapsed?
Yes
No
363
N=1
Examine effect (N)
364
Tagged?
Yes
366
No
Calculate force for effect
374
Add force to total force
376
368
N+=1
Update parameter block
378
No
N > M?
Yes
370
Output total force
372

FIG. 6

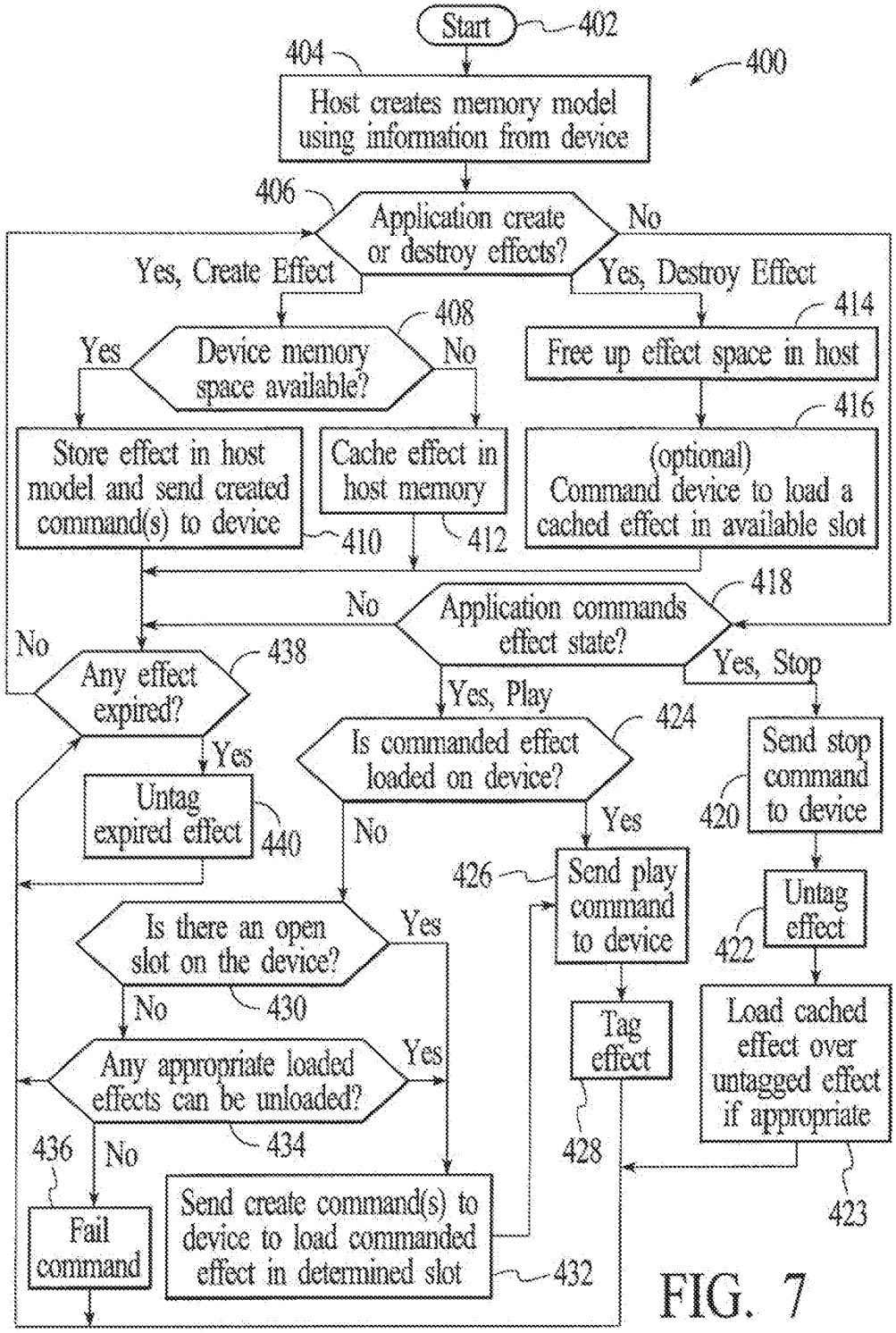

Start
402
400
404
Host creates memory model using information from device
406
Application create or destroy effects?
No
Yes, Create Effect
Yes, Destroy Effect
408
Device memory space available?
Yes
No
414
Free up effect space in host
416
(optional) Command device to load a cached effect in available slot
Store effect in host model and send created command(s) to device
410
Cache effect in host memory
412
418
Application commands effect state?
No
Yes, Stop
Yes, Play
438
Any effect expired?
No
Yes
Untag expired effect
440
424
Is commanded effect loaded on device?
Yes
No
Send stop command to device
420
426
Send play command to device
Untag effect
422
Is there an open slot on the device?
Yes
No
430
Tag effect
Load cached effect over untagged effect if appropriate
Any appropriate loaded effects can be unloaded?
Yes
No
434
436
428
423
Fail command
Send create command(s) to device to load commanded effect in determined slot
432

FIG. 7

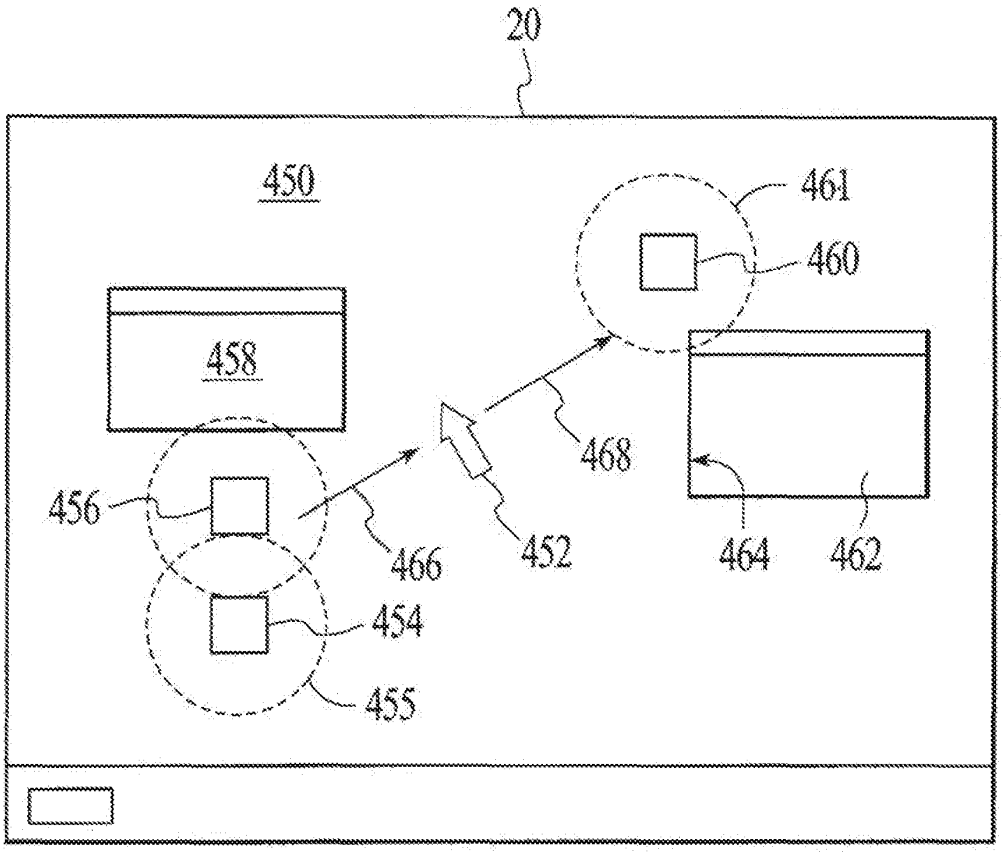


FIG. 8

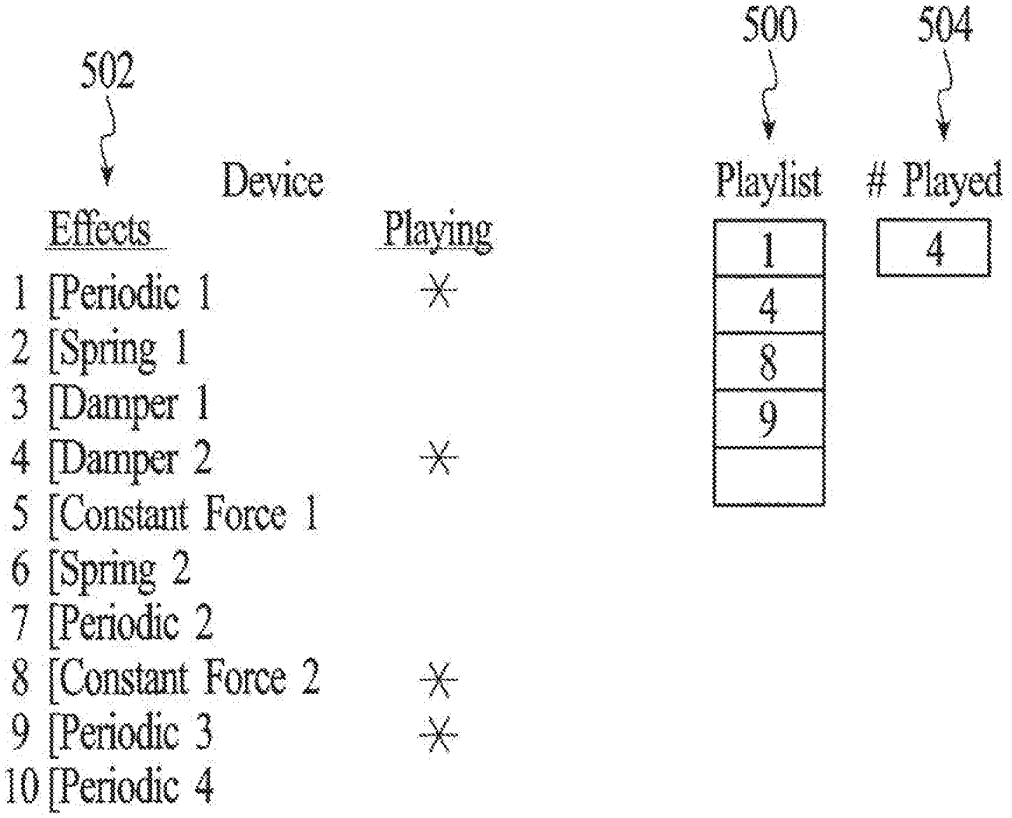

500
504
502
Device
Playlist
Played
Effects
Playing
1 [Periodic 1
2 [Spring 1
3 [Damper 1
4 [Damper 2
5 [Constant Force 1
6 [Spring 2
7 [Periodic 2
8 [Constant Force 2
9 [Periodic 3
10 [Periodic 4
1
4
8
9
4

FIG. 10

HOST CACHE FOR HAPTIC FEEDBACK EFFECTS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 09/401,564, U.S. Pat. No. 6,343,349, filed Sep. 22, 1999, which is a continuation of U.S. patent application Ser. No. 09/305,872, now U.S. Pat. No. 6,252,583, filed May 5, 1999, which is a continuation-in-part of parent patent application Ser. No. 08/970,953, now U.S. Pat. No. 6,300,936, filed Nov. 14, 1997, assigned to the assignee of this present application, and which are incorporated herein by reference in their entireties.

Some of the inventions herein were made with Government support under Contract Number F41624-96-C-6029, awarded by the Department of Defense. The Government has certain rights in this invention.

BACKGROUND OF THE INVENTION

The present invention relates generally to interface devices for allowing humans to interface with computer systems, and more particularly to computer interface devices that allow the user to provide input to computer systems and provide force feedback to the user.

Computer systems are used extensively to implement many applications, such as word processing, data management, simulations, games, and other tasks. A computer system typically displays a visual environment to a user on a display screen or other visual output device. Users can interact with the displayed environment to perform functions on the computer, play a game, experience a simulated environment, use a computer aided design (CAD) system, etc. One visual environment that is particularly common is a graphical user interface (GUI), and include such systems as the Windows™ operating system from Microsoft Corporation, the MacOS operating system from Apple Computer, Inc., and X-Windows for the Unix operating system. Most GUI's are currently 2-dimensional as displayed on a computer screen; however, three dimensional (3-D) GUI's with 3-D environments can also be provided. Other graphical environments include games, simulations, CAD environments, World Wide Web/Internet interfaces, etc. which present 2-D or 3-D interactive environments manipulatable by the user.

The user interaction with and manipulation of the computer environment is achieved using any of a variety of types of human-computer interface devices that are connected to the computer system controlling the displayed environment. In most systems, an application program running on the host computer updates the environment in response to the user's manipulation of a user manipulandum that is included in the interface device, such as a mouse, joystick handle, track ball, steering wheel, etc. The computer provides feedback to the user utilizing the display screen.

Force feedback interface devices allow a user to experience forces on the manipulandum, based on interactions and events within the displayed graphical environment. Force feedback devices can be implemented in many forms, such as a joystick, mouse, steering wheel, etc. Typically, computer-controlled actuators are used to output forces on the user object in provided degrees of freedom to simulate various sensations, such as an obstruction force when moving a cursor into a wall, a vibration force when a virtual race car drives off a race track, or a spring force to bias a cursor to move back toward a starting position of the spring.

Force sensations are usually commanded to be output on the device by the application program running on the host computer. Most consumer-market force feedback devices include a microprocessor and memory to parse host commands and store and manage various force feedback effects local to the device. The device microprocessor can check user input and other conditions based on commands from the host, and can output force sensations using the force sensation data stored in local memory. The local management of force sensations on the device greatly increases the realism of generated force sensations due to the responsiveness of the device processing; if the host had to process all input and generate all forces, the transmission of data between host and device would cause delays in responsiveness that would seriously degrade the quality of force sensations. Thus, the ability of the device to store force sensation data and independently command those force sensations when conditions warrant is critical to realistic force feedback.

When providing force feedback sensations on a force feedback device, several issues arise as to the management of force feedback sensations. One problem is that the memory on the force feedback device is limited due to cost concerns. A device may only be able to store a certain limited number of force sensation data ("force effects") before the local memory is filled. An application program, however, may require a large number of different force effects to be output during different conditions and events in the program. For example, a racing game program may wish to output 20 different force effects for various racing conditions during a game; however, the device may only be able to store data for 10 force effects at a time.

Since data for a force effect should be stored local to the device before the force is output, the application program must first attempt to store effect data to the device. One existing way to store force effects on a device is for the host application to send a request to the device to store a specified force effect in device memory. The device determines if sufficient memory is available and responds to the host that either the requested force effect has been stored in device memory, or that the requested force effect could not be stored due to lack of sufficient space. If the effect could not be stored, the host application can send a "destroy" command to the device to remove a currently-unused force effect from device memory to free up sufficient room for the requested force effect, and then send the request again to store the new force effect. However, this method can cause some degradation in force quality on the device since the device and host must transmit data several times back and forth to free up device memory and store a new force effect.

In addition, since the device memory usually cannot store all the force effects which a host application wishes to use, the host application must spend processing time for memory management tasks. For example, the host application must determine whether to swap out an old force effect in device memory with a new force effect and then command that such a swap take place. The application must keep track of how much space is available in device memory and which force effects are currently being output. Such extra processing by the host application can degrade the overall performance of the application and compels the designer of the application to focus on low-level processing, thereby detracting from the higher-level force design process.

SUMMARY OF THE INVENTION

The present invention is directed to memory management of force effects and other management of force sensations

for a force feedback system. Embodiments are disclosed which provide for efficient management of device memory and force effect output.

More specifically, the present invention provides force effects with a force feedback device having local control of the output of force sensations. A representation of device memory is created, where the device memory is provided on the force feedback device, and the representation is allocated in memory of the host computer. A force effect load command is received from an application program running on the host, where the force effect load command instructs that data for a force effect be stored in the device memory. It is then determined whether the device memory can store the force effect by examining the representation of device memory. If the device memory can store the force effect, the data for the force effect is send to the force feedback device to be stored in the device memory. The force feedback device uses the data to control a force output to a user of the force feedback device. If the device memory can store the force effect, the data for said force effect can be stored in a location of the representation of device memory, or an indication of the memory space taken by the force effect can be stored. The application program can later send a play command or a stop command, which is sent to the force feedback device to output or stop the output of force based on the loaded force effect. The total number of playing force effects loaded to the device are summed to provide the total output force on the user.

In a different aspect of the present invention, the management of storage of force effects in a force feedback system includes receiving a force effect create command by a driver running on the host computer. The command is sent from an application program running on the host computer and instructs that particular force effect data for a particular force effect be stored in memory local to the force feedback device. It is then determined whether the local memory has sufficient space to store the particular force effect data. If there is sufficient space, the particular force effect data is sent to the force feedback device to be stored in the local memory. If there is not sufficient space, the particular force effect data is stored in a cache implemented in host computer memory instead of the local memory. When a command is later received by the driver to output the cached force effect to a user of the force feedback device, the driver swaps the particular force effect data with loaded force effect data in the local memory and instructs the force feedback device to output the particular force effect.

Preferably, the driver creates a representation of the local memory in the host computer memory, and the representation can be examined for sufficient space for the force effect. Alternatively, the force feedback device can be queried and a response can be received indicating whether sufficient space is available. In addition, it can be determined whether a force effect can be loaded by comparing a priority of the particular force effect with a priority of one or more loaded force effects, where the greater priority effect can be loaded to the device memory. Priority of the loaded force effect(s) can be determined based at least partially on whether the loaded force effect is currently being output by the device, on the time period since the loaded force effect was last output by said device, and/or on whether said loaded force effect is likely to be output based on a direction of movement of a manipulandum of the force feedback device in a workspace of the manipulandum of the device. The priority can also be predefined, e.g. by the application program. Furthermore, force effects can be grouped in categories to help determine which loaded force effects can be swapped with cached force effects. An apparatus for managing storage of effect using a host cache operates as described above.

In a different aspect of the present invention, forces are output from a force feedback device coupled to a host computer. A force effect play command is received from the host computer which instructs that a particular force effect be output by the force feedback device. The data for the particular force effect and data for at least one other force effect is stored in a memory local to the force feedback device. An identification of the particular force effect is designated in a play list in local memory. When a force is to be output, the play list is examined to determine which of the stored force effects are to be output. A force is then determined based on the force effects designated in the playlist and the force is output to a user of the force feedback device. Preferably, the output force is based on a sum of contributions from the force effects designated in the playlist. A number can be stored in local memory indicating how many the force effects stored in local memory are currently designated to be output. This allows efficient access to only the playing force effects on the device.

In yet another aspect of the present invention, force output is provided to a user of a force feedback device only at predetermined time intervals. A first force to be output by actuators of the force feedback device is determined and then output at a first point in time occurring when a predetermined time interval has passed. A second force to be output is then determined. If the predetermined time interval has not passed when the second force has been determined, then the device waits for a second time interval and outputs the second force at a second point in time. If the predetermined time interval has passed when the second force has been determined, indicating the processing of the force has taken longer than one time interval, then the device waits for a successive time interval after an integer number of the predetermined time intervals has passed, and outputs a third force at the successive point in time. The third force is appropriate to the successive point in time. For example, the first force and the second force can be at least partially based on a periodic function that varies with time, so that the third force is based on an appropriate later point of the periodic function. This allows a small time interval to be used and thus faster updating of output forces; during infrequent intervals where force processing takes longer than one time interval, the force can be output at later intervals.

The present invention provides several embodiments for managing force effect and force output in a force feedback system. A representation of the device memory is preferably maintained in host computer memory to allow the host computer to efficiently determine when effects can be loaded in device memory. Host caching of force effects allows the application program to function as if the device can store an almost unlimited number of effects, thereby freeing the application from managing low-level processing and swapping of force effects. The playlist and discrete interval force output on the force feedback device allows efficient and high fidelity output of force sensations.

These and other advantages of the different embodiments of the present invention will become apparent to those skilled in the art upon a reading of the following specification of the invention and a study of the several figures of the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a force feedback system suitable for use with the present invention;

FIG. **2** is a block diagram illustrating a hierarchy of programs running on the host computer in the force feedback system of FIG. **1**;

FIG. **3** is a diagrammatic illustration of an example force effect structure which can be used in the present invention;

FIG. **4** is a diagrammatic illustration of an organization of device memory in the force feedback device of the system of FIG. **1**;

FIG. **5** is a flow diagram illustrating a method of the present invention for host management of force effects using a host representation of device memory;

FIG. **6** is a flow diagram illustrating a process for outputting forces running on the force feedback device;

FIG. **7** is a flow diagram illustrating a method of the present invention for host management of force effects using a device memory representation and host caching of force effects;

FIG. **8** is a diagrammatic illustration of a graphical user interface and cursor for illustrating the spatial caching of the present invention;

FIGS. **9***a* and **9***b* are diagrammatic illustrations of device memory, the host representation thereof, and force effects stored in each; and

FIG. **10** is a diagrammatic illustration of device memory and a playlist of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. **1** is a block diagram illustrating a force feedback system **10** suitable for use with the present invention. System **10** includes a host computer **18** and a force feedback interface device **11**. A similar system is described in detail in patent application Ser. No. 08/970,953 and U.S. Pat. No. 5,734,373, which are incorporated herein by reference.

Host computer **18** is preferably a personal computer or workstation, such as a PC compatible computer or Macintosh personal computer, or a SUN or Silicon Graphics workstation. Alternatively, host computer system **18** can be one of a variety of home video game systems commonly connected to a television set, such as console systems available from Nintendo, Sega, or Sony. In other embodiments, host computer system **18** can be a "set top box" which can be used, for example, to provide interactive television functions to users, or a "network-" or "internet-computer" which allows users to interact with a local or global network using standard connections and protocols such as used for the Internet and World Wide Web.

Host computer **18** commonly includes a host microprocessor **108**, random access memory (RAM) **110**, read-only memory (ROM) **112**, input/output (I/O) electronics **114**, a clock **116**, a display device **20**, and an audio output device **118**. Host microprocessor **108** can include a variety of available microprocessors from Intel, AMD, Motorola, or other manufacturers. Microprocessor **108** preferably retrieves and stores instructions and other necessary data from RAM **110** and ROM **112** as is well known to those skilled in the art. In the described embodiment, host computer **18** can receive sensor data or a sensor signal via a bus **120** from sensors of device **11** and other information. Microprocessor **108** can receive data from bus **120** using I/O electronics **114**, and can use the I/O electronics, bus **120**, and/or other buses to control other peripheral devices, such as disk drives, hard drives, CDROM, DVDROM, non-volatile memory etc. Host computer **18** can also output commands to interface device **11** via bus **120** to cause force feedback for the system **10**.

Computer **18** can operate under the Windows™, MacOS, Unix, or other operating systems, or other software. Host computer **18** preferably implements one or more application programs ("applications") with which a user is interacting via mouse **12** and other peripherals, if appropriate, and which can include force feedback functionality. For example, the host applications can include a simulation, video game, Web page or browser that implements HTML or VRML instructions, word processor, drawing program, spreadsheet, scientific analysis program, or other application program that utilizes user input from device **11** and outputs force feedback commands to the device **11**. In the preferred embodiment, multiple applications can run simultaneously in a multitasking environment of the host computer. Herein, computer **18** may be referred as displaying "graphical objects" or "computer objects." These objects are not physical objects, but are logical software unit collections of data and/or procedures that may be displayed as images by computer **18** on display screen **20**, as is well known to those skilled in the art. A displayed cursor or a simulated cockpit of an aircraft might be considered a graphical object. Suitable software drivers which interface such applications with computer input/output (I/O) devices are available from Immersion Corporation of San Jose, Calif.

Display device **20** can be included in host computer **18** and can be a standard display screen (LCD, CRT, etc.), 3-D goggles, or any other visual output device. Typically, the host application provides images to be displayed on display device **20**. For example, display screen **20** can display images from a GUI, from a moving, first person point of view in a virtual reality game, a third-person perspective of objects, backgrounds, a simulation (such as a medical simulation), etc.

Clock **116** is a standard clock crystal or equivalent component used by host computer **18** to provide timing to electrical signals used by host microprocessor **108** and other components of the computer **18**. Audio output device **118**, such as speakers, can be coupled to host microprocessor **108** via amplifiers, filters, and other circuitry well -known to those skilled in the art. Host processor **108** outputs signals to speakers **118** to provide sound output to the user when an "audio event" occurs during the implementation of the host application program. Other types of peripherals can also be coupled to host processor **108**, such as storage devices (hard disk drive, CD ROM drive, floppy disk drive, etc.), printers, and other input and output devices.

Force feedback device **11** is coupled to host computer system **18** by a bi-directional bus **120**. The bidirectional bus sends data in either direction between host computer system **18** and the interface device **11**. Bus **120** can be a serial interface bus providing data according to a serial communication protocol, a parallel bus using a parallel protocol, or other types of buses. An interface port of host computer system **18**, such as a USB or RS232 serial interface port, connects bus **120** to host computer system **18**. Alternatively, Firewire (also called IEEE 1394) can be used as bus **120**; or, the bus can be between an interface card in the host computer **18**, where the interface card holds components of device **11** such as microprocessor **130**. In other embodiments, signals can be sent between interface **14** and computer **18** by wireless transmission/reception.

Force feedback device **11** includes an electronic interface **26**, a mechanical portion **24**, and a manipulandum or "user object" **12**. Electronic interface **26**, mechanical portion **24**, and user object **12** can also collectively be considered the force feedback device **11**.

The electronic portion **26** of interface **14** may couple the mechanical portion **24** of the interface to the host computer

18. The electronic portion 26 is preferably included within a housing of the device 11 or, alternatively, the electronic portion may be included in host computer 18 or as a separate unit with its own housing. Electronic interface 26 includes a local microprocessor 130, local clock 132, local memory 134, sensor interface 136, and actuator interface 138. Interface 26 may also include additional electronic components for communicating via standard protocols on bus 120. In various embodiments, electronic interface 26 or components thereof can be included in mechanical portion 24, in host computer 18, or in its own separate housing.

Local microprocessor 130 preferably coupled to bus 120 and may be closely linked to mechanical portion 24 to allow fast communication with other components of the interface device. Processor 130 is considered "local" to interface device 11, where "local" herein refers to processor 130 being a separate microprocessor from any processors 108 in host computer 18. "Local" also preferably refers to processor 130 being dedicated to force feedback and sensor I/O of the system 10, and being closely coupled to sensors and actuators of the mechanical portion 24, such as within the housing of or in a housing coupled closely to portion 24. Microprocessor 130 can be provided with software instructions to wait for commands or requests from computer host 18, parse/decode the command or request, and handle/control input and output signals according to the command or request. In addition, processor 130 preferably operates independently of host computer 18 by reading sensor signals and calculating appropriate forces from those sensor signals, time signals, and force processes selected in accordance with a host command, and output appropriate control signals to the actuators. A suitable microprocessor for use as local microprocessor 130 includes the 8X930AX by Intel, or alternatively the MC68HC711E9 by Motorola or the PIC16C74 by Microchip, for example. Microprocessor 130 can include one microprocessor chip, or multiple processors and/or co-processor chips. In other embodiments, microprocessor 130 can include digital signal processor (DSP) functionality or be implemented as state logic or circuitry.

In a local control embodiment that utilizes microprocessor 130, host computer 18 provides high level supervisory commands to microprocessor 130 over bus 120, and microprocessor 130 manages low level force control loops to sensors and actuators in accordance with the high level commands and independently of the host computer 18. The microprocessor 130 can process inputted sensor signals to determine appropriate output actuator signals by following the instructions of a "force process" that may be stored in local memory and includes calculation instructions, formulas, force magnitudes, or other data. The force process can command distinct force sensations, such as vibrations, textures, jolts, or even simulated interactions between displayed objects. The microprocessor can be provided with the necessary instructions or data to check sensor readings, determine graphical object positions, and determine output forces independently of host computer 18. The host can implement program functions (such as displaying images) when appropriate, and synchronization commands can be communicated between the microprocessor and host 18 to correlate the microprocessor and host processes. Sensor signals (and/or processed sensor signals) received and used by microprocessor 130 are also reported to host computer system 18, which updates the host application program. Such commands and related functionality is discussed in greater detail in U.S. Pat. No. 5,734,373. The host can send the local processor a spatial layout of objects in the graphical environment to store in local memory 134 so that the microprocessor has a mapping of locations of graphical objects like enclosures and can determine interactions with the cursor locally. Alternatively, the computer 18 can directly send force feedback signals to the microprocessor 130 to be directly output to actuators and provide forces on user object 12. Force feedback used in graphical environments is described in greater detail in U.S. Pat. Nos. 5,825,308; 6,219,032; and 6,252,579, all of which are incorporated by reference herein. In a different embodiment, host computer 18 can provide low-level force commands over bus 120, which microprocessor 130 directly transmits to the actuators.

A local clock 132 can be coupled to the microprocessor 130 to provide timing data, similar to system clock 116 of host computer 18; the timing data might be required, for example, to compute forces output by actuators 64 (e.g., forces dependent on calculated velocities, accelerations, or other time dependent factors). In alternate embodiments using the USB communication interface or other bus having a synchronization signal, timing data for microprocessor 130 can be retrieved from the USB interface.

Local memory 134, such as RAM and/or ROM, is preferably coupled to microprocessor 130 in interface 26 to store force sensations ("force effects"), other instructions for microprocessor 130, and store temporary and other data. Microprocessor 130 may also store calibration parameters in a local memory 134. Memory 134 may also be used to store the state of the force feedback device, including a reference position, current control mode or configuration, etc. Memory management techniques of the present invention for local memory 34 are described in greater detail below.

Sensor interface 136 may optionally be included in electronic interface 26 to convert sensor signals to signals that can be interpreted by the microprocessor 130 and/or host computer system 18. Such circuits, or equivalent circuits, are well known to those skilled in the art. Alternately, microprocessor 130 or host 18 can perform these interface functions. Actuator interface 138 can be optionally connected between the actuators 64 and microprocessor 130 to convert signals from microprocessor 130 into signals appropriate to drive the actuators. Interface 138 can include power amplifiers, switches, digital to analog controllers (DACs), and other components as well known to those skilled in the art. In alternate embodiments, interface 138 circuitry can be provided within microprocessor 130 or in the actuators. Power supply 140 can be used to supply power to the actuators 64 and other components. Power can also be supplied by the host computer over USB 120.

Mechanical portion 24 is coupled to electronic portion 26 and preferably includes sensors 62, actuators 64, and mechanism 40. Sensors 62 sense the position, motion, and/or other characteristics of manipulandum 12 along one or more degrees of freedom and provide signals to microprocessor 130 including information representative of those characteristics. A sensor 62 is provided for each degree of freedom of the manipulandum 12, or, a single compound sensor can be used for multiple degrees of freedom. Example of sensors suitable for embodiments described herein are rotary optical encoders, as described above, linear optical encoders, analog sensors such as potentiometers, or non-contact sensors, such as Hall effect magnetic sensors or an optical sensor such as a lateral effect photo diode having an emitter/detector pair. In addition, velocity sensors (e.g., tachometers) and/or acceleration sensors (e.g., accelerometers) for measuring acceleration can be used. Furthermore, either relative or absolute sensors can be employed.

Actuators 64 transmit forces to user object 12 in one or more directions along one or more degrees of freedom in

response to signals output by microprocessor **130** and/or host computer **18**, i.e., they are "computer controlled." Typically, an actuator **64** is provided for each degree of freedom along which forces are desired to be transmitted. Actuators **64** can be electromagnetic actuators such as DC motors, or can be other active actuators, such as linear current control motors, stepper motors, pneumatic/hydraulic active actuators, a torquer (motor with limited angular range), voice coil motors, or passive actuators such as magnetic particle brakes, friction brakes, or pneumatic/hydraulic passive actuators, passive damper elements, an electrorheological fluid actuator, a magnetorheological fluid actuator. In some embodiments, all or some of sensors **62** and actuators **64** can be included together as a sensor/actuator pair transducer.

Mechanism **40** can any of several types of mechanisms. For example, mechanisms disclosed in U.S. Pat. Nos. 5,623,582, 5,731,804, 5,767,839, 5,721,566, 5,805,140, 5,691,898, 6,028,593, 6,024,576, and 5,828,197, all incorporated herein by reference, can be included.

User object **12** is a physical object that is preferably grasped or gripped and manipulated by a user. By "grasp," it is meant that users may physically engage a portion of the object in some fashion, such as by hand, with their fingertips, etc. A great number of types of user manipulable objects can be used with the method and apparatus of the present invention. For example, such objects may include a mouse, sphere, a puck, a joystick, cubical- or other-shaped hand grips, a fingertip receptacle for receiving a finger or a stylus, a flat planar surface like a plastic card having a rubberized, contoured, and/or bumpy surface, a gamepad, a steering wheel, a pool cue, a handheld remote control used for controlling web pages or other devices, or other objects.

Other input devices **141** can optionally be included in system **10** and send input signals to microprocessor **130** and/or host computer **18**. Such input devices can include buttons, switches, dials, knobs, or other controls used to supplement the input from the user to an application program. Also, voice recognition hardware (with software implemented by host **18**), or other input mechanisms can be used. Safety or "deadman" switch **150** is preferably included in interface device to provide a mechanism to allow a user to deactivate actuators **64** for safety reasons. The user must continually close safety switch **150** during manipulation of user object to enable the actuators **64**. A capacitive contact sensor, mechanical switch, electrostatic contact switch, or optical switch, z-axis force sensor, piezo electric sensor, force sensitive resistor, a strain gauge, or a hand weight safety switch can be used to sense the presence of the user's contact with the user object.

Host Computer Force Feedback Architecture

The host computer **18** interacts with interface device **11**, in the present invention, using a number of different levels of controllers. These controllers are preferably implemented in software, e.g. program instructions or code, and such is the embodiment described herein, however, all or part of the controllers may also be implemented in hardware, where the conversion of functionality of the software to hardware is well known to those skilled in the art. The architecture described herein is oriented towards providing force feedback functionality for a system including a host computer connected to a force feedback interface device, where the interface device stores force information from the host and receives commands from the host to implement forces based on the stored information. The described architecture is most applicable to a computer such as a PC, Macintosh, workstation, etc., and is not as applicable to other host computers such as console game systems. However, such other systems often include the equivalent to many of the described control levels. For example, a game program on a console can be considered an application and a library on the console that is accessed by function calls from the game program can be the equivalent of the API and/or translation layers.

FIG. **2** is a block diagram of a preferred architecture for the host computer to communicate with and control a force feedback interface device **11**. One or, more application programs **202** and **204** can be running on the host computer **18** (concurrently, if more than one application is running). If more than one application is running, one of the application programs is actively running in an operating system as the "active" application program (also known as the application program that is "in focus" or which has "keyboard focus"). In a GUI, the active window is typically the topmost displayed window in which input is provided by the user using the mouse-controlled cursor, a keyboard, or other peripheral. The other applications are "inactive" in that they are not receiving input from the user (although they may have a window displayed in the GUI which can be updated on the screen). The inactive applications may also receive input or send output from other sources, such as peripherals. For example, the Windows™ operating system from Microsoft Corp. provides a multitasking or pseudo-multitasking environment in which programs run simultaneously; other operating systems such as Unix also offer multitasking. For example, a word processor may be the active application to receive input from the keyboard and display input characters in a displayed active window on display screen **20**, while a inactive communication program may be receiving data over a network and saving the data on a storage device, or sending data out to be printed. When the user moves the cursor over an inactive window and provides a command gesture such as clicking a button on a mouse, the inactive window becomes the active window and the former active window becomes inactive. Alternatively, the active application program may take control of the entire screen; for example, an active game program may display its environment exclusively on a full screen rather than in a window of the GUI. The active and inactive applications are also known as "foreground" applications, as opposed to the background application described below.

A master application **206** may also be running on host computer **18** and is referred to as the "background" force feedback application. This application is preferably a general purpose program that always runs inactively in the operating system and whose set of commanded forces are always available to be output and controlled on the interface device **11** and/or other devices. An example interface window for master application is a "desktop" control panel for force feedback, described in greater detail in the parent application Ser. No. 08/970,953. The types of forces possible to be output by the device are described in greater detail in U.S. Pat. Nos. 5,734,373, 6,020,876, and 6,169,540, all incorporated by reference herein.

The force sensations specified by the background application will be output by the force feedback device by default, unless a different foreground application program deactivates the force sensations or replaces a force sensation with its own. For example, a background-specified snap force is preferably applied to all menus of all running application programs in the GUI, since it is a background force effect. If the foreground active application program has

its own force sensations which define that application's menus to have a jolt instead of a snap, then the jolt will be superimposed on the snap unless the active application program deactivates the background force(s). In general, a particular active application program can only command forces to objects of its own, e.g., that application's own menus, windows, scrollbars, icons, window borders, etc.

A user can specify multiple background force sensations for each graphical object. This allows the multiple force sensations to be superimposed on each other, unless the application program overrides one or more of the superimposed forces. Thus, a user can assign a damper force sensation and a "ticks" force sensation to scrollbars, and all scrollbars will have these forces associated with them unless overridden by the foreground application program. Other controls in the background application can include a device gain to set the percentage of maximum magnitude for all the forces of the background application.

Application programs **202**, **204**, and **206** communicate with a force feedback Application Programming Interface ("API") **208** which is resident in the host computer's memory and which allows a given application program to communicate with lower level drivers and other force feedback functions. For example, in the Windows operating system, API's are commonly used to allow a developer of an application program to call functions at a high level for use with the application program, and not worry about the low level details of actually implementing the function.

The API of the present invention includes a set of software "objects" that can be called to command a force feedback interface device **11**. Objects are a set of instructions and/or data which can be called by a pointer and/or an identifier and parameters to implement a specified function. For example, three types of objects are provided in one preferred API implementation: interface objects, device objects, and effect objects. Each of these objects makes use of one or more force feedback device drivers which are implemented as objects in the API **208**.

Interface objects represent the API at the highest level. An application program (which is referred to as a "client" of the API) can create an interface object to access lower level objects and code that implement force feedback device functionality. For example, the interface object allows an application program to enumerate and receive information about individual devices and create lower level objects for each device used by the application program.

Device objects each represent a physical force feedback device (or other compatible device or peripheral) in communication with the host computer **18**. For example, the force feedback device **11** would be represented as a single device object. The device objects access the set of force feedback routines to receive information about an associated physical device, set the properties of the physical device, register event handlers (if events are implemented on the host), and to create effect objects.

Effect objects each represent a force feedback effect defined by the application program to be output one or more times to the user using a force feedback device. The effect objects access the set of force feedback routines to download force effects to the force feedback device, start and stop the output of force effects by the force feedback device, and modify the parameters of the effects.

A "force effect," as referred to herein, is a definition for a force or series of forces that may be commanded within the API. The force effect typically has a name (identifier) to identify it and one or more parameters to characterize the force effect as desired. For example, several types of force effects have been defined, including vibrations, enclosures, grids, textures, walls, dampers, snap sensations, vibrations, circles, ellipses, etc. For example, a vibration force effect may have parameters of duration, frequency, magnitude, and direction. The force sensations output to the user can be derived from one or more force effects (e.g., force effects can be superimposed on each other). Force effects, in turn, are made up of one or more basic force prototypes, such as springs, dampers, and vector forces.

In some embodiments, an application program client interacts with the API **206** by first receiving a pointer to a resident force feedback interface; for example, a preferred interface includes procedures specified by the Component Object Model (COM) of Microsoft Windows, an object oriented model for constructing interfaces (embodiments in which host computer **18** is a console game system, for example, may use other software architectures). Using the force feedback interface, the application program enumerates the force feedback devices on the computer system **18**. The application program selects a desired one of the force feedback devices and creates a device object associated with that device. Using the force feedback interface, the application then acquires the device, sets the device up with setup and default parameters, and creates effect objects and event objects during the execution of the application program at times designated by the developer of the application. At appropriate times, the application program will command the creation/destruction of force effects and the start, stop, or, pause of the playback of force effects by accessing the appropriate interface instructions associated with the desired effect. If appropriate (see below), the API can indicate to a context driver **210** to create a "context" (i.e. "effect set") for an application program, and sends effects and events to be associated with that context. A "context" is a group or set of effects and events that are associated with a particular application program.

In embodiments allowing multiple application programs to be simultaneously running on the host, each application program may have its own set of force sensations to output to the force feedback device. Since the device cannot implement all force sensations at any one time due to cost and hardware constraints, the forces commanded by each application must be organized by the architecture to take these limitations into account.

Context driver **210** is used to implement force effects for multiple application programs. Context driver **210** receives contexts **222** and device manipulation data **223** from the API **208**. The context driver is provided at a level below the API to organize contexts for applications **202** and **204** running on the host computer. In the preferred embodiment, the effects and events in a context are not known to the application program itself, rather, the context driver **210** creates a context internally for an application. Thus, an application commands that a particular force sensation be output in response to different interactions or occurrences, e.g., an interaction of a cursor with an object or region, or the output of a force based on other criteria (time, received data, random event, etc.). The API sends the commanded effect(s) to the context driver **210**, and the context driver stores the effects in the context created for that application program.

Since each application may have a completely different set of force effects to output, each context must be associated with its particular application program. In the preferred embodiment, there are two types of contexts, foreground contexts and background contexts. One foreground context is associated with the application program **202** or **204** that is

currently active in the operating system. Different foreground contexts can include the effects and events for inactive application programs. A background (primary) context includes effects for the master application program **206**. In addition, a "global context" can be provided, which includes common effects almost always used by application programs (e.g. a pop force) and which can automatically be downloaded to the force feedback device. Effects in the global context need not be stored in individual contexts for particular application programs.

When an application program is first executed by the host computer and loaded into memory, if the application is able to command a force feedback device, the application will query for the API **208**. Once communication is established, the API will contact the context driver **210** to create an entry location for a context set for the initiated application program.

The context driver **210** receives individual effects and events as they are created by the application program using API **208** and stores the effects and events in a context list **212**, storing each context in a different storage location in the host's memory or on some other type of storage device. An active or inactive application program can create a context and have it stored, but only the active application's context will be sent to the force feedback device. The context driver **210** can examine an identifier in a created effect or event to determine which application program is associated with it and thus store the effect or event in the proper memory location. The context driver sets pointers to the contexts and to the effects and events in the contexts to access them. An effect can be created initially when the application program is first executed, before any forces are commanded, or the effect can be later created during application execution and then immediately commanded to be played by the force feedback device. Each context also preferably includes an entry into a device state structure. This entry governs the "gain" or force level for all effects in the context. For example, all the forces in the context can be cut to 50% of full magnitude by storing a value of 50 in the device state structure. One of the contexts stored in list **214** is a primary context **216**, which is the list of effects and events used by the master application **206** or "background" application.

At a later time, after the context driver has stored the contexts in list **212**, an application program may send a command to the API to output or "play" a particular force sensation. The API checks whether the application program is active or in the background (primary), if not, the API does not send any data to the device and/or to the lower drivers. Alternatively, the commands from an inactive foreground application can be stored and then sent to the device when the application becomes active. If the application is active or background, the API sends the start information to the context driver **210** indicating the application program that commanded the force and the particular force effects to be commanded. The context driver **210** then associates the commanding application program with a context **214** in list **212** and sends the effects from the context to the force feedback device (if not previously sent). For example, if a context for a particular application program includes a spring effect, a damper effect, and a vibration effect, and the application program commands the vibration to be output, then the context driver selects the vibration effects to be output to the device. The data describing this effect is then output by the context driver **210**. Similarly, the application program can send a command to stop particular force effects, to pause the effects, to get the status information of an effect, or to destroy an effect. Some of these commands are described in greater detail below. Thus, the application program believes it is the only one using the force feedback device when in actuality the context driver uses one particular set of multiple sets of force effects based on the active application. In effect, there is a virtual force feedback device dedicated to each running application program.

A context is therefore only allowed to exert forces with the force feedback device when that context is active, i.e., is associated with an active application program or the background application. In the described embodiment, only one foreground context can be active at any given time. Any number of background contexts may be simultaneously active; however, there may be a device limit on the number of background contexts that may be created. For example, the device **11** may only allow one background context to be created at any one time, which is the preferred embodiment. Thus, if an inactive (not in focus) foreground application program commands a force to be output, the API will ignore the command after determining that the commanding application is not active (or, the command will only be sent to the device when that application becomes active).

If the active application program becomes inactive (or is removed from the host's memory) and a different application becomes active, then the API indicates this to the context driver **210**, which then deactivates the context associated with that application program and loads the effects from the new active context to the force feedback device **11**. Likewise, when the original application program again becomes active, the API tells the context driver to activate the associated context and load the appropriate effects to the force feedback device.

Device manipulation data **223** is also received by context driver **210**. Data **223** is used to set a global device state on the force feedback device, as described below, and this information is passed unmodified to the translation layer.

Some embodiments may not allow multiple simultaneous application programs to each command forces; there is only one active application that uses the device **11**. For example, in such an implementation, a force feedback game might be running on the host, and no other application programs can be allowed to command forces to the device **11**. Such an implementation does not require the context driver **210** to operate; commands from the API can be passed directly to the translation layer **218**, described below. The translation layer would access a single context list **220** in such a case, i.e., there would be no need to provide multiple contexts **214**.

Translation layer **218** manages the sending of effects to the device **11**, receives information from the device to the host (in some embodiments), and maintains a representation or model of the memory of device **11**. Translation layer **218** receives an individual effect **219** for the active (or background) application program and device manipulation data **223** sent by the context driver **210** (or from the API **208** if no context driver **210** is used). The translation layer provides the effect from a context list **220** of individual effects **222** (list **220** represents a context **214**). A different context list **220** is provided in each context **214** of list **212**. Each effect **222** in list **220** defines a force or series of forces that is to be output on the user object **12** by the force feedback device **11**. When the effects are to be loaded on the device **11** ("created") by the application, they are selected and copies are output to the device by the translation layer. Preferably, each effect is output by the translation layer as soon as it is received by the layer **218**. Each effect stored in

list **220** as examined by the translation layer is available on force feedback device **11**, i.e., the local microprocessor **130** should recognize the effect and be able to output the effect immediately or when conditions dictate.

In a multiple-application system, when an active application becomes inactive, the translation layer is instructed by the context driver **210** to "unload" the effects of the context of the previous active application from the force feedback device (e.g., designate the memory space for those effects as free), receives the effects from the now active application and loads those effects to the force feedback device **11** (the effects for the background (primary) application are preferably never unloaded).

The translation layer also preferably handles events. For example, when a screen position is received from the device **11**, the translation layer can check whether any of the conditions/triggers of the active events are met. If so, a message is sent which eventually reaches the associated active or background application program. In alternate embodiments, the microprocessor **130** on device **11** can check for events and send event notifications through translation layer **218** up to the application program.

The translation layer also can store a device state **224** in memory. Device manipulation data **223** from the active application and the background application determines the device state. This is the state that the active application program wishes to impose on the device, if any. For example, an overall condition can be stored, such as an enable or disable for all forces, so that if all forces are disabled, no forces will be output by the device. An overall gain can also be set to limit all output force magnitudes to a desired level or percentage of maximum output.

The translation layer outputs device messages **225** (commands) to the device **11** by way of the next layer. Messages may include force effects to be output and/or any other information such as device identification numbers or instructions from the context driver for an effect (start, stop, pause, reset, etc.) The translation layer outputs messages **225** to the device driver **226**.

Device communication driver **226** communicates directly with the force feedback device. Driver **226** receives the device messages **225** from translation layer **218** and directly transmits the messages to the force feedback device over bus **120**, e.g. a USB, in a form the device **11** can understand. The driver **226** is implemented, in the preferred embodiment, as a standard device driver to communicate over such a serial port of host computer **18**. Other types of drivers and communication interfaces can be used in other embodiments.

Memory Management of Force Effects

FIG. **3** illustrates an example data structure for a force effect. An important aspect of the present invention is that a model or representation of the memory **134** on device **11** is maintained by the translation layer (or API or other driver) on the host computer **18**. Thus, the translation layer knows exactly when an effect can be downloaded to and stored by the device **11** and when there is not sufficient memory on the device to store a particular effect. The size of the effect list **220** on the host computer should be the same as (or smaller than) the available memory for such a list in the force feedback device so that the translation layer knows when the memory of the force feedback device is full. If the memory **134** is full, the translation layer can delay the output of additional effects until enough memory space is available (e.g. see effect caching with regard to FIG. **7**), or can simply discard the effect.

Example data structure **240** may include several fields, such as duration **242** indicating the amount of time the force effect is to be played, direction **244** indicating the direction in one or more degrees of freedom the force is applied, an envelope pointer **246** pointing to an envelope data structure **248**, and a type pointer **250** pointing to a type data structure. The duration **242** and direction **244** fields can simply store one or more values associated with those characteristics. The envelope data structure **248** can either be null if the force effect does not use an envelope (e.g. a condition force), or the data structure **248** can hold several values that define an "envelope" for a periodic wave, such as impulse time **252**, impulse level **254**, fade time **256**, and fade level **258**. Shaping of waves using such parameters is described in greater detail in U.S. Pat. No. 5,959,613, incorporated by reference herein. Type pointer **250** can point to one of multiple possible different data structures, depending on the type of force effect. For example, if it is a constant force effect, data structure **260** is pointed to, having a magnitude parameter **262** (which can be signed). If it is a periodic effect, data structure **264** is referenced, having values of magnitude **266**, offset **268**, phase **270**, and period **272** that define the periodic effect. If it is a condition effect, such as a spring or damper, then data structure **274** is referenced, having offset **276**, deadband **278**, constant **280** (e.g., spring constant or damping constant), and saturation **282** values.

As exemplified by FIG. **3**, different force effects have different storage requirements. Some force effects may not need to store envelope data from structure **248**, while some periodic and constant effects may require additional space to store the envelope information. Condition force effects require a different amount of memory space for data in structure **274** than do constant force effects for data in structure **260**. Since a model of the device memory is maintained on the host computer, the host knows how much memory is available on the device, i.e., when a particular effect can be stored by the device and when an effect cannot be stored.

FIG. **4** illustrates another example of a layout of device memory **134** provided in device **11** which is modeled on the host computer. An effect memory block **300** can be allocated in memory (both host and device memory) for storing data relating to the identification of distinct force effects. Each force effect stored in effect block **300** has the same size. For example, in FIG. **4** the device **11** can store six force effects in block **300**, one effect in each effect space **302** of an array. Each effect space **302** holds a pointer to the particular parameters defining that force effect. The parameters can be stored in a parameter block **304** of the memory **134**. Since the parameters can differ in amount and in size for different force effects, there is no constant amount of memory space in the parameter block allocated for each force effect. Rather, the amount of space (e.g. the offsets into the memory) that each set of parameters occupies must be tracked so that additional parameters can be stored around existing parameters, and so that it is known when the memory is full. Furthermore, the parameter block **304** is used to store working values used during playback of a force effect; thus, additional space is often needed beyond what is required simply to store the parameters. In other embodiments, the effect block and parameter block may be combined as a single block of memory, similar to the embodiment for a single context **220** shown in FIG. **2**. For example, parameters for an effect can be stored directly after the identifying information.

As explained above, the translation layer on the host computer preferably maintains a model of the device

memory **134** to determine where to store parameters and to determine when the memory is full. Initially, such as at power up of the device **11**, the host preferably asks the device for any relevant information to model the memory, such as the size of the available effect and parameters blocks, as well as the number of effects that can be stored in effect block **300** (which can vary depending on the device **11**). Some devices **11** may be able to inform the host how much space must be allocated for each effect slot **302**, parameters for an effect, and/or how to specify the usage of parameter pointers.

FIG. **5** is a flow diagram illustrating a basic memory management process **310** for use with a single application program and a force feedback device. This process is described from the point of view of a lower-level program on the host (generically called a "driver" herein), such as the translation layer, the API, a library (e.g., library functions and procedures), or another driver, but may be implemented at other levels of the host architecture in other embodiments. Process **310** may be used whether the application program is the only application program, or if the program is one of multiple programs concurrently running on the host. It should be noted that the order of steps described below is only provided for explanatory purposes, and that the various steps, checks and events can occur in different sequences or in parallel (multitasking) in various embodiments. For example, many of the checks can be implemented as function calls or interrupts, where associated steps can simply be processed when called regardless of any current stages of other processes.

The process **310** begins at **311**. In step **312**, the host **18** creates a memory model using information from the device **11**. For example, a context **220** can be created as explained above with reference to FIG. **2**. The model used in FIG. **4** can be used; this model is referred to in the following discussion. As explained above, the device can send the host **18** information such as the size of memory and number of effects that can be stored.

In step **314**, the process determines whether the application program (e.g. by a function call to the API or library) is commanding to create or destroy any force effects on the device **11**. Creation of effects typically occurs when the application program is first executed on the host computer, but also may occur at other times during application execution. For example, when a game program is first executed, the program has a set of force effects which are intended to be used by and with the game. The game typically creates the force effects on the device **11** at startup of the game so the effects will be available immediately for output. Different effects can also be later created during the game if needed. If a GUI is executed on the host, the GUI can immediately create background (primary) force effects on the device **11** so that such effects are immediately available.

If the application has not commanded to create or destroy any effects on the device in step **314**, the process continues to step **324**, explained below. If the application wishes to create an effect on the device, then in step **316** the host determines if there is any device memory available to store the effect. The host driver (e.g. translation layer or, alternatively, the API) checks the host model of device memory to determine if there is sufficient space. Preferably, the host driver checks for sufficient space both in the effect block **300** and in the parameter block **304**; there should be sufficient space in both blocks. If there is not, in step **318** the force effect is discarded, never to be used; preferably, the application program is informed that the effect could not be created, i.e. that the create command failed (in an alternate embodiment of the present invention described below, the effect can be cached by the host). The process then continues to step **334**, described below. If there is sufficient memory for the created effect in step **316**, then in step **320** the host stores the effect in its memory model and also sends one or more create commands are sent to the device to load the effect in the actual device memory. It should be noted that, in embodiments providing multiple concurrently-running application programs, the device **11** can includes a number of effects standardized in its memory which it can implement if the effects are within the active or background context. Such effects do not need to be downloaded from the host and stored in an effect slot.

As an example, a set of commands and appropriate parameters are shown below to create a periodic effect on the device:

SET_ENVELOPE (offset1, values)

SET_PERIODIC (offset2, values)

SET_EFFECT (effect_index, values, flags, offset1, offset2)

The SET_ENVELOPE command provides a "msg_id" value indicating its command type (identifier). The offset value "offset1" indicates the offset into the parameter block **304** at which to store the accompanying values. The values can be, in this example, the envelope parameters in the data structure **248** shown in FIG. **3**, such as impulse time, impulse level, fade time, and fade level. Alternatively, for other types of force effects (e.g. conditions), the envelope parameters can be null, or the envelope command need not even be sent. The SET_PERIODIC command similarly provides an identifier and a second offset value "offset2" (different from offset1) at which to store the values in the periodic command. The host **18** knows how much memory space is taken by each effect and parameters and thus can determine the appropriate offsets at which to store the effect data in the device memory without writing over other values. For example, the host knows how much space the envelope parameters of the SET_ENVELOPE command take, and can calculate offset2 to be appropriately located in the parameter block. The values for a periodic command can be those shown in data structure **264** of FIG. **3**, for example.

The SET_EFFECT command provides the data to be stored in the effect block **300** of the device memory. After an identifier value, the "effect_index" value indicates which effect slot **302** in which the effect is to be stored. Since the host is modelling the device memory, the host knows which effect slots are available, e.g. open or no longer used. The values can be those shown in structure **240** of FIG. **3**, for example. Offset1 and offset2 indicate where the envelope parameters and the periodic parameters, respectively, are stored in the parameter block (if these parameters are not used then the offset values can be null).

It should be noted that the host can store in its memory model either the actual data for the effect, or only the location and size of the portion of memory space that the effect occupies. This is because, at a basic level, the host is only keeping track of available device memory and does not need the actual effect data. However, in a preferred embodiment, the host does store the actual effect data in the memory model. In some embodiments, this allows the host driver to examine effect data and to perform some decisions about whether to send a command to the device. For example, the application may command that a new effect be created which is a periodic wave having a frequency of 20 Hz. The host driver might examine the data for currently-loaded effects in its memory model and find that there is already a periodic wave loaded on the device having a

frequency of 25 Hz. The host driver could then decide that the new, 20 Hz periodic is redundant in view of the 25 Hz periodic, and thus ignore the create command (and use the 25 Hz effect whenever the 20 Hz effect is commanded to be played). This type of host driver ability can be performed only if actual effect data is stored in the host memory model. Furthermore, this type of "smart" effect management must be balanced in view of extra processing time and the intentions of the application developer. For example, if the application believes that multiple (redundant) effects are stored in the device and will provide an additive force output, the host driver will not want to simply modify an existing effect but should create a new effect. Also, the efficiency in effect storage gained may not in some cases be worth the extra processing time in managing the effects intelligently. After step **320**, the process continues to step **334**, described below.

If in step **314** the application has commanded to destroy an effect, then in step **323** an effect slot is freed up in the host memory model. In the preferred embodiment, the device **11** need not be instructed to destroy an effect in the device memory in most cases; rather, old effect data can be simply written over with new effect data in the device memory when the new data is ready to be loaded. The host, however, must free up memory space in its own memory model to allow other effects to be stored and thus the driver should be instructed to destroy an effect to clear the effect data in the memory model. After a destroy command has been received, the host driver knows that the slot of the destroyed effect is available to store a different force effect that may be created in the future by the application program.

In some cases, the device needs to be informed that an effect has been destroyed. For example, a trigger effect can be loaded into device memory and outputs a force if a particular trigger condition occurs, such as a button being pressed on the user manipulatable object. If a trigger effect is being stored in the device memory and is destroyed by the application, that trigger effect cannot be simply left in device memory until it is written over, since a trigger condition may occur before the trigger is overwritten; instead, the device must be immediately informed that the trigger effect should be destroyed or flagged appropriately. Likewise, if an effect is playing when it is destroyed, the device should be immediately informed so that it can turn off the effect. After step **323**, the process continues to step **334**, described below.

If no create or destroy command is received in step **314**, the process checks in step **324** whether the application program on the host is commanding to change an effect state. Herein, an effect state is the current status of the effect, e.g. "playing," "stopped," "paused," etc. If no effect state is being commanded, the process continues to step **334**, described below. In a preferred embodiment, steps **314** and **324** are actually function calls made to and implemented by the API which can be made at any time, such that steps **314** and **324** need not be implemented in the sequence shown.

If in step **324** the effect state being commanded is to "play" or "start" (output) a particular force effect to the user, then in step **326** an appropriate "play" command is sent, from the host driver to the device. For example, the command can be SET_EFFECT_STATE (effect_index, state, loop_count). The effect_index value indicates the slot in the effect block in device memory and thus the particular force effect which is to be played. The state value indicates to "play" the designated effect. The loop count value can optionally be used to designate a number of times for the device to repeat playing the entire force effect. In step **328**, the host (e.g. translation layer) "tags" the effect (i.e. sets a flag) in its memory model so that the host knows which effects are currently playing on the device (the device also tags the effect, as described in greater detail with respect to FIG. **6**). The process then returns to step **314**.

If in step **324** an effect state is being commanded to stop playing a particular force effect, then in step **330** an appropriate command is sent from the host to the device. Such a command can be similar to the play command described above except that the state indicates to stop playing the designated effect. In step **332**, the host "untags" the designated effect in its model of device memory, i.e. removes the tag for the designated effect. The process then returns to step **314**. In other embodiments, additional changes in effect states can also be commanded, such as to pause and resume a force effect, etc.

In step **334**, the host can check whether any playing effect has expired or finished, e.g. whether an effect has played to its full duration. The device preferably keeps track of effect duration since it is actually implementing the output of the forces. To inform the host of the expiration of an effect, the device preferably sends a status report to the host, which is checked in step **334**. In some embodiments, the host can also independently keep track of the duration of a force effect for memory management purposes, i.e. it can be useful for the host to independently determine when a force effect is finished playing to help determine which cached effects can be loaded. Furthermore, the host can resynchronize its tracked durations if the host and device durations are learned to be out of synchronization. If no effects have expired, the process returns to step **314**. If at least one effect has expired, then the process continues to step **336** to untag the expired effect in the host memory model. The process then returns to step **314**.

The host can also receive status reports from the device **11** at periodic intervals and/or when the status of force effects and other conditions change, such as an effect starting to play or finishing playing, a deadman switch being activated, power supply interrupted, etc.

FIG. **6** illustrates a process **350** running on the device **11** which creates and plays designated force effects for the device. The process begins at **351**, and at **352**, the process checks whether it has received a command from the host computer **18**. In the preferred embodiment, the device process is in actuality "event" or interrupt driven such that when a host command is received, an event has occurred, and the device will immediately process it rather than having to check for received commands. Note that this type of event is provided from the host to the device, not from the device to the host. (The device can also send events to the host, such as the movement of the user object into an area corresponding to a graphical object, and status reports to the host at periodic intervals or when events occur; such events are described in co-pending patent application Ser. No. 08/970,953.) If a command has not been received by the host in step **352** (e.g., no command event has occurred), then the process continues to step **362**, described below.

If a host command has been received by the device and that command creates a force effect on the device, then in step **354** the process writes the effect data in the device memory in the effect slot designated by the, command, i.e. the identifier and the parameters are stored in device memory **134**. For example, the local microprocessor **130** can parse the msg_id value (identifier) of each command to determine the type of command. Once the device knows the type of command, it also knows how to store and process each of the succeeding parameters in the command. Thus, the device knows that the second value in the SET_...

EFFECT command indicates the effect slot in the effect block **302** at which to store the succeeding values. The device also knows to store values at the appropriate offsets provided in the periodic and envelope commands. The process then continues to step **362**, described below.

If a command has been received to change the state of an effect already created on the device, then in step **356** the process parses the command to check whether the command is a "play" command. If so, then in step **358** the device "tags" the effect designated in the command. The tag is an indication (such as a flag) that the effect is to be played, to be later examined by the process as detailed below. The process then continues to step **362**.

If the command received in step **356** is not a "play" command, then it is a "stop" command to cause the designated force effect to stop playing. Additional commands can also be implemented in other embodiments, such as "pause", which can stop the playing of a force effect in its current state; after a "resume" or "unpause" command is received, the effect would continue playing from the point at which it was paused rather than restarting, or a "stop_all" command which stops the playing of all effects; or a "modify" command, which modifies only the parameters of a previously-loaded effect. In step **360**, the process "untags" the effect designated in the command, i.e. indicates the designated effect should not be played The process then continues to step **362**.

In step **362**, the process checks whether the time interval has lapsed, i.e. whether a time event has occurred. In the described embodiment of the present invention, the device operates according to a time interval as measured by a clock. At each time interval, the device **11** should output a force for that interval as contributed to by any playing force effects. For example, the time interval can be 1 millisecond, where the device is expected to process any required information and output a force on the user object **12** every millisecond. When the millisecond time interval passes, it is considered an event which causes the microprocessor to output a force. Thus, if no time interval has elapsed in step **362**, the process returns to step **352**, e.g. the microprocessor continues to wait for an event such as a command or time interval. Before the next event occurs, the device can perform other tasks such as suspending operation until the next event, processing input sensor values, calculating the next forces, building and sending messages to the host computer, and/or updating force output from the actuators.

If a time interval has elapsed, then a force should be output, and the process continues to step **363** to start the implementation of force output. In step **363**, a variable N is set to 1. N indicates the index or slot of an effect in the effect block of device memory. In step **364**, the process examines the effect(N), i.e. the effect stored at slot(N). If the examined effect is determined in step **366** to be untagged, then in step **368** N is incremented. In step **370** the process checks whether N>M, where M is the number of effects that the device **11** can store. If N>M, then all the effects have been checked, and the process continues to step **372**, explained below. If N is not greater than M, then the process examines the next effect in the device memory in step **364**. For an alternate method of examining effects in memory, see the "playlist" embodiment of FIG. **10**.

If the effect(N) is determined in step **366** to be tagged, then in step **374** a force is calculated by the device microprocessor **130** based on the data for effect(N), e.g. the parameters such as magnitude, direction, and the like. The microprocessor **130** can use locally-stored force processes, force algorithms, stored force magnitudes, functions of space and/or time, a history of stored motion values of the user object, and/or other instructions to calculate the force as explained above with reference to FIG. **1**. For example, the microprocessor can calculate the raw contribution to the output force from the effect and apply an envelope scaling (detailed in U.S. Pat. No. 5,959,613, incorporated by reference herein). In step **376**, the calculated force is added to a sum of forces calculated for the other playing effects. In determining the total sum, the device preferably combines all constant forces (e.g., conditions and time-based forces) and limits the constant force sum to a predetermined magnitude, then combines all dynamic forces and limits the dynamic force sum to a predetermined magnitude. Dynamic forces are detailed in U.S. Pat. No. 6,147,674, incorporated herein by reference. The two sums are then added together and the total force sum is output by the actuators of the device **11**. Alternatively, all forces can be treated the same and summed together. Furthermore, steps **374** and **376** can be processed together or intermixed when determining the effect force and the total force.

In step **378**, any working values in parameter block **304** are updated. For example, such values can include a time value that indicates the amount of time that has expired for the current force effect. If the microprocessor **130** has determined that the time value for the effect has reached the duration limit for the effect, the microprocessor **130** preferably untags the effect so that it will no longer be played. Parameters for the effect can also be updated if a command has required such. After step **378**, the process continues to step **368**, where N is incremented, and then to step **370**, where N is compared to M as described above to determine whether all the effects in the device memory have been checked. If N>M, step **372** is implemented, where the total force is output by the device to the user. The total force is the sum of each force contributed by each playing force effect. The process outputs force signals to one or more actuators to apply a force in the appropriate direction with the appropriate magnitude. The process then returns to step **352** to wait for the next command event or in step **353**, the next time interval. The device also preferably sends status reports to the host concerning the status of effects, and these status reports can be sent periodically and/or when the status of an effect changes. Of course, other data and conditions of the device are also reported to the host (sensor data, button data, whether power is being received, deadman switch state, etc.) which are not detailed in process **350**.

The processes described with reference to FIGS. **5** and **6** are very efficient. Since the host knows the layout of memory and what is currently stored there, the host need only send one command to load new effects; the host already knows when effects can or cannot be created. In previous embodiments, the host would have to query the device and wait for an answer from the device as whether an effect could be created, thus slowing down communication and response of the device and creating potential confusion when multiple application programs are running and commanding forces.

One aspect of the present invention concerns the time interval event and its implementation as described above for step **353**. One way to implement the time interval is to choose a long enough period of time that allows the microprocessor to perform any potential required calculation and still output a force at each time interval. A different implementation of the present invention can provide a smaller time interval which usually is sufficiently long to allow a force to be output at each interval, but which may be insufficient in length in particular circumstances. If the time

interval is too short in a particular circumstance, the microprocessor **130** preferably then waits the next discrete time interval to output the force instead of outputting force as soon as it has been determined. This allows a consistent period of force output to be maintained. Preferably, the force output at the second interval point is appropriate to that interval and is not necessarily the force which should have been output at the skipped interval point. For example, if the time interval is specified as 1 ms, the device is usually able to make calculations and output a force every millisecond. However, in some cases such as when a complex command is received, when calculations for several and/or complex force effects are made, or other condition requiring more processing occurs, the extra processing might cause a delay in the output of the force past the 1 ms interval point. Instead of outputting the force when the calculation is complete, the process delays the output of the force until the next discrete interval point, i.e. after an integer number of time intervals have passed. Furthermore, the process also computes the force which should be output at the second interval rather than the first. For example, if the force is based on a periodic function, then the force that should be output at the second interval can be determined using the periodic function. This maintains the fidelity of the force sensation to the user and is important for time-based effects. This method allows a faster update interval with only occasional delays in force output, thus providing better overall force output quality than if a longer time interval is used.

Effect Caching on the Host Computer

One limitation of force feedback devices is the relatively small amount of memory included on the devices. To create a realistic, immersive environment, many different force effects should be output by an application program. However, only a small number of effects can usually be stored on a force feedback device, often less than the application program wishes to use. In current implementations, if an application program commands the creation of more force effects than can be stored by the device, the effects that cannot be stored are simply discarded and not output, and the application program is informed of the failure (the application program can react to the failure in any way the developer desires). One way around the limitation is to provide a "smart" application program that only outputs a small number of force effects at once which can all be stored on the device; when the application wishes to create and output a new, different force effect, it destroys a previously-used effect and commands a new force effect. However, ideally the application program should be able to output as many force effects as it wishes without having to consider the memory limitations of the force feedback device and without having to spend extra processing time swapping force effects.

Effect caching by the host is a way to use to the host's memory in addition to limited device memory to store as many force effects as an application program needs to use. Host memory is used as an overflow cache for the device to store any effects not able to be stored on the device. In the view of the application program, all commanded effects have been stored on the device, so that the application program need never receive a failure message for running out of device memory. A driver program on the host (such as the translation layer, API or other library, or a lower-level driver) handles all the effect caching at a lower level than the application program.

FIG. **7** is a flow diagram illustrating a memory management process **400** from the point of view of the host (e.g. the translation layer or other levels of the host architecture in other embodiments) using a host cache to store effects. The term "cached effect" herein refers to an effect whose data is stored in the host memory but is not stored in the device memory due to the device memory being full. The force effect is cached by the host when the application program (via the API) requests to create a force effect on the device and the device has no effect slots available to store the effect. Instead of returning a "failure" message to the application program, the host caches the force effect in the host's memory. Preferably, this is done by a driver on the host so that the application program believes that the device has loaded all effects. It should be noted that the order of steps described below is only an example, and that the various checks and events can occur in at any time or in different sequences as function calls, interrupts, and/or in parallel (multitasking) in various embodiments.

FIG. **7** illustrates a process **400** running on host **18**. The process **400** is similar to process **310** of FIG. **5** at many steps. Process **400** begins at **402**, and in step **404**, then host **18** creates a memory model similarly to step **312** of FIG. **5**. In step **406**, the process determines whether the application program (e.g. through the API) is commanding to create or destroy any force effects on the device **11**. If the application does not currently wish to create or destroy any effects on the device, then step **418** is initiated, explained below. If the application wishes to modify a force effect by creating an effect on the device, then in step **408** the host checks the host model of device memory to determine if there is any device memory available to store the effect. If there is not, in step **412** the force effect is cached in the host memory but is not loaded into the device memory. Since host memory is for, many practical purposes unlimited when compared to device memory, the host cache should be able to store all force effects created by the application program. The cached force effects are preferably included in the same device memory model as the actual loaded effects (see FIGS. **9***a* and **9***b*). The process then continues to step **438**, described below. If there is sufficient memory for the created effect in step **408**, then in step **410** one or more create commands are sent to the device to load the effect on the device and the effect is also stored in the host memory model. The process then continues to step **438**, described below.

If in step **406** the application has commanded to destroy an effect, then in step **414** an effect slot is freed up on the host, creating an open slot in the device memory model. In next optional step **416**, the host can send a create command to the device to load a cached effect into the empty slot in device memory. Since there is an empty slot in device memory, and since the host cache may include effects that the application program assumes are loaded on the device, it can be efficient to have all the slots in the device memory filled. The host can load a cached effect based on the order in which it was cached, e.g. the effect that was cached first has the highest priority to be loaded. Alternatively, the host can prioritize the cached effects in some way and load the effect having the highest priority. For example, trigger effects may be considered higher priority than other effects. Effects can also be assigned priority based on several factors including the effect's magnitude, type, duration, or age, and/or a weighted combination of several of these factors. In other embodiments, step **416** is not implemented and the host can load cached effect data to the device at the time the effect is commanded to be played, as in step **432** below. The process then continues to step **438**, described below.

If no create or destroy command is made in step **406**, the process checks in step **418** whether the application program

on the host is commanding an effect state. If in step **418** a "stop" command has been made, then in step **420** the host sends a stop command to the device similarly to step **330** of FIG. **5**. In step **422** the host untags the effect in the host memory model similarly to step **332** of FIG. **5**. Next step **423** is similar to step **416**, described above, where the host can send a create command to the device to load a cached effect into the memory space occupied by the effect that was commanded to stop. As explained above, the host can determine which of the cached effects has the highest priority to be loaded. However, step **423** has the additional step of checking whether any cached effect, such as the highest-priority cached effect, has a greater priority than the stopped effect. In some cases, the stopped effect may have a higher priority than any cached effects and thus should remain in device memory, e.g. in an implementation placing high priority on trigger effects, the stopped effect may be a trigger and the cached effects may be periodics with lesser priority. Priority of effects is described below with respect to step **434**. The process then continues to step **438**, described below.

If in step **418** a "play" command was made, then in step **424** the process checks whether the commanded effect is already loaded on the device. The host can maintain a list indicating which of the effects have been loaded to the device and which have been cached on the host, as shown in FIGS. **9***a* and **9***b*. If the commanded effect has previously been loaded on the device, then the play command is sent to the device in step **426** similarly to step **326** of FIG. **5**, and the effect is tagged in step **428** in the host memory model similarly to step **328** of FIG. **5** (the device also tags the effect, as described in greater detail with respect to FIG. **6**). The process then continues to step **438**.

If the commanded effect(s) has not been loaded on the device, i.e., has been cached on the host, then in step **430** the process checks whether there is an open slot in the device memory in which to store the cached effect. An open slot does not have any effect data stored therein. If there is an open slot, then the process continues to step **432**.

If it is determined that the commanded effect (or a waiting effect; in step **414** any waiting effect that is to loaded can be considered a "commanded effect") can be loaded on the device, then in step **432** the host sends a create command to the device to create the commanded effect in the available effect slot of the device memory in step **416**, e.g. the effect is stored in the effect block and parameter block (if such a memory structure is being used), as explained with reference to step **320** of FIG. **5**. The process then continues to step **426** to send the "play" command for the created effect as explained above. After the effect is tagged in step **428** on the device and the host, the process continues to step **438**, described below.

If there is no open slot on the device in step **430**, then in step **434** the process checks whether any of the loaded effects can be "swapped" with the commanded effect, e.g. whether the loaded effect can be unloaded (written over) in its device memory slot and the commanded effect stored in its place.

The process can use many different criteria to determine if any slots are available in the device memory. In one embodiment, the process checks whether all the loaded effects are currently playing; the slots of all of the loaded effects that are not currently playing might be considered available slots. The host can simply write the commanded effect in the first available slot of memory.

In some embodiments, time-based (temporal) criteria can be used. For example, a long period of time may have passed since a loaded effect was last played, such that this effect can be considered to be expendable and the slot it occupies can be available for the newly-commanded effect. Such an expendable effect may perhaps no longer be in immediate use by the application program and thus is most eligible to be unloaded. The loaded effect having the longest time since last played can be considered the most eligible to be unloaded.

In other embodiments, instead of or in addition to using such time-based criteria, spatially-based criteria can be used to determine slot availability. This method predicts movement of the user object **12** by the user to help determine which effects should be loaded on the device. FIG. **8** illustrates one use of spatial caching. In a GUI **450** displayed on screen **20**, the user of device **11** can move a cursor **452** to different areas of the GUI. Many force effects are output based on the cursor's location in the GUI. For example, an attractive gravity field can be output to bias the cursor/user object to an icon **454** when the cursor is moved within an external range **455** around the icon. Or, a snap force can be output when the cursor moves over a window border **464** of window **462**.

Using spatial criteria, those force effects that are associated with graphical objects in the current path of movement of the cursor can be considered more essential since they are more likely to have to be output in the immediate future when the cursor moves to the associated graphical objects. Those effects associated with graphical objects away from the current path of the cursor are more expendable since they are less likely to require immediate output. Thus, the host can determine the current direction (and velocity, if desired) of the cursor **452** to determine which graphical objects and effects are in the current path of movement of the cursor and which graphical objects and effects are far away from the current path of movement. The effect associated with the graphical object furthest away from the cursor path can be considered the most expendable effect and can be unloaded and replaced by an effect closer to the cursor path of movement.

For example, in FIG. **8**, it has been determined by the host, e.g. by examining a history of two or more cursor positions, that the cursor **452** is currently moving in the direction **466**. The cursor is likely to continue moving in the direction **468** (the velocity of the cursor can optionally influence this determination; if the cursor is moving fast, it is much more likely to continue in the same direction **466** than if it is moving slower or is currently stopped). Therefore, the icons **454** and **456** and the window **458** are away from the likely path of the cursor and any force effects associated with these objects may not be required to be output in the immediate future. However, the cursor may be heading directly to icon **460**, since the attractive field associated with the icon range **461** may have to be output very soon, the attractive field effect has a much higher spatial priority than the effects associated with objects **454**, **456**, **458**. Window **462** is not in a direct a path of the cursor as is icon **460**, but since it is near the path **468**, the effects associated with window **462** should have a higher spatial priority than the effects of objects **454**, **456**, and **458** and should be loaded in place of one of the lower-priority effects.

In a more general sense, the host can monitor the motion of the user object **12** and swap multiple effects on the device with cached effects that are more likely to be output in the immediate future. Spatially-based criteria also can be used in conjunction with time-based criteria for determining memory slot availability.

Referring back to FIG. **7**, a priority system can also be used to determine which effect is most eligible to be

unloaded or swapped out and replaced with a cached effect. For example, each type of force effect can be assigned a priority in an absolute priority system, where each effect can be given a rank in a priority list according to the type of effect. For example, a damping effect may be considered lower priority than a vibration periodic effect that may be more noticeable to the user. A "trigger" effect preferably has a higher priority than non-trigger effects. A trigger effect is an effect that is not always playing, but which must be immediately output if a predefined event or condition occurs. For example, a gun recoil trigger effect can be played each time a button on the device **11** is pushed by the user. Since trigger effects need to be played quickly, they should remain loaded in device memory as much as possible. Furthermore, an effect that is currently playing can have a higher priority than non-playing effects (including trigger effects not currently being played), since it can be disruptive to a user to suddenly stop playing an effect before it has finished. However, this may not be the case when using spatial caching since an effect currently playing can be immediately turned off if the user moves the user object **12** to a different location.

The priority of the commanded effect is compared to the priorities of the loaded effects; the first effect having a lower priority is eligible to be swapped with the commanded effect. Alternatively, all the loaded effects can be examined, and the effect having the lowest priority can be eligible to be replaced with the commanded effect if the commanded effect has a higher priority than that effect. In some embodiments, only effects not currently playing are examined for availability; alternatively, all the loaded effects, whether currently playing or not, can be examined and the lowest priority effect unloaded.

Furthermore, in some embodiments the priorities of effects for caching purposes can be changed by an operating system, application, or other program or user. For example, a developer, of a force feedback application program can in some embodiments assign priorities to particular effects so that the developer has the flexibility to designate the importance of various effects to his or her particular application program. A priority system for a particular application could be provided to the host driver upon start-up of the application program. Such a priority system could be stored in a context for that application program, as described for FIG. **2**, for example. In such a system, the developer should be able to assign the highest possible priority to any effect desired, which will cause a commanded effect having such a priority to be always loaded on the device regardless of which effects are already loaded. This allows the application to directly command force feedback on the device with no concerns about receiving failure messages.

In addition, effects can be organized into various categories or "suites", where the effects in a category are assigned priorities and/or where only particular categories need be in use at a particular time. This allows effects from other "inactive" categories to be unloaded from the device and effects included in the "active" category to be loaded. The priorities in some cases can be assigned by the developer of an application program. For example, a developer of a game application can make a category "On Land" which includes a collision effect and a weapon fire effect as priority **1**, an engine rumble effect as priority **2**, and a "slight breeze" effect as priority **3**. The developer also can make a category of "In Water" including a water resistance (damping) effect and explosion effect as priority **1**, a "strong current" effect as priority **2**, and "hitting sea kelp" as priority **4**. The application program calls the API to inform the host driver which category is currently in use, and when to switch categories. When, in the game, the user controls a vehicle to move from land into water, the application program indicates that the "On Land" category of effects should be switched to the "In Water" category of effects. The host driver then knows that all "On Land" effects are free to be unloaded from the device memory and that the "In Water" effects should be loaded. Furthermore, since each effect has been assigned a priority, the host driver knows that if there is not enough slots to store all of the "On Water" effects, the water resistance and explosion effects should be loaded before the lower priority effects. Other uses of categories and priorities is described in co-pending patent application Ser. No. 09/306,002, filed concurrently herewith, and incorporated herein by reference.

The priority system described above can also be combined with other criteria, such as time-based and/or spatially-based criteria described above. For example, a priority can be assigned to a loaded effect based on multiple factors such as its effect type, its application-assigned priority, its time-based criteria, and/or its spatially-based criteria. For example, some force effects may be "one-shot" effects which are played once and then not used. These effects could have an initially high priority; once they are played, their priority can go to zero. In some embodiments, a total weighted priority can be assigned to the effect based on these factors and any weights assigned to the factors. The weighted priority of the loaded effect can then be compared to the (weighted) priority of the commanded effect to determine if the loaded effect can be swapped with the commanded effect.

Furthermore, other criteria may also determine whether the commanded effect can be loaded. When implementing more sophisticated comparisons, weights, etc. the tradeoffs between available host processing power and gains in caching efficiency should be considered.

A further consideration is whether the commanded effect can actually fit into the memory space occupied by a particular loaded effect. All effects occupy the same amount of space in the a effect block **300**, but different effects occupy different amounts of space in the parameter block **304** based on how many parameters are used and workspace required for an effect. If the commanded effect will not fit into the space occupied by the loaded effect with the lowest priority, then that loaded effect should be excluded from comparison and other loaded effects are examined for eligibility. Alternatively, if the examined loaded effect does not occupy sufficient space for the commanded effect, the loaded effect can still be unloaded or destroyed. The process then examines another low-priority loaded effect and unloads that effect as well; this process may continue until sufficient space is freed for the commanded effect.

If it is determined that the commanded effect can be loaded over a loaded effect in step **434**, then in step **432** a create command(s) is sent to the device to load the data for the commanded effect in the space of the expendable effect. It should be noted that the expendable effect is still available to be commanded by the application since it still resides in the host cache and memory model. The process then continues to step **426** to send a play command to the device and play the commanded effect as described above.

If it is determined that the commanded effect cannot be loaded in step **434**, then in step **436** the command is given a failure status, and the commanded effect is not loaded to the device. Of course, only the "play" command itself has failed; the effect data still resides in the host cache and memory model. In some embodiments, the application pro-

gram can remain ignorant of the failure; this allows the application program to believe that the force effect is playing properly and to issue another play command for that effect at a later time without disruption or additional processing (and the later command may succeed); in addition, this prevents the application from overreacting to the failure. In other embodiments, it may be desirable to inform the application program of any failure to play an effect so that the application program can compensate for the failure in other ways. The application program can be provided with varying degrees of information; for example, that the effect has been cached but did not play, or that the effect simply did not play. The process continues to step **438**, described below.

In an alternate embodiment, the process can mark a failed cached commanded effect as "waiting." Effects which have a status of "waiting" can be given a high priority to be loaded if any of the effect slots on the device should open up in future iterations. The host can maintain the effect's duration while it has a waiting status so that if an effect slot opens up, the host will know whether the waiting effect should still be output and if so, at which point in its duration. Thus, only effects which have a relatively long duration need be given a waiting status. For example, if a periodic effect having a duration of 4 seconds is waiting to be loaded on the device, the host keeps track of the duration; if 2 seconds have elapsed before an effect slot is available, the host commands the periodic effect starting at the third second. If four seconds have elapsed rah before an effect slot becomes available, then the host should cancel the effect since its duration has expired. In such a waiting embodiment, the process can check whether any waiting effects can be loaded to the device after an effect is untagged in step **422** or destroyed in step **414**, if so, the create command of step **416** or step **423** can be sent for the waiting effect (if the waiting effect has a high enough priority), and a play command can be sent, if appropriate, to play the formerly-waiting effect. Also, in steps **430** and **434**, a waiting effect can be assigned a priority or its existing priority can be increased due to the waiting status, and the waiting effect may be loaded before a currently-commanded effect if its priority is higher. It should be noted that in many implementations, such a waiting status is unnecessary, since many force effects are too short in duration to justify the extra processing required. In addition, devices having several effect slots can usually maintain realistic forces even if some force effects are discarded.

In step **438**, the host can check whether any playing effect has expired, similarly to step **334** of FIG. **5**. If no effects have expired, the process returns to step **406**. If at least one effect has expired, then the process continues to step **440** to untag the expired effect in the host memory model. In other embodiments, steps **438** and **440** can be omitted. The process then returns to step **406**.

Force effect caching on the host can also be useful in other memory management paradigms in addition to the implementation described above where the host maintains a device memory model. For example, if only the device knows whether a commanded force effect can be stored in device memory, the device is queried by the host. If the device says that it cannot store any more effects, a driver on the host can create and cache the effect and inform the application program that its effect has been created, rather than indicating that the create command has failed.

It is important to note that the process described above preferably is implemented at a level on the host computer lower than the application program controlling the forces. The application program thus is unaware of all the effect processing that may be going on. This relieves the application program from having to determine which effects should be destroyed and which should be created at different times, and allows the developer of the application to focus on other important aspects of application and force design.

FIGS. **9***a* and **9***b* are diagrammatic illustrations of the memory of the host and device when caching a force effect as explained in FIG. **7**. In the example of FIG. **9***a*, a device has five effect slots **480**, and all five slots have been filled with a force effect as shown. Two of the effects are currently playing (tagged) as shown in column **482**. The host, meanwhile, is storing a memory model **484** that includes seven force effects **485**. This is because the application program has created seven force effects and believes that all seven effects have been created on the device. Therefore, two of the created force effects have been cached by the host since the device can only store five effects.

As shown in column **486**, the host driver keeps track of which force effects have actually been created (loaded) on the device. The host driver also keeps track in column **488** of which force effects are currently playing, i.e. output to the user. Thus, in the example shown, the host knows that the effects in slots **1**, **3**, **4**, **5**, and **6** of the host are loaded in the available slots of the device. The slots of the host and the device need not correspond since the host loads and unloads different effects from the device during application execution; however, the host driver does need to know which slots of the device the effects are stored so that the proper index into the effect block may be sent to the device. The host also knows that the effects in slots **3** and **4** of the host are currently playing on the device. If a cached effect is commanded to be played by the application, such as the Spring effect in slot **7** of the host, then the host can examine the loaded effect slots **480** to determine which slot the Spring effect can be loaded to. For example, the Periodic**1**, TriggerForce, and Periodic**2** effects on the device are not currently playing; since Trigger effects have a high priority, the Periodic**1** or Periodic**2** effect could likely be unloaded and the Spring**2** effect loaded in the available slot, depending on the conditions of availability and priorities used. In addition, in some embodiments the host can also maintain a "priority" field for each effect in the model **485** to allow the comparison of priorities for loading purposes.

FIG. **9***b* illustrates an embodiment **490** providing the waiting feature described above as an alternative to step **436** in FIG. **7**. The host keeps track of which force effects are "waiting" as shown in column **492**. Thus, in the example shown, the effects in slots **1**, **3**, **4**, **5**, and **6** of the device have been loaded to the device and are all tagged, meaning they are all being currently output. The ConstantForce**1** effect in slot **2** of the host has been commanded by the application program tobe played, but there is no available effect slot to store the commanded effect. The host therefore marks the commanded effect as "waiting" and monitors the device memory to determine if the commanded effect can be later loaded to the device and played. The host internally maintains the duration of the ConstantForce**1** effect so as to output the correct force magnitude, direction, etc. at the point in time when the waiting effect can be actually loaded to the device.

FIG. **10** is a diagrammatic illustration of an alternate "playlist" embodiment of the device memory of device **11**. In the above embodiments as shown in steps **362**–**378** of FIG. **6**, the device **11** examined each effect slot in order and checked whether each effect was tagged (playing); if the effect were tagged, a force based on that effect was added to a total force that was output on the user manipulatable object

12. FIG. **10** illustrates an alternate method in which a playlist **500** is stored in device memory. An effect block **502** is stored on the device and host as explained above (a parameter block (not shown) may also be stored). When an effect is tagged by process **310** (e.g. in step **328** of FIG. **5**), a pointer to that effect or index into the effect block is stored in the next available slot in the playlist **500**. Thus, only the topmost slots of the playlist are preferably filled, with any open slots at the bottom of the list. The total number of tagged effects is stored as a number in a memory location **504**, and is updated whenever an effect is tagged or untagged. In most implementations, the number of slots in the playlist **500** can be less than the number of effect slots implemented in the effect block **502**, since the number of playing effects is likely to be smaller than the total number of effects stored on the device. For example, the device may be able to store **30** effects, but the playlist might only require 10 slots.

When an effect finishes or is stopped by a command, the effect is removed from the playlist. If there are other effects still playing which are located further down in the list past the removed effect, then one or more of these later effects can be moved to maintain a continuous playlist without gaps. For example, the last effect in the playlist can be moved to the location at which the removed effect used to be stored. In addition, after the effect is removed from the playlist, the total number of effects in location **504** is decremented.

The efficiency of the playlist **500** is demonstrated when the playing process **350** of FIG. **6** examines the device memory to determine which effects are to be output as forces. Instead of sequentially examining each slot in the effect block **502** as described in FIG. **6**, the process instead simply examines the memory location **504** for the number of effects currently tagged (playing). Once this number T is known, the process then looks at the top T entries in the playlist **500** to determine which particular effects are playing, and calculates forces for those effects. This is much more efficient than examining the tag field for each entry in the effect block **502**, especially when there are many effects in the effect block **502**. Furthermore, if no effects or only a small number of effects are playing, no processing time is wasted checking each slot in the effects table.

While this invention has been described in terms of several preferred embodiments, it is contemplated that alterations, permutations and equivalents thereof will become apparent to those skilled in the art upon a reading of the specification and study of the drawings. Also, the various features of the embodiments herein can be combined in various ways to provide additional embodiments of the present invention. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the present invention. It is therefore intended that the following appended claims include all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

What is claimed is:

1. A method comprising:

creating a representation of a device memory in a computer memory;

storing a force effect in a cache allocated in said computer memory;

determining whether said device memory can store said force effect by examining said representation of said device memory; and

sending said force effect to said device memory.

2. A method as recited in claim **1** wherein said force effect is sent to said device memory only if said device memory can store said force effect.

3. A method as recited in claim **2** wherein determining whether said device memory can store said force effect comprises:

comparing a priority of said force effect with a priority of a loaded force effect already stored in said device memory; and

sending said force effect if said priority of said force effect is greater than said priority of said loaded force effect.

4. A method as recited in claim **1** further comprising storing a plurality of force effects in said cache in said computer memory regardless of whether said device memory comprises sufficient space to store said plurality of force effects.

5. A method as recited in claim **1**, further comprising delaying the sending of said force effect to said device memory if said device memory is full.

6. A method as recited in claim **1**, further comprising:

storing a plurality of force effects in said computer memory;

sending one of said plurality of force effects to to said device memory when said one of said plurality of force effects is to be played; and

replacing a force effect stored in said device memory with said one of said plurality of force effects.

7. A method comprising:

receiving a force effect create command;

sending a force effect data corresponding to said force effect create command to a device memory if said device memory comprises a sufficient space to store said particular force effect data; and

storing said force effect data in a cache allocated in a computer memory if said device memory does not comprise said sufficient space.

8. A method as recited in claim **7** further comprising:

receiving a command to output a force effect; and

swapping said force effect data with a loaded force effect data in said device memory.

9. A method as recited in claim **8**, further comprising storing a representation of said device memory in said computer memory.

10. A method as recited in claim **9**, further comprising examining said representation to determine if said device memory comprises said sufficient space.

11. A method as recited in claim **9** wherein said representation and said device memory each comprises an effect block and a parameter block, wherein an identifier of said force effect is stored in said effect block and at least one parameter for said force effect is stored in said parameter block.

12. A method as recited in claim **7**, further comprising:

querying haptic feedback device comprising said device memory; and

receiving a response indicating whether said device memory comprises said sufficient space.

13. A method as recited in claim **7**, further comprising associating a waiting status with said force effect data if said device memory does not comprise said sufficient space.

14. A system comprising:

a haptic feedback device comprising a device memory; and

a computer in communication with said haptic feedback device, said computer comprising system memory in which a cache is implemented, wherein said cache stores a force effect data if said device memory does not have said sufficient space.

15. A system as recited in claim 14 wherein said cache comprises a representation of said device memory.

16. A system as recited in claim 15 wherein said representation and said device memory each comprises an effect block and a parameter block, wherein an identifier of said force effect is stored in said effect block and a parameter for said force effect is stored in said parameter block.

17. A system as recited in claim 14, further comprising a driver said computer for receiving a force effect create command.

18. A system as recited in claim 17 wherein said driver creates a representation of said device memory in said system memory, wherein said driver examines said representation to determine if said device memory has said sufficient space.

19. A system as recited in claim 14 wherein if said force effect is stored in said cache and said force effect is to be played, said force effect data is swapped with a loaded force effect in said device memory.

20. A system as recited in claim 14 wherein when said device memory does not have sufficient space, said force effect is given a waiting status such that said force effect data for said force effect is sent to said device memory at a later time.

* * * * *

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Grant et al.

(10) **Patent No.: US 7,890,863 B2**
(45) **Date of Patent: Feb. 15, 2011**

(54) **HAPTIC EFFECTS WITH PROXIMITY SENSING**

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G06F 3/01 (2006.01)

(52) **U.S. Cl.** **715/702**; 715/701; 715/763

(58) **Field of Classification Search** 715/702, 715/710, 863; 345/169, 173
See application file for complete search history.

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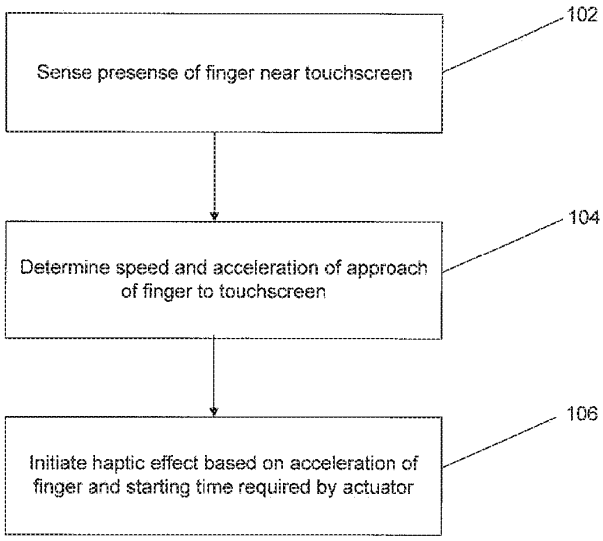
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Primary Examiner—Boris Pesin
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(57) **ABSTRACT**

A method of generating haptic effects on a device includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

20 Claims, 3 Drawing Sheets



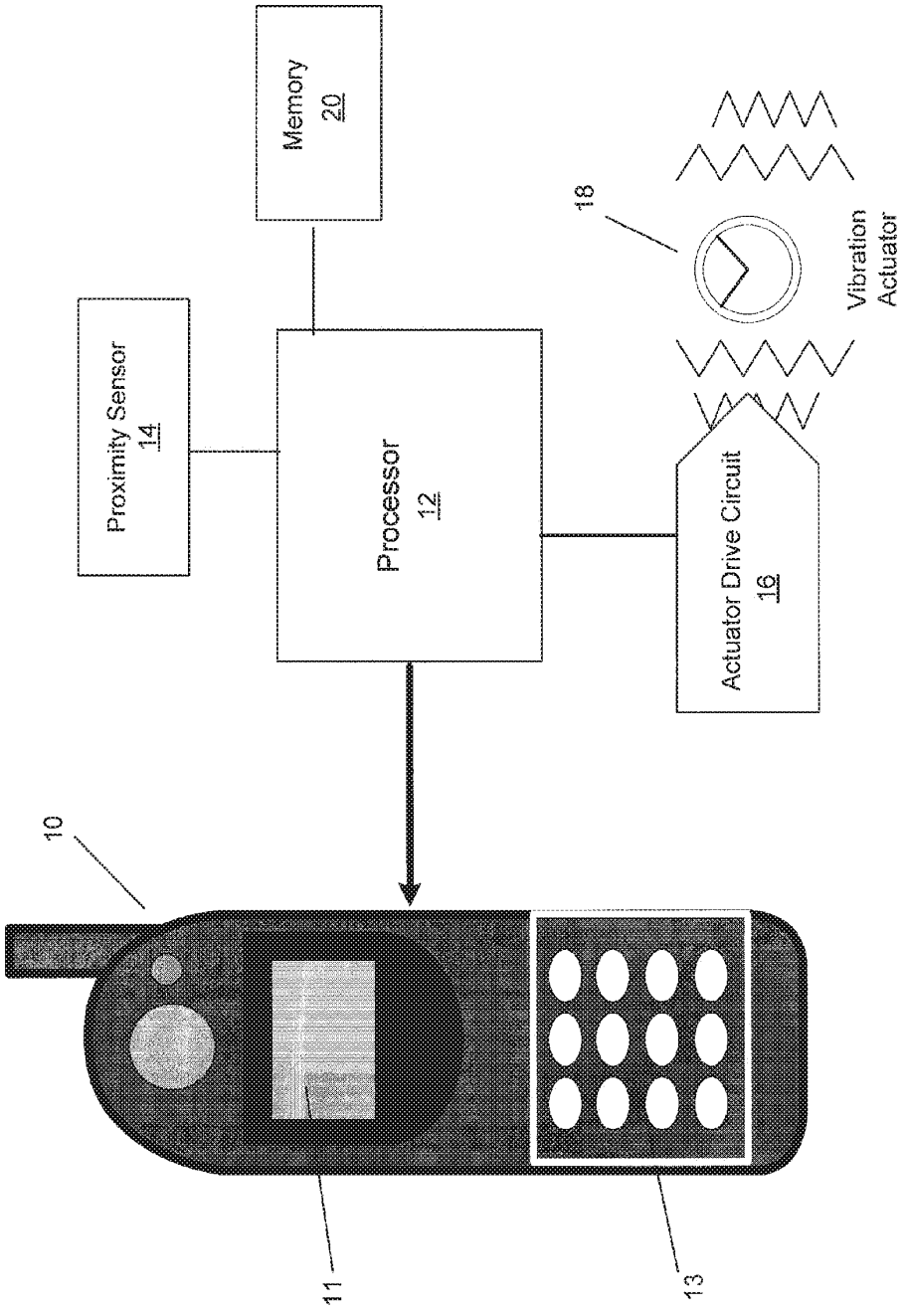

Memory
20
18
Vibration
Actuator
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
10
11
13

Fig. 1

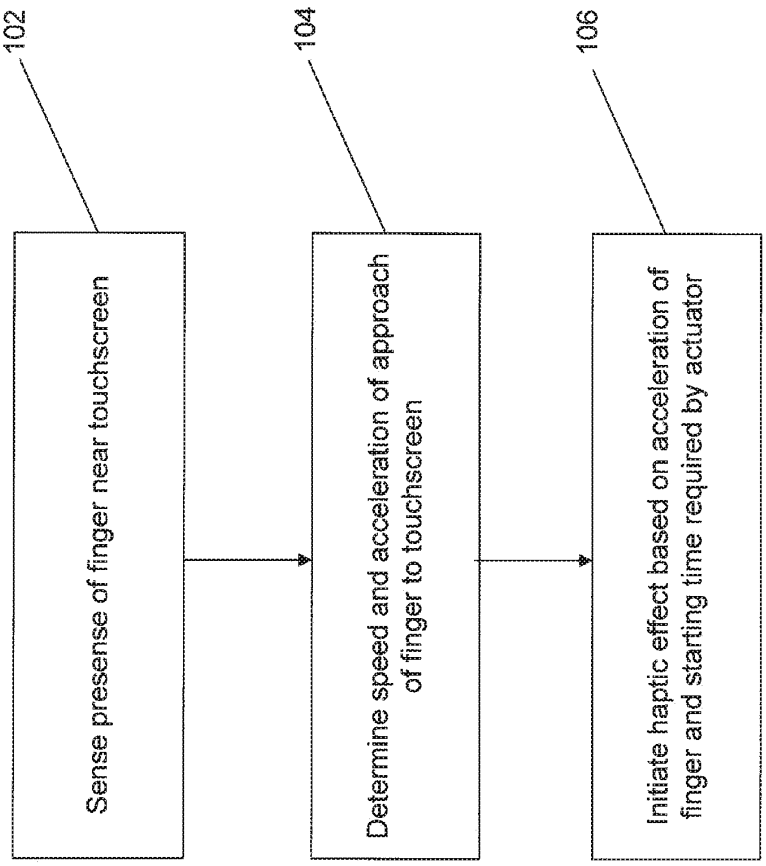


Fig. 2

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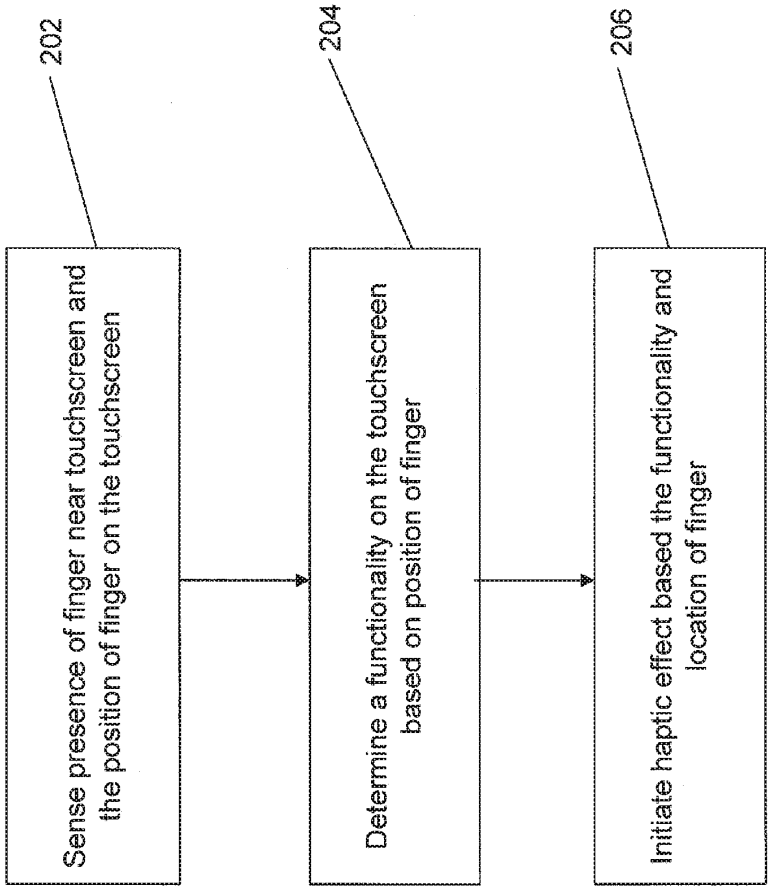


Fig. 3

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HAPTIC EFFECTS WITH PROXIMITY SENSING

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application No. 60/828,195, filed Oct. 4, 2006.

FIELD OF THE INVENTION

One embodiment of the present invention is directed to a haptic feedback system. More particularly, one embodiment of the present invention is directed to a haptic feedback system that utilizes proximity sensing.

BACKGROUND INFORMATION

Electronic device manufacturers strive to produce a rich interface for users. Conventional devices use visual and auditory cues to provide feedback to a user. In some interface devices, kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, texture, and heat) is also provided to the user, more generally known collectively as "haptic feedback." Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, vibration effects, or vibrotactile haptic effects, may be useful in providing cues to users of electronic devices to alert the user to specific events, or provide realistic feedback to create greater sensory immersion within a simulated or virtual environment.

Haptic feedback has also been increasingly incorporated in portable electronic devices, such as cellular telephones, personal digital assistants (PDAs), portable gaming devices, and a variety of other portable electronic devices. For example, some portable gaming applications are capable of vibrating in a manner similar to control devices (e.g., joysticks, etc.) used with larger-scale gaming systems that are configured to provide haptic feedback. Additionally, devices such as cellular telephones and PDAs are capable of providing various alerts to users by way of vibrations. For example, a cellular telephone can alert a user to an incoming telephone call by vibrating. Similarly, a PDA can alert a user to a scheduled calendar item or provide a user with a reminder for a "to do" list item or calendar appointment.

Increasingly, portable devices are moving away from physical buttons in favor of touchscreen-only interfaces. This shift allows increased flexibility, reduced parts count, and reduced dependence on failure-prone mechanical buttons and is in line with emerging trends in product design. When using the touchscreen input device, a mechanical confirmation on button press or other user interface action can be simulated with haptics.

For portable devices, cost is an important driving factor. Therefore, to generate haptic effects a single low cost actuator is generally used, for example an eccentric rotating mass ("ERM") motor or an electromagnetic motor. These actuators are able to produce strong magnitude haptic outputs. However, they also require a certain amount of time to achieve their peak haptic output (e.g., approximately 50 ms). These actuators are also used to provide feedback to the user when operating a touch sensitive input of a touchscreen device. For example when the user presses a button on a touchscreen a haptic effect is output to give the sensation of pressing a mechanical button. It is desired to output the haptic effect at the same time the user has selected the button in the interface. However, due to the time it takes to have actuator reach a desired magnitude, the haptic effect lags behind the button press event. If this lag becomes too long the user will not perceive the button press and the haptic effect as a single event.

Based on the foregoing, there is a need for an improved system and method for generating haptic effects for a touchscreen.

SUMMARY OF THE INVENTION

One embodiment is a method of generating haptic effects on a device. The method includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a cellular telephone in accordance with one embodiment.

FIG. **2** is a flow diagram of the functionality performed by a telephone when generating haptic effects in response to the proximity of a user to a touchscreen in accordance with one embodiment.

FIG. **3** is a flow diagram of the functionality performed by the telephone when generating haptic effects in response to the proximity of a user to the touchscreen in accordance with one embodiment.

DETAILED DESCRIPTION

One embodiment is a portable device that includes a haptic feedback system with proximity sensing. The haptic system initiates the haptic feedback before a user actually touches a touchscreen or other input area based on the proximity information.

FIG. **1** is a block diagram of a cellular telephone **10** in accordance with one embodiment. Telephone **10** includes a screen **11** and an input area, touchscreen **13**, that includes "keys" and can include other types of user interfaces, including menus, etc. In another embodiment, the keys of telephone **10** can be mechanical type keys. Internal to telephone **10** is a haptic feedback system that generates vibrations on telephone **10**. In one embodiment, the vibrations are generated on the entire telephone **10**. In other embodiments, specific portions of telephone **10** can be haptically enabled by the haptic feedback system, including the entire touchscreen **13** or individual keys of touchscreen **13**.

The haptic feedback system includes a processor **12**. Coupled to processor **12** is a memory **20** and an actuator drive circuit **16**, which is coupled to a vibration actuator **18**. Although the embodiment of FIG. **1** is a cellular telephone, embodiments can be implemented with any type of handset or mobile/portable device, or any device that uses an actuator to generate vibrations. For example, other embodiments may not include touchscreens but are haptic devices with other types of input areas. Other input areas besides touchscreens may be a mini-joystick, scroll wheel, d-Pad, keyboard, touch sensitive surface, etc. As with a cellular telephone, for these devices there is a desire for a haptic effect to be generated on the input area and/or the entire device.

Processor **12** may be any type of general purpose processor, or could be a processor specifically designed to provide haptic effects, such as an application-specific integrated circuit ("ASIC"). Processor **12** may be the same processor that operates the entire telephone **10**, or may be a separate processor. Processor **12** can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters. In general, the high level parameters

that define a particular haptic effect include magnitude, frequency and duration. Low level parameters such as streaming motor commands could also be used to determine a particular haptic effect.

Processor **12** outputs the control signals to drive circuit **16** which includes electronic components and circuitry used to supply actuator **18** with the required electrical current and voltage to cause the desired haptic effects. Actuator **18** is a haptic device that generates a vibration on telephone **10**. Actuator **18** can include one or more force applying mechanisms which are capable of applying a vibrotactile force to a user of telephone **10** (e.g., via the housing of telephone **10**). Memory device **20** can be any type of storage device, such as random access memory ("RAM") or read-only memory ("ROM"). Memory **20** stores instructions executed by processor **12**. Memory **20** may also be located internal to processor **12**, or any combination of internal and external memory.

A proximity sensor **14** is coupled to processor **12**. Proximity sensor **14** detects when a finger (or stylus) is in close proximity to but not in contact with touchscreen **13**. Proximity sensor **14** may also detect location (e.g., x, y, z), direction, speed and acceleration, orientation (e.g., roll, pitch, yaw), etc. of the finger relative to touchscreen **13**. Proximity sensor **14** provides its information as an input to processor **12** when a finger is placed above touchscreen **13**. This input can be used by processor **12** when generating haptic feedback for telephone **10**.

Proximity sensor **14** may use any technology that allows the proximity of a finger or other object to touchscreen **13** to be sensed. For example, it may be based on sensing technologies including capacitive, electric field, inductive, hall effect, reed, eddy current, magneto resistive, optical shadow, optical visual light, optical IR, optical color recognition, ultrasonic, acoustic emission, radar, heat, sonar, conductive or resistive and the like.

In one embodiment, proximity sensor **14** includes one or more proximity sensors that each generate a sensing field above touchscreen **13** and that produce signals when an object disturbs or intercepts the sensing field(s). Each sensing field typically generates its own signals when disturbed. In one embodiment, a single sensing field is used to cover the entire touchscreen **13** surface. In another embodiment, a single sensing field only covers a portion of the touchscreen **13** surface. In another embodiment, multiple sensing fields are used to cover the entire touchscreen **13** surface. Any number of sensing fields may be used. In some cases, in order to perform tracking, the sensing fields may even be distributed as a pixelated array of nodes.

FIG. **2** is a flow diagram of the functionality performed by telephone **10** when generating haptic effects in response to the proximity of a user to touchscreen **13** in accordance with one embodiment. In one embodiment, the functionality of FIG. **2** is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

At **102**, proximity sensor **14** senses the presence of a finger, stylus, or other object above or in some other manner near touchscreen **13** or other input area of telephone **10**.

At **104**, proximity sensor **14** determines the position, speed and/or acceleration of the finger relative to the surface of touchscreen **13**. This enables processor **12** to determine whether the user's finger will actually contact touchscreen **13**. For example, if the proximity signal is increasing at a certain rate, it is highly likely that the user will contact touchscreen **13** and press a button.

At **106**, based on the determination at **104**, processor **12** can calculate when the finger is expected to contact touchscreen **13**. In anticipation of this contact, processor **12** initiates the haptic effect before the actual contact, thus avoiding the lag time caused by actuator **18**. Processor **12** may use the acceleration of the finger and the starting time required by actuator **18** to determine how far in advance to initiate the haptic effect and energize actuator **18**. Therefore, the haptic effect will be implemented at approximately the exact time that the finger actually contacts touchscreen **13** and result in better synchrony of the haptic effect with the button press event. In another embodiment, processor **12** may initiate the haptic effect upon sensing the mere presence of the finger at **102**.

In typical use of cell phones or PDA's, the user generally holds the device in one hand and uses the other hand to interact with the user interface such as touchscreen **13**. For handheld haptic devices with proximity sensing this means that the user can sense the haptic feedback with the hand holding the device even though the finger has not yet touched the surface. Therefore, useful haptic effects can be created as a function of the proximity even when a finger never touches touchscreen **13**.

In one embodiment, if a user is hovering a finger over the touchscreen and moving over a grid of displayed buttons, a first haptic effect can be played when the user is moving from over one button to over the next button. The first haptic effect can be a short soft haptic effect in order to simulate the feel of moving over the edge of one button to the next. This first haptic effect will give the user an indication of the button locations without the user activating the buttons. A second haptic effect can be played when the user actually touches the screen and acts to select the button. The second haptic effect can be a strong haptic effect simulating a sharp button click.

FIG. **3** is a flow diagram of the functionality performed by telephone **10** when generating haptic effects in response to the proximity of a user to touchscreen **13** in accordance with one embodiment. In one embodiment, the functionality of FIG. **3** is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

At **202**, proximity sensor **14** senses the presence and position of a finger, stylus, or other object above or in some other manner near touchscreen **13**. The sensed position may include the x and y coordinates of the finger relative to touchscreen **13**.

At **204**, the functionality on the touchscreen is determined based on position of the finger. For example, if a multiple button graphical user interface on touchscreen **13** is displayed, the closest button that the finger is above and the functionality of that button is determined.

At **206**, processor **12** initiates a haptic effect based the functionality and location of finger. Depending on the functionality on the touchscreen, a different haptic effect may be generated by processor **12**. Because the finger does not actually touch touchscreen **13** in this embodiment, the haptic effect is felt by the other hand that is holding telephone **10**.

In one embodiment, haptic effects can be applied to various menu navigation steps. For a user holding a hand held haptic enabled device, the haptics can be directed to the housing such that the user's hand holding the device will experience the haptic effect. For example, when using a touchscreen, if the user hovers over a top level menu choice and a sub-menu exists for that choice, then a light haptic effect simulating a soft button click (first haptic effect) can be played as the graphics display the preview sub-menu items. If there is no sub-menu attached to that particular menu item (or no valid

choices exist) then a second haptic effect can be generated, for example a buzz created by series of pulses. If the user then selects the top level menu item, a strong haptic effect simulating a sharp button click (third haptic effect) can be played. If the user decides to move to another top-level menu a fourth haptic effect can be played when entering the new menu. The fourth haptic effect can be the same as the first haptic effect if it is a similar menu item. These haptic effects, resulting while a user finger is still hovering over a surface, i.e., before contract has been made, would be directed to the other hand that is holding the haptic device.

In one embodiment, different haptic effects can be applied depending on the intended use of the touchscreen area. For example, when a user's finger is hovering over a touch screen integrated into a cell phone or PDA, different haptic effects can be produced in the cell phone when in a map/GPS navigation mode than when managing climate control or when entering hand written notes.

In one embodiment, during typical operation of a cell phone, the user can have many different proximity relationships to the device. For example the cell phone could be in the user's hand, in the user's pocket, or right next to the user's face. These different operating conditions required different levels of haptic feedback to the user. A proximity sensor could be used to detect these different operating conditions. It is also possible to detect these user conditions through the use of acceleration and/or orientation measurements. Once the current operating condition of the device is known, for example holding the phone next to an ear, a global haptic volume adjustment could be made for the different operating states. In one example, the user could have a specific vibration pattern set for a reminder event. If the user has the phone attached to a belt clip the vibration pattern could contain strong haptic effects in order to signal the reminder event. If the user is actually using the phone and has the phone pressed up next to the user's face where the user will be more sensitive to the haptic effects, when the reminder event is triggered, it would be useful to have the haptic magnitude reduced for that event.

In one embodiment, gestures can be recognized such as a virtual jog dial. A jog dial recognizes rotation and when performed above a proximity active surface can be recognized without the surface being touched. A movement in the x, y and/or z direction can also be recognized. As an example, haptic effects can be attached to the use of the virtual jog wheel. A first haptic effect can be played at regular intervals of the jog wheel to give the user an indication and confirmation of progress in moving the wheel. A second haptic effect can be output when the user reaches the end of a list that the jog wheel is controlling. These jog and/or x, y, z motions can be recognized even when performed with proximity sensing, over a mechanical alpha/numeric keypad such as which exists on most cell phones today.

Several embodiments disclosed are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

1. A method of generating haptic effects on a device, said method comprising:

detecting the presence of an object near an input area of the device and not in contact with the device;

calculating an approximate contact time when the object will contact the input area;

and

initiating a haptic effect on the device in response to the presence detection;

wherein the initiating comprises energizing an actuator that has a delay time to reach a peak haptic output, and wherein the energizing occurs at a time in advance of the approximate contact time so that the delay time has elapsed by the approximate contact time;

wherein the haptic effect is generated on the device by the approximate contact time when the object contacts the input area.

2. The method of claim **1**,

wherein the calculating comprises determining at least one of a position, speed, or acceleration of the object relative to the input area.

3. The method of claim **1**, wherein said haptic effect comprises generating a vibration on the input area.

4. The method of claim **1**, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

5. The method of claim **1**, wherein said device is a cellular telephone.

6. The method of claim **1**, wherein said input area is a touch sensitive surface.

7. The method of claim **1**, further comprising:

determining a position of the object relative to the input area; and

determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

8. The method of claim **7**, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

9. A haptically enabled device comprising:

an input area;

a proximity sensor coupled to said input area;

and a haptic feedback system coupled to said input area;

wherein said proximity sensor is adapted to detect the presence of an object near the input area but not touching the input area, and the haptic feedback system is adapted to calculate an approximate contact time when the object will contact the input area and initiate a haptic effect before the object touches the input area;

wherein the initiating comprises energizing an actuator that has a delay time to reach a peak haptic output, and wherein the energizing occurs at a time in advance of the approximate contact time so that the delay time has elapsed by the approximate contact time;

wherein the haptic effect is output on the device by the approximate contact time when the object contacts the input area.

10. The device of claim **9**, wherein the calculating comprises determining at least one of a position, speed, or acceleration of the object relative to the input area.

11. The device of claim **9**, wherein said input area comprises a touch sensitive surface.

12. The device of claim **11**, wherein said touch sensitive surface is a touchscreen.

13. A computer readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate haptic effects on a device, said processor:

detecting the presence of an object near an input area of the device and not touching the input area;

determining an approximate contact time when the object will contact the input area;

and

initiating a haptic effect on the device in response to the presence detection;

wherein the initiating comprises energizing an actuator that has a delay time to reach a peak haptic output, and wherein the energizing occurs at a time in advance of the approximate contact time so that the delay time has elapsed by the approximate contact time;

wherein the haptic effect is generated on the device by the approximate contact time when the object contacts the input area.

14. The computer readable medium of claim **13**, wherein the determining comprises determining at least one of a position, speed, or acceleration of the object relative to the input area.

15. The computer readable medium of claim **13**, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

16. The computer readable medium of claim **13**, wherein said device is a cellular telephone.

17. The computer readable medium of claim **13**, wherein said input area is a touch sensitive surface.

18. The computer readable medium of claim **13**, said processor further:

determining a position of the object relative to the input area; and

determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

19. The computer readable medium of claim **18**, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

20. A haptically enabled device comprising:

means for detecting the presence of an object near an input area of the device, wherein the object is not touching the input area;

means for determining an approximate contact time when the object will contact the input area;

and

means for initiating a haptic effect on the device in response to the presence detection, wherein the initiating comprises energizing an actuator that has a delay time to reach a peak haptic output, and wherein the energizing occurs at a time in advance of the approximate contact time so that the delay time has elapsed by the approximate contact time;

wherein the haptic effect is generated on the device by the approximate contact time when the object contacts the input area.

* * * * *

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(54) DATA PROCESSING SYSTEM

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(57) ABSTRACT

A data processing system includes an application unit including a force pattern calculating section and a data processing section. The force pattern calculating section analyzes screen definition data for defining display screen data which is generated by the data processing section, determines a force pattern based upon the disposition of display elements, such as buttons and spaces, in a display screen and based upon force patterns corresponding to the types of the display elements recorded in an object attribute table, and stores the force pattern in a force pattern table. The force pattern is applied to a user based upon an input to the display screen. A commander driver determines a force corresponding to an input from a haptic commander, and controls the haptic commander such that the determined force is applied to the user.

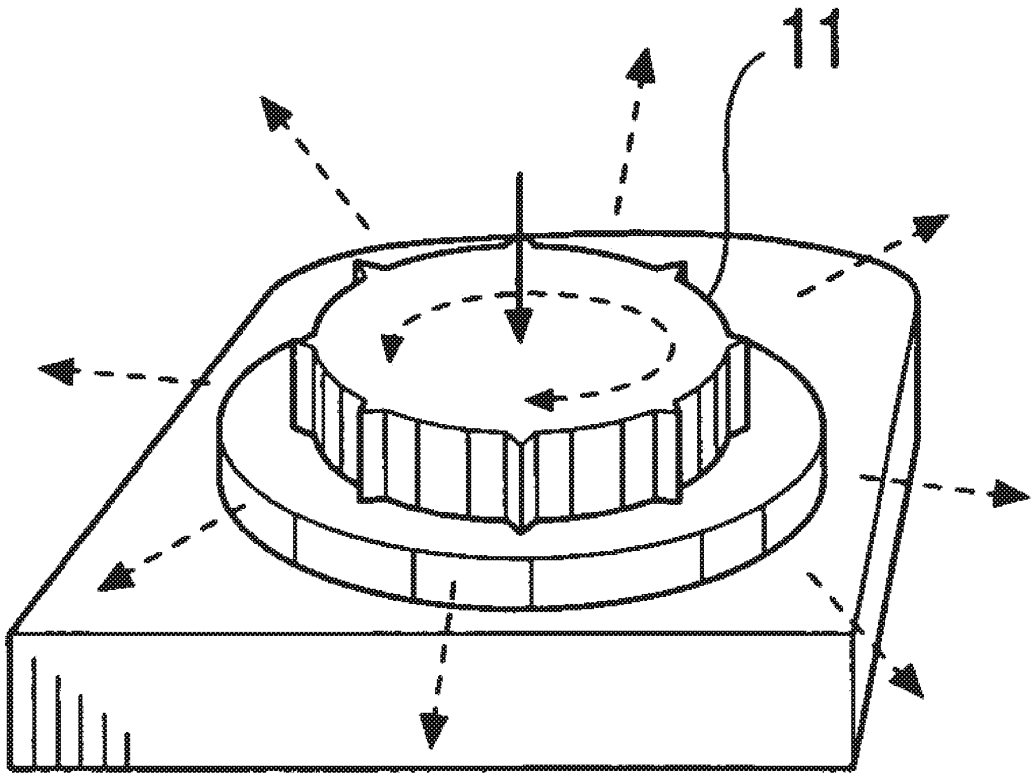


FIG. 1

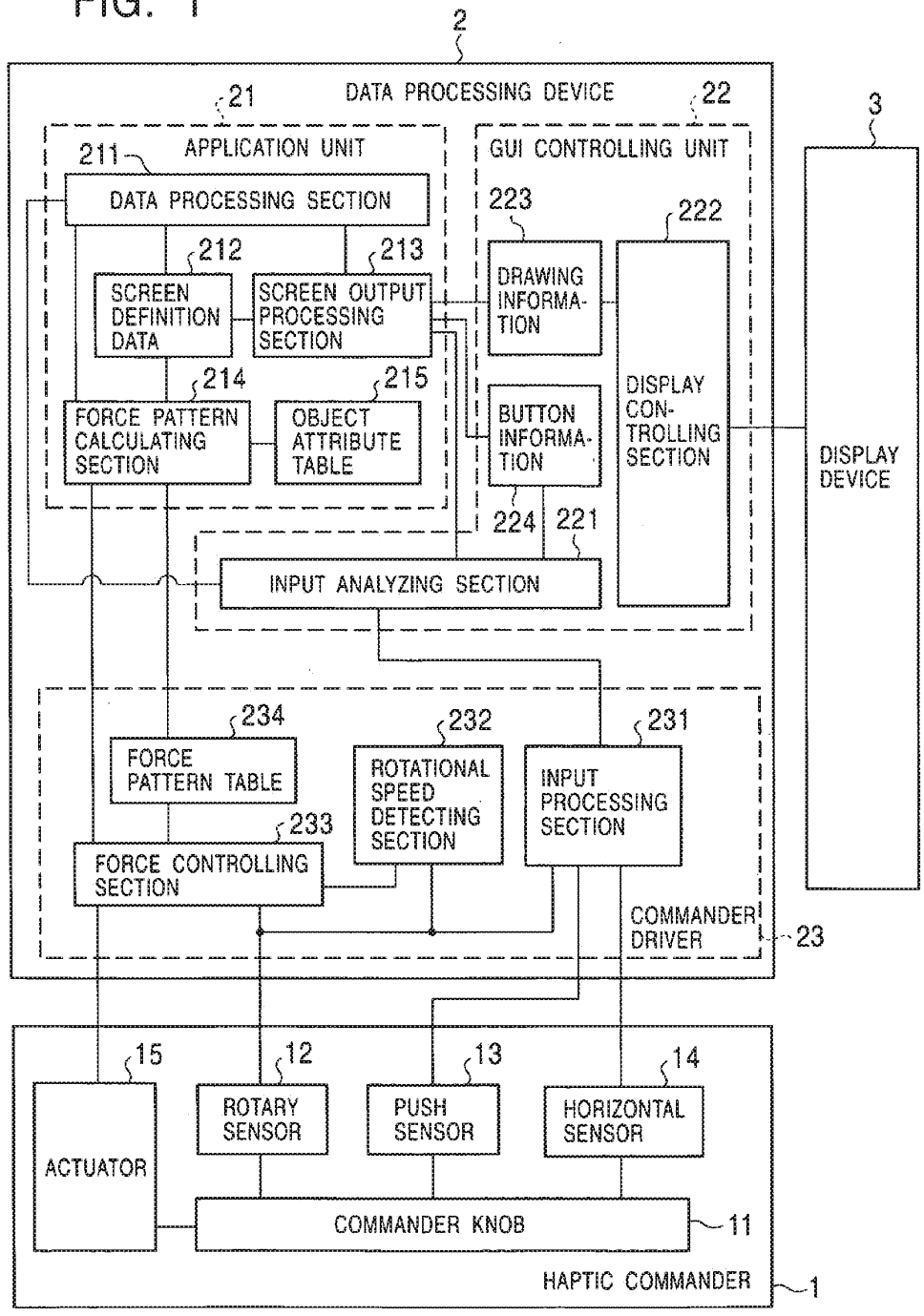

2
DATA PROCESSING DEVICE
21
22
3
APPLICATION UNIT
211
DATA PROCESSING SECTION
212
213
SCREEN DEFINITION DATA
SCREEN OUTPUT PROCESSING SECTION
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GUI CONTROLLING UNIT
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222
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BUTTON INFORMATION
DISPLAY CONTROLLING SECTION
DISPLAY DEVICE
224
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INPUT ANALYZING SECTION
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231
FORCE PATTERN TABLE
ROTATIONAL SPEED DETECTING SECTION
INPUT PROCESSING SECTION
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FORCE CONTROLLING SECTION
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15
12
13
14
ACTUATOR
ROTARY SENSOR
PUSH SENSOR
HORIZONTAL SENSOR
COMMANDER KNOB
11
HAPTIC COMMANDER
1

FIG. 2A

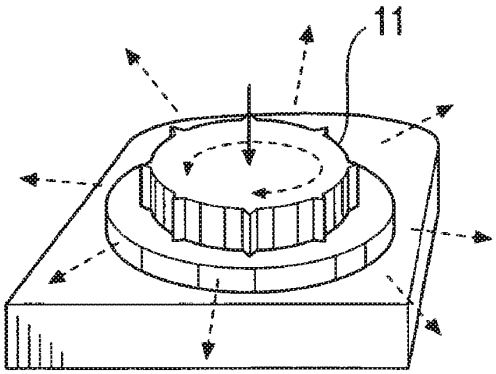


FIG. 2B

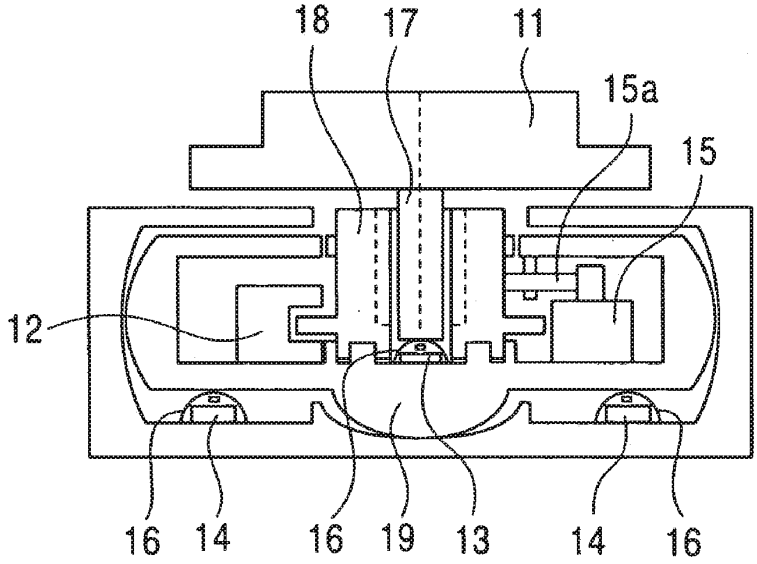


FIG. 3A

DIRECTION OF ROTATION	ANGLE θ	FORCE F
CLOCKWISE	⋮	⋮
	2φ	
		G3 (θ)
	φ	
		G1 (θ)
	0	
		G2 (θ)
	−φ	
		G4 (θ)
	−2φ	
	⋮	⋮
COUNTER-CLOCKWISE	⋮	⋮

FIG. 3B

BUTTON ID	ANGLE RANGE	VALUE
# 1	θ1 – θ2	funca()
# 2	θn – θm	funcb()
⋮	⋮	⋮

FIG. 4A

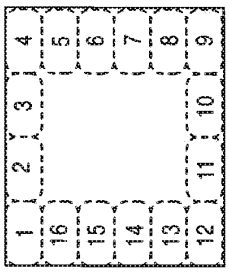


FIG. 4B

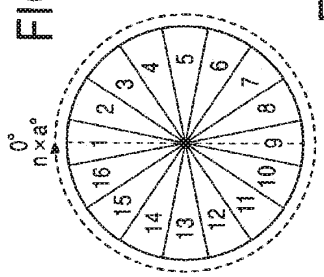


FIG. 4C

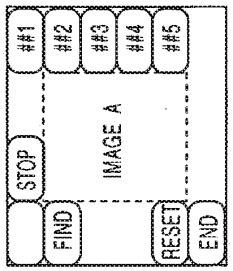


FIG. 4D

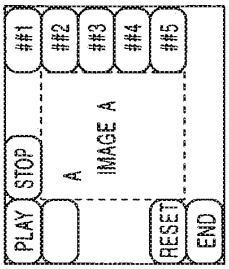


FIG. 4E

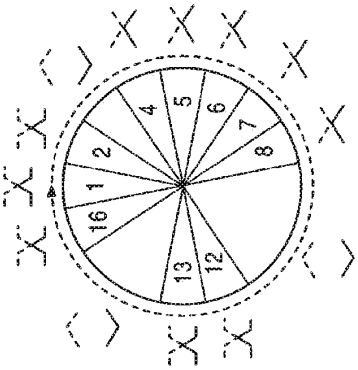


FIG. 4F

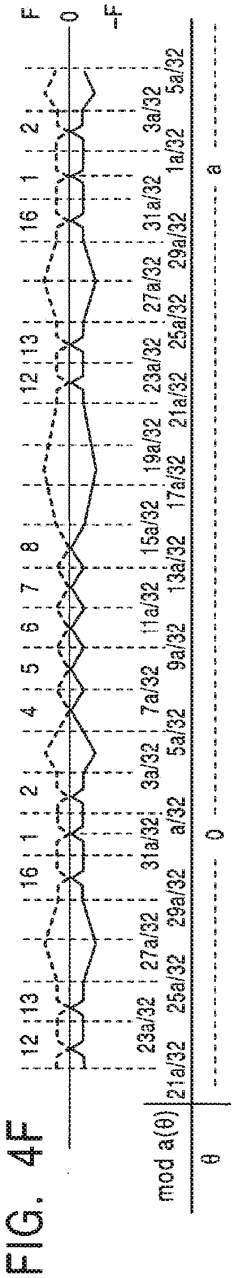


FIG. 5A

```
image (A, x, y-x, y)
button (type=command style, label, value, x, y-x, y)
button (type=command style, label, value, x, y-x, y)
                    :
button (type=item style, label, value, x, y-x, y)
button (type=item style, label, value, x, y-x, y)
```

FIG. 5B

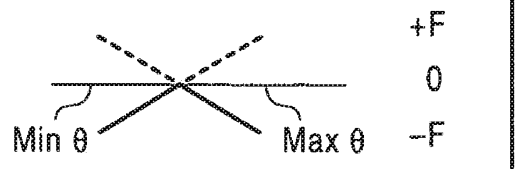
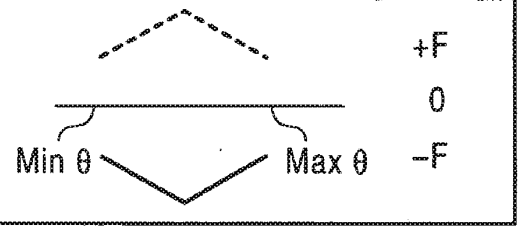
DISPLAY ELEMENT	FORCE PATTERN
COMMAND	
ITEM	
SPACE	

FIG. 6A

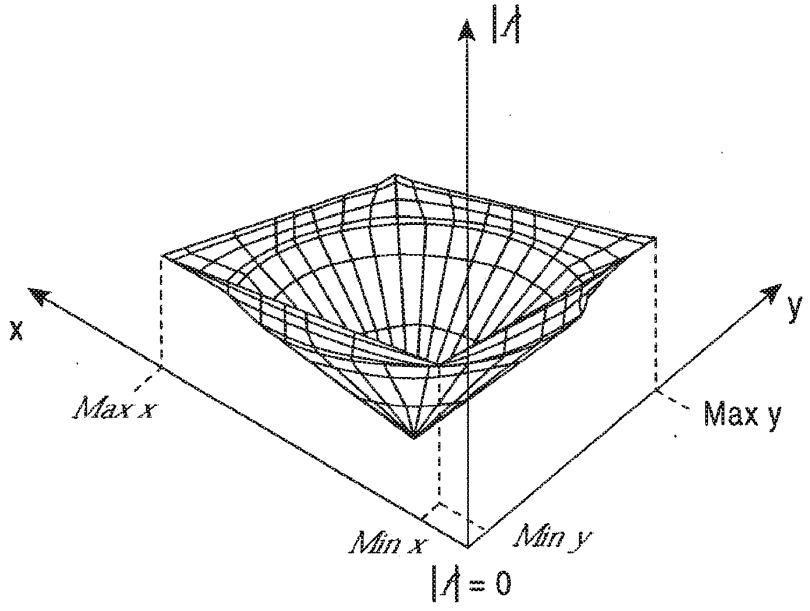
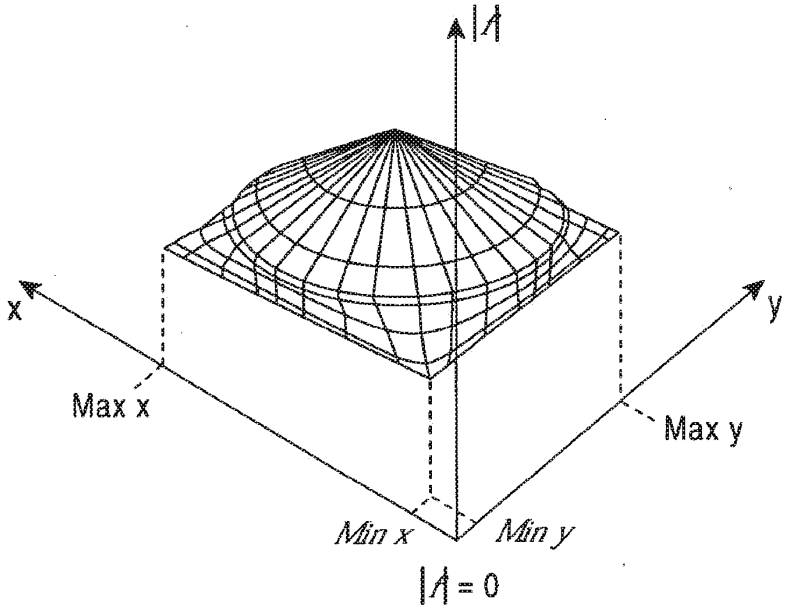


FIG. 6B



DATA PROCESSING SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a user interface technology using tactile sensation as an interface element.

[0003] 2. Description of the Related Art

[0004] A technology, which is described below, is known as a user interface technology using tactile sensation as an interface element. In the technology, a pointing device, such as a track ball, a mouse, or a joystick, including a mechanism for generating a force opposing an operation of a user or a mechanism for generating vibration is used. The relationship between the position of a cursor, moved by the pointing device, and the position of a display object, such as a menu button, displayed on a display screen is monitored. When a detection is made that the positional relationship between the display object and the cursor is a predetermined relationship, the pointing device applies a predetermined tactile sensation to the user. Such a technology is disclosed in, for example, the following documents which provide related art information related to the invention of the application: Japanese Unexamined Patent Application Publication Nos. 11-305938, 8-95693, and 10-198521.

[0005] The related user interface technology, which uses tactile sensation as an interface element, has a problem in that a delayed tactile sensation is applied to the user because the time at which the tactile sensation is applied to the user lags behind the time at which the user performs an operation due to, for example, the time required to determine the positional relationship between the cursor and the display object.

[0006] In contrast, if, instead of defining the tactile sensation in terms of the relationship between the position of the display object and the cursor, the tactile sensation which is applied to the user is defined directly by an input (such as input coordinates) from the pointing device in accordance with a layout, such as a menu button layout, on a display screen, the tactile sensation which is applied to the user can be directly defined by the operation of the user. Therefore, it is possible to substantially eliminate the time lag from the time at which the user performs the operation to the time at which the tactile sensation is applied to the user, so that a current tactile sensation can be applied to the user.

[0007] However, the technique of directly defining the tactile sensation which is applied to the user at the time of a display screen layout can only be applied to the case in which the layout on the display screen is fixed. Therefore, it cannot be applied to a display screen in which a display screen layout is changed in accordance with a preceding processing result, such as a display screen in which the number of menu buttons on the display screen changes in accordance with a preceding searching result.

SUMMARY OF THE INVENTION

[0008] Accordingly, it is an object of the present invention to properly control a tactile sensation applied to a user by an operation of an input device by the user on any display screen.

[0009] To this end, according to the present invention, there is provided a data processing system comprising a display device, an input device capable of controlling a tactile sensation applied to a user, and a processing device which operates as a graphical user interface for inputting and outputting data through the input device and the display device. The processing device comprises a display screen generation means, a tactile sensation control pattern setting means, and a tactile sensation controlling means. The display screen generation means generates display screen data which is output to the display device. The tactile sensation control pattern setting means calculates a relationship between input from the input device and the tactile sensation in accordance with a disposition of display elements in a display screen when the output of the display screen data generated by the display screen generation means to the display device starts, and sets the calculated relationship as a tactile sensation control pattern, the tactile sensation being applied to the user based upon the input from the input device, each display element constituting the display screen. The tactile sensation controlling means controls the tactile sensation based upon the input from the input device, in accordance with the tactile sensation control pattern set by the tactile sensation control pattern setting means.

[0010] According to such a data processing system, when the display screen in which a layout is not previously determined starts a displaying operation, the relationship between the input and the tactile sensation which is applied to the user by the input operation is calculated in accordance with the disposition of display elements in the display screen. Each display element is illustrated on the display screen. As a result of the calculation, the tactile sensation is set so that it matches the display content on the display screen, after which the tactile sensation is applied to the user based upon the input from the input device in accordance with the setting. Therefore, for any display screen used, it is possible to properly control the tactile sensation which is applied to the user based upon the operation of the input device by the user. In addition, it is possible to directly set a tactile sensation pattern based upon an input value of the input device. In this case, it is possible to substantially eliminate the time lag between the time at which the user performs the operation and the time at which the tactile sensation is applied to the user, so that a current tactile sensation can be applied to the user.

[0011] Here, the setting of a tactile sensation control pattern in such a data processing system may be achieved as follows. For example, when the output of the display screen data generated by the display screen generation means to the display device starts, tactile sensation patterns indicating the relationship between the input and the tactile sensation are connected in accordance with the disposition of the display elements in the display screen, and set as the tactile sensation control pattern. The tactile sensation patterns are previously determined in terms of the types of display elements.

[0012] More specifically, the setting of a tactile sensation control pattern in such a data processing system may be achieved as follows. For example, the tactile sensation control pattern setting means connects the tactile sensation patterns which are previously determined in terms of the types of display elements in the display screen so that they are tactile sensation patterns which are applied to the user based upon the input from the input device that indicates the

positions of the display elements in a display range, and sets the connected tactile sensation patterns as the tactile sensation control pattern.

[0013] When an input device comprising an operation unit rotatable by the user, a rotation detecting means for detecting the rotational angle of the operation unit, and an actuator for applying a force corresponding to the direction of rotation of the operation unit to the operation unit is used as the input device, the data processing system may be such that the tactile sensation control pattern setting means sets the tactile sensation control pattern as a pattern indicating the relationship between the rotational angle of the operation unit and the force applied to the operation unit in order for the tactile sensation controlling means to control the actuator in accordance with the tactile sensation control pattern so that the force corresponding to the rotational angle detected by the rotation detecting means is applied to the operation unit.

[0014] For example, each display element may be an operation acceptance display object for accepting an operation by the user, a combination of operation acceptance display objects, or a space between the operation acceptance display objects (or a portion where the operation acceptance display objects do not exist on the display screen).

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a block diagram of the structure of a data processing system of an embodiment of the present invention;

[0016] **FIGS. 2A and 2B** are an external view and a schematic structural view of a haptic commander in the embodiment of the present invention;

[0017] **FIGS. 3A and 3B** illustrate a force pattern table and button information used in the data processing system of the embodiment of the present invention, respectively;

[0018] **FIGS. 4A** to **4F** illustrate an example of a display screen and setting of force patterns in the embodiment of the present invention;

[0019] **FIGS. 5A and 5B** illustrate screen definition data and an object attribute table used in the data processing system of the embodiment of the present invention; and

[0020] **FIGS. 6A and 6B** illustrate other examples of force patterns which are set at display elements in the embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Hereunder, a description of an embodiment of the present invention will be given.

[0022] **FIG. 1** illustrates the structure of a data processing system of an embodiment of the present invention.

[0023] As shown in **FIG. 1**, the data processing system comprises a haptic commander **1**, a data processing device **2**, and a display device **3**. The haptic commander **1** is an input device which can control tactile sensation which is applied to a user. The data processing device **2** is an electronic calculator.

[0024] As shown in the external view of **FIG. 2A**, the haptic commander **1** comprises a commander knob **11** which can be operated by rotating it horizontally, by moving or tilting it in **8** horizontal directions (that is, towards the front and back, left and right, upper left and upper right, and lower left and lower right), or by depressing it vertically. As shown in **FIG. 1**, the haptic commander **1** also comprises a rotary sensor **12** for detecting a horizontal rotational angle of the commander knob **11**, a push sensor **13** for detecting whether or not the commander knob **11** has been depressed vertically, a horizontal sensor **14** for detecting whether or not the commander knob **11** has been moved or tilted in any of the **8** horizontal directions, and an actuator **15**, such as a DC motor, for applying a horizontal rotational torque to the commander knob **11**.

[0025] Such a haptic commander **1** may be formed with various structures. For example, as shown in the schematic structural view of **FIG. 2B**, the haptic commander **1** may comprise a rotor **18**, a tiltable member **19**, a biasing mechanism, the actuator **15**, the rotary sensor **12**, the push sensor **13**, and the horizontal sensor **14**. The rotor **18** holds a commander knob shaft **17** so that the commander knob shaft **17** can slide vertically, and rotates horizontally along with the commander knob shaft **17**. The tiltable member **19** holds the rotor **18** so that the rotor **18** can rotate horizontally. The biasing mechanism comprises, for example, a group of plate springs **16**. When the user is not applying a force, the biasing mechanism maintains the tiltable member **19** at an upright position, and maintains the commander knob **11** at a neutral position in a vertical direction. The actuator **15** is disposed in the tiltable member **19** and applies a torque to the rotor **18** through a pulley **15***a*. The push sensor **13** detects any depression of the commander knob shaft **17**. The horizontal sensor **14** is disposed so as to detect tilting of the tiltable member **19**.

[0026] Returning to **FIG. 1**, in the structure of the haptic commander **1**, the rotational angle detected by the rotary sensor **12** is output as rotation data to the data processing device **2**, the presence or absence of movement or tilting detected by the horizontal sensor **14** is output as horizontal data to the data processing device **2**, and the presence or absence of vertical depression detected by the push sensor **13** is output as push data to the data processing device **2**. The actuator **15** applies a torque to the commander knob **11** in accordance with a controlling operation by the data processing device **2**.

[0027] The data processing device **2** comprises an application unit **21**, a graphical interface (GUI) controlling unit **22**, and a commander driver **23**. The application unit **21** provides a graphical interface (GUI) for the user and processes data in accordance with a user's operation accepted by the GUI. The GUI controlling unit **22** carries out GUI processing, such as inputting and outputting operations between the display device **3** or the haptic commander **1** and the data processing device **2**. The commander driver **23** receives data from and outputs data to the haptic commander **1** and controls the torque generated by the actuator **15** of the haptic commander **1**. Here, the data processing device **2** may be constructed as a device in which application programs are run on an operating system. In this case, the application unit **21** may be a unit where one of such application programs is run. The GUI controlling unit **22** may provide some of the functions of the operating system for the application unit **21**. The commander driver **23** may be incorporated as a device driver in the operating system.

[0028] The application unit **21** comprises a data processing section **211**, a screen output processing section **213**, and a force pattern calculating section **214**. The data processing section **211** processes data as necessary, and generates screen definition data **212** for defining a display screen. The screen output processing section **213** generates drawing information **223** and button information **224** based upon the screen definition data **212**, and outputs them to the GUI controlling unit **22**. The drawing information **223** indicates the content of an image on the display screen, and the button information **224** defines buttons which are objects for accepting a user's operation on the display screen. The force pattern calculating section **214** calculates a force pattern based upon the screen definition data **212** and an object attribute table **215** (described below).

[0029] The GUI controlling unit **22** comprises a display controlling section **222** and an input analyzing section **221**. The display controlling section **222** is used to perform a displaying operation on the display device **3** in accordance with the drawing information **223** sent from the application unit **21**. The input analyzing section **221** analyzes the button information **224** sent from the application unit **21** and information input from the haptic commander **1** through the commander driver **23**, and sends a message defining the operation of a button by the user to the data processing section **211**.

[0030] The commander driver **23** comprises an input processing unit **231**, a rotational speed detecting unit **232**, and a force controlling section **233**. The input processing unit **231** receives rotation data, horizontal data, and push data input thereto from the haptic commander **1** and sends the data to the GUI controlling unit **22**. The rotational speed detecting unit **232** determines the direction of rotation and the rotational speed of the commander knob **11** from the rotation data input from the haptic commander **1**. The force controlling section **233** controls the actuator **15** in accordance with a force pattern table **234** set by the application unit **21**, and the direction of rotation and strength of a torque applied to the commander knob **11**.

[0031] **FIG. 3A** shows the content of the force pattern table **234** set by the application unit **21**.

[0032] As shown in **FIG. 3A**, in the force pattern table **234**, force patterns (torques applied to the commander knob **11**) are defined as functions of rotational angles for pairs of directions of rotation and rotational angles of the commander knob **11**. However, the forces may be defined as direct numerical values.

[0033] The force controlling section **233** calculates the current direction of rotation and the rotational angle of the commander knob **11** from the direction of rotation and the rotational speed of the commander knob **11**, and applies a torque defined in terms of the calculated direction of rotation and rotational angle in the force pattern table **234** to the commander knob **11** by controlling the actuator **15**. The reference rotational angle (that is, zero degrees) of the commander knob **11** is the rotational angle when the force pattern calculating section **214** instructs the force controlling section **233** to be reset.

[0034] **FIG. 3B** illustrates the button information **224** which is set by the application unit **21**.

[0035] The button information **224** is information pertaining to the buttons included in the display screen where an image is set as the drawing information **223** by the application unit **21**. The button information **224** includes the ID of each button, rotational angle ranges of the commander knob **11**, and message values which are sent to the data processing section **211**. Each rotational angle range is allocated to an associated button selection. A message value is sent when a determination is made of the operation of the associated button.

[0036] When the current rotational angle of the commander knob **11**, obtained from the rotational data received from the commander driver **23**, changes to that within an angle range corresponding to any of the other buttons defined by the button information **224**, the input analyzing section **221** of the GUI controlling unit **22** sends, along with the associated button ID, a message indicating the change in button selection from the previous button to this associated button to the data processing section **211**. The reference rotational angle (zero degrees) of the commander knob **11** is the rotational angle when the screen output processing section **213** directs a resetting operation.

[0037] When any of the buttons is selected, if the push data received from the commander driver **23** indicates that the push switch is on, the input analyzing section **221** of the GUI controlling unit **22** sends to the data processing section **211** a message containing the value of the selected button defined by the button information **224**.

[0038] While switching between displays as required, the data processing section **211** of the application unit **21** accepts an operation of the user and carries out a predetermined data processing operation. Displays are switched by generating the screen definition data **212** and instructing the force pattern calculating section **214** and the screen output processing section **213** to be reset. The data processing section **211** accepts the operation of the user by receiving a message from the GUI controlling unit **22**. When the force pattern calculating section **214** is instructed to be reset, the force pattern calculating section **214** calculates a new force pattern based upon the screen definition data **212** and the object attribute table **215**, updates the definition of the force pattern stored in the force pattern table **234** to that of the new force pattern, and instructs the force controlling section **233** to be reset. On the other hand, when the screen output processing section **213** is directed to be reset, the screen output processing section **213** updates the drawing information **223** based upon the screen definition data **212**, and instructs the input analyzing section **221** to be reset.

[0039] Hereunder, force patterns which are calculated as described above by the force pattern calculating section **214** will be described.

[0040] For clarity of the description, a display screen layout used by the application unit **21** will be one in which, for example, as shown in **FIG. 4C**, buttons are disposed in any number of button areas situated anywhere, among **16** button areas, from the first to the sixteenth button areas **1** to **16** which are displayed on the display screen as shown in **FIG. 4A**.

[0041] In this case, for example, the rotational angle ranges of the commander knob **11** are previously defined, as shown in **FIG. 4B**, in order to select any button disposed in the corresponding button area. More specifically, in the illustrated example, angle ranges are successively defined

clockwise and circularly for the button areas from the first to the sixteenth button areas 1 to 16 at an a/16 degree interval so that the center of the angle range of the button area **1** is zero. The angle range of the commander knob **11** in which modulus a is from 31a/32 to 0 and the angle range of the commander knob **11** in which the modulus a is from 0 to a/32 are defined as the angle ranges for selecting the button disposed in the button area **1**. With regard to each of the second to the sixteenth button areas **2** to **16**, the angle ranges of the commander knob **11** in which the modulus a is from (−a/32)+{(i−1)a/16} to (−a/32)+(ia/16) are defined as angle ranges for selecting the button in the corresponding i^{th} button area.

[0042] **FIG. 5A** illustrates an example of the screen definition data **212** which is generated by the data processing section **211**.

[0043] In this example, an image A and disposition areas x, y-x, and y are indicated beside the term "image" in the first row. The image A is displayed as background on the display screen, and the areas x, y-x, and y are on the display screen for displaying the image A. Pieces of information regarding the buttons disposed on the display screen are indicated beside the terms "button" in the remaining rows.

[0044] More specifically, the pieces of information are indicated by the terms "type,""style,""label," and "value", and by x, y-x, and y beside each term "button." Each term "type" indicates the type of the corresponding button. Each term "style" indicates the display style, such as the color of display, of the corresponding button. Each term "label" indicates the text which is displayed on the corresponding button. Each term "value" indicates a message value (value which is recorded in the button information **224**) which is sent to a data outputting section by the GUI controlling unit **22** when the operation of a corresponding button is determined. "x, y-x, and y" indicate the area where the corresponding button is displayed on the display screen. Here, in the embodiment, the types of buttons used are command buttons for accepting a request for executing an operation selected by the user, and item buttons for accepting the selection of an item by the user.

[0045] **FIG. 5B** shows an example of the object attribute table **215**.

[0046] As shown in **FIG. 5B**, the object attribute table **215** previously defines force patterns of display elements on the display screen, such as buttons and a space. In the illustrated example, force patterns which are defined in accordance with the types of buttons and force patterns defined in terms of the space are recorded in the object attribute table **215**.

[0047] In each force pattern shown in **FIG. 5B**, the horizontal axis represents the rotational angle, with direction towards the right corresponding to the clockwise direction; and the vertical axis represents a torque which is applied to the commander knob **11**, with a positive torque representing a clockwise torque and a negative torque representing a counterclockwise torque. Minθ and Maxθ represent points on the force patterns corresponding to the lower limits and the upper limits measured clockwise in the angle ranges of the commander knob **11** corresponding to the buttons and space. Each of the force patterns represented by a solid line is used when the commander knob **11** is rotated clockwise, whereas each of the force patterns represented by a dotted line is used when the commander knob **11** is rotated counterclockwise.

[0048] According to each of the illustrated force patterns defined in terms of the buttons, when the commander knob **11** is rotated from an angle range boundary point corresponding to the button to a central angle within the angle range corresponding to the button, a force opposing the operation of the user is gradually reduced, and becomes zero at the central angle of the angle range corresponding to the button. Thereafter, when the commander knob **11** is further rotated from the central angle of the angle range corresponding to the button to outside the angle range corresponding to the button, the force opposing the operation of the user is gradually increased up to the boundary point of another angle range corresponding to the button. In other words, a force which produces a tactile sensation, like that which guides the operation of the user to the central angle of the button, acts upon the user. Such a guiding force is defined so that it is strong at a command button, and is weak at an item button.

[0049] According to the illustrated force patterns defined in terms of the space, when the commander knob **11** is rotated from an angle range boundary point corresponding to the space to a central angle of the angle range corresponding to the space, a force opposing the operation of the user is gradually increased, and becomes a maximum at the central angle of the angle range corresponding to the space. Thereafter, when the commander knob **11** is further rotated from the central angle of the angle range corresponding to the space to outside this angle range corresponding to the space, the force opposing the operation of the user is gradually reduced. In other words, a force acts upon the user so that the user feels the space as an obstacle.

[0050] These force patterns are set so that the torques which are applied at the boundary points (Minθ and Maxθ) to the operation of the user in the same direction of rotation are equal to each other.

[0051] The force pattern calculating section **214** calculates force patterns for the entire display screen as follows in accordance with the screen definition data **212** and the object attribute table **215**, and records them in the force pattern table **234**.

[0052] More specifically, as shown in **FIG. 4C**, the screen definition data **212** indicates that buttons are disposed in only 10 of the 16 button areas shown in **FIG. 4A**. Command buttons are disposed in the button areas **1**, **2**, **12**, **13**, and **16**, and item buttons are disposed in the button areas **4**, **5**, **6**, **7**, and **8**.

[0053] In this case, as shown in **FIG. 4E**, the force pattern calculating section **214** defines force patterns defined according to the button types given in the object attribute table **215** in terms of the angle ranges of the button areas where the buttons are disposed as a result of adjusting angle direction scales so that Minθ and Maxθ match the lower limits and the upper limits which are determined clockwise in the angle ranges of the corresponding buttons. In addition, the force pattern calculating section **214** defines force patterns defined by continuous portions (spaces where the buttons are not disposed) in the object attribute table **215** in terms of the angle ranges of the corresponding spaces as a result of adjusting angle direction scales so that Minθ and Maxθ match the lower limits and the upper limits which are determined clockwise in the angle ranges of the corresponding spaces.

[0054] The force pattern calculating section **214** determines the relationships shown in **FIG. 4F** in terms of the torques of the commander knob **11** being functions of the rotational angles of the commander knob **11**. The relationships are obtained as a result of defining the force patterns in the object attribute table **215** in terms of angle ranges. The force pattern calculating section **214** stores the determined relationships as calculated force patterns in the force pattern table **234**. The horizontal axis in **FIG. 4F** represents clockwise rotational angle of the commander knob **11**, with mod a(θ) representing the modulus a in terms of θ. The vertical axis in **FIG. 4F** represents torque, with a positive torque representing a clockwise torque and a negative torque representing a counterclockwise torque. Each of the force patterns represented by a solid line is used when the commander knob **11** is rotated clockwise, whereas each of the force patterns represented by a dotted line is used when the commander knob **11** is rotated counterclockwise.

[0055] The data processing section **211** may control the display screen shown in **FIG. 4C**, for example, as follows.

[0056] First, as shown in **FIG. 4C**, the data processing section **211** generates the screen definition data **212** which defines a display screen in which the button in the button area **1** is defined as a button selection color, and instructs the force pattern calculating section **214** and the screen output processing section **213** to be reset. If the data processing section **211** receives a message which indicates that the button selection is changed from the button disposed in the button area **1** to the button disposed in the button area **16** from the GUI controlling unit **22** in accordance with an operation of the user, the data processing section **211** generates the screen definition data **212** which defines the display screen in which the button in the button area **16** is defined as a button selection color, and instructs the screen output processing section **213** to be reset. Here, since the button layout on the display screen is not changed, that is, since the button display color is only changed, it is not necessary to instruct the force pattern calculating section **214** to be reset. When any of the buttons is selected, if a message is given in accordance with a determined operation of the button, an operation is carried out in accordance with the given message. If necessary, the data processing section **211** generates the screen definition data **212** which defines a new display screen, and instructs the force pattern calculating section **214** and the screen output processing section **213** to be reset.

[0057] An embodiment of the present invention has been described above.

[0058] Although the content of the object attribute table **215** is described as being fixed, the data processing section **211** may be such as to update the content of the object attribute table **215** in accordance with the display screen used. The relationships between the button areas and the commander knob **11** shown in **FIG. 4B** can be changed as required by the data processing section **211** in accordance with the display screen used.

[0059] Although, in the object attribute table **215**, the force patterns are defined in terms of display elements, the force patterns may be defined in terms of combinations of continuously disposed display elements, or as functions of the sizes of angle ranges of the display elements or combinations of the display elements.

[0060] Although, in the foregoing description, when the data processing device **2** is constructed as a system comprising an operating system, the force patterns (stored in the force pattern table **234**) are calculated and established for the display screen by an application program, the force patterns may be calculated and established for the display screen by the operating system.

[0061] In the foregoing description, the tactile sensation applied to the user is controlled by torque generated by the actuator **15**. However, the method of the embodiment of calculating patterns which apply a tactile sensation to the user in accordance with types of display elements, such as buttons and spaces on the display screen, and in accordance with the disposition of the display elements, and of defining the patterns by the operation of the input device by the user may be similarly applied to the case in which a tactile sensation is applied to the user in terms of other types of forces, such as vibration or frictional force.

[0062] Although, in the above-described embodiment, the input device is described as being the haptic commander **1** which accepts only a uniaxial (axis of rotational angle θ) input as a spatial operation on the display screen by a rotational operation by the user, the embodiment may similarly be applied to an input device which accepts an XY biaxial input on the display screen, performed by, for example, a trackball, a mouse, or a joystick. More specifically, in this case, force patterns shown in **FIGS. 6A and 6B** are defined in the object attribute table **215**. By allocating the force patterns shown in **FIGS. 6A and 6B** to a button display area and an empty display area (space) based upon the object attribute table **215** and the screen definition data **212**, the relationship between the coordinates on the display screen and the torque applied to the user is determined and stored in the force pattern table **234**. The torque in accordance with the coordinates to which the user is pointing to with an input device (that is, the coordinates of a displayed cursor when the cursor is moved by the user) is generated based upon the force pattern table **234**. **FIG. 6A** shows the force pattern with regard to a button, and **FIG. 6B** shows the force pattern with regard to the space. **FIGS. 6A and 6B** show the absolute values of the torques, and the torques are in a direction opposite to the direction of rotational operation by the user.

[0063] In the embodiment, even if a display screen having a layout which is not previously fixed is used, when the display screen starts a displaying operation, it is possible to set a tactile sensation to be applied to the user based upon an input from the input device so that the tactile sensation matches the contents on the display screen, after which the tactile sensation is applied to the user based upon the input from the input device in accordance with the setting. Therefore, it is possible to properly control the tactile sensation which is applied to the user by the operation of the input device by the user on any display screen.

What is claimed is:

1. A data processing system comprising:

a display device for displaying at least one display screen element;

an input device for applying a variable tactile sensation to a user and generating input data based upon input from a user; and

a processing device for generating display screen data comprising data for each display screen element and a tactile sensation control pattern, the processing device sending the display screen data to the display device and controlling the tactile sensation applied by the input device in accordance with the tactile sensation control pattern;

wherein the processing device receives input data from the input device, calculates a relationship between the input data and the tactile sensation in accordance with the arrangement of at least one display element on the display screen at the time that the display screen data is sent to the display device and stores the calculated relationship as a tactile sensation control pattern, so that the tactile sensation applied to the user is based upon the input data.

2. A data processing system according to claim 1, wherein the processing unit connects tactile sensation patterns in accordance with the arrangement of the display elements on the display screen at the time that the display screen data is sent to the display device, and stores the connected tactile sensation patterns as the tactile sensation control pattern, the tactile sensation patterns indicate the relationship between the input data and the tactile sensation and are previously determined according to the types of the display elements.

3. A data processing system according to claim 2, wherein the display elements comprise display objects for accepting an operation selected by the user and a space between the display objects, the space being a portion on the display screen where the display objects are not present.

4. A data processing system according to claim 2, wherein the input device comprises an operation unit rotatable by the user and an actuator for applying a force to the operation unit corresponding to the direction of rotation of the operation unit,

the tactile sensation control pattern indicates a relationship between the rotational angle of the operation unit and the force applied to the operation unit, and

the processing device controls the force applied by the actuator in accordance with the tactile sensation control pattern.

5. A data processing system according to claim 2, wherein the tactile sensation applied to the user is based upon the input data from the input device which indicates the positions of the display elements within a display range.

6. A data processing system according to claim 5, wherein the input device is a pointing device for inputting coordinates on the display screen.

7. A data processing system according to claim 5, wherein the input device is a haptic commander.

8. A method for applying a variable tactile sensation to the user through an input device, the method comprising:

generating display screen data comprising data for at least one display element;

sending the display screen data to the display device;

calculating a relationship between input data from the input device and the tactile sensation in accordance with an arrangement of at least one display element on a display screen at the time that the display screen data is sent to the display device;

storing the calculated relationship as a tactile sensation control pattern; and

controlling the tactile sensation based upon the input data from the input device, in accordance with the stored tactile sensation control pattern, whereby a variable tactile sensation is applied to the user through the input device.

9. A method for applying a variable tactile sensation to the user through an input device according to claim 8, wherein the tactile sensation control pattern is calculated by connecting tactile sensation patterns in accordance with the arrangement of the display elements on the display screen at the time that the display screen data is sent to the display device, the tactile sensation patterns indicating the relationship between the input data and the tactile sensation and are previously determined according to the types of the display element.

10. A method for applying a variable tactile sensation to the user through an input device according to claim 9, wherein the display elements comprise display objects for accepting an operation selected by the user and a space between the display objects, the space being a portion in the display screen where the display objects are not present.

11. A method for applying a variable tactile sensation to the user through an input device according to claim 9, wherein the input device comprises an operation unit rotatable by the user and an actuator for applying a force to the operation unit corresponding to the direction of rotation of the operation unit, and the tactile sensation control pattern indicates a relationship between the rotational angle of the operation unit and the force applied by the actuator.

12. A method for applying a variable tactile sensation to the user through an input device according to claim 9, wherein the tactile sensation applied to the user is based upon the input data from the input device which indicates positions of the display elements within a display range.

13. A computer program which is read and executed by a computer system comprising a display device and an input device for applying a variable tactile sensation to a user, the computer program directs the computer system to generate display screen data comprising data for at least one display element, send the display screen data to the display device,

calculate a relationship between input data from the input device and the tactile sensation in accordance with an arrangement of at least one display element on a display screen at the time that the display screen data is sent to the display device, and store the calculated relationship as a tactile sensation control pattern, so that the tactile sensation being applied to the user is based upon the input data received from the input device, in accordance with the tactile sensation control pattern.

14. A computer program according to claim 13, wherein the computer system connects tactile sensation patterns in accordance with the arrangement of the display elements on the display screen at the time that the display screen data is sent to the display device, and stores the connected tactile sensation patterns as the tactile sensation control pattern, the tactile sensation patterns indicate the relationship between the input data and the tactile sensation and are previously determined according to the types of the display elements.

15. A computer program according to claim 14, wherein the display elements comprise display objects for accepting

an operation selected by the user and a space between the display objects, the space being a portion on the display screen where the display objects are not present.

16. A computer program according to claim 14, wherein the input device comprises an operation unit rotatable by the user and an actuator for applying a force to the operation unit corresponding to the direction of rotation of the operation unit,

the computer system stores the tactile sensation control pattern as a pattern which indicates a relationship between the rotational angle of the operation unit and the force applied to the operation unit and controls the force applied by the actuator in accordance with the tactile sensation control pattern.

17. A computer program according to claim 14, wherein the tactile sensation applied to the user is based upon the input data from the input device which indicates the positions of the display elements within a display range.

18. A computer program according to claim 17, wherein the input device is a pointing device for inputting coordinates on the display screen.

19. A storage medium which stores a computer program which is read and executed by a computer system comprising a display device and an input device for applying a variable tactile sensation to a user,

wherein the computer program directs the computer system to generate display screen data comprising data for at least one display element, send the display screen data to the display device,

calculate a relationship between input data from the input device and the tactile sensation in accordance with an arrangement of at least one display element on a display screen at the time that the display screen data is sent to the display device, store the calculated relationship as a tactile sensation control pattern, and control the tactile sensation based upon the input data from the input device, in accordance with the tactile sensation control pattern.

20. A storage medium according to claim 19, wherein the computer system connects tactile sensation patterns in accordance with the arrangement of the display elements on the display screen at the time that the display screen data is sent to the display device, and stores the connected tactile sensation patterns as the tactile sensation control pattern, the tactile sensation patterns indicate the relationship between the input data and the tactile sensation and are previously determined according to the types of the display elements.

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Rekimoto (43) **Pub. Date: Jul. 13, 2006**

(54) **INPUTTING METHOD AND INPUTTING APPARATUS**

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G09G 5/00 (2006.01)

(52) **U.S. Cl.** **345/173**

(57) **ABSTRACT**

There are provided with a detection sensor **110** for detecting an approach and a contact of a living body or a material body in a predetermined detection region, a control means which outputs a drive signal in a case when an approach is detected by a detection sensor and which performs an input process for accepting an input of a predetermined function in a case when a contact is detected on a predetermined condition, and an actuator **120** being vibrated temporarily by the drive signal outputted by the control means. By doing like this, in a case when, for example, a finger, a pen or the like is approached to the detection region of the sensor while the equipment is held in a hand, the equipment vibrates temporarily by detecting the approach in the sensor **110** and the vibration transmits to the hand holding the equipment such that it becomes possible to comprehend that an input will be carried out by touching the position.

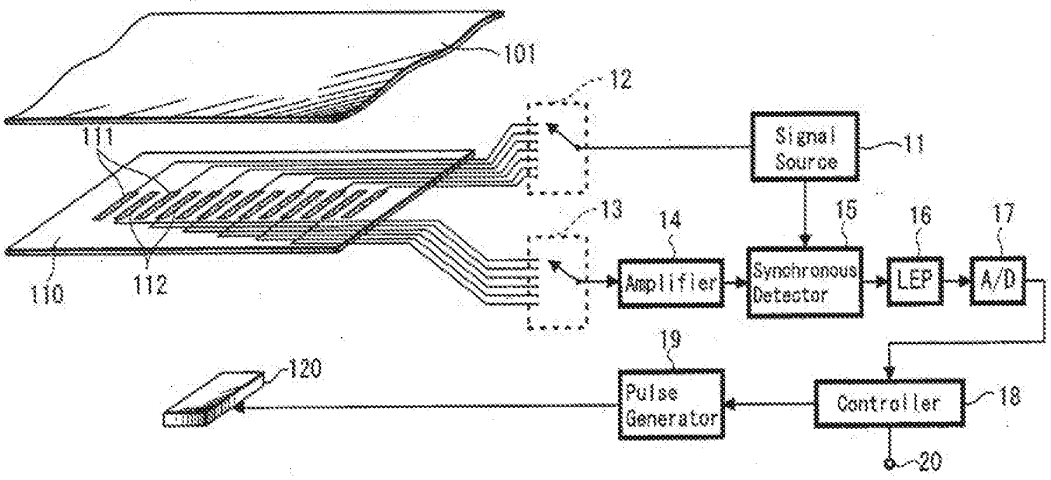


FIG. 1

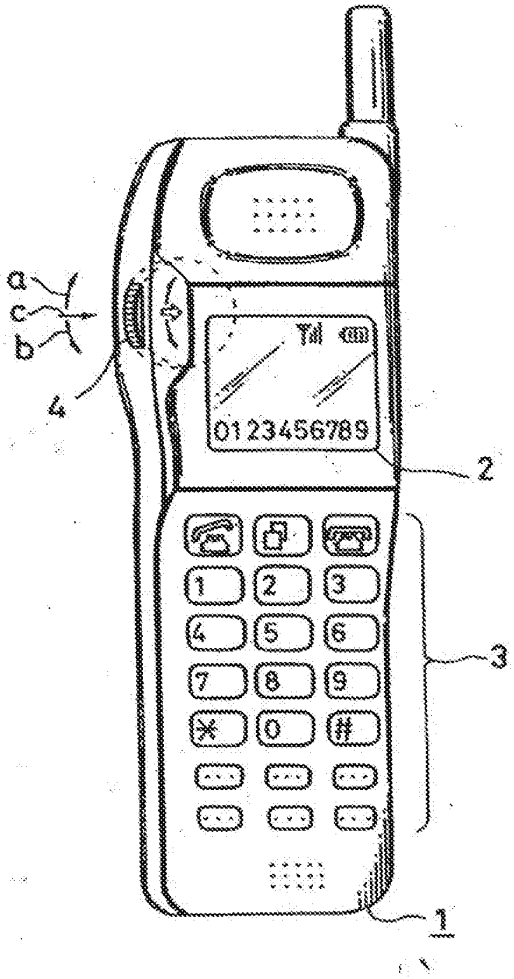


FIG. 3

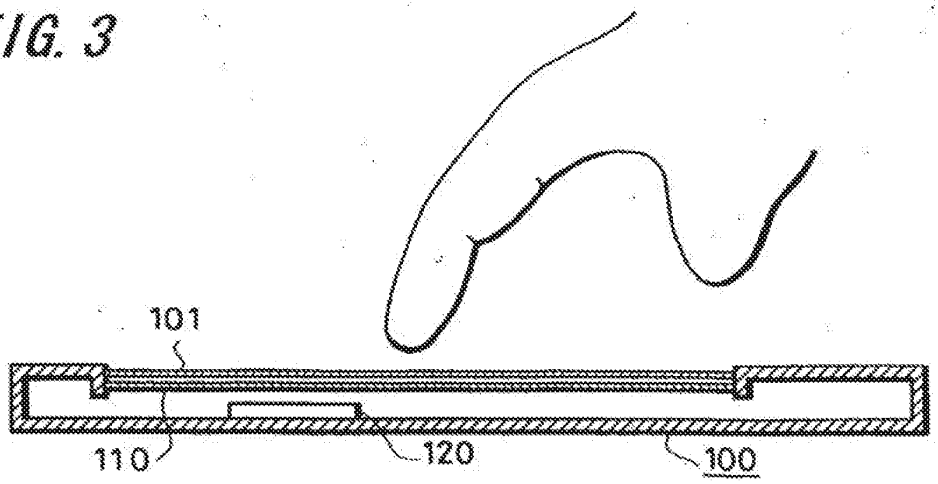
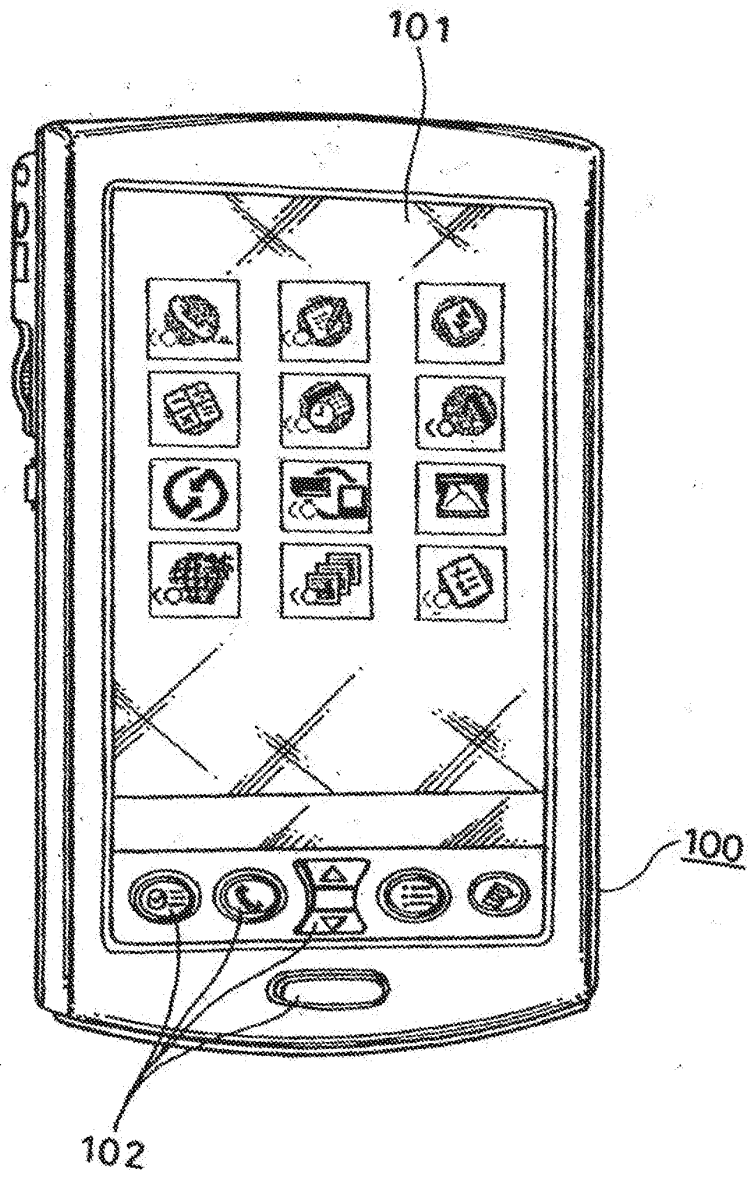


FIG. 2



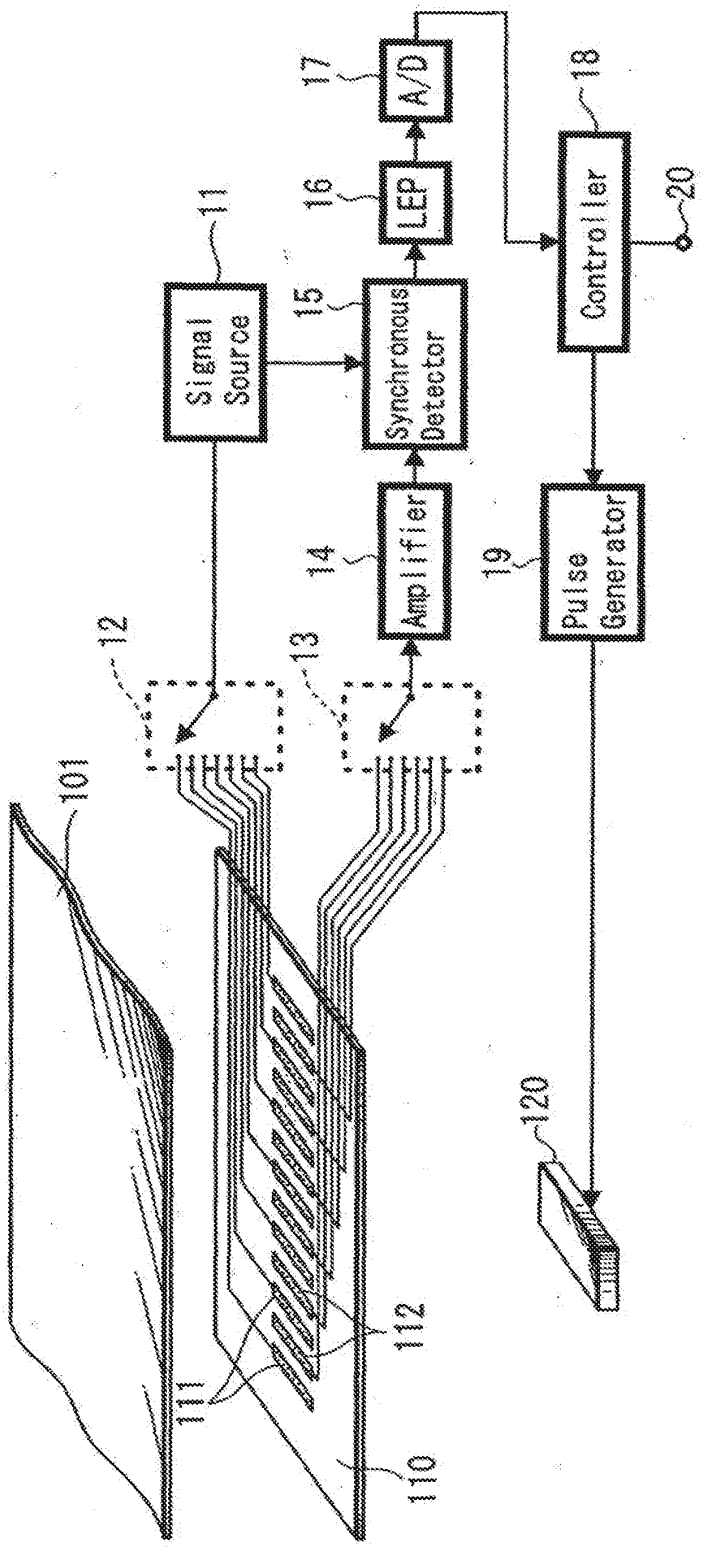


FIG. 4

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FIG. 5

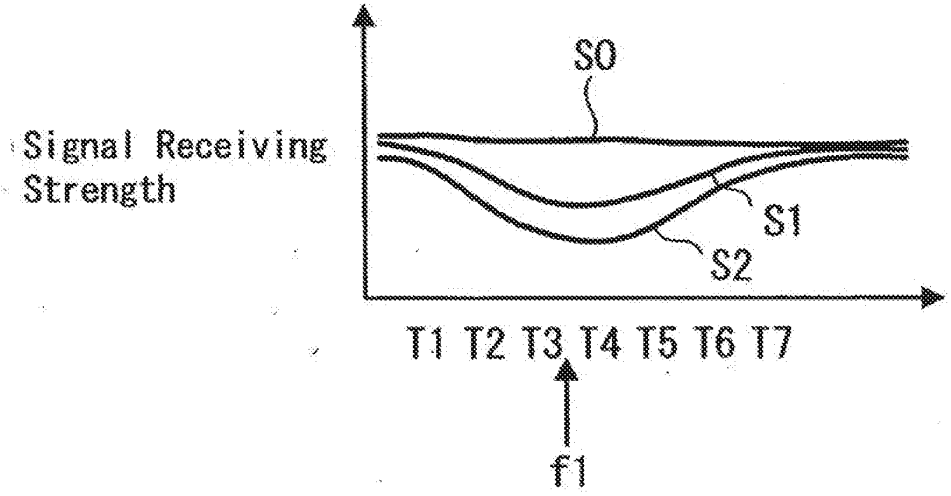

Signal Receiving Strength
S0
S1
S2
T1 T2 T3 T4 T5 T6 T7
f1

FIG. 6

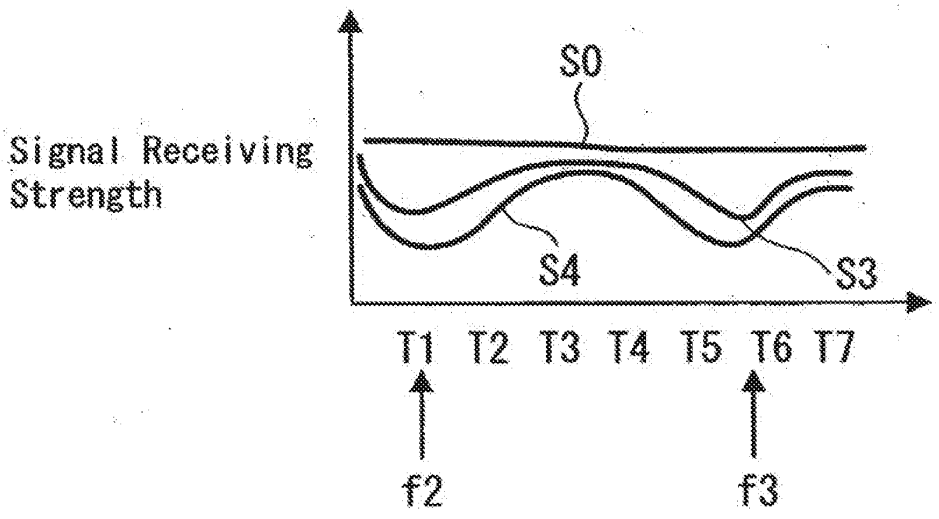

Signal Receiving Strength
S0
S4
S3
T1 T2 T3 T4 T5 T6 T7
f2
f3

FIG. 7

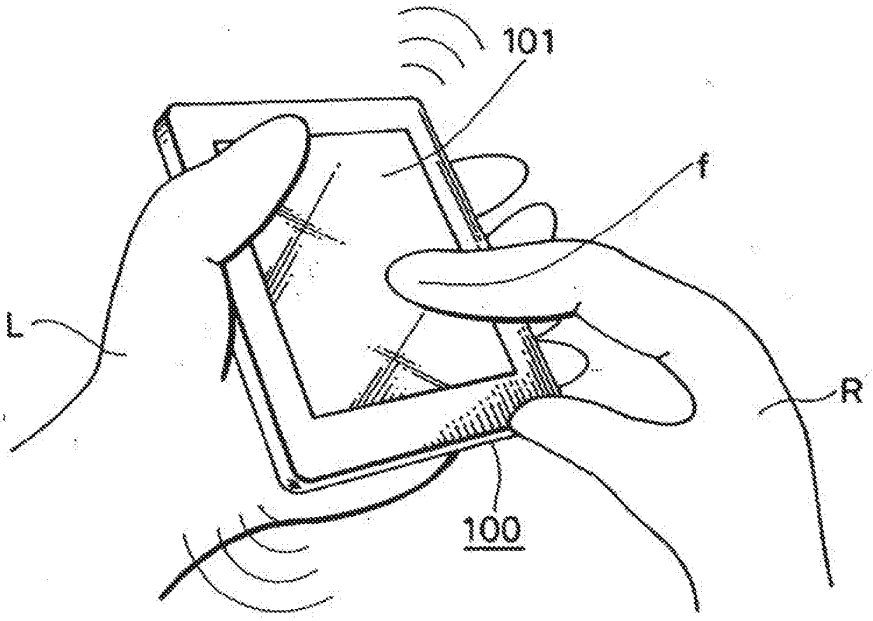


FIG. 9

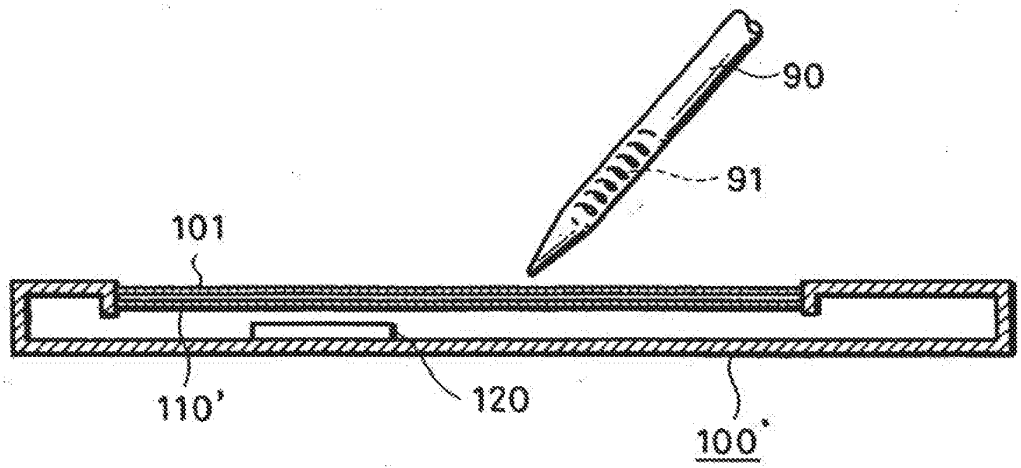
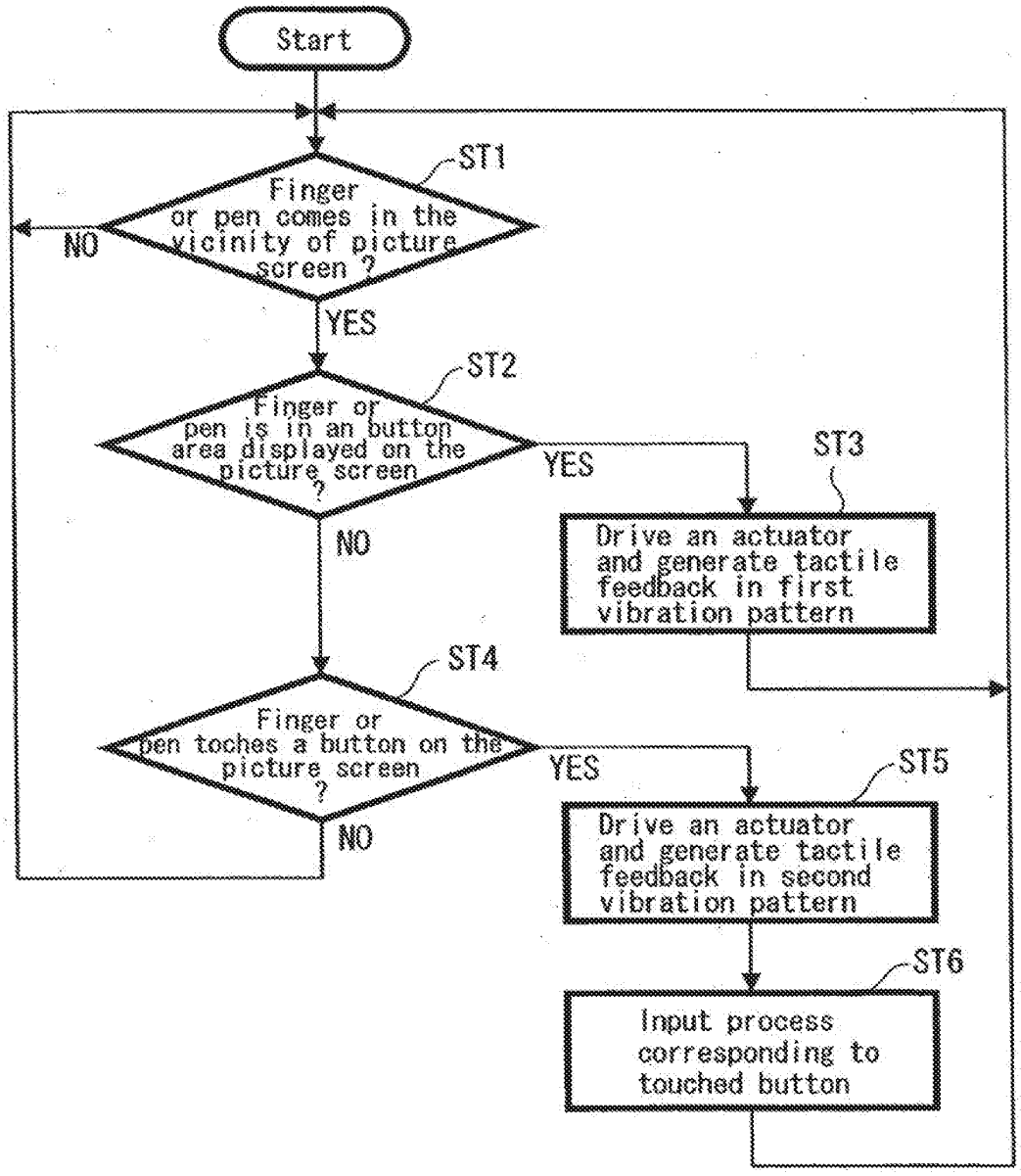


FIG. 8


Start
ST1
Finger or pen comes in the vicinity of picture screen ?
NO
YES
ST2
Finger or pen is in an button area displayed on the picture screen ?
YES
ST3
Drive an actuator and generate tactile feedback in first vibration pattern
NO
ST4
Finger or pen toches a button on the picture screen ?
YES
ST5
Drive an actuator and generate tactile feedback in second vibration pattern
ST6
Input process corresponding to touched button
NO

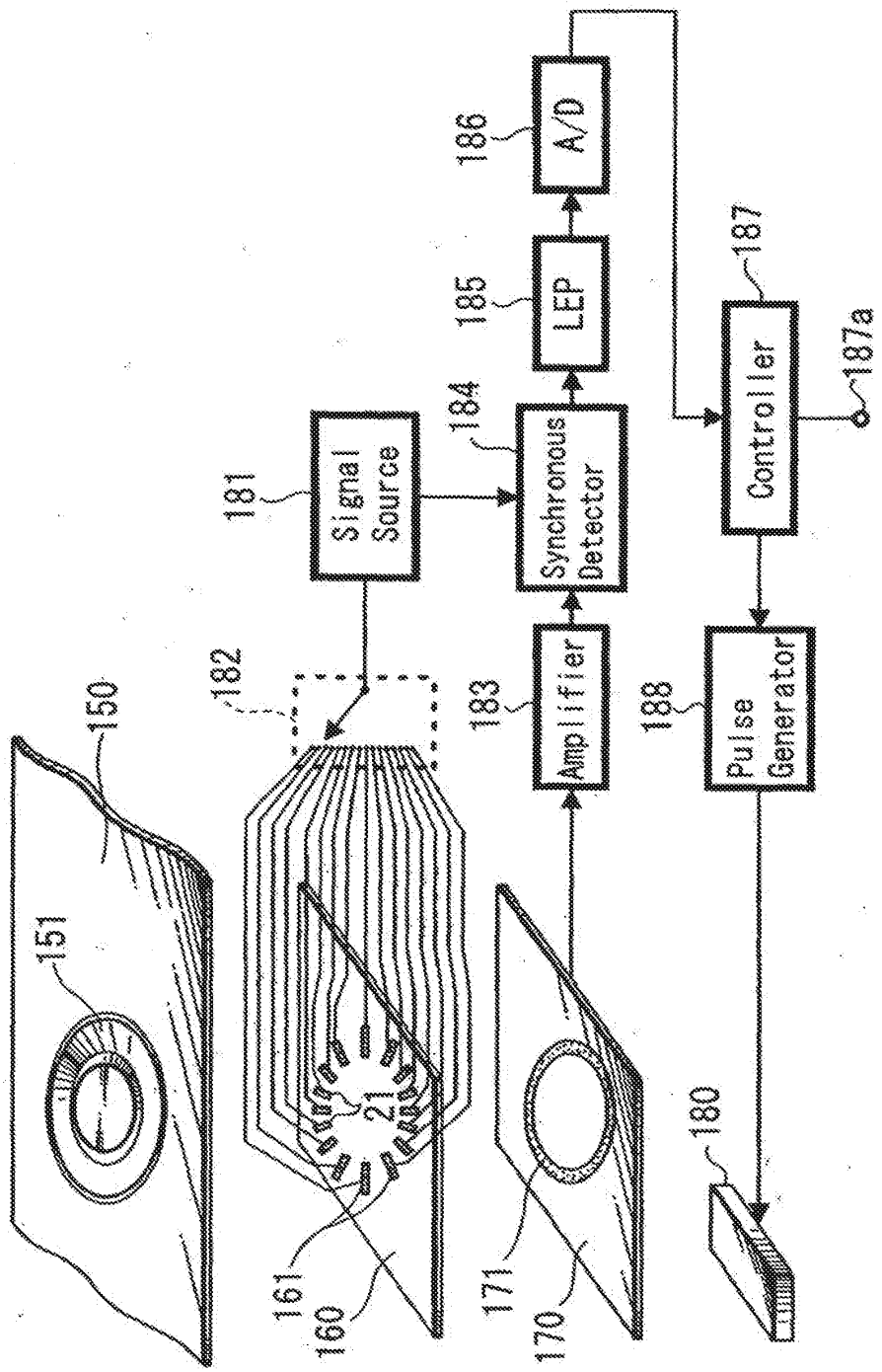


FIG. 10

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FIG. 11

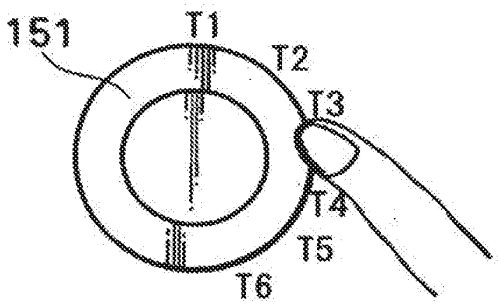

151
T1
T2
T3
T4
T5
T6

FIG. 12

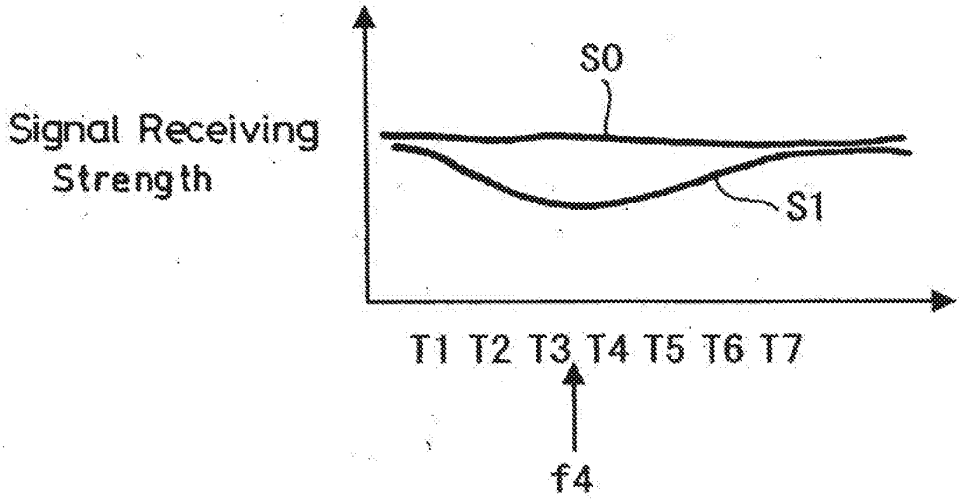

Signal Receiving Strength
S0
S1
T1 T2 T3 T4 T5 T6 T7
f4

FIG. 13

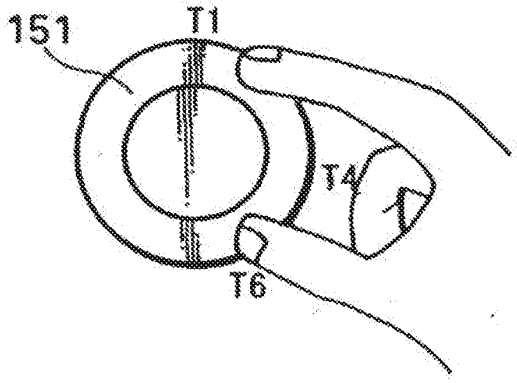

151
T1
T4
T6

FIG. 14

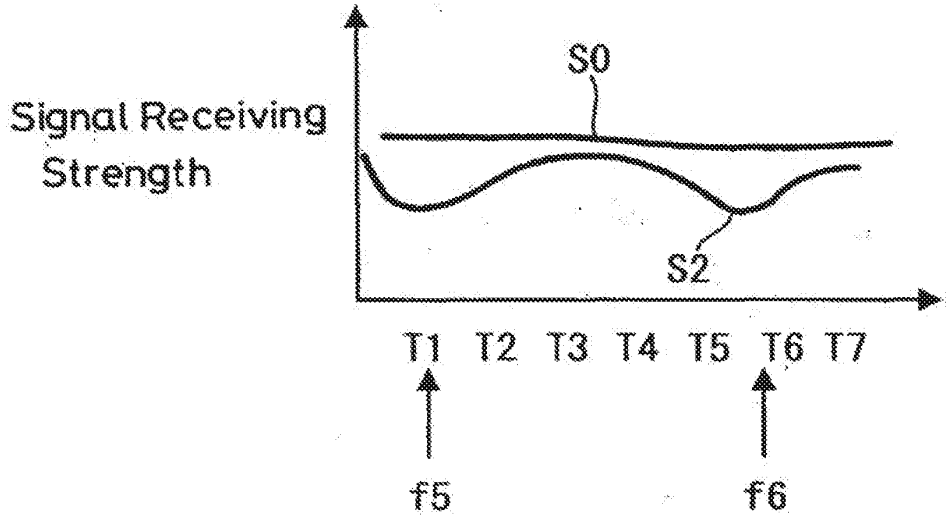

Signal Receiving Strength
S0
S2
T1 T2 T3 T4 T5 T6 T7
f5
f6

FIG. 15

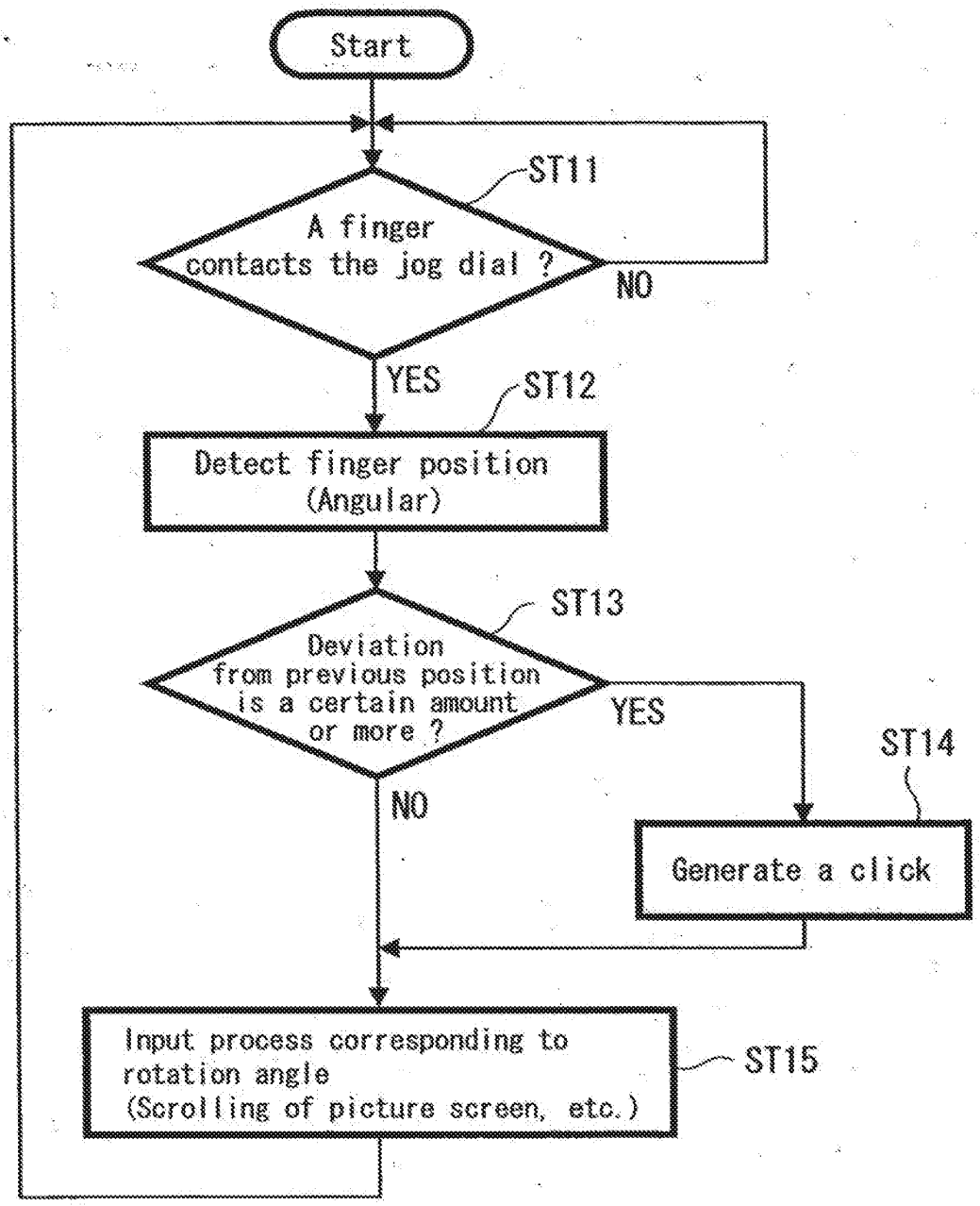
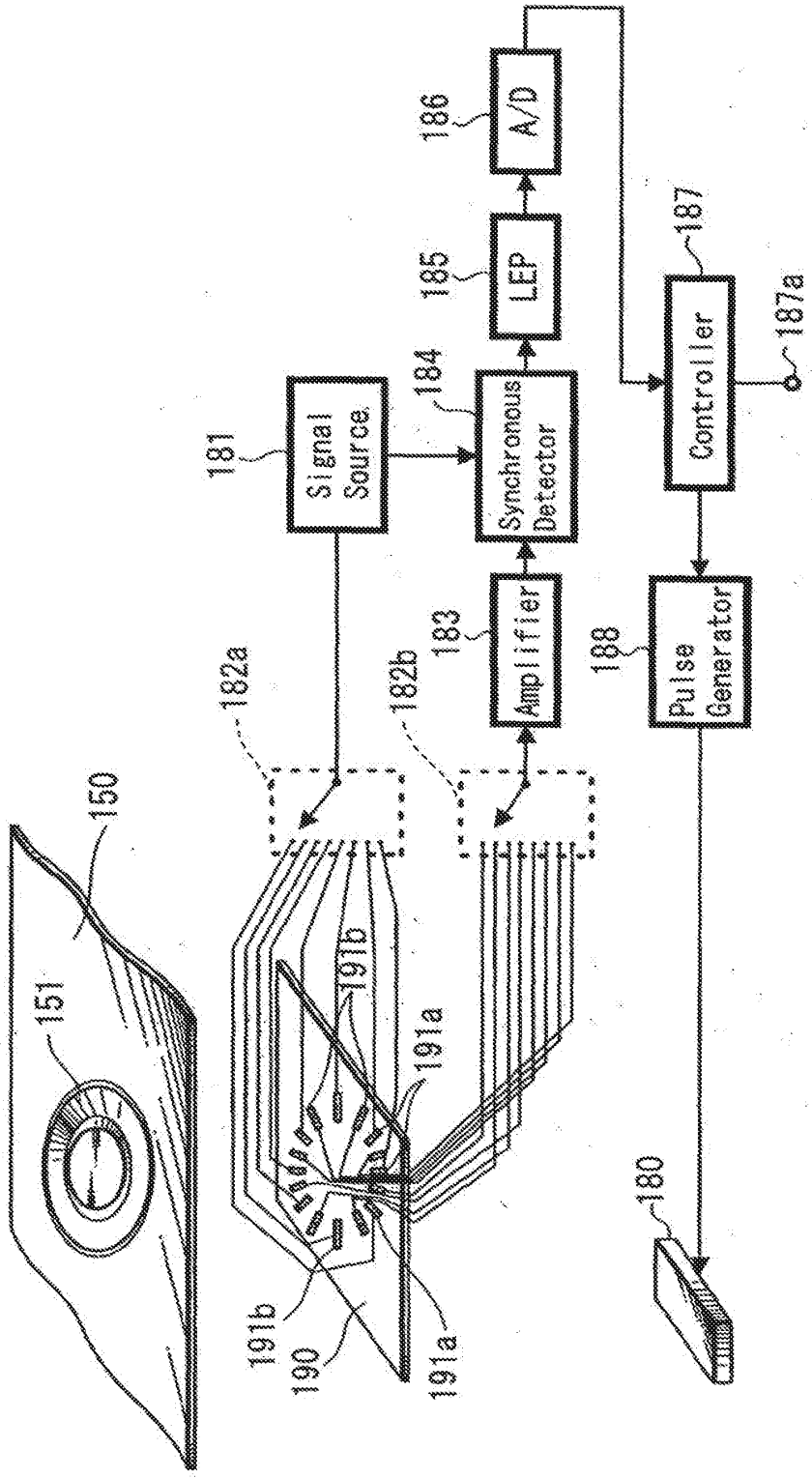

Start
ST11
A finger contacts the jog dial ?
NO
YES
ST12
Detect finger position (Angular)
ST13
Deviation from previous position is a certain amount or more ?
YES
NO
ST14
Generate a click
Input process corresponding to rotation angle (Scrolling of picture screen, etc.)
ST15

FIG. 16



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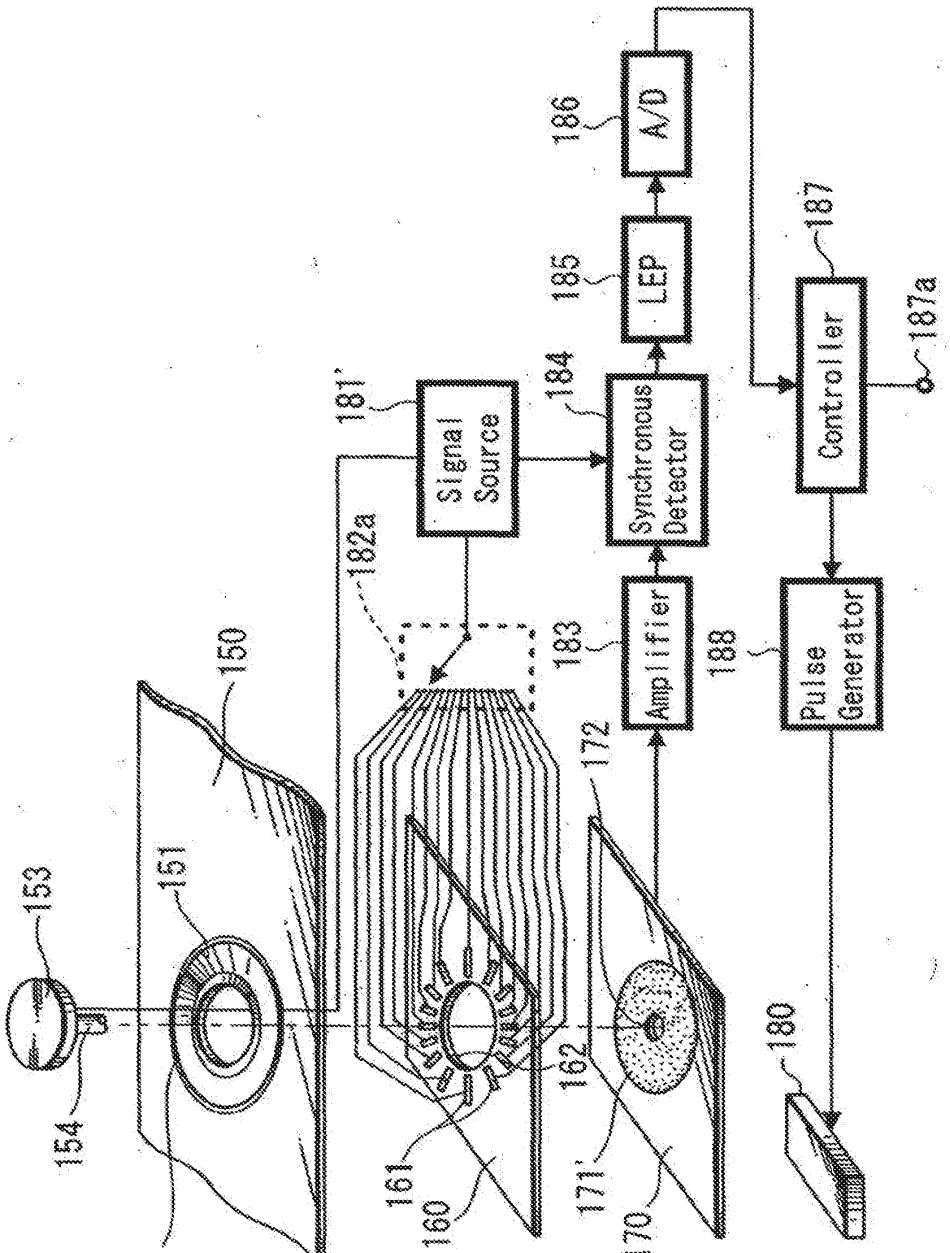
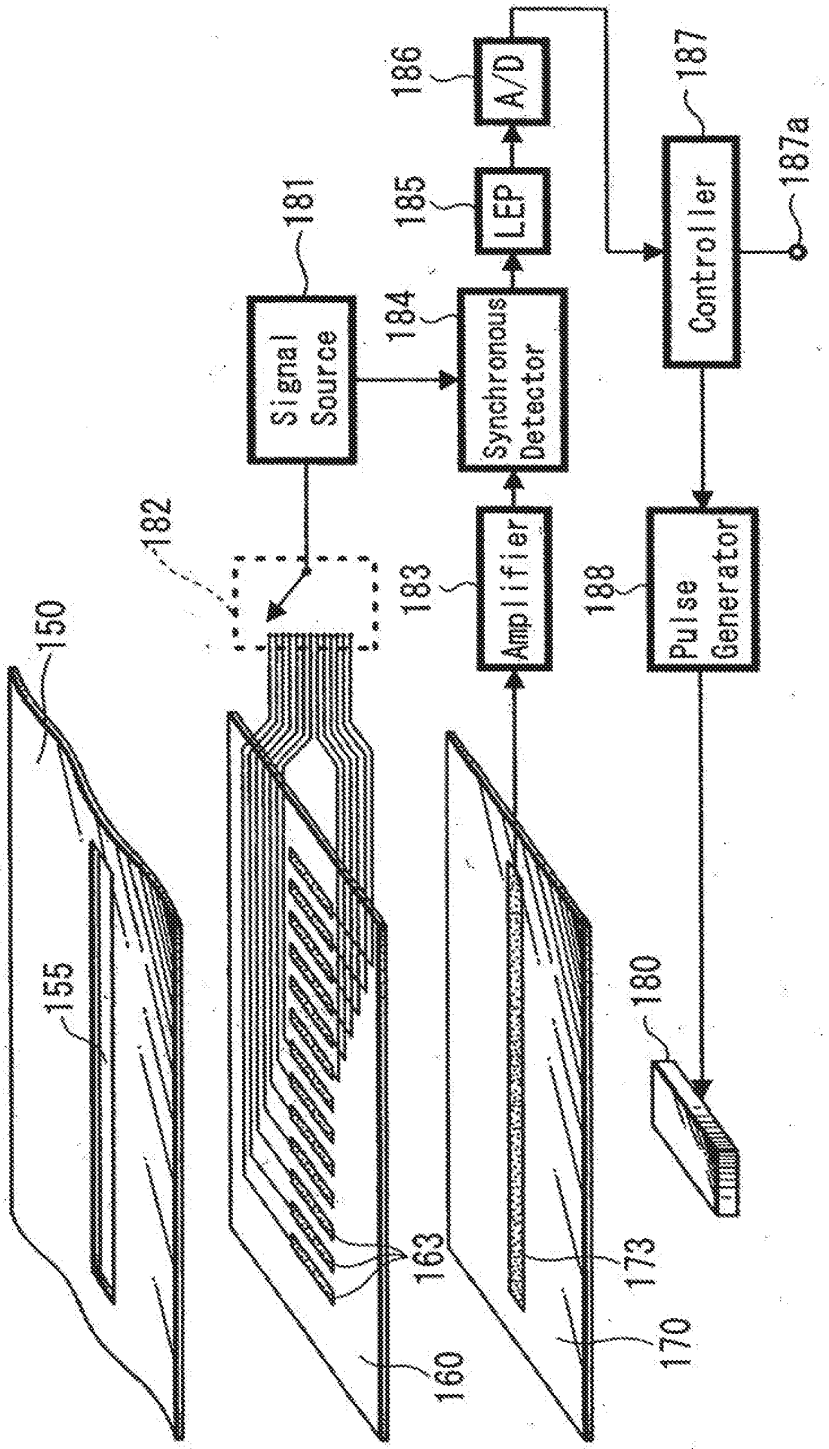


FIG. 17

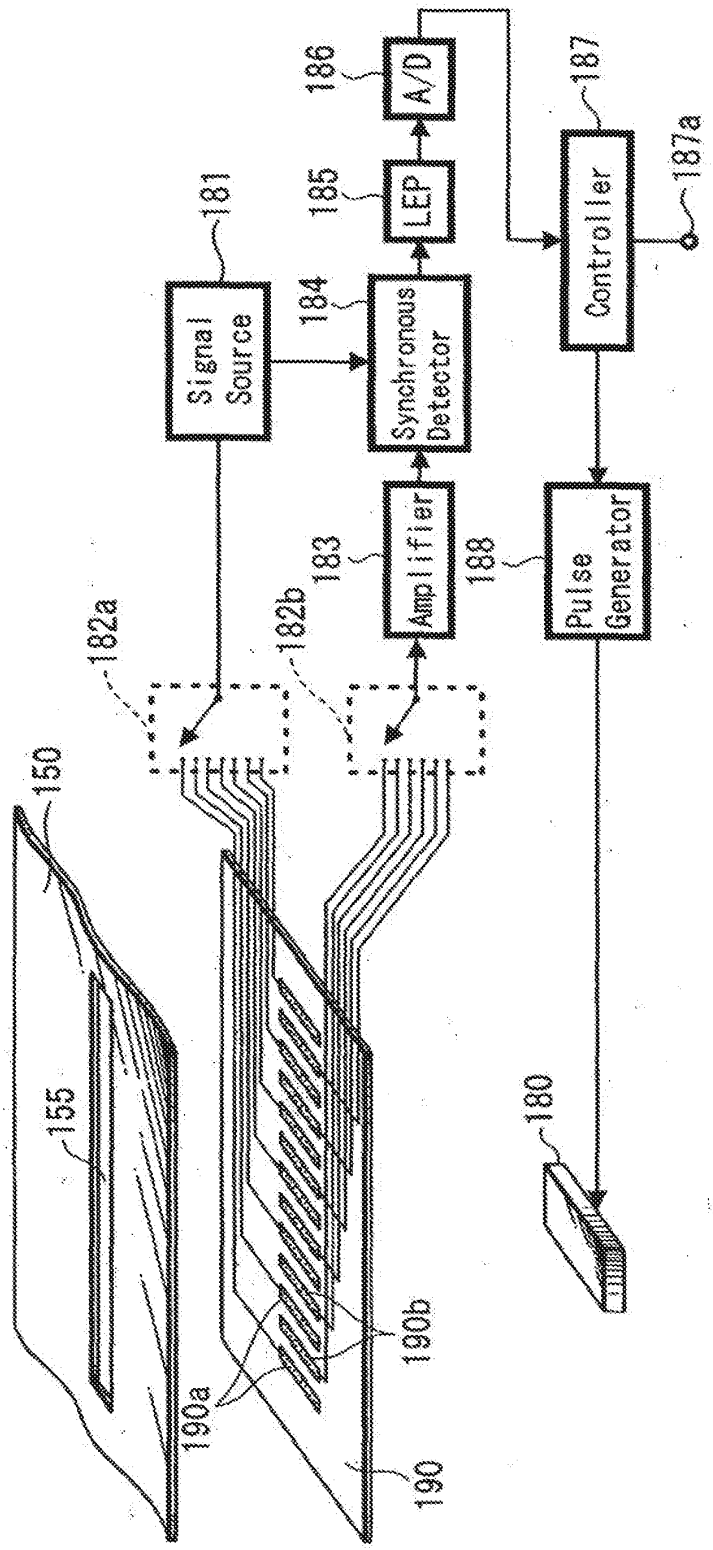
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FIG. 18



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FIG. 19



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FIG. 20

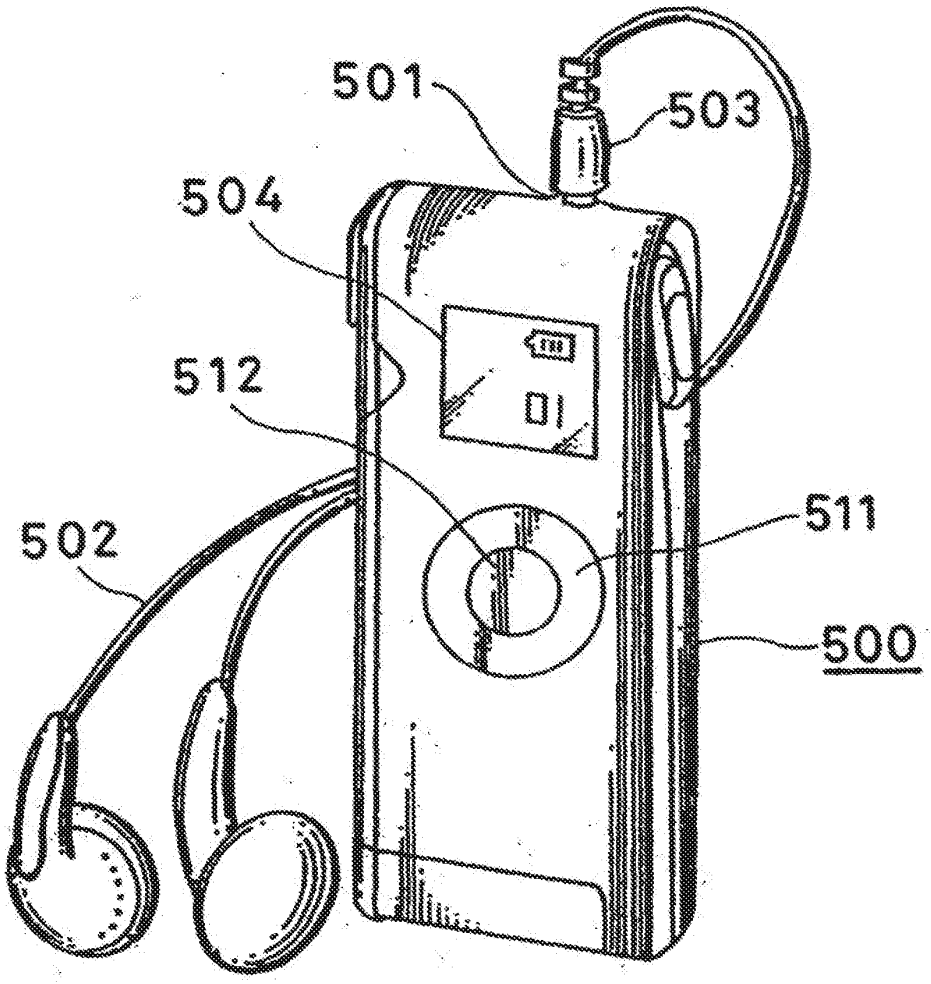


FIG. 21A

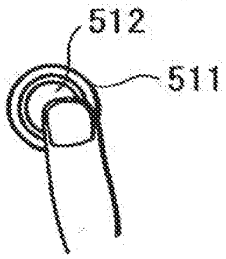


FIG. 21B

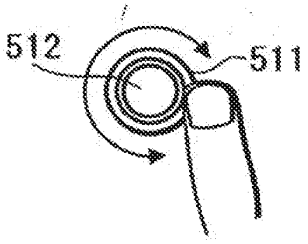


FIG. 21C

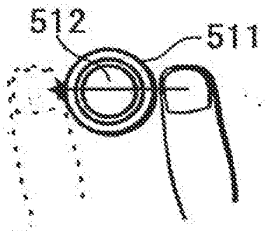


FIG. 21D

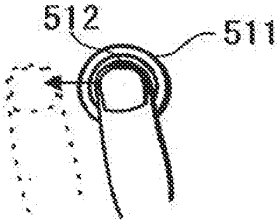


FIG. 21E

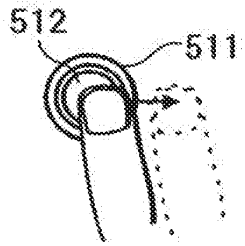


FIG. 21F

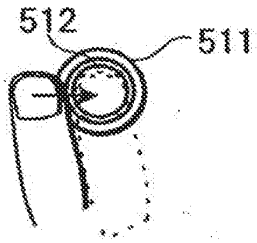


FIG. 21G

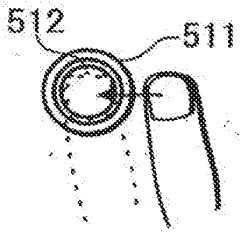


FIG. 22

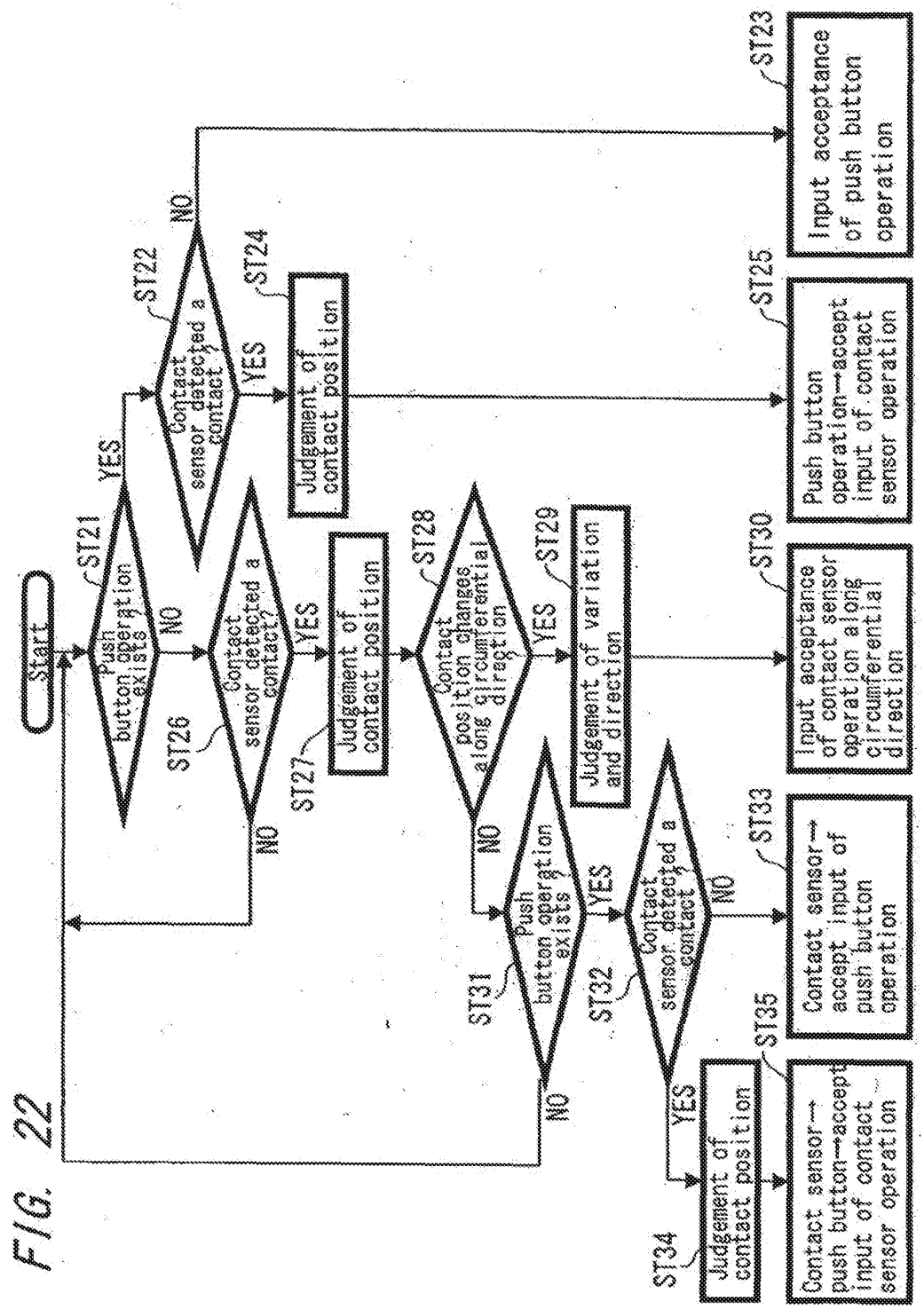

Start
ST21
Push button operation exists
YES
NO
ST22
Contact sensor detected a contact?
YES
NO
ST23
Input acceptance of push button operation
ST24
Judgement of contact position
ST25
Push button operation→accept input of contact sensor operation
ST26
Contact sensor detected a contact?
YES
NO
ST27
Judgement of contact position
ST28
Contact position changes along circumferential direction
YES
NO
ST29
Judgement of variation and direction
ST30
Input acceptance of contact sensor operation along circumferential direction
ST31
Push button operation exists
YES
NO
ST32
Contact sensor detected a contact?
YES
NO
ST33
Contact sensor→accept input of push button operation
ST34
Judgement of contact position
ST35
Contact sensor→push button→accept input of contact sensor operation

FIG. 23

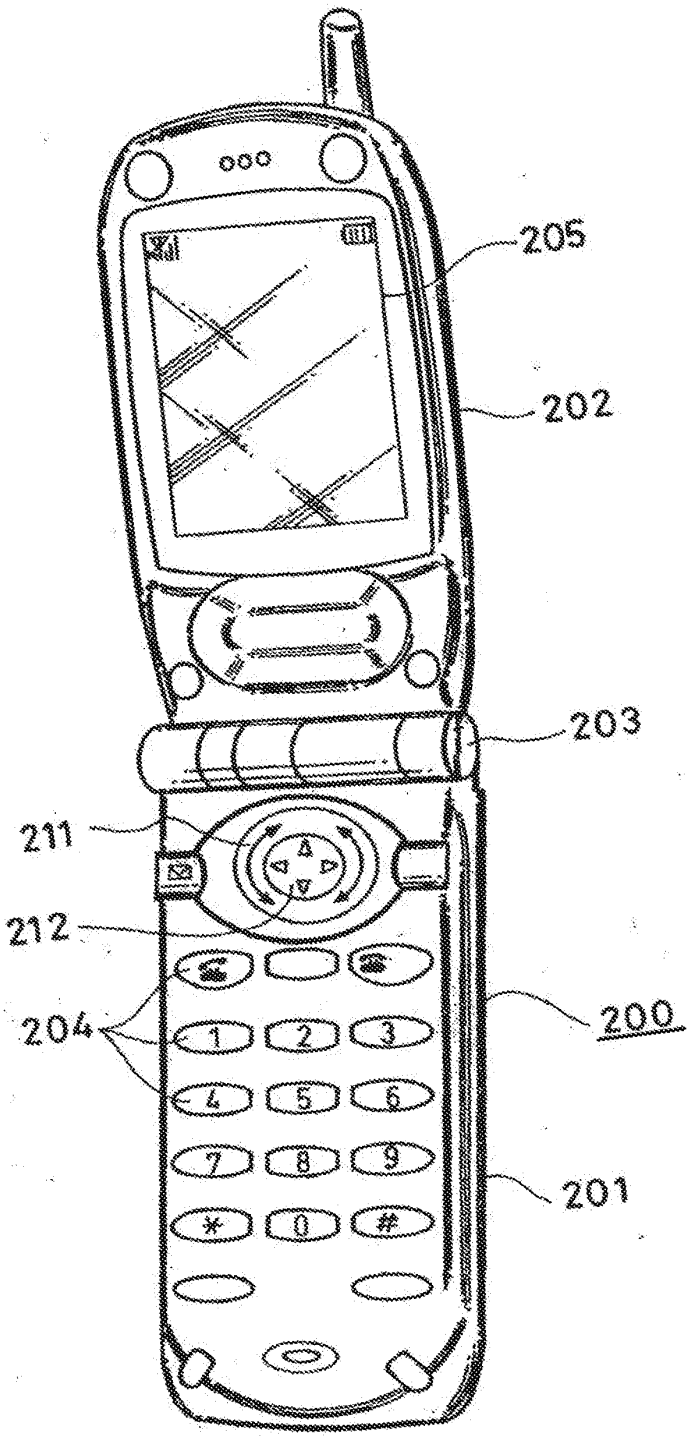


FIG. 24

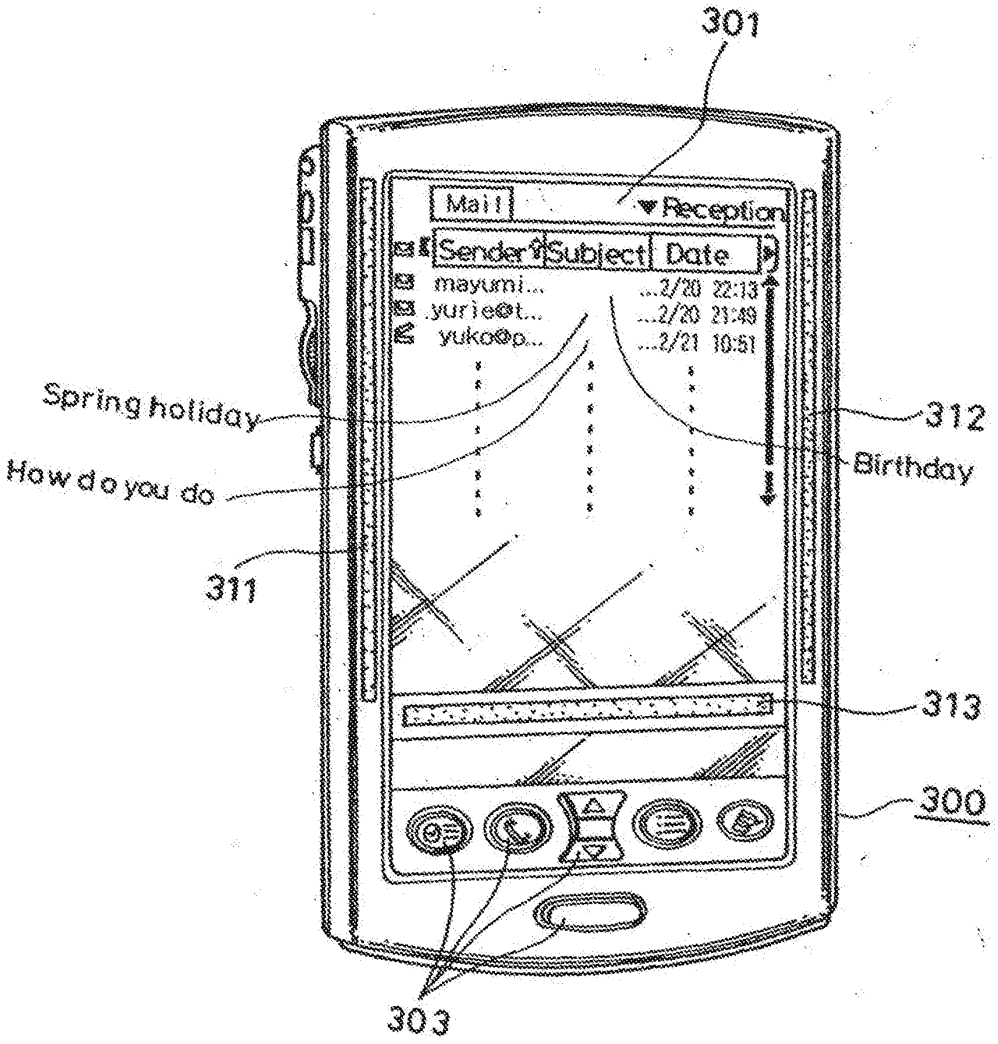

301
Mail
Reception
Sender
Subject
Date
mayumi...
yurie@t...
yuko@p...
...2/20 22:13
...2/20 21:49
...2/21 10:51
Spring holiday
How do you do
311
312
Birthday
313
300
303

FIG. 25A

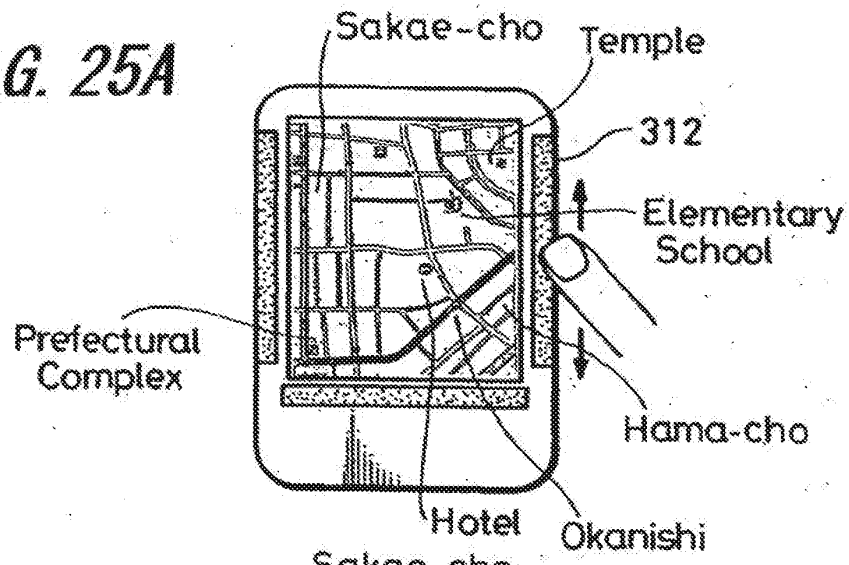


FIG. 25B

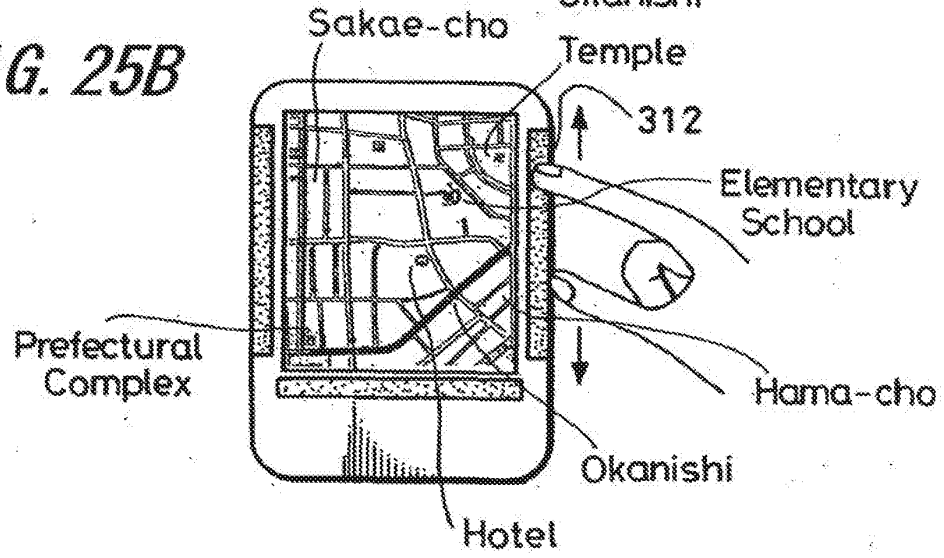


FIG. 25C

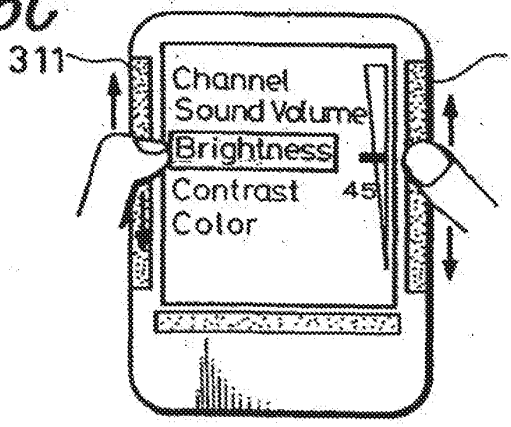


FIG. 26

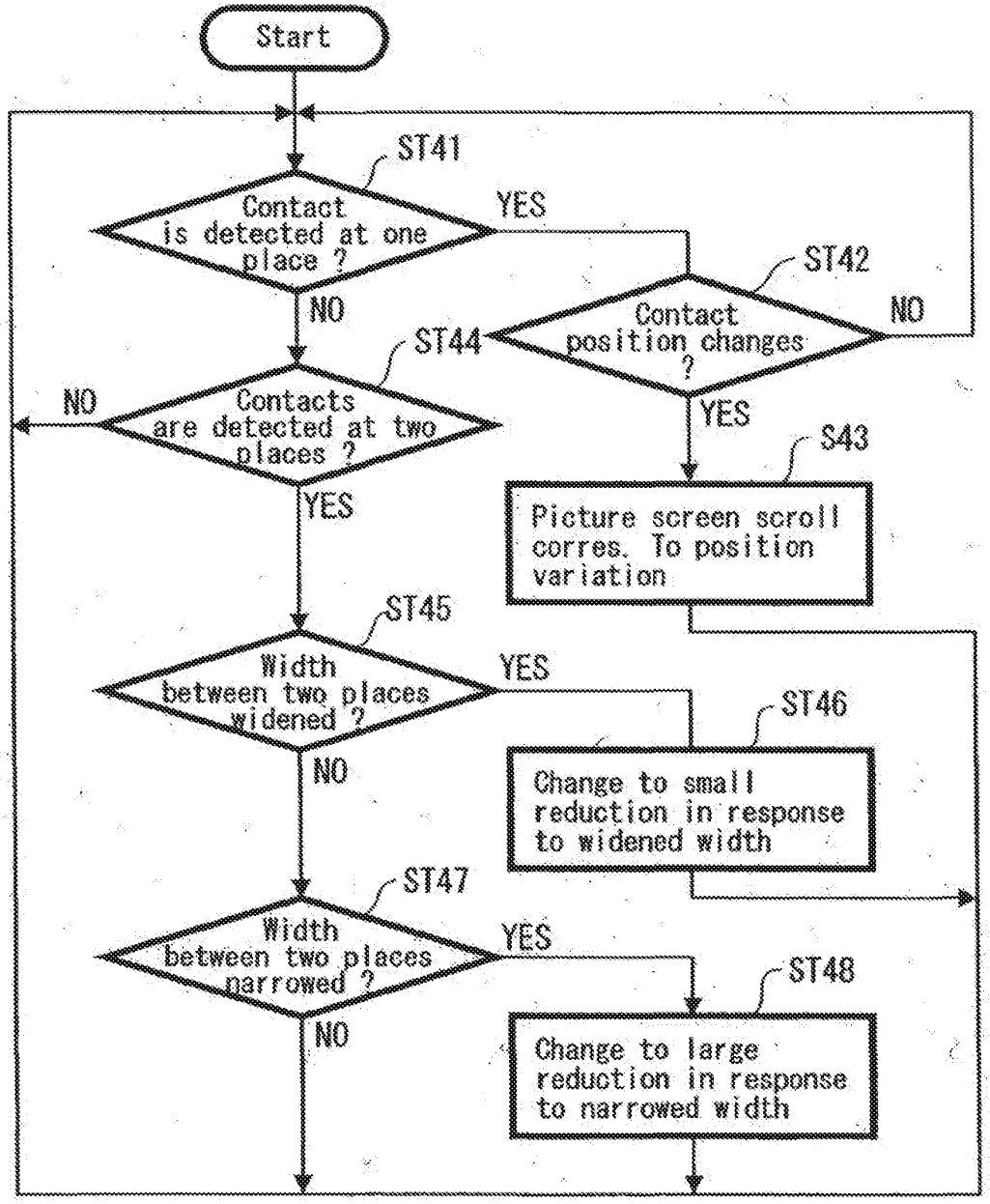

Start
ST41
Contact is detected at one place ?
YES
NO
ST42
Contact position changes ?
NO
YES
ST44
Contacts are detected at two places ?
NO
YES
S43
Picture screen scroll corres. To position variation
ST45
Width between two places widened ?
YES
NO
ST46
Change to small reduction in response to widened width
ST47
Width between two places narrowed ?
YES
NO
ST48
Change to large reduction in response to narrowed width

FIG. 27

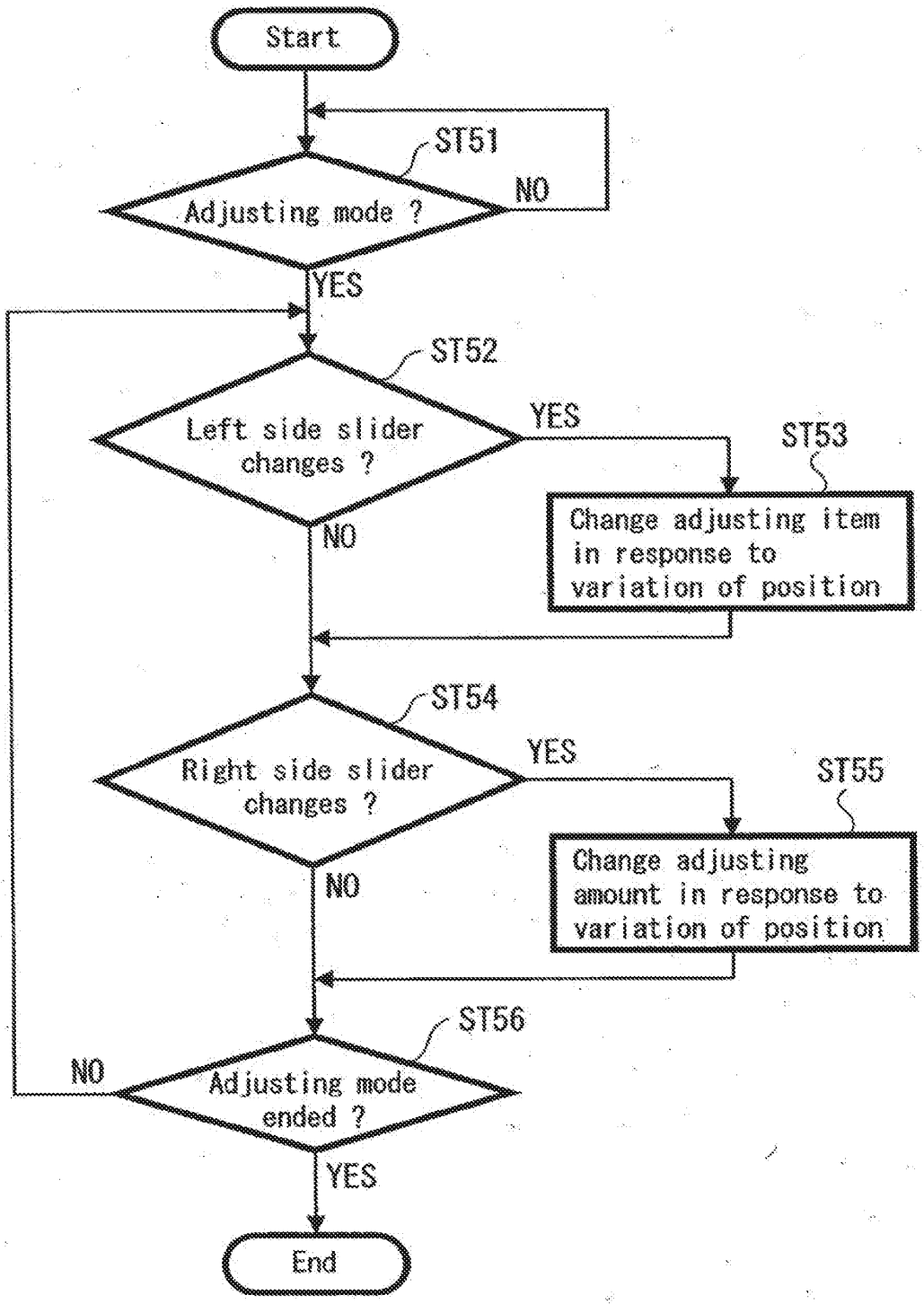

Start
ST51
Adjusting mode ?
NO
YES
ST52
Left side slider changes ?
YES
ST53
Change adjusting item in response to variation of position
NO
ST54
Right side slider changes ?
YES
ST55
Change adjusting amount in response to variation of position
NO
ST56
Adjusting mode ended ?
NO
YES
End

FIG. 28

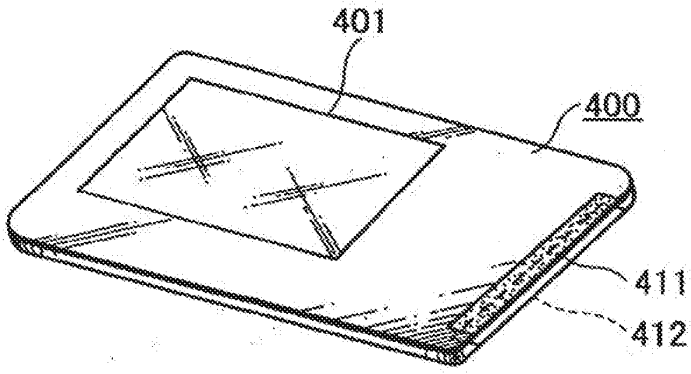


FIG. 29A

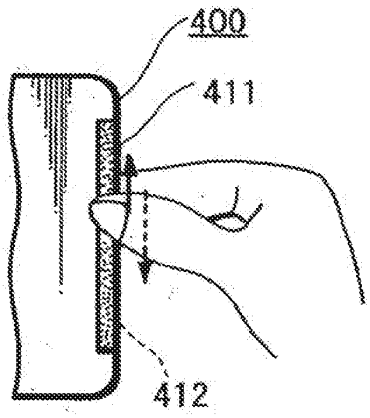


FIG. 29B

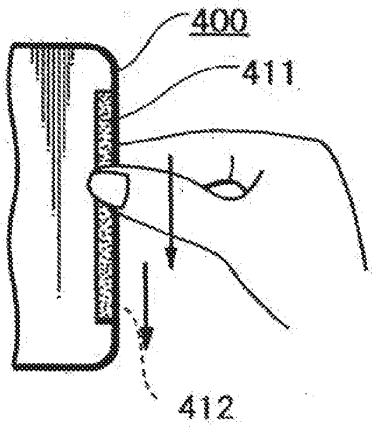
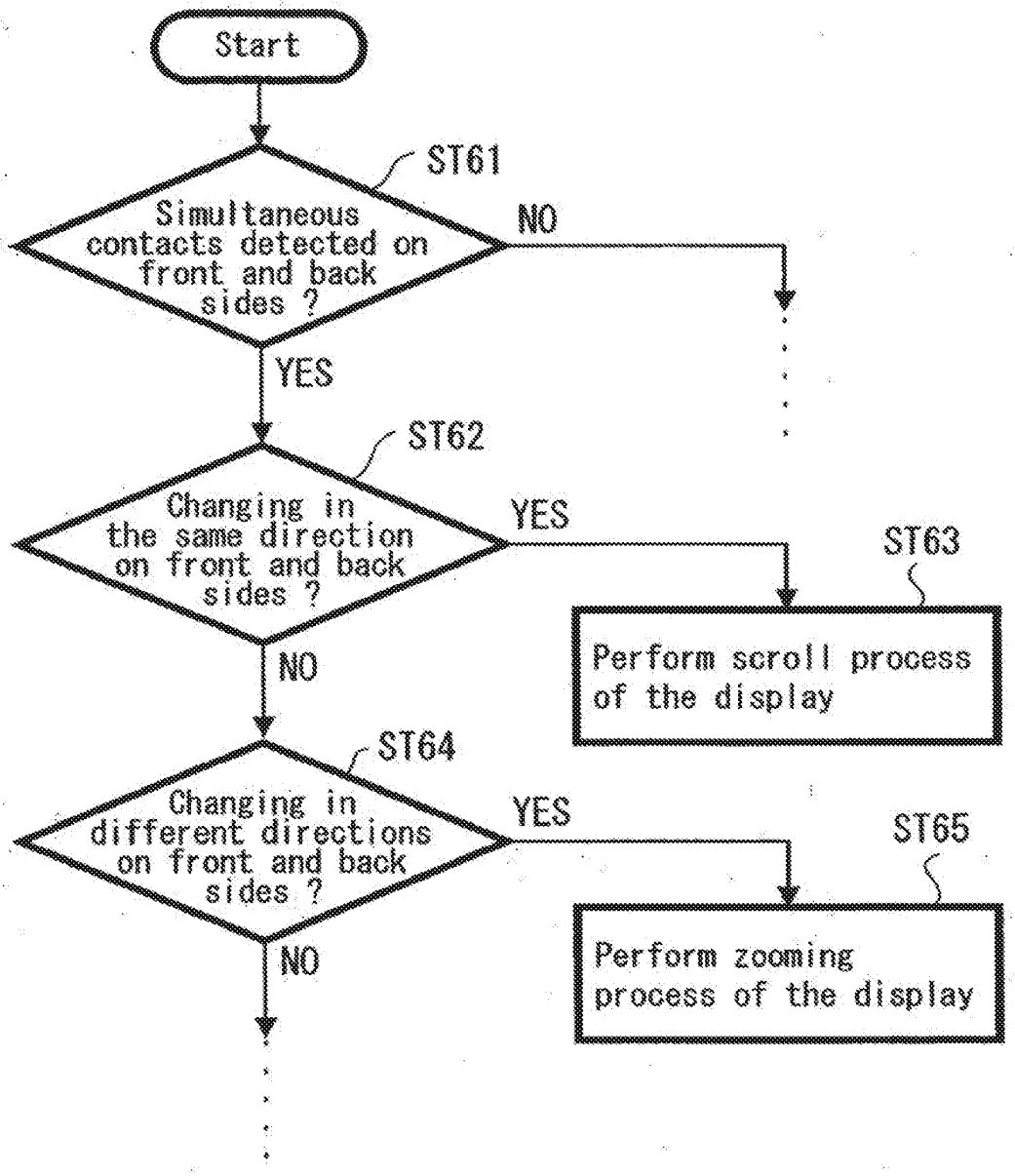


FIG. 30


Start
ST61
Simultaneous contacts detected on front and back sides ?
NO
YES
ST62
Changing in the same direction on front and back sides ?
YES
ST63
Perform scroll process of the display
NO
ST64
Changing in different directions on front and back sides ?
YES
ST65
Perform zooming process of the display
NO

DESCRIPTION OF REFERENCE NUMERALS

11 · · · · signal source

12, 13 · · · · change-over switch

14 · · · · amplifier

15 · · · · synchronous detector

16 · · · · low pass filter

17 · · · · analog/digital converter

18 · · · · controller

19 · · · · pulse generator

20 · · · · output terminal

90 · · · · input pen

91 · · · · coil

100, 100′ · · · · PDA

101 · · · · display panel

110, 110′ · · · · substrate

111 · · · · electrode (first group)

112 · · · · electrode (second group)

120 · · · · vibrator

150 · · · · housing

151 · · · · convex portion

152 · · · · opening

153 · · · · button

154 · · · · axis

155 · · · · convex portion

160 · · · · substrate

161 · · · · electrode

162 · · · · opening

163 · · · · electrode

170 · · · · substrate

171, 171' · · · · electrode

172 · · · · opening

173 · · · · electrode

180 · · · · vibrator

181, 181' · · · · signal source

182, 182a, 182b · · · · change-over switch

183 · · · · amplifier

184 · · · · synchronous detector

185 · · · · low pass filter

186 · · · · analog/digital converter

187 · · · · controller

188 · · · · pulse generator

190 · · · · substrate

191a, 191b, 192a, 192b · · · · electrode

200 · · · · portable telephone terminal

201 · · · · first housing

202 · · · · second housing

203 · · · · junction portion

204 · · · · key

205 · · · · display unit

211 · · · · annular operation unit (convex portion)

212 · · · · push button unit

300 · · · · PDA

301 · · · · display unit

303 · · · · operation key

311, 312, 313 · · · · slider type operation unit

400 . . . . card type equipment

401 . . . . display unit

411, 412 . . . . slider type operation unit

500 . . . . audio equipment

501 . . . . jack

502 . . . . headphone

503 . . . . plug

504 . . . . display unit

511 . . . . annular operation unit (convex portion)

512 . . . . push button unit

INPUTTING METHOD AND INPUTTING APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to an input method and an input apparatus suitable for operating electronic equipment constituted as a portable type in a comparatively small size.

BACKGROUND ART

[0002] Heretofore, since it is difficult to arrange a keyboard such as for a general computer apparatus in electronic equipment such as PDA (Personal Digital Assistants) which is constituted as a portable type in a comparatively small size, electronic equipment which is provided with an input means referred to as a touch panel has been practically produced where various inputs can be carried out by using a finger or a dedicated pen so as to be contacted with the face of the panel.

[0003] For example, in a case when a touch panel is constituted on a display panel such as an LCD panel, it becomes possible to be adaptable for complicated inputs by accepting the functional input allotted to the button or key if operation buttons, a keyboard or the like is displayed on the display panel first and then the portion of each portion of the displayed buttons and keys is touched even though it is a panel of a comparatively small area.

[0004] On the other hand, electronic equipment provided with an input apparatus referred to as a jog dial for another input apparatus other than a touch panel was practically produced in order to carry out complicated input operations easily in electronic equipment such as a portable telephone terminal. **FIG. 1** is a diagram showing one example of a portable telephone terminal provided with a conventional jog dial type input apparatus. In this example, a display panel **2**, a dial key **3** and the like are disposed on the front face of a housing which constitutes a portable telephone terminal **1** and a jog dial **4** is disposed on a side face of the housing.

[0005] The jog dial **4** is constituted by a rotational member which is rotatable one way and the other as shown by arrows a and b in **FIG. 1** and moreover it can be pushed down to a direction of a rotational axis as shown by an arrow c in **FIG. 1**. In this case, it is designed such that a click feeling is contained to a certain degree with respect to the rotation of the rotational member and a mechanical click is to be generated whenever, for example, the rotational member is made rotated by a certain angle in a range of several tens' degree.

[0006] It is possible by providing such a jog dial **4** to carry out various operations which are combined by the rotational operation and the push-down operation. For example, selection of input items (for example, input characters) can be carried out by rotating it in an arrow a or b direction and the selected item can be decided by pushing it down in a direction shown as the arrow c, so that there is an effect that various operations can be carried out easily by using a single operation means. Then, it is constituted such that a mechanical click is to be generated whenever rotated by a certain angle as mentioned above, so that a user can comprehend relying upon the number of clicks generated how much degree (for example, how many steps) it was inputted and the operationality is improved.

[0007] Now, in case of a conventional touch panel, there was a problem that a user who is carrying out the operation cannot judge whether or not it was correctively touched until an input corresponding to the touched position is executed after the panel face of the equipment is touched and a sensor in the equipment detects the contact in either case when a finger is used or when a dedicated pen is used.

[0008] In a case when, for example, a place where an operation button is displayed on a display panel is touched by an input pen, if such an operation as making a displayed color of the displayed operation button to be reversed is carried out after the condition of being touched is detected by a sensor in the equipment, it is notified that an input is done and it is comprehended that the operation was performed by the contact just after the display panel is touched. However, such a conventional input notifying process is a process for notifying after detecting that an operation was performed and it was difficult to say that it is definitely easy for a user to understand how to touch the panel for completing an input or the like.

[0009] More specifically, being different from a case of a physical button or a keyboard, there was a problem that it could not be comprehended whether or not an input is detected in a case when the panel is touched by how much degree of strength, whether or not the button is to be touched in a case when a boundary portion between the portion displayed as a button and its circumference is touched, or the like until the equipment is activated practically. Such a matter can be solved to a certain degree by being acclimated to the operation of the touch panel, but it is difficult to say that it is preferable for operating this sort of equipment, because habituation is necessary for the operational reliability.

[0010] Also, a conventional jog dial type input apparatus as shown in **FIG. 1** needs an operation member arranged rotatably, so that there is a problem that parts for an input apparatus becomes comparatively large-scaled as compared with a case when push buttons or the like is simply arranged in the equipment. With respect to the operation member constituting the jog dial **4** of the example shown in **FIG. 1**, the portion which can be seen from the outside of the housing is only a partial portion of the member and it is practically a circular shaped component as shown by a dotted line such that relatively a large cubic capacity is expended for the disposing space of its component inside the equipment. Consequently, a case often happens where it is difficult to arrange the conventional jog dial type input apparatus for the reason of miniaturization of the equipment.

[0011] It should be noted that it was explained about an example applied to a portable telephone terminal with reference to the example of **FIG. 1**, but there is a similar problem also in case of other various electronic equipment on which a similar operation means (input means) is disposed.

[0012] A first object of the present invention is to propose an input method and an input apparatus in which operations using an input apparatus of a contact detecting type such as a touch panel can be carried out simply and certainly.

[0013] A second object of the present invention is to propose an input method and an input apparatus in which

EX1002 - Page 293

operationality is satisfactory such as a jog dial type input apparatus and at the same time a large installing space is not necessary.

DISCLOSURE OF THE INVENTION

[0014] An input method of a first invention is constituted so as to comprise a detection step for detecting an approach and a contact of a living body or material body in a predetermined detection region; a vibration step for making a vibration temporarily in response to a detection of the approach in aforesaid detection step; and an input step for performing a predetermined input process in response to a detection of the contact on a predetermined condition in aforesaid detection step. In this manner, in a case when, for example, a panel is approached by a finger of one hand, a pen or the like by making the face of the panel of a small-sized portable equipment as a detection region on a condition that the equipment is held by the other hand, the equipment vibrates temporarily by the detection of that approach such that the vibration is transmitted to the hand holding the equipment and it becomes possible for the user to comprehend that an input can be carried out by the contact to the position on the panel. Consequently, it will be comprehended caused by the temporary vibration that an input could be done by touching the position just before the face of the panel is touched, so that a secure operation of the touch panel becomes possible.

[0015] An input method of a second invention is constituted according to the input method of the first invention such that aforesaid vibration step performs a process for making a vibration temporarily also in response to a detection of the contact on a predetermined condition in aforesaid detection step. In this manner, it becomes possible to comprehend not only an approach but also a contact from the vibration.

[0016] An input method of a third invention is constituted according to the input method of the first invention such that aforesaid vibration step performs a process for making a vibration temporarily also in response to a detection of the contact on a predetermined condition in aforesaid detection step such that in aforesaid vibration step, a vibration condition in a case when the approach is detected is made different from a vibration condition in a case when the contact is detected. In this manner, it becomes possible by the vibration condition to distinguish a condition of approaching and a condition of contacting.

[0017] An input method of a fourth invention is constituted so as to comprise a detection step for detecting a contact position of a living body or material body in a predetermined detection region; an input step for accepting a specific input corresponding to a contact position or a change of a contact position which is detected in aforesaid detection step; and a vibration step for vibrating at least a vicinity of aforesaid detection region temporarily every time when a change of a predetermined amount or more occurs relating to the contact position in aforesaid detection step. In this manner, a specific input is accepted in response to a position or its position change which was detected by a sensor with respect to the contact of the living body or the material body, so that it becomes possible to accept an input by using a planar contact-detection sensor. Then, whenever a change of a predetermined amount or more exists for a position contacted by the sensor, a vibration corresponding to a click feeling is transmitted to a user contacting the sensor (or to a user through a material body contacting the sensor) by vibrating at least the vicinity of the detection region temporarily such that a similar feeling as in a case as if a dial having a click feeling is making rotated can be obtained and a satisfactory operationality can be obtained.

[0018] An input method of a fifth invention is constituted according to the input method of the fourth invention such that the contact detection in aforesaid detection step is detected according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in aforesaid predetermined detection region and one or a plurality of receiving electrodes. In this manner, it is possible to carry out the detection of the contact position simply and certainly.

[0019] An input method of a sixth invention is constituted according to the input method of the fourth invention such that the contact detection in aforesaid detection step detects simultaneous contacts on a plurality of places according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in aforesaid predetermined detection region and one or a plurality of receiving electrodes. In this manner, it becomes possible to detect a plurality of simultaneous contacts easily and satisfactorily.

[0020] An input method of a seventh invention is constituted according to the input method of the fourth invention such that the region for performing the contact detection in aforesaid detection step is made to be an annular region and the detection is performed according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in the annular detection region and one or a plurality of receiving electrodes. In this manner, the detection region becomes of an endless constitution and restriction for the number of steps capable of the input instruction disappears.

[0021] An input method of an eighth invention is constituted according to the input method of the fourth invention such that the region for performing the contact detection in aforesaid detection step is made to be an annular region and an operation inside the region where aforesaid annular contact detection is performed is detected by another detection step than aforesaid detection step. In this manner, a high technical input process combining an operation of a contact detection sensor and an operation of a push button type switch becomes possible.

[0022] An input method of a ninth invention is constituted according to the input method of the fourth invention such that the region for performing the contact detection in aforesaid detection step is made to be an annular region; an operation inside the region where aforesaid annular contact detection is performed is detected by another detection step than aforesaid detection step; and a function for accepting an input in aforesaid input step is changed in response to a detection pattern in the two detection steps. In this manner, it becomes possible to be adaptable for the operations of various functions.

[0023] An input method of a tenth invention is constituted according to the input method of the fourth invention such that the contact detection in aforesaid detection step is

detected according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in aforesaid predetermined linear detection region and one or a plurality of receiving electrodes. In this manner, the input apparatus is to be constituted as a slider type one, so that it is possible to dispose the input apparatus satisfactorily in conformity with the shape of the equipment.

[0024] An input method of an eleventh invention is constituted according to the input method of the fourth invention such that the contact detection in aforesaid detection step is detected according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in a detection region which is disposed linearly adjacent any one side of a display means performing a display of a character or a figure and one or a plurality of receiving electrodes. In this manner, it is possible to attain a satisfactory disposal combining with a display apparatus in one united body.

[0025] An input method of a twelfth invention is constituted according to the input method of the fourth invention such that the contact detection in aforesaid detection step is a process for detecting according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in a detection region which is disposed linearly adjacent any one side of a display means performing a display of a character or a figure and one or a plurality of receiving electrodes; and an input of a function relating to the display in aforesaid display means is accepted by detecting the contact in the detection step. In this manner, the operation related to the display come to be performed satisfactorily.

[0026] An input method of a thirteenth invention is constituted according to the input method of the fourth invention such that the contact detection in aforesaid detection step is a process for detecting according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in a detection region which is disposed linearly adjacent any one side of a display means performing a display of a character or a figure and one or a plurality of receiving electrodes and is a process for accepting an input of a function relating to the display in aforesaid display means by detecting the contact in the detection step; and an input of a function for changing magnification or reduction of the display in aforesaid display means to one or the other is accepted in a case when the contact positions of two places detected approximately simultaneously in aforesaid detection step change such as mutually approaching and in a case when they change such as being mutually apart. In this manner, the operation for the magnification or the reduction of the display comes to be performed very easily.

[0027] An input apparatus of a fourteenth invention is constituted so as to comprise a detection sensor for detecting an approach and a contact of a living body or a material body in a predetermined detection region; control means for outputting a drive signal in a case when an approach is detected by said detection sensor and performing an input process for accepting an input of a predetermined function in a case when a contact is detected on a predetermined condition; and an actuator responsive to an instruction from said control means for making a vibration temporarily. In this manner, in a case when, for example, a panel is approached by a finger of one hand, a pen or the like by making the face of the panel of a small-sized portable equipment as a detection region on a condition that the equipment is held by the other hand, the equipment vibrates temporarily by the detection of that approach such that the vibration is transmitted to the hand holding the equipment and it becomes possible for the user to comprehend that an input can be carried out by the contact to the position on the panel. Consequently, it will be comprehended caused by the temporary vibration that an input could be done by touching the position just before the face of the panel is touched, so that a secure operation of the touch panel becomes possible.

[0028] An input apparatus of a fifteenth invention is constituted according to the input apparatus of the fourteenth invention such that aforesaid control means performs a process for making a vibration temporarily in aforesaid actuator also in a case when a contact on a predetermined condition is detected in aforesaid detection sensor. In this manner, it becomes possible to comprehend not only an approach but also a contact from the vibration.

BRIEF DESCRIPTION OF DRAWINGS

[0029] **FIG. 1** is an oblique perspective view showing one example of a portable telephone terminal provided with a conventional jog dial type input apparatus;

[0030] **FIG. 2** is an oblique perspective view showing a constitutional example of equipment applied with an input apparatus according to a first exemplified embodiment of the present invention;

[0031] **FIG. 3** is a cross sectional diagram showing an arrangement example inside equipment according to a first exemplified embodiment of the present invention;

[0032] **FIG. 4** is an explanatory diagram showing one example of an approach and a contact detecting constitution according to a first exemplified embodiment of the present invention;

[0033] **FIG. 5** is a characteristic diagram showing an example of a detection characteristic according to a first exemplified embodiment of the present invention;

[0034] **FIG. 6** is a characteristic diagram showing an example of a detection characteristic according to a first exemplified embodiment of the present invention;

[0035] **FIG. 7** is an explanatory diagram showing an operational example according to a first exemplified embodiment of the present invention;

[0036] **FIG. 8** is a flow chart showing an input process example according to a first exemplified embodiment of the present invention;

[0037] **FIG. 9** is a cross sectional view showing a constitutional modified example (example of a pen input) according to a first exemplified embodiment of the present invention;

[0038] **FIG. 10** is an explanatory diagram showing a constitutional example of an input apparatus (example 1 of a jog dial type) according to a second exemplified embodiment of the present invention;

[0039] **FIG. 11** is an explanatory diagram showing a condition of touching an input apparatus according to a second exemplified embodiment of the present invention;

[0040] **FIG. 12** is an explanatory diagram showing an output characteristic example on a condition of being touched as shown in **FIG. 11**;

[0041] **FIG. 13** is an explanatory diagram showing a condition of touching an input apparatus at two places simultaneously according to a second exemplified embodiment of the present invention;

[0042] **FIG. 14** is an explanatory diagram showing an output characteristic example on a condition of being touched as shown in **FIG. 13**;

[0043] **FIG. 15** is a flow chart showing a process example based on an input detection according to a second exemplified embodiment of the present invention;

[0044] **FIG. 16** is an explanatory diagram showing a constitutional example of an input apparatus (example 2 of a jog dial type) according to a second exemplified embodiment of the present invention;

[0045] **FIG. 17** is an explanatory diagram showing a constitutional example of an input apparatus (example where a push button is combined) according to a second exemplified embodiment of the present invention;

[0046] **FIG. 18** is an explanatory diagram showing a constitutional example of an input apparatus (example 1 of a slider type) according to a second exemplified embodiment of the present invention;

[0047] **FIG. 19** is an explanatory diagram showing a constitutional example of an input apparatus (example 2 of a slider type) according to a second exemplified embodiment of the present invention;

[0048] **FIG. 20** is an oblique perspective view showing an example applying an input apparatus according to a second exemplified embodiment of the present invention to audio equipment;

[0049] **FIGS. 21***a* to **21**G is explanatory diagrams respectively showing operational examples of a jog dial type input apparatus according to a second exemplified embodiment of the present invention;

[0050] **FIG. 22** is a flow chart showing an input judgment example according to the operational examples in **FIGS. 21***a* to **21**G;

[0051] **FIG. 23** is an oblique perspective view showing an example applying an input apparatus according to a second exemplified embodiment of the present invention to a portable telephone terminal;

[0052] **FIG. 24** is an oblique perspective view showing an example applying an input apparatus according to a second exemplified embodiment of the present invention to a PDA;

[0053] **FIGS. 25A** to **25**C are explanatory diagrams respectively showing operational examples of a slider type input apparatus according to a second exemplified embodiment of the present invention;

[0054] **FIG. 26** is a flow chart showing a process example according to the operational examples of **FIGS. 25A** to **25**C;

[0055] **FIG. 27** is a flow chart showing a process example in a case of an adjusting mode according to the operational examples of **FIGS. 25A** to **25**C;

[0056] **FIG. 28** is an oblique perspective view showing an example applying an input apparatus according to a second exemplified embodiment of the present invention to card type equipment;

[0057] **FIG. 29A** and **FIG. 29B** are explanatory diagrams respectively showing operation examples of the example of the equipment in **FIG. 28**; and

[0058] **FIG. 30** is a flow chart showing a process example according to the operational examples in **FIGS. 29A and 29B**.

BEST MODE FOR CARRYING OUT THE INVENTION

[0059] Hereinafter, a first exemplified embodiment according to the present invention will be explained.

[0060] In this example, there is shown an input apparatus which is disposed on a face of a housing constituting electronic equipment so as to be operated by a user. **FIG. 2** is an oblique perspective view showing an example in which the input apparatus according to this example is applied to a data processing terminal which is referred to as PDA and is constituted in a small size as a portable type. As shown in **FIG. 2**, PDA **100** of this example is mounted with a display panel **101** on the face. This display panel **101** is constituted, for example, by an LCD panel and it is possible to display various characters, figures and the like thereon. In addition, operation keys **102** are disposed at a lower edge portion of the face of the PDA **100**.

[0061] Then, in this example, a sensor which can detect an approach and a contact of a finger or the like to the face of the display panel **101** is installed in the PDA **100**. More specifically, for example, as shown in **FIG. 3**, a substrate **110** disposed with an electrode which functions as an approach and contact detecting sensor is disposed on the backside of the display panel **101** inside the PDA **100** it is constituted such that respective conditions can be detected in a case when a living body such as a finger approaches to the face of the display panel **101** and in a case when it is contacted therewith. In this case, it is constituted such that it is possible to detect which position of the display panel **101** is approached or contacted. A concrete constitutional example for detecting an approach and a contact will be described later on.

[0062] Also, as shown in **FIG. 3**, a vibrator **120** which functions as an actuator for transmitting a vibration to the housing constituting the PDA body is disposed inside the PDA **100** of this example and it is constituted such that the housing is vibrated temporarily according to the detected condition of the approach and the contact in the detection sensor.

[0063] **FIG. 4** is a diagram showing a constitutional example of a sensor for detecting an approach and a contact according to this example by decomposing it. In case of this example, a plurality of electrodes **111** of a first group and a plurality of electrodes **112** of a second group are disposed alternately and linearly with an approximately fixed distance on the substrate **110** disposed on the backside of the display

panel **101**. Here, the electrode **111** of the first group is an electrode functioning as a transmission electrode and the electrode **112** of the second group is an electrode functioning as a receiving electrode. It should be noted that in order to make the explanation simple, the electrodes **111** and **112** are aligned only by one row in **FIG. 4**, but it is necessary to arrange a plurality of rows in a case when the region for detecting the approach and the contact is a broad area. For example, in a case when approximately the whole face of the display panel **101** is made to be the region for detecting the approach and the contact, it is necessary to make the substrate **110** have approximately the same area as that of the display panel **101** and to dispose the electrodes **111** and **112** by a predetermined pattern approximately on the whole face and on the downside of the display face of the display panel **101**.

[0064] The capacitance value between the adjacent electrodes **111** and **112** changes in response to a condition that a finger approaches to the face and in accordance with capacitance coupling between the approached finger and the electrodes **111** and **112**. In case of this example, the change of this capacitance value is measured electrically so as to detect the approach and the contact and at the same time also so as to detect its approach or contact position simultaneously. The detail of its detection process will be described later on. It should be noted that an approach in the example of the present invention means a condition where a finger or the like approaches, for example, within a range of several millimeters from the face of the display panel **101**.

[0065] The electrodes **111** of the first group are supplied with a specific signal outputted from a signal source **11** in a time divisional manner through a change-over switch **12**. The change-over switch **12** performs a process for switching each of the electrodes **111** sequentially in a comparatively short period so as to supply a signal to all the provided electrodes **111** from the signal source **11** in a time divisional manner and in a sequential order. In addition, it is constituted such that a change-over switch **13** which is switched in synchronism with the change-over switch **12** is provided and signals obtained at the electrodes **112** of the second group are supplied to an amplifier **14** in a time divisional manner and in a sequential order. The change-over switch **12** and the change-over switch **13** are constituted so as to be switched by the same period. For example, with respect to a timing in which the change-over switch **12** is changed over such that an electrode **111** of a certain position is supplied with a signal from the signal source **11**, a signal obtained at an electrode **112** of the position adjacent to the electrode **111** to which the signal is supplied is selected by the change-over switch **13** and supplied to the amplifier **14**.

[0066] The signal source **11** is a circuit for outputting a preset specific signal such as, for example, an AC signal having a specific frequency. The signal outputted from the signal source **11** is supplied to the plurality of transmission electrodes **111** sequentially through the change-over switch **12**. In the amplifier **14** is connected to the electrodes **112** which are electrodes for receiving signals from respective transmission electrodes **111**, supplied signals are amplified and thereafter supplied to a synchronous detector **15**. The synchronous detector **15** is also supplied with an output signal of the signal source **11** so as to detect a signal component included in the output of the amplifier **14** in synchronism with the frequency of the output signal of the signal source **11**. The detected signal component is supplied to a low pass filter **16** so as to be converted to a direct current and the direct current converted signal component is supplied to an analog/digital converter **17** so as to convert the signal receiving strength to digital data.

[0067] The data obtained in the analog/digital converter **17** are supplied to a controller **18** which performs a control of the input apparatus. The controller **18** judges the operation condition based on the supplied data and an instruction obtained according to the judgment of the operation condition is outputted from a terminal **20**. In case of this example, the controller **18** judges a change of the signal strength based on the data supplied by means of the converter **17** and judges the condition in which the finger or the like approaches and contacts the display panel **101** based on the change of the signal strength.

[0068] Also, the controller **18** controls a pulse signal output of a pulse generator **19** according to the condition judged based on the data which is supplied from the converter **17** side. The pulse signal outputted from the pulse generator **19** is supplied to the vibrator **120** so as to vibrate the vibrator **120**. As the pulse signal outputted from the pulse generator **19**, for example, a pulse signal of about 20 H_z frequency is outputted in a short time such as one period. A member which vibrates by being applied with a signal, for example, such as a piezo vibrator is used for the vibrator **120** which is an actuator for vibration. The vibrator **120** vibrates temporarily only in a short time by supplying a pulse signal of such a short time to the vibrator **120** and the housing mounted with the vibrator **120** (namely, PDA **100** body) vibrates.

[0069] For example, two kinds of vibrations can be made set according to a case when a single-shot like vibration is made generated only one time by supplying a pulse signal of one period to the vibrator **120** only one time and according to a case when two consecutive vibrations are made generated by supplying a pulse signal of one period two times in succession with about 0.5 seconds apart to the vibrator **120**.

[0070] Here, it is possible to make the controller **18** as a control means provided as an input apparatus alone and it is also possible to make the controller of the electronic equipment (here, PDA) installed with this input apparatus operate also for it. Next, the principle of detecting an approach and a contact of a finger and the like in the input apparatus of this example will be explained with reference to **FIGS. 5 and 6**. **FIG. 5** shows a condition in which a specific position f1 on the display panel **101** in a right above portion disposed with the electrodes **111** and **112** is touched by one finger and the touched positions are designated as T1, T2, T3, T4, ... According to this example, it is in a condition that approximately an intermediate position f1 between a position T3 and a position T4 is touched by one finger. When touched in this way, the signal strength detected by the synchronous detector **15** through an electrode corresponding to a touched angular position becomes weaker than the signal strength detected synchronously through another electrode.

[0071] For example, supposing that the positions T1, T2, T3, T4, . . . corresponds to one by one of the positions of the electrodes **111** disposed by a fixed distance respectively, the receiving signal strength of the signal which is obtained by detecting the signal from the electrode **112** adjacent to the electrode **111** by the synchronous detector **15** at a timing

when the signal from the signal source **11** is supplied to the electrode **111** of the position T1 becomes the signal strength of the position T1. In this manner, signal strengths of all positions on which electrodes **111** and **112** are disposed are measured and signal strengths between the positions on which the electrodes **111** and **112** are disposed are produced so as to in the controller **18** by an interpolation process such that on a condition that a finger or the like does not approach the display panel **101** at all, approximately a uniform signal strength is obtained at any angular position as shown as a characteristic S0 for a signal receiving strength on a usual condition in **FIG. 5**. On the other hand, for example, on a condition when one finger approaches approximately the intermediate position fl between the position T3 and the position T4, a characteristic S1 is obtained as shown in **FIG. 5** where the signal receiving strength at the approached position lowers as compared with that of other position. Further, on a condition when the approached finger touches the face of the display panel **101** at that position, a characteristic S2 is obtained as shown in **FIG. 5** where the signal receiving strength at the approached position lowers moreover as compared with that of other position.

[0072] The lower of the signal receiving strength at the touched position occurs according to a capacitance coupling of the finger and the electrodes **111** and **112**, so that the receiving strength lowers most at the position of the finger. The controller **18** judges the lowering of the receiving strength such that the position approached or touched by the finger is calculated in the controller **18**. Further, the level difference between the receiving strength S1 obtained when the panel is approached and the receiving strength S2 obtained when the panel is touched is judged in the controller **18** such that it becomes possible to distinguish an approached condition and a contacted condition.

[0073] It should be noted that the detection is possible even in a case when plural places on the panel are simultaneously touched or approached if the approach and contact detection of the constitution is done as shown in **FIG. 4**. In a case, for example, when one finger approaches a position f **2** in the vicinity of the position T1 and the other one finger approaches a position f **3** in the vicinity of the position T6, the signal receiving strength on this condition has a characteristic S3 as shown in **FIG. 6** where the signal receiving strength has lowering peaks at two places of the position f **2** and the position f **3** as compared with approximately a flat signal receiving strength S0 in case of non-contact. Further, when the fingers contact the face of the panel at respective positions, a characteristic S4 is obtained where the signal receiving strength becomes lower. Consequently, positions approached or contacted by the two fingers are found in the controller **18** by calculating each of the peak positions. It is possible to detect according to a similar principle in a case when three places or more are approached or contacted simultaneously.

[0074] In a case when the approach or the contact of the finger is detected in this way, it is constituted according to this invention such that the vibrator **120** is vibrated temporarily. More specifically, an operation example is shown in **FIG. 7** as example and when a finger f of the right hand R is approached within several millimeters from the face of the display panel **101** on a condition that the PDA **100** is held by a left hand L of a user, the vibrator **120** in the PDA **100** vibrates temporarily and the temporary vibration is transmitted to the left hand L holding the PDA **100**, so that it comes to be comprehended that an input can be carried out in case of touching that position. Further, in a case when the face of the display panel **101** at the approached position is touched, an input operation by means of a button and the like displayed at the position is carried out in response to that touch. In case of this touch, the vibrator **120** in the PDA **100** vibrates temporarily such that the touch can be comprehended and it comes to be comprehended that an input process was performed.

[0075] Next, a process performed in this way corresponding to the detection of an approach and a contact in the controller **18** will be explained with reference to a flow chart of **FIG. 8**. First, the controller **18** judges whether or not a finger (or an input pen such as described later on) approaches the display panel constituted as a detection sensor (step ST1). In a case when an approach is not detected, it stands by until an approach is detected. In a case when an approach is detected in step ST1, it is judged whether or not the position of the approached finger (or an input pen) is within an area of an operation button displayed on the panel (step ST2).

[0076] Here, in a case when it is judged that it approaches within the area of the operation button displayed, an instruction is transmitted to the pulse generator **19** so as to vibrate the actuator (vibrator **120**) in a first vibration pattern and the vibrator **120** is vibrated temporarily such that a tactile feedback is performed onto the hand holding the equipment (step ST3). As for the first vibration pattern at this time, for example, a condition for vibrating only one time like a single-shot is made.

[0077] Also, in a case when it is judged in step ST2 that the finger on an approaching condition is not within the area of the button, the flow is shifted to step ST4 and it is judged whether or not the finger (or the input pen) came to be on a condition of contacting the button displayed on the screen. Here, in a case when it is judged that a contact is done, an instruction is transmitted to the pulse generator **19** so as to vibrate the actuator (vibrator **120**) in a second vibration pattern and the vibrator **120** is vibrated temporarily such that a tactile feedback is performed onto the hand holding the equipment (step ST5). With respect to the second vibration pattern at this time, for example, the vibration is performed two times in succession so as to be distinguishable from the tactile feedback when approaching.

[0078] After tactile feedback is performed in step ST5 (or simultaneously), the controller **18** performs an input process corresponding to the touched button (step ST6). For example, in a case when a button for instructing a shift to a certain specific operation mode is touched, an instruction for shifting the operation mode of the equipment to an operation mode allotted to that button is outputted from the output terminal **20**.

[0079] Then, after the processes of step ST3 and ST6 are performed and at the same time in a case when it is judged in step ST4 that the button on the screen is not touched the flow returns to the judgment in step ST1.

[0080] By performing a tactile feedback process for vibrating the equipment in this way based on the detection of the approach and the contact of a finger and the like, a user operating this equipment can comprehend by a tactile caused

by a vibration whether or not the position on the panel to be touched by a finger is a position being operated for a contact, so that the operationality of the touch panel is advanced. For example, in a case when it is attempted to touch by a finger a vicinity of a boundary portion between an operation button displayed on the display panel and a portion which is not a button, it is comprehended whether or not the operation button was to be pushed down when the position is touched by a vibration when a finger approaches. More specifically, in a case when a tactile by means of a vibration exists, it can be comprehended that the operation button was pushed down when the position was touched and in a case when a tactile by means of a vibration does not exist, it becomes possible to push down the operation button correctively by slightly correcting the position to be touched by the finger.

[0081] Consequently, in a case when an operation cannot be performed caused by touching a vicinity of a boundary portion between an operation button and a portion which is not a button by a finger heretofore, an operation such as reattempting to push down the same button once again was necessary, but according to a case of this example, a position to be touched can be set relying upon a tactile, so that it is possible to make an operation certainly by touching once.

[0082] It should be noted that, the PDA **100** which was explained in connection with the first exemplified embodiment explained so far shows an example of equipment to be applied with an input apparatus according to the example of the present invention and it is needless to say that a similar input apparatus can be applied to various kinds of electronic equipment other than the PDA **100**. In addition, the PDA **100** mentioned above was constituted so as to detect an approach and a contact to the face of the display panel, but it is possible to apply an input apparatus constituted so as to detect an approach and a contact to positions where a display means does not exist.

[0083] Also, in the example mentioned above, the vibrator **120** was vibrated temporarily in both cases when an approach was detected and when a contact was detected, but it is possible to employ a constitution where, for example, a vibration is made performed temporarily only in a case when an approach is detected while a vibration by the vibrator **120** is not performed in a case when a contact is detected. Alternatively, with respect to a vibration of the vibrator **120** by detecting a contact, it is possible to make it to vibrate temporarily in a case when the condition of being contacted continues to a certain degree or in a case when a predetermined amount of change is detected for the contact position. Also, it is possible to make it such that a user can select whether or not a vibration is to be made when detecting these approach and contact by setting an operation mode of the equipment. For example, it is possible to select a mode for vibrating temporarily only in a case when an approach is detected or a mode for vibrating temporarily in both cases when an approach and a contact are detected.

[0084] Further, in the circuit constitution of the input apparatus shown in **FIG. 4** mentioned above, signals transmitted through respective electrodes in a time divisional manner are detected in such a way for applying the signals to respective electrodes in a time divisional manner, but it is possible to employ a constitute where signals transmitted through respective electrodes in other constitution or process are detected.

[0085] Also, in the examples explained so far, the input apparatus was to detect an approach and a contact of a finger which is a living body in restricted and a predetermined region of a display panel and the like, but it is possible to detect a contact of a material body such as an inputting pen other than a living body and to perform an input process based on the detection of that contact.

[0086] More specifically, as shown in **FIG. 9**, for example, it is possible to provide an input pen **90** installed with a coil **91** and the like inside its front edge portion and to use electrodes and the like disposed on a substrate **110'** which is disposed on the backside of the display panel **101** of the PDA **100** so as to detect an approach and a contact of the front edge of the input pen **90**. By doing like this, it becomes possible to detect a change of a magnetic field which is generated by an electromagnetic induction of the coil **91** caused by the front edge of the input pen **90** installed with the coil **91** approaching the display panel **101** and to detect the position of the pen approached.

[0087] Also, with respect to the constitution for performing an approach or a contact explained in connection with the first exemplified embodiment mentioned above, only one example was shown and it is possible to apply other constitutions.

[0088] Next, a second exemplified embodiment according to the present invention will be explained with reference to FIGS. **10** to **29**.

[0089] According to this example, an input apparatus is constituted such that it is disposed on a face of a housing which constitutes electronic equipment and a user operates it. **FIG. 10** a diagram showing one example in a case when the input apparatus of this example is constituted as a jog dial type input apparatus and parts such as a substrate are shown by exploded.

[0090] A portion where an input apparatus is constituted on the housing **150** of the equipment has a convex portion **151** formed as an annular circular-form. The annular convex portion **151** is formed by making the thickness of the resin constituting the housing **150** slightly thin such that the position formed with the convex portion **151** can be comprehended by a tactile when, for example, a user touches it by his finger. In case of this example, this annular convex portion **151** corresponds to an input portion to be operated when a user touches by a finger and the like. It should be noted here that the annular convex portion **151** is formed such that the operation position can be comprehended by a tactile and it is possible to make the operation position comprehended by other shapes such as a circular projection. Alternatively, it is possible to make the operation position comprehended by printings and the like without providing a convex portion or a convex portion as a shape on the face of the housing **150**.

[0091] Two substrates **160** and **170** are disposed on the backside of the convex portion **151**. Each of the substrates **160** and **170** is shown by being apart from the other in **FIG. 10** for an explanatory purpose, but practically the two substrates **160** and **170** are disposed in a condition of being contacted closely on the backside of the convex portion **151**. The material constituting each of the substrates **160** and **170** is made to be a comparatively thin material having an insulation characteristic.

[0092] Here, a plurality of electrodes **161** are disposed circularly and radially with approximately fixed distance on the face of the substrate **160** in conformity with the annular shape of the convex portion **151**. One electrode **171** of a circular shape is disposed on the substrate **170** in conformity with annular shape of the convex portion **151**. The electrodes **161** are used as transmission electrodes supplied with signals from a signal source **181** through a change-over switch **182**. The electrode **171** is used as receiving electrodes for supplying signals obtained at the electrode to an amplifier **183** side.

[0093] It should be noted that an example is shown here where the electrodes **161** and **171** are disposed on the two substrates **160** and **170**, but it is possible to dispose the two of the electrode **161** and the electrode **171** on the same substrate if it is on a condition of insulating each of the electrode **161** and the electrode **171**. Alternatively, it is possible to dispose the electrode **161** on the face side of one substrate and to dispose the electrode **171** on the backside thereof. In either case, the distance between the electrode **161** and the electrode **171** is made to be a very adjacent distance such that a space between both the electrodes **161** and **171** is functioned as a capacitor and signals applied to the transmission electrode **161** are transmitted by means of the capacitance coupling between both the electrodes **161** and **171** to the receiving electrode **171** side. Here, the capacitance value between both the electrodes **161** and **171** changes when the face of the convex portion **151** is touched by a finger and the like according to a capacitance coupling which is produced between the finger and the electrodes **161** and **171** by that contact. In case of this example, the contact position is to be detected by measuring the change of this capacitance value electrically. The detail of the detection process will be described later on.

[0094] Then, according to this example, a vibrator **180** is mounted as an actuator for transmitting a vibration in the vicinity of a mounting position of the substrates **160** and **170** on the backside of a forming position of the convex portion **151** of the housing **150** and it is possible to vibrate the vicinity of the convex portion **151** by supplying a pulse signal from a pulse generator **188**. As the vibrator **180**, for example, a piezo vibrator, a coil or the like is used. It should be noted that it is not necessary to dispose the vibrator **180** necessarily on the backside of the forming position of the convex portion **151** if the vicinity of the forming position of the convex portion **151** can be vibrated temporarily by the vibration thereof.

[0095] Next, to explain about circuits connected to these electrodes **161** and **171** and to the vibrator **180**, the signal source **181** is provided as shown in **FIG. 10** and a specific signal such, for example, as an AC signal of a specific frequency is outputted from the signal source **181**. The signal outputted from the signal source **181** is supplied sequentially to the plurality of electrodes **161** through the change-over switch **182**. With respect to the electrodes **161**, a lot of them are provided for every approximately certain angle position as already explained and the change-over switch **182** performs a process for switching the respective electrodes **161** sequentially in a comparatively short period such that all of the provided electrodes **161** are supplied with the signal from the signal source **181** in a time divisional manner and in a sequential order.

[0096] Then, the electrode **171** which is an electrode for receiving signals from respective transmission electrodes **161** is connected with the amplifier **183** and the signal received by the electrode **171** is amplified by means of the amplifier **183** and thereafter supplied to a synchronous detector **184**. The synchronous detector **184** is supplied also with an output signal of the signal source **181** and detects a signal component included in the output of the amplifier **183** and being in synchronism with the output signal frequency of the signal source **181**. The detected signal component is supplied to a low pass filter **185** so as to be made to be a direct current and the direct current made signal component is supplied to an analog/digital converter **186** so as to make the signal receiving strength to be digital data.

[0097] The data obtained in the analog/digital converter **186** is supplied to a controller **187** which performs a control of the input apparatus. The controller **187** judges the operation condition based on the supplied data and outputs an instruction obtained based on the judgment of the operation condition from a terminal **187***a*. In case of this example, the controller **187** judges a change of a signal strength based on the data supplied by means of the converter **186** and judges an operation condition of the convex portion **151** according to the change of the signal strength.

[0098] Also, the controller **187** controls the output of the pulse signal from the pulse generator **188** according to the operation condition of the convex portion **151** which was judged based on the data supplied from the converter **186** side. With respect to the pulse signal outputted from the pulse generator **188**, a pulse signal having a frequency, for example, of about ^{20} Hz is outputted only for one period. Here, the controller **187** performs a control for outputting a pulse signal to make the vibrator **180** vibrate temporarily every time when it detects that the position touching the annular shaped convex portion **151** changes as much as a certain angle (for example, every 30°). It should be noted that the controller **187** can be a control means provided as an input apparatus alone, but it is possible to use the controller of the electronic equipment on which this input apparatus is installed also for that purpose.

[0099] Next, the principle of detecting a condition touched to the convex portion **151** in the input apparatus according to this example will be explained with reference to FIGS. **11** to **14**. **FIG. 11** shows a condition in which a position being formed with the convex portion **151** is touched by one finger and the touched angular position is shown as T1, T2, T3, T4, ... In this example, it is on a condition that approximately an intermediate position f4 between the position T3 and the position T4 is touched by one finger. When touched in this manner, the signal strength detected by the synchronous detector **184** through the electrode corresponding to the touched angular position becomes weak as compared with the signal strengths detected synchronously through other electrodes.

[0100] For example, assuming that the angular positions T1, T2, T3, T4, . . . correspond to angular positions of the electrodes **161** one by one which are disposed by a fixed distance, the receiving signal strength of the signal detected by the synchronous detector **184** becomes the signal strength of the angular position T1 at the timing when the signal from the signal source **181** is supplied to the electrode **161** of the position T1. In this manner, by measuring signal strengths of

all angular positions disposed with the electrodes **161** so as to produce signal strengths among the angular positions disposed with the electrodes **161** according to an interpolation process in the controller **187**, approximately a uniform signal strength is obtained at any angular position on a condition that a finger or the like does not touch the convex portion **151** at all as shown in **FIG. 12** as a characteristic S0 of a signal receiving strength on a usual condition.

[0101] On the other hand, on a condition that approximately an intermediate position f **4** between the position T3 and the position T4 is touched by one finger as shown in **FIG. 11**, a characteristic S1 as shown in **FIG. 12** is obtained where the signal receiving strength at the touched angular position is made lowered compared with those of other positions.

[0102] The lowering of the signal receiving strength at the touched position is produced by the capacitance coupling between the touched finger and the electrodes **161** and **171**, and the receiving strength is most lowered at an angular position touched by the finger. The controller **187** judges the lowering of the receiving strength such that the angular position touched by the finger is calculated in the controller **187**.

[0103] In the example of **FIGS. 11 and 12** only an example where only one place of the convex portion **151** is touched was explained, but it is possible for the contact position detection according to the principle of this example to detect the contact even if it happens that a plurality of places of the convex portion **151** are to be touched simultaneously. For example, when a position f **5** in the vicinity of the angular position T1 is touched by one finger and a position f **6** in the vicinity of the angular position T6 is touched by another finger as shown in **FIG. 13**, the signal receiving strength on this condition comes to have a characteristic S2 as shown in **FIG. 14** where lowered peaks of the signal receiving strengths are obtained at two places in the vicinity of the angular position T1 and in the vicinity of the angular position T6 as compared with approximately a flat signal receiving strength S0 of non-contacting case. Consequently, angular positions touched by the two fingers are found in the controller **187** by calculating each peak position. It is possible to detect in a case when three or more places are contacted simultaneous according to a similar principle.

[0104] Next, a process performed for detecting a contact position of the convex portion **151** in this way in the controller **187** will be explained with reference to a flow chart of **FIG. 15**. First, the controller **187** judges whether or not it is detected that a finger contacts the convex portion **151** corresponding to the jog dial (step ST**11**). In a case when a contact is not detected, it stands by until a contact is detected. Then, in a case when a contact is detected, a contact position (here, an angular position) of the finger when its contact was detected is detected (step ST**12**). Here, it is judged whether or not a change of a certain amount (here, a certain amount of angle) or more occurred as compared with a contact position detected previously (step ST**13**) and in a case when a change of a certain amount or more occurred, a generation process of a click is performed (step ST**14**).

[0105] The generation process of a click here is a process for transmitting a pulse generation instruction from a controller **47** to the pulse generator **188** and for making the vibrator **180** vibrate temporarily by supplying a single-shot like pulse signal from the pulse generator **188** to the vibrator **180** such that a temporary vibration is transmitted to the finger touching the convex portion **151**.

[0106] Then, in a case when after a click generating process is performed in step ST**14** and a change of a certain amount or more was not detected in step ST**13**, the flow shifts to step ST**15** and the controller **187** outputs an instruction for performing an input process corresponding to a rotational direction and a rotation amount of the contact position at that time from the terminal **187***a*. For example, in a case when a scroll of the display screen in the display apparatus is set to be performed in response to a contact operation to the convex portion **151** corresponding to a jog dial and when a rotation of the contact position is detected by approximately 180° in a clockwise direction, the picture screen is made scrolled in one direction to the position corresponding to that 180°. Also, when a rotation of the contact position by approximately 90° in a counterclockwise direction is detected, the picture screen is made scrolled in the other direction as much as a position corresponding to that 90°. After the input process is performed in this way, the flow returns to a contact detection of step ST**11**.

[0107] In this manner, it is possible to constitute an input apparatus corresponding to a conventional jog dial without using a movable member such as a rotational knob at all. In this case, it is constituted such that a vibration corresponding to a click feeling is to be transmitted to a finger touched by temporarily vibrating the vibrator **180** every time when an angle touched by the finger changes by a certain angle or more, so that similar operation sensitivity is obtained as when a jog dial having a click feeling is operated and satisfactory operationality can be secured. It should be noted that an input process is performed in response to the rotation detection of the contact position in a process example according to the flow chart of **FIG. 15**, but in a case when a temporary or continuous contact without being accompanied by a rotation is detected, it is also possible to perform an input process corresponding to each detection.

[0108] Also, the disposition example of the transmission electrode and the receiving electrode shown in **FIG. 10** is merely shown as one example and it is possible to detect contact positions by other electrode disposition. According to a constitution shown in **FIG. 16**, in a case when a plurality of electrodes are disposed radially on a substrate **190** disposed on a backside of the annular convex portion **151**, electrodes **191***a* of a first group and electrodes **191***b* of a second group are divided one by one and alternately. The electrode **191***a* of the first group is supplied with a signal in a time divisional manner from the signal source **181** through a change-over switch **182***a*. Also, it is constituted such that a change-over switch **182***b* which is switched in cooperation with the change-over switch **182***a* is provided and the signals obtained in the electrodes **191***b* of the second group are supplied to the amplifier **183** in a time divisional manner.

[0109] The constitution for processing the output of the amplifier **183** is made to be same as the constitution shown in **FIG. 10**. More specifically, an output of the amplifier **183** is supplied to the synchronous detector **184** so as to perform a detection in synchronism with the output of the signal source **181**, the detected signal is passed through the low

pass filter **185**, thereafter made to be data in the analog/digital converter **186**, and the converted data are judged in the controller **187**. Also, a control of a pulse supplied from the pulse generator **188** to the vibrator **180** is carried out based on the judged condition of the controller **187** and a vibration corresponding to a click feeling is generated.

[0110] In case of employing the constitution as shown in FIG. **16**, when there is no contact of a finger or the like on the annular convex portion **151** at all, capacitances formed between electrodes **191***a* of the first group and adjacent electrodes **191***b* of second group become approximately equal at any position, so that the signal receiving strengths detected by the controller **187** become approximately constant. On the other hand, in a case when a finger or the like contacts any one of the positions of the annular convex portion **151**, the capacitance formed between an electrode **191***a* of the first group and an electrode **191***b* of the second group which are positioned at the back portion of that contact position changes in response to a capacitance coupling between the contacted finger and both the electrodes **191***a* and **191***b*, so that the lowering in the signal receiving strength at that position is detected by the controller **47**. Consequently, similar characteristics as the examples shown in FIGS. **11** to **14** are obtained as characteristics caused by a contact of a finger or the like and it becomes possible that a contact position by a finger or the like is to be detected in the controller **47**. It is needless to say that simultaneous contacts at a plurality of positions as shown in FIG. **13** can be detected.

[0111] Also, it is possible to combine the input apparatus according to the example of the present invention with other operation means such as a push button type switch. An example shown in FIG. **17** is an example where the input apparatus according to the example of the present invention and a push button type switch are combined. According to this example, an opening **152** is formed at the center of the annular convex portion **151** as shown in FIG. **17** and a button **153** of a circular form or the like is to be engaged into the opening **152** so as to be constituted as a switch which performs an input by the pushing down of the button **153**. In this case, openings **162** and **172** are provided at the center of the substrates **160** and **170** respectively such that an axis **154** of the button **153** is to be retained on a condition that it is inserted through the openings **162** and **172** of the substrates **160** and **170**. In this case, button **153** is constituted such that it is retained on a condition of slightly pushed up by means of a sprug or the like. Also, a receiving electrode **171**' on the substrate **170** is constituted as an electrode portion having an area enlarged until near the center such that an electrode (not shown) of the button **153** side and the electrode **171**' contact each other when the button **153** is pushed down.

[0112] Then, the signal is to be supplied from the signal source **181**' also to the bottom face side of the button **153** and it is constituted such that when the button **153** inserted through the opening **152** of the housing **150** is operated (that is, pushed down), the signal supplied from the signal source **181**' is to be transmitted to the electrode **171**' on the substrate **170**. By doing like this, when the button **153** is operated, signals received by the electrode **171**' is processed in the receiving system circuits succeeding to the amplifier **183** and signals corresponding to the condition of the button **153** pushed down are detected in the controller **187**. The signal supplied from the signal source **181**' to the button **153** side and the signal supplied from the signal source **181** to each of the transmission electrodes **161** are made distinguished on the controller **187** side, for example, as different signals. Alternatively, with respect to signals supplied to the button **153** side, it is possible to make them to be transmitted by way of the change-over switch **182** so as to supply them thereto in a time divisional manner together with each of the transmission electrodes **161**. It should be noted that the vibrator **180** is not vibrated during the operation detection period of the button **153**.

[0113] By constituting like this, it happens that the operation means by means of the convex portion **151** and the operation means by means of the push button **153** are to be combined such that it becomes possible to perform an operation instruction more high-technically. Details of a more specific operational example in case of employing such a constitution will be described later on as an example combined with actual equipment. It should be noted also with respect to a push button type switch disposed at the center the annular convex portion **151** that it is possible to employ a switch using a contact detection sensor which can operate only by being touched with a finger or the like.

[0114] Also, the examples explained so far were related to examples constituted as a jog dial type input apparatus which is constituted by a circular convex portion or the like, but it is possible to constitute as another shaped input apparatus to which a contact detection processing constitution according to this invention is applied. For example, as shown in FIG. **18**, it is possible to constitute it as a slider type input apparatus having a contact detection portion elongated linearly.

[0115] In the example shown in FIG. **18**, it is constituted such that a linear convex portion **155** is formed on the face of the housing **150** and contacting this linear convex portion **155** by a finger or the like can be detected. The linear convex portion **155** is formed by a process for making the thickness of the resin constituting the housing **150** slightly thin or the like such that the position formed with the convex portion **155** can be comprehended by a tactile when, for example, a user touched it with his finger. It should be noted that it is possible to comprehend the linear operation position by a shape other than a convex portion or by a printing.

[0116] Two substrates **160** and **170** are disposed on the backside of the convex portion **155**. Each of the substrates **160** and **170** is shown by being apart from the other in FIG. **18** for an explanatory purpose, but practically the two substrates **160** and **170** are disposed in a condition of being contacted closely on the backside of the convex portion **155**. The material constituting each of the substrates **160** and **170** is made to be a compressively thin material having an insulation characteristic.

[0117] Here, a plurality of electrodes **163** which are aligned linearly with approximately fixed distance in conformity with the linear shape of the convex portion **155** are disposed on the face of the substrate **160**. One electrode **173** of a linear shape is disposed on the substrate **170** in conforming with the shape of the convex portion **151**. The electrodes **163** are used as transmission electrodes supplied with signals from a signal source **181** through a change-over switch **182**. The electrode **173** is used as receiving electrodes for supplying signals obtained at the electrode to an amplifier **183** side.

[0118] It should be noted also in this example of **FIG. 18** that an example is shown similarly as the example of **FIG. 10** or the like already explained where the electrodes **163** and **173** are disposed on the two substrates **160** and **170**, but it is possible to dispose the two of the electrode **163** and the electrode **173** on the same substrate if it is on a condition of insulating each of the electrode **163** and the electrode **173**. Alternatively, it is possible to dispose the electrode **161** on the face side of one substrate and to dispose the electrode **171** on the backside thereof. In either case, the distance between the electrode **163** and the electrode **173** is made to be a very adjacent distance such that a space between both the electrodes **163** and **173** is functioned as a capacitor and signals applied to the transmission electrode **163** are transmitted by means of the capacitance coupling between both the electrodes **163** and **173** to the receiving electrode **173** side. Here, the capacitance value between both the electrodes **163** and **173** changes when the face of the convex portion **155** is touched by a finger and the like according to a capacitance coupling which is produced between the finger and the electrodes **163** and **173** by that contact. In case of this example, the contact position is to be detected by measuring the change of this capacitance value electrically.

[0119] Then, according to this example, a vibrator **180** is mounted in the vicinity of a mounting position of the substrates **160** and **170** on the backside of a forming position of the convex portion **155** of the housing **150** and it is possible to vibrate the vicinity of the convex portion **155** by supplying a pulse signal from a pulse generator **188**. As the vibrator **180**, for example, a piezo vibrator, a coil or the like is used. It should be noted that it is not necessary to dispose the vibrator **180** necessarily on the backside of the forming position of the convex portion **155** if the vicinity of the forming position of the convex portion **155** can be vibrated temporarily by the vibration thereof.

[0120] With respect to the circuits connected to these electrodes **163** and **173** and the vibrator **180** have the same constitutions as those already explained in **FIG. 10** or the like. More specifically, the signal source **181** is provided and a specific signal such, for example, as an AC signal of a specific frequency is outputted from the signal source **181**. The signal outputted from the signal source **181** is supplied sequentially to the plurality of electrodes **163** through the change-over switch **182**. With respect to the electrodes **163**, a lot of them are provided for every approximately certain distance and the change-over switch **182** performs a process for switching the respective electrodes **163** sequentially in a comparatively short period such that all of the provided electrodes **163** are to be supplied with the signal from the signal source **181** in a time divisional manner and in a sequential order.

[0121] Then, the electrode **173** which is an electrode for receiving signals from respective transmission electrodes **163** is connected with the amplifier **183**, the output of this amplifier **183** is detected by the synchronous detector **184**, the detected output is supplied to a low pass filter **185** so as to be made to be a direct current, and the filtered output is supplied to an analog/digital converter **186** so as to make the signal receiving strength to be digital data.

[0122] The data obtained in the analog/digital converter **186** is supplied to a controller **187** which performs a control of the input apparatus. The controller **187** judges the operation condition based on the supplied data and outputs an instruction obtained based on the judgment of the operation condition from a terminal **187***a*. In case of this example, the controller **187** judges a change of a signal strength based on the data supplied by means of the converter **186** and judges an operation condition of the convex portion **155** according to the change of the signal strength.

[0123] Also, the controller **187** controls the output of the pulse signal from the pulse generator **188** according to the operation condition of the convex portion **155** which was judged based on the data supplied from the converter **186** side. Here, the controller **187** performs a control for outputting a pulse signal to make the vibrator **180** vibrate temporarily every time when it detects that the position touching the linear shaped convex portion **155** changes as much as a certain distance (for example, every 1 cm).

[0124] With respect to the principle for detecting the condition of touching the convex portion **155** in the input apparatus of the constitution in **FIG. 18**, it is completely similar to the principle for detecting the condition of touching the annular convex portion **151** shown in **FIG. 10** or the like such that a change of the signal receiving strength cooperated with the change of the capacitance caused by the contact of a finger or the like is detected so as to detect the contact position. It is possible to detect the contact position according to the principle shown in **FIGS. 13 and 14** in a case when a plurality of positions are touched simultaneously. Then, the controller **187** performs an input process in response to the variation of the detected position or the like. Also, the vibrator **180** vibrates temporarily every time when the change of the contact position becomes a predetermined distance such that a vibration corresponding to a click feeling is transmitted.

[0125] It should be noted that it is possible to employ other arrangement also with respect to the electrode arrangement in a case when a slider type input apparatus is applied. For example, as shown in **FIG. 19**, in a case when a plurality of electrodes are aligned linearly with a fixed distance on a substrate **190** disposed on a backside of the linear convex portion **155**, electrodes **192***a* of a first group and electrodes **192***b* of a second group are divided one by one and alternately. The electrode **192***a* of the first group is supplied with a signal in a time divisional manner from the signal source **181** through a change-over switch **182***a*. Also, it is constituted such that a change-over switch **182***b* which is switched in cooperation with the change-over switch **182***a* is provided and the signals obtained in the electrodes **192***b* of the second group are supplied to the amplifier **183** in a time divisional manner.

[0126] The constitution for processing the output of the amplifier **183** is made to be same as the constitution shown in **FIG. 18**. More specifically, an output of the amplifier **183** is supplied to the synchronous detector **184** so as to perform a detection in synchronism with the output of the signal source **181**, the detected signal is passed through the low pass filter **185**, thereafter made to be data in the analog/digital converter **186**, and the converted data are judged in the controller **187**. Also, a control of a pulse supplied from the pulse generator **188** to the vibrator **180** is carried out based on the judged condition of the controller **187** and a vibration corresponding to a click feeling is generated.

[0127] In a case when the constitution as shown in **FIG. 19** is employed, the receiving signal strength of the receiving

electrode **192***b* at the contact position also lowers and it is detected by the controller **187** that a contact exists at that position. Also with respect to a case of this example, the detection is possible with respect to simultaneous contacts at a plurality of positions.

[0128] Next, it will be explained about an example where an input apparatus explained until now is to be mounted on electronic equipment. **FIG. 20** is a diagram showing an example applied to portable type audio equipment. This example shows portable type audio equipment **500** which is provided with a jack **501** for connecting a headphone and a plug **503** of a headphone **502** is connected to the jack **501**. Then, an audio signal stored (recorded) on a medium (semiconductor memory, etc.) in the equipment **500** is reproduced such that the reproduced audio is to be listened-in through the headphone **502**. A display unit **504** for displaying a reproducing circumstance and the like is provided on a face of the equipment **500**. Then, a so-called jog dial type input apparatus of the present invention composed of an annular operation unit (convex unit) **511** and a push button unit **512** disposed at the center of the annular operation unit is disposed on a face of a housing constituting the equipment **500** and adjacent to the display unit **504**. The input apparatus is realized, for example, by a constitution shown in **FIG. 17**.

[0129] As for operation examples on the condition that the annular operation unit **511** and the push button unit **512** are disposed in this manner, there are operation examples, for example, such as shown in **FIGS. 21***a* to **21**G. More specifically, it can be carried out relating to an operation for pushing down the push button unit **512** (**FIG. 21***a*), a rotational operation touching the annular operation unit **511** by a finger like turning it (**FIG. 21***b*), an operation for moving a finger from the right edge of the annular operation unit **511** to the left edge of the annular operation unit **511** by passing through the push button unit **512** (**FIG. 21**C), an operation for pushing down the push button unit **512** and thereafter moving it to the left side (**FIG. 21D**), an operation for pushing down the push button unit **512** and thereafter moving it to the right side (**FIG. 21**E), an operation for touching the left edge of the annular operation unit **511** and thereafter pushing down the push button unit **512** (**FIG. 21**F), an operation for touching the right edge of the annular operation unit **511** and thereafter pushing down the push button unit **512** (**FIG. 21**G) and the like.

[0130] In a case when these operations are detected by the controller in the input apparatus, the operation modes corresponding to respective operations are to be set and input processes in the operation modes are to be performed such that various operations become possible for the audio equipment **500** by using the annular operation unit **511** and the push button unit **512**.

[0131] The flow chart of **FIG. 22** is a process example for discriminating respective operation conditions shown in **FIG. 21** by the controller. For example, first, the controller judges whether or not an operation of the push button exists (step ST**21**) and in a case when an operation of the push button is detected, it is judged after the operation detection of the push button whether or not a detection of a contact exists in the annular operation unit constituted as a contact sensor (step ST**22**). Here, in a case when a contact in the annular operation unit is not detected, it is judged that there exists merely an operation of the push button and the flow is shifted to step ST**23** so as to perform a process for accepting an input of the push button operation. The input accepting process of this step ST**23** corresponds, for example, to an operation of **FIG. 21A**.

[0132] In a case when a contact to the annular operation unit is detected in step ST**22**, the contact position is judged (step ST**24**). Then, the flow is shifted to step ST**25**, and the operation of the push button and a process thereafter for accepting the input corresponding to the contact at a specific position in the annular operation unit are performed. The input accepting process of this step ST**25** corresponds, for example, to an operation of **FIG. 21D** or **FIG. 21E**.

[0133] In a case when an operation of the push button is not detected in step ST**21**, the flow is shifted to step ST**26** so as to judge whether or not a detection of a contact in the annular operation unit constituted as a contact sensor exists. Here, in a case when a contact is not detected in the annular operation unit, the flow returns to a judgment of step ST**21** and stands by until any one of the operations is performed. Then, in a case when a contact in the annular operation unit is detected in step ST**26**, the contact position is judged (step ST**27**). Further, it is judged whether or not the contact position changes along the circumferential direction of the convex portion (step ST**28**), in a case when it is judge that the contact position changes along the circumferential direction, its variation and the changing direction are judged (step ST**29**), and an input accepting process corresponding to the judged direction and variation is performed (step ST**30**). The input accepting process of this step ST**30** corresponds, for example, to the operation of **FIG. 21***b*.

[0134] In a case when a change of a contact position along the circumferential direction is not detected in step ST**28**, it is judged whether or not an operation of the push button exists (step ST**31**) and in a case when an operation of the push button is not detected, the flow returns to step ST**21** and stands by until any one of the operations is performed. In a case when an operation of the push button is detected in step ST**31**, it is judged further thereafter whether or not a detection of a contact exists in the annular operation unit constituted as a contact sensor (step ST**32**). In a case when a contact in the annular operation unit is not detected according to this judgment, an input accepting process corresponding to a contact operation on a specific position at the annular operation unit and an operation of the push button thereafter is performed (step ST**33**). The input accepting process of this step ST**33** corresponds, for example, to the operation of **FIG. 21F** or **FIG. 21G**.

[0135] In a case when a contact in the annular operation unit is detected according to the judgment in step ST**32**, the contact position is judged (step ST**34**). Then, a contact operation in the annular operation unit, an operation of the push button thereafter and a process for accepting the input corresponding to the contact operation in the annular operation unit further thereafter are performed (step ST**35**). The input accepting process of this step ST**35** corresponds, for example, to an operation of **FIG. 21C**.

[0136] In this manner, it becomes possible to discriminate respective operation examples shown in **FIGS. 21A** to **21**G by the controller. Here, since the operation examples are for the audio equipment **500**, various operations necessary for the audio equipment become possible only by using the operation unit **511** and the push button unit **512** if respective

operations are allotted to operations of respective functions which are necessary for the audio equipment. For example, almost all operations necessary for the audio reproduction become possible by allotting the rotational operation shown in **FIG. 21***b* to an adjustment of the reproduced sound volume, by allotting the operation of the push button unit **512** merely shown in **FIG. 21A** to a reproducing stop operation and by allotting other operations to a reproduce start, a track shift and the like.

[0137] Then, since the annular operation unit **511** has a constitution of detecting a contact by using electrodes disposed inside even though the input apparatus can carry out such complicated operations, an input apparatus can be constituted as a very thin type and it is easy to install it in small-sized audio equipment **500**. In addition, in case of operating by using the annular operation unit **511**, a vibration is to be generated corresponding to the movement of the contact position for the sake of operationality, so that a feeling corresponding to a click feeling can be obtained similarly as in a case when a roller having a click feeling such as that in a conventional jog dial type input apparatus is to be rotated and satisfactory operationality can be obtained.

[0138] In the example of **FIG. 20**, an example is shown where an input apparatus of this invention is applied to audio equipment, but the input apparatus of this invention is also applicable to other electronic equipment. For example, it can be disposed on a portable telephone terminal **200** as shown in **FIG. 23**. More specifically, the portable telephone terminal **200** is to be constituted such that a first housing **201** and a second housing **202** are joined at a junction portion **203** so as to be foldable. In this case, keys **204** such as a dial key and a function key are disposed on the first housing **201**, a display unit **205** is disposed on the second housing **202** and an annular operation unit (convex portion) **211** and a push button unit **212** at the center of the operation unit **211** are further disposed in the first housing **201** such that a so-called jog dial type input apparatus according to this invention is disposed.

[0139] With respect to the push button unit **212** here, it is not a switch of a simple push button, but it is constituted as a push button which is combined with a plurality of push buttons (for example, four ones) and can appoint directions such as up and down, right and left or the like according to its pushing down direction. Then, the annular operation unit **211** which can carry out an input according to a contact of a finger or the like is disposed such as surrounding the push button unit **212**. This input apparatus can be applied, for example, to the constitution of the input apparatus shown in **FIG. 17**. However, the push button unit **212** has a different number of buttons, so that it is necessary to make a slight change in the constitution from that shown in **FIG. 17**.

[0140] By providing an input apparatus constituted in this manner on the portable telephone terminal **200**, various input operations necessary for the telephone terminal can be carried out by using the annular operation unit **211** and the push button unit **212**. In case of this portable telephone terminal, the annular operation unit **211** can be constituted as a thin type, so that it is easy to install it into a thin type portable telephone terminal. In addition, a satisfactory operationality can be secured with respect to the operationality. More specifically, in case of operating by using the annular operation unit **211**, a vibration is to be generated corresponding to the movement of the contact position, so that a feeling corresponding to a click feeling can be obtained similarly as in a case when a roller having a click feeling such as that in a conventional jog dial type input apparatus is to be rotated and satisfactory operationality can be obtained. It should be noted that it is possible to employ a constitution using a dedicated vibrator **180** as a vibration means for vibrating the vicinity of the input apparatus as explained in **FIG. 10** or the like in a case when an input apparatus of this invention is installed in the portable telephone terminal **200**, and it is also possible to vibrate the terminal temporarily in case of operating by means of the annular operation unit **211** by using a vibration means for vibrating when receiving signals in a case, for example, when the portable telephone terminal is a terminal provided with a function of notifying receiving signals by vibrating the terminal when receiving signals. Conversely, it is possible not only to vibrate the vibrator **180** provided with this invention when being operated by the operation unit but also to use it as a vibration means for vibrating the terminal when receiving signals.

[0141] Also, with respect to the annular operation unit **211** in this example, it is formed as an elliptical shape but not as a perfect circle shape as shown in **FIG. 23**, but the shape of the operation unit can be arbitrarily changeable in conformity with the shape of the equipment to be applied, because the member of the operation unit according to this example has no mechanism which is physically rotational such as that of a conventional jog dial.

[0142] Next, an example in which an input apparatus of this invention constituted as a slider type input apparatus is installed in electronic equipment will be explained. **FIG. 24** is an example in which a slider type input apparatus of this invention is installed in a portable type data processing terminal which is referred to as PDA (Personal Digital Assistants). The PDA **300** is constituted to have a thin type of and perpendicularly long housing in which a comparatively large-scaled display unit **301** is disposed on the front face and several operation keys **303** are disposed on the downside. A display of character data such as a received E-mail, a schedule and the like or a display of map data stored in a memory within the terminal and the like can be carried out on the display unit **301**. It should be noted that, in case of displaying maps on the PDA **300** of this example, it is designed such that the reduction of display can be changed by two or more steps.

[0143] Then, it is constituted here such that slider type operation units **311**, **312** and **313** are disposed along the borders of the three sides of the quadrangle display unit **301**. More specifically, with respect to the display unit **301**, there are disposed a slider type operation unit **311** on the left side, a slider type operation unit **312** on the right side and a slider type operation unit **313** on the downside respectively. Each of the slider type operation units **311**, **312** and **313** is constituted, for example, as an input apparatus shown in **FIG. 18** or **FIG. 19** such that they can operate when the operation unit is touched by a finger or the like. In this case, it is constituted such that simultaneous contacts on a plurality places can be also detected according to the principle shown in **FIGS. 13 and 14**.

[0144] Here, an input process using the slider type operation units **311**, **312** and **313** is to be performed according to

a process mainly related to a picture screen displayed on the display unit **301**. **FIGS. 25A** to **25C** are diagrams showing examples of operation conditions. Here, it is assumed that at least three kinds of operations can be carried out.

[0145] More specifically, in a case when a map or the like is displayed on the display unit **301**, it is constituted as shown in **FIG. 25A** such that if the slider type operation unit is touched by one finger and the touched position is moved, the display region of the display screen (map, etc.) is to be scrolled according to that movement. In this case, the scroll of the display region in a longitudinal direction is performed by the operation of the slider type operation unit **311** or **312** which is disposed longitudinally and the scroll of the display region in a lateral direction is performed by the operation of the slider type operation unit **313** which is disposed laterally.

[0146] Then, in case of a map displayed and as shown in **FIG. 25B**, in a case when two fingers touch the slider type operation unit and an operation such as widening the distance between the two fingers is performed or in a case when an operation such as narrowing the distance between the two fingers is performed, it is constituted such that the reduction of the displayed map changes. For example, in a case when an operation such as widening the distance between the two fingers is performed, a map in which the reduction of the displayed map is made small and only a partial region is magnified is displayed on the display unit **301**. Also, in a case when an operation such as narrowing the distance between the two fingers is performed, a map in which the reduction of the displayed map is made large and only a wide region is displayed by being reduced is displayed on the display unit **301**.

[0147] Also, it is constituted as shown in **FIG. 25C** such that in a case when the slider type operation unit **311** on the left side and the slider type operation unit **312** on the right side are touched simultaneously to be operated, an adjusting mode for adjusting a setting circumstance of the equipment or the like is obtained and an adjustment is carried out.

[0148] Process examples in the controller in a case when operations relating to scrolling, magnifying and reducing of the picture screen as shown in **FIGS. 25A and 25B** are performed will be explained with reference to the flow chart of **FIG. 26**. First, it is judged whether or not a contact is detected at only one place of any one of the operation units (step **ST41**). In a case when a contact at only one place is detected according to this judgment, it is judged whether or not the contact position is changing (step **ST42**). In a case when the contact position does not change, the flow returns to the judgment of step **ST41** and stands by.

[0149] In a case when the contact position changed according to the judgment of step **ST42**, scrolling of the picture screen corresponding to contact position is performed (step **ST43**). At this time, the scroll at this time is performed with respect to the direction in which the contact position changes. More specifically, in a case when a change of the contact position upward is detected for the slider type operation unit **311** or **312** of the right and left, the display screen is scrolled upward and in a case when a change of the contact position downward is detected for the slider type operation unit **311** or **312** of the right and left, the display screen is scrolled downward. Also, in a case when a change of the contact position to the left direction is detected for the slider type operation unit **313** on the downside, the display screen is scrolled to the left direction and in a case when a change of the contact position to the right direction is detected for the slider type operation unit **313** on the downside, the display screen is scrolled to the right direction.

[0150] Also, in a case when it is judged according to the judgment of step **ST41** that the contact is not for only one place, it is judged whether or not there are simultaneous contacts of two places within one operation unit (step **ST44**). When it is judged according to this judgment that it is other than simultaneous contacts of two places, the flow returns to the judgment of step **ST41** and stands by. In a case when it is judged according to the judgment of step **ST44** that there are simultaneous contacts of two places, it is judged whether or not the width between the two contacted places changes such as being widened (step **ST45**). In a case when it is judged here that it is widened, the reduction of the displayed map is changed to a small reduction in response to the widened width (step **ST46**). For example, it is designed such that the reduction of the display changes so as to display a magnified map of a small reduction by one step every time when the distance between the two fingers touching the one operation unit is widened by approximately 1 cm.

[0151] Also, in a case when it is judged according to the judgment of step **ST45** that the width between the two places is not widened, it is judged whether or not the width between the two contacted places is changing such as being narrowed (step **ST47**). In a case when it is judged here that it is narrowed, the reduction of the displayed map is changed to a large reduction in response to the narrowed width (step **ST48**). For example, it is designed such that the reduction of the display changes so as to display a reduced map of a large reduction by one step every time when the distance between the two fingers touching the one operation unit is narrowed by approximately 1 cm.

[0152] In a case when it is not detected in step **ST47** that it is narrowed, the flow returns to the judgment of step **ST41** and stands by. Also, the flow returns to step **ST41** after the input processes of steps **ST43**, **ST46** and **ST48** are performed and stands by until there is a next operation.

[0153] By being processed as shown in the flow chart of **FIG. 26**, it is possible to perform operations of scrolling the displayed map and reduction-setting of the display easily by using a slide type operation unit. It should be noted that the reduction of the display is to be changed here, because an example of displaying a map is taken, but it is possible to change the display magnification according to a similar process when characters, figures or the like other than a map are displayed. More specifically, it is possible to perform a magnifying process such as making the display magnification high in a case when there is an operation such as widening the distance between two fingers and to perform a reducing process such as making the display magnification low in a case when there is an operation such as narrowing the distance between two fingers.

[0154] Next, a process example according to the control of the controller in a case when the two slider type operation units **311** and **312** are operated simultaneously as shown in **FIG. 25C** will be explained with reference to the flow chart of **FIG. 27**. First, controller judges whether or not there is an operation for making an adjusting mode (step **ST51**). Here, an adjusting mode is supposed to be established in a

case when it is detected that the two operation units **311** and **312** are contacted simultaneously. In case of not detecting such a contact condition, it remains and stands by. It should be noted that it is possible to design with respect to an operation for making an adjusting mode such that an operation of another key or the like is to be necessary.

[0155] In a case when an adjusting mode is established by this process, a list of adjusting items is displayed to the left of the picture screen on the display unit **301** and it is to be displayed that one adjusting item is selected therein as shown in **FIG. 25**C as an example. Also, an adjusting amount for the selected item is to be displayed to the right of the picture screen. In the displayed example of **FIG. 25**C, a condition is shown where an adjustment for the brightness of the picture screen [brightness] is selected as an adjusting item and 45% brightness is set as an adjusting amount.

[0156] It is detected in step ST**51** that an adjusting mode is established and in a case when an adjusting picture screen was displayed, it is judged whether or not the contact position detected in the operation unit **311** on the left side changes (step ST**52**). Here, in a case when the contact position detected in the operation unit **311** on the left side changes, the adjusting item is changed in response to the variation of the position and the display is also changed correspondingly (step ST**53**). For example, when the contact position detected in the operation unit **311** changes a little bit to the upper side on a condition that [brightness] is selected as an adjusting item as shown in **FIG. 25**C, it will be changed to [volume] which is displayed on the upper side of [brightness]. In a case when a change of the contact position in the operation unit **311** on the left side is not detected in step ST**52** and after and a process for changing the adjusting item is performed in step ST**53**, the flow is shifted to step ST**54** whether or not the contact position detected in the operation unit **312** on the right side changes. Here, in a case when the contact position detected in the operation unit **312** on the right side changes, the adjusting amount relating to the adjusting item selected at that time is changed in response to the variation of the position and the display thereof is also changed correspondingly (step ST**55**). For example, when the contact position detected in the operation unit **312** changes to the upper side or to the downside on a condition that [brightness] is selected as an adjusting item as shown in **FIG. 25**C, the value will be changed up or down from the adjusting amount of 45% at present.

[0157] Thereafter, it is judged whether or not a process for ending the adjusting mode was performed (step ST**56**). As for the judgment here, for example, an item designated as "adjusting mode ended" is provided for one of the adjusting items which are set according to the change of the contact position in the operation unit **311** on the left side such that the adjusting mode is to be ended in case of selecting that item by the operation of the operation unit **311** on the operation unit **311**. Alternatively, the adjusting mode is to be ended in a case when a condition that there is no contact in the two operation units **311** and **312** becomes beyond a period of a certain degree. Further alternatively, the adjusting mode is to be ended by an operation of any of the keys. In a case when an ending process of the adjusting mode is not performed, the flow returns to the judgment of step ST**52**.

[0158] In this manner, it is possible to carry out an adjusting operation of data set in the equipment easily by using two slider type operation units **311** and **312** on the right hand and on the left hand and by using a finger of a hand holding the PDA **300** or the like. It was explained here in connection with an example for performing an adjustment, but it is possible to perform other input operation by a similar process.

[0159] Next, an example will be explained where an input apparatus of this invention constituted as a slider type input apparatus is installed in another electronic equipment. **FIG. 28** shows an example in which a slider type input apparatus of this invention is installed in a card type data processing terminal (hereinafter referred to as card type equipment). The card type equipment **400** of this example is constituted in a card shaped and thin type of housing, is provided with a display unit **401** and the like, and a slider type operation unit **411** is disposed on the face of the end face of the equipment (namely, a card), and further, a slider type operation unit **412** is disposed also on the backside and at the backside position of the slider type operation unit **411**.

[0160] Each of the slider type operation units **411** and **412** is constituted as an input apparatus shown, for example, in **FIG. 18** or **FIG. 19** and the operation is made possible by a finger or the like touching the operation unit. In this case, it is constitution such that simultaneous contacts of a plurality of places can also be detected according to the principle shown in **FIGS. 13 and 14**.

[0161] **FIGS. 29A and 29B** are diagrams showing an example of operation conditions of the equipment **400**. Here, it is constituted such that the operation can be carried out not only by an operation using the operation unit **411** or **412** on each side alone but also by an operation using the operation units **411** and **412** on both of the front and the back sides simultaneously. More specifically, as shown in **FIG. 29A**, the operation units **411** and **412** are touched such as the end faces on which the operation units **411** and **412** of the card type equipment **400** are disposed are put between two fingers, the touched position of the operation unit **411** of the front side is moved to the upper side by one of the fingers touching, and the touched position of the operation unit **412** of the backside is moved to the downside by the other of the fingers. By operating such as enlarging the distance between the two fingers in this manner, for example, a zooming process is performed in order to change the display reduction or the display magnification of the picture screen displayed on the display unit **401** to one direction similarly as an example shown in **FIG. 25B** with reference to the PDA **300** mentioned above. Also, in a case when the distance between the two fingers is operated so as to be narrowed conversely with respect to the operation of **FIG. 29A**, the display magnification or the display reduction (or display magnification) of the picture screen is changed to the opposite direction.

[0162] Also, as shown in **FIG. 29B**, when the operation units **411** and **412** are touched such as the end faces on which the operation units **411** and **412** of the card type equipment **400** are disposed are put between two fingers and the two fingers touching are moved downward approximately simultaneously, the display position of the picture screen displayed on the display unit **401** is scrolled downward. Also, when the two fingers are moved upward approximately simultaneously conversely with respect to the operation of **FIG. 29B**, the display position of the picture screen displayed on the display unit **401** is scrolled upward.

[0163] To explain a process example in the controller in case of performing the input process in this manner with reference to a flow chart of **FIG. 30**, first, it is judged whether or not it is detected that simultaneously contacts exist in the slider type operation units **411** and **412** on the front and back sides (step ST61). In a case when a condition in which only either one of operation units is contacted or a condition in which there is no contact at all was detected according to that judgment, the flow is shifted to other process which is not shown. Then, in a case when it was detected that simultaneously contacts exist in the operation units **411** and **412**, it is judged whether or not the contact positions are changing in the same direction in the slider type operation units **411** and **412** on the front and back sides (step ST62). Here, in a case when it is judged that they are changing in the same direction, the flow is shifted to step ST63 and performs a scroll process of the display.

[0164] Also, in a case when a change in the same direction is not detected in step ST62, it is judged whether or not they are changing in the different direction in the slider type operation units **411** and **412** on the front and back sides (step ST64). Here, in a case when it is judged that they are changing in the different directions, the flow is shifted to step ST65 and a zooming process of the display is performed.

[0165] The slider type operation units **411** and **412** are provided on both the front and back sides in this manner and a scrolling process, a zooming process and the like of the display are performed according to the operation conditions of the two slider type operation units **411** and **412**, so that a highly technical operation becomes possible by using only fingers of one hand for holding while, for example, the card type equipment **400** is held by that one hand. It should be noted that a scroll process and a zooming process of the display are to be performed here, but it is possible to perform an input process of other function necessary for the equipment **400** according to a similar operation.

[0166] It should be noted that the equipment **200**, **300**, **400** and **500** so far explained show examples of equipment to be applied with a jog dial type or a slider type operation unit and it is needless to say that the operation unit of this invention can be applied also to various electronic equipment other than these of equipment **100** to **400**.

[0167] Also, in the example of the input apparatus shown in FIGS. **10** to **19**, it is constituted such that a click feeling is obtained by providing the vibrator **180** and by applying a temporary vibration based on the detect of the contact position, but it is possible to employ a constitution where such a vibration means is omitted for no vibration relying upon equipment to be applied. Further, in case of providing the vibrator **180**, it is also possible to employ a constitution where it does not vibrate relying upon the operation mode.

[0168] Also, in the circuit constitution of the input apparatus shown FIGS. **10** to **19**, signals transmitted to respective electrodes were detected in a time divisional manner by applying signals to respective electrodes in a time divisional manner, but it is possible to constitute such that signals transmitted to respected electrodes are to be detected by means of other constitution or process.

[0169] Also, it is constituted in the examples explained so far such that the input apparatus detects a contact of a finger which is a living body within a restricted region such as an annular or a linear convex portion, but it is needless to say that it is possible to detect a contact of a material body such as a pen for input other than a living body and to perform an input process based on the detection of the contact.

INDUSTRIAL APPLICABILITY

[0170] According to the present invention described in claims **1** to **3** and claims **4** to **15**, a vibration is made in a case when an approach of a living body or a material body is detected in a predetermined detection region, so that in a case when the panel is approached by a finger of one hand, a pen or the like on a condition that the equipment is held by the other hand on a condition, for example, that the face of the panel of small-sized portable equipment is made as a detection region, the equipment vibrates temporarily caused by the detection of that approach and the vibration is transmitted to the hand holding the equipment such that a user is to comprehend according to the contact at the position on the panel that an input can be carried out. Consequently, it is to be comprehended from the temporary vibration just before the face of the panel is touched that an input can be carried out when the position will be touched, so that it becomes possible to operate the touch panel securely.

[0171] In this case, it is to be comprehended from a vibration not only with respect to an approach but also with respect to a contact by outputting a drive signal also in a case when a contact on a predetermined condition is detected in a detection sensor and by performing a process for vibrating temporarily in an actuator.

[0172] Also, by setting a vibration condition for vibrating the actuator in a case when an approach is detected by the detection sensor and a vibration condition for vibrating the actuator in a case when a contact is detected by the detection sensor to be different vibration conditions, it becomes possible from the vibration conditions to distinguish a condition of approaching and a condition of contacting.

[0173] Also, the detection sensor is a sensor for detecting a magnetic field or signal strength in a detection region and it is to be judged by distinguishing an approach of a living body or a material body and a contact of a living body or a material body based on a variation of the magnetic field or signal strength detected by the detection sensor, so that it becomes possible by using one sensor to detect certainly by distinguishing an approach and a contact.

[0174] Also, the judgment is performed relating to an approach and/or a contact position according to a position or a timing at which the magnetic field or the signal strength changed in the detection region of the detection sensor, so that it becomes possible to judge easily also with respect to the approach and/or the contact position.

[0175] Also, according to the present invention described in claims **4** to **11**, a specific input is accepted in response to a position or a change of the position at which the sensor detected a contact of a living body or a material body, so that it becomes possible to accept an input by using a planar shaped contact detection sensor. Then, by temporarily vibrating at least the vicinity of the detection region every time when a change of a predetermined amount or more of the contact position occurs in the sensor, a vibration corre-

sponding to a click feeling is transmitted to a user contacting the sensor (or a user through a material body contacting the sensor) and a similar feeling can be obtained as if a dial having a click feeling were rotated and a satisfactory operationality can be obtained.

[0176] In this case, the contact detection sensor is composed of a transmission electrode disposed in the detection region on a predetermined condition and a receiving electrode and a contact position is detected based on the signal strength of a specific signal obtained at the receiving electrode, so that it is possible to detect simply and certainly relating to the detection of the contact position.

[0177] Also, in case of detecting a contact position by disposing the transmission electrode and the receiving electrode in such a manner, simultaneous contacts at a plurality of places are detected based on the signal strength received by the receiving electrode, so that it becomes possible to detect a plurality of simultaneous contacts easily and satisfactorily.

[0178] Also, the detection region of the contact detection sensor is made to be an annular region, so that the detection region becomes an endless constitution and the restriction for the number of steps capable of input instructions or the like disappear.

[0179] Also, the detection region of the contact detection sensor is made to be an annular region and a push button type switch is disposed inside the annular region, so that a highly technical input process becomes possible by combining the operation of the contact detection sensor and the operation of the push button type switch. For example, it becomes possible to handle various functions of operations by changing the function for accepting the input in response to detection patterns of two detections of a detection of a contact in the contact detection sensor and a detection of an operation of a push button type switch.

[0180] Also, it is constituted as a slider type input apparatus by forming the detection region of the contact detection sensor to be a linear region, so that it is possible to dispose the input apparatus satisfactory in conformity with the shape of the equipment. For example, it is possible to dispose it satisfactorily in one united body with the display apparatus by disposing this linear detection region adjacent to any one of the sides of the display means which performs the display of characters or figures.

[0181] In a case when it is disposed adjacent to the display means in this manner, it becomes possible to carry out operations relating to the display satisfactorily by making inputs of the function relating to the display on the display means to be accepted according to the detection of the contact in the contact detection sensor.

[0182] Further, it becomes possible to carry out an operation for the magnification or the reduction of the display very easily by accepting an input of the function for changing the magnification or the reduction of the display on the display means to one or the other in a case when the contact positions at two places which were detected approximately simultaneously by the one or a plurality of contact detection sensors change such as being approaching mutually and in a case when they change such as being apart mutually.

1. An input method comprising:

a detection step for detecting an approach and a contact of a living body or material body in a predetermined detection region;

a vibration step for generating a vibration which is transmitted to a predetermined region other than said detection region in response to a detection of the approach in said detection step; and

an input step for performing a predetermined input process in response to a detection of the contact on a predetermined condition in said detection step.

2. An input method according to claim 1 further comprising a vibration step for generating a vibration which is transmitted to said contact position in response to a detection of the contact on a predetermined condition in said detection step.

3. An input method according to claim 1, wherein said vibration step performs a process for making a vibration temporarily also in response to a detection of the contact on a predetermined condition in said detection step such that in said vibration step, a vibration condition in a case when the approach is detected is made different from a vibration condition in a case when the contact is detected.

4. An input method comprising:

a detection step for detecting a contact position of a living body or material body in a predetermined detection region;

an input step for accepting a specific input corresponding to a contact position or a change of a contact position which is detected in said detection step; and

a vibration step for vibrating at least a vicinity of said detection region every time when a change of a predetermined amount or more occurs relating to the contact position in said detection step.

5. An input method according to claim 4, wherein the contact detection in said detection step is detected according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in said predetermined detection region and one or a plurality of receiving electrodes.

6. An input method according to claim 4, wherein the contact detection in said detection step detects simultaneous contacts on a plurality of places according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in said predetermined detection region and one or a plurality of receiving electrodes.

7. An input method according to claim 4, wherein the region for performing the contact detection in said detection step is made to be an annular region and the detection is performed according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in the annular detection region and one or a plurality or receiving electrodes.

8. An input method according to claim 4, wherein the region for performing the contact detection in said detection step is made to be an annular region and an operation inside the region where said annular contact detection is performed is detected by another detection step than said detection step.

9. An input method according to claim 4, wherein the region for performing the contact detection in said detection

step is made to be an annular region; an operation inside the region where said annular contact detection is performed is detected by another detection step than said detection step; and a function for accepting an input in said input step is changed in response to a detection pattern in the two detection steps.

10. An input method according to claim 4, wherein the contact detection in said detection step is detected according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in said predetermined linear detection region and one or a plurality of receiving electrodes.

11. An input method according to claim 4, wherein the contact detection in said detection step is detected according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in a detection region which is disposed linearly adjacent any one side of a display means performing a display of a character or a figure and one or a plurality or receiving electrodes.

12. An input method according to claim 4, wherein the contact detection in said detection step is a process for detecting according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in a detection region which is disposed linearly adjacent any one side of a display means performing a display of a character or a figure and one or a plurality of receiving electrodes; and an input of a function relating to the display in said display means is accepted by detecting the contact in the detection step.

13. An input method according to claim 4, wherein the contact detection in said detection step is a process for detecting according to strength change by a contact of a signal transmitted between one or a plurality of transmission electrodes disposed in a detection region which is disposed linearly adjacent any one side of a display means performing a display of a character or a figure and one or a plurality of receiving electrodes and is a process for accepting an input of a function relating to the display in said display means by detecting the contact in the detection step; and an input of a function for changing magnification or reduction of the display in said display means to one or the other is accepted in a case when the contact positions of two places detected approximately simultaneously in said detection step change such as mutually approaching and in a case when they change such as being mutually apart.

14. An input apparatus comprising:

a detection sensor for detecting an approach and a contact of a living body or a material body in a predetermined detection region;

control means for outputting a drive signal in a case when an approach is detected by said detection sensor and performing an input process for accepting an input of a predetermined function in a case when a contact is detected on a predetermined condition; and

an actuator responsive to an instruction from said control means for making a vibration.

15. An input apparatus according to claim 14, wherein said control means performs a process for making a vibration temporarily in said actuator also in a case when a contact on a predetermined condition is detected in said detection sensor.

* * * * *

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(54) **KEY TOUCHPAD MODULE**

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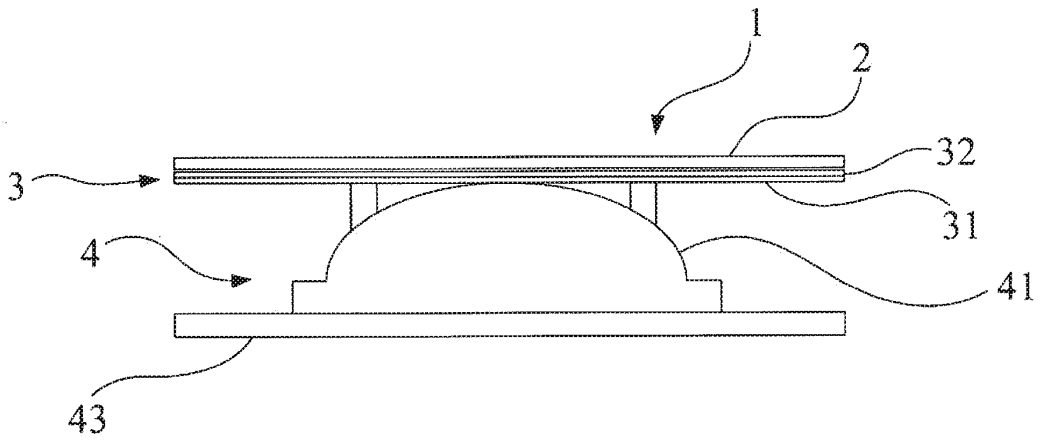
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(52) **U.S. Cl.** **345/169**

(57) **ABSTRACT**

The present invention provides a touchpad module which obtains a touching sensibility and a uniform transmission of light to avoid non-linear problem by using a soft touch pad.



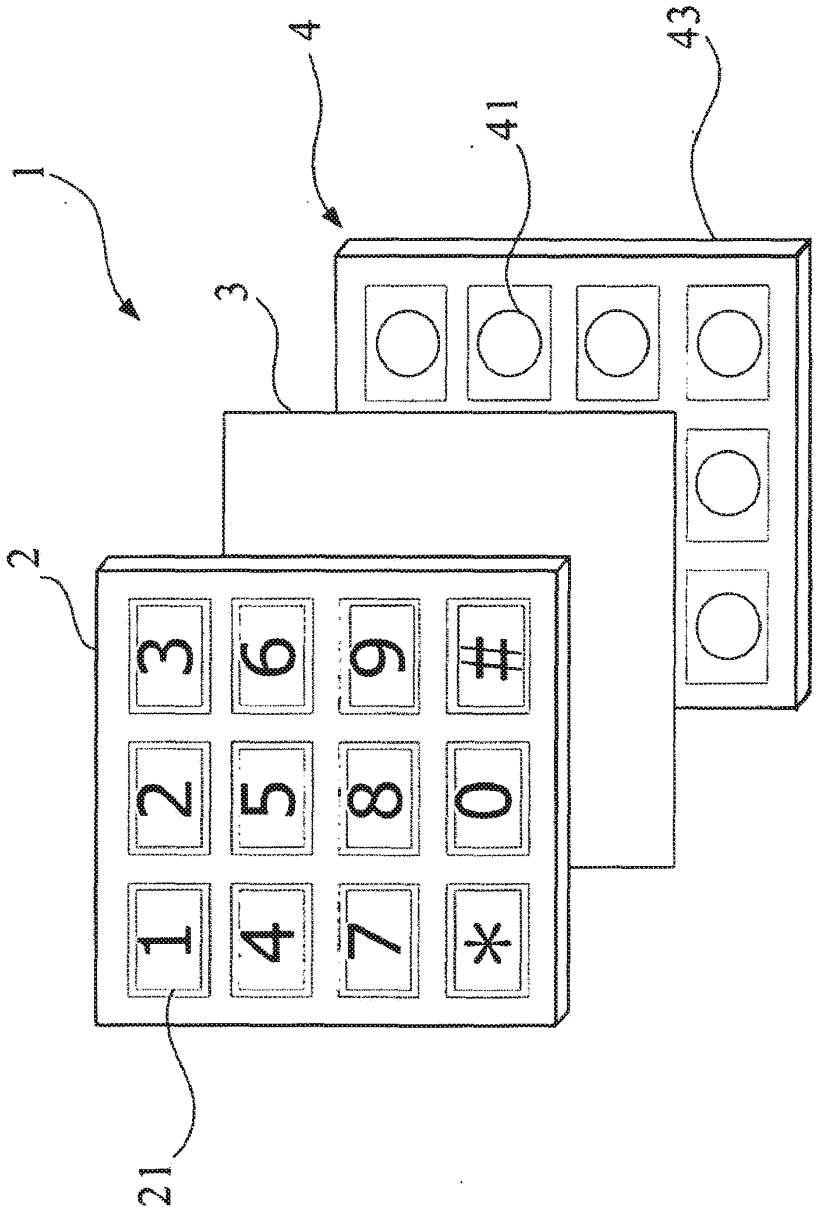


FIG. 1

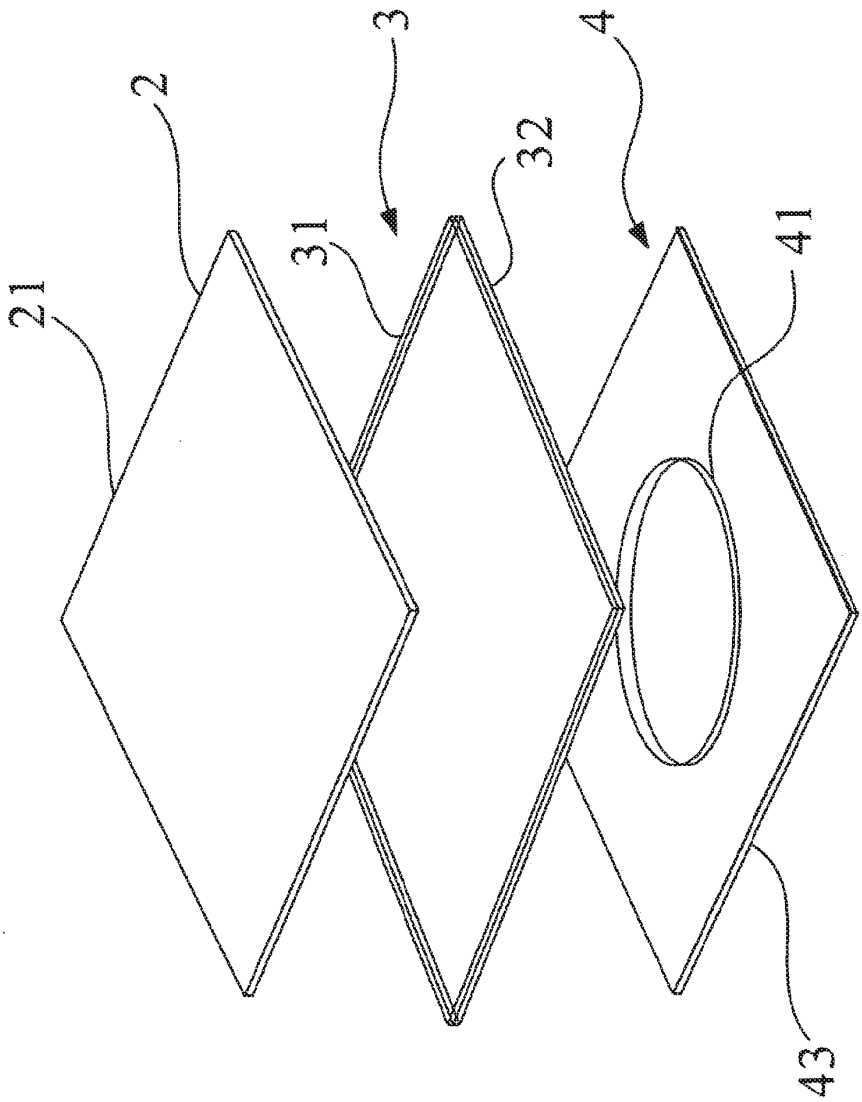


FIG. 2

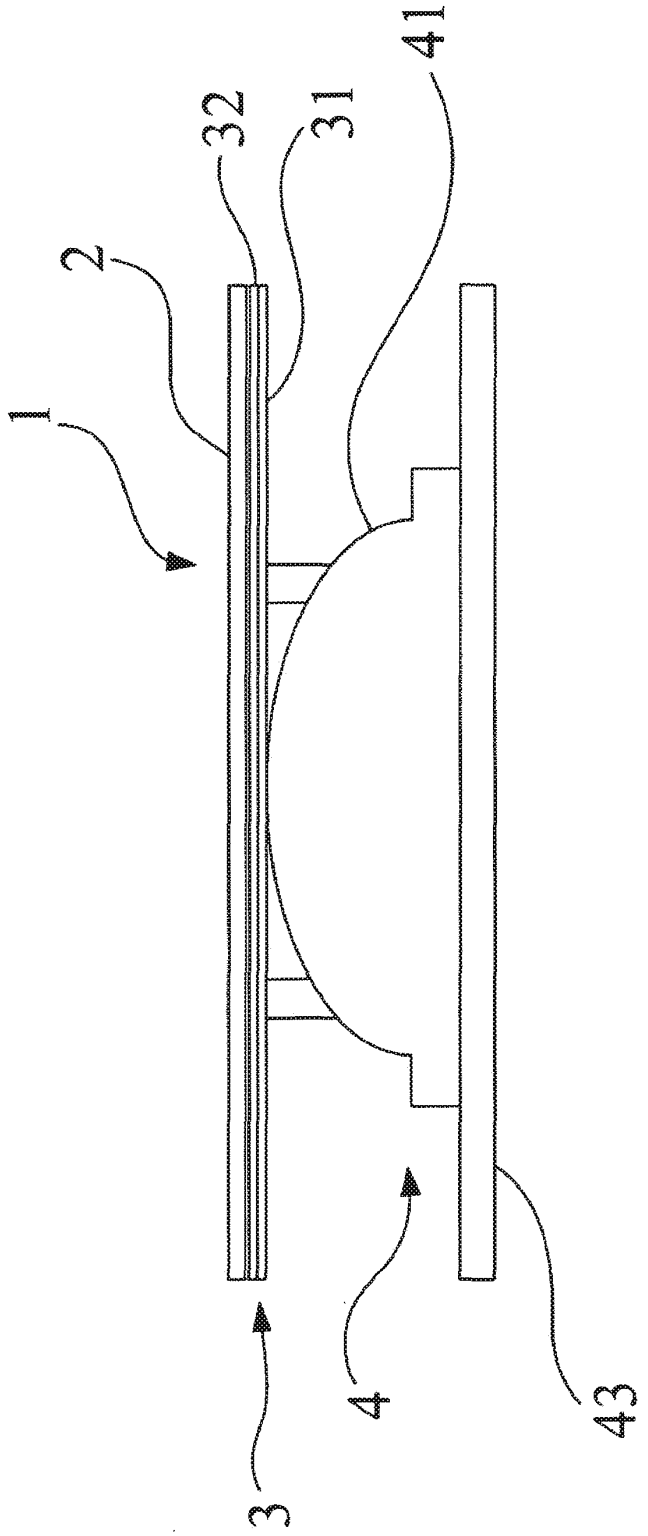


FIG. 3A

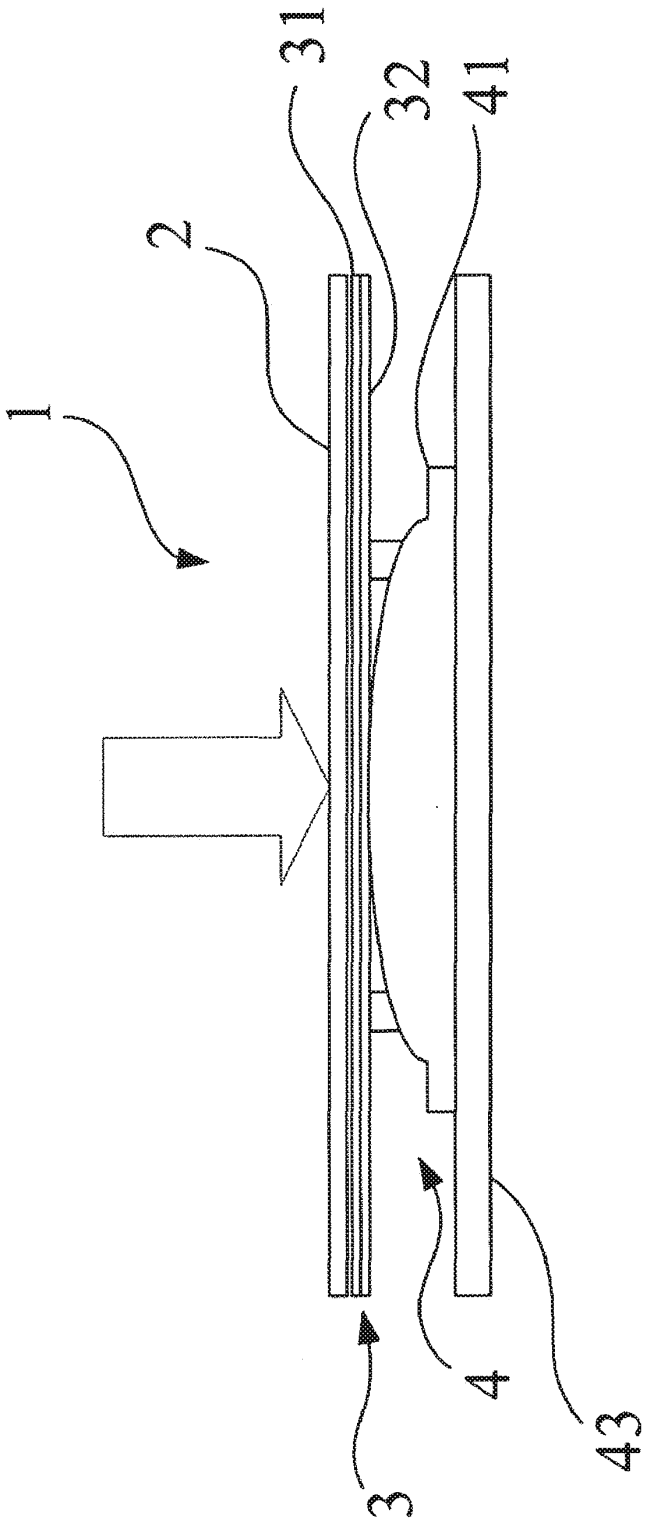


FIG. 3B

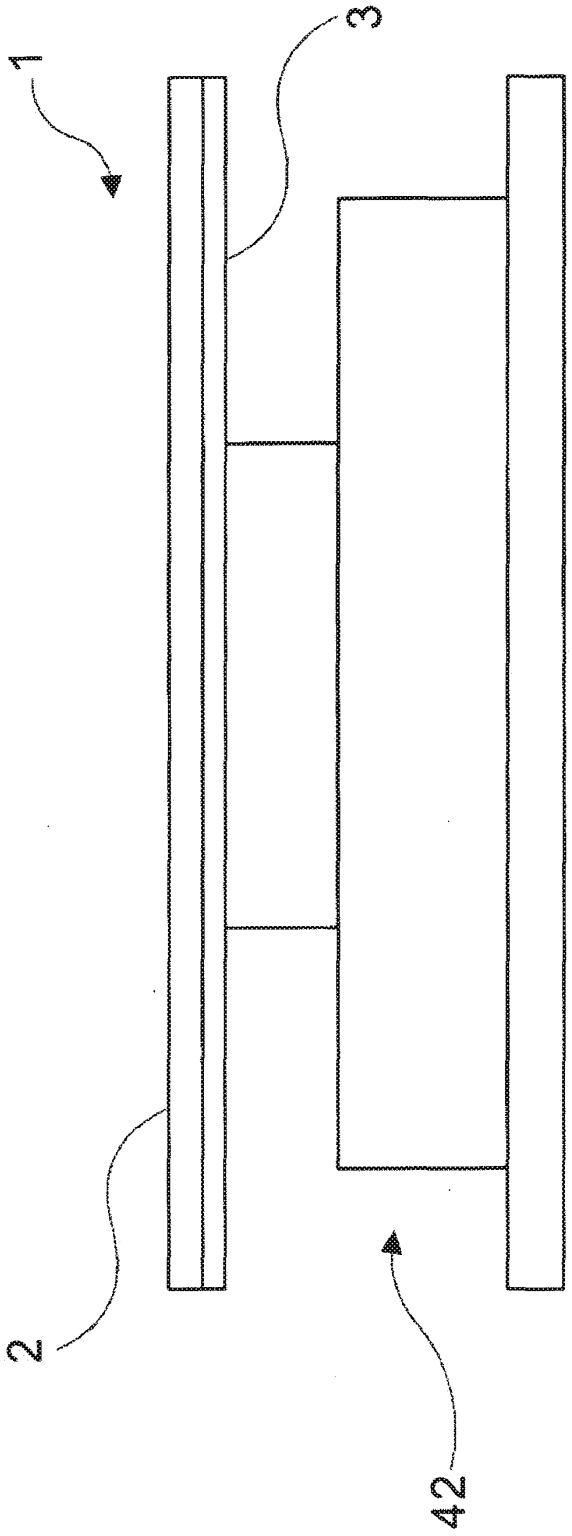


FIG. 4A

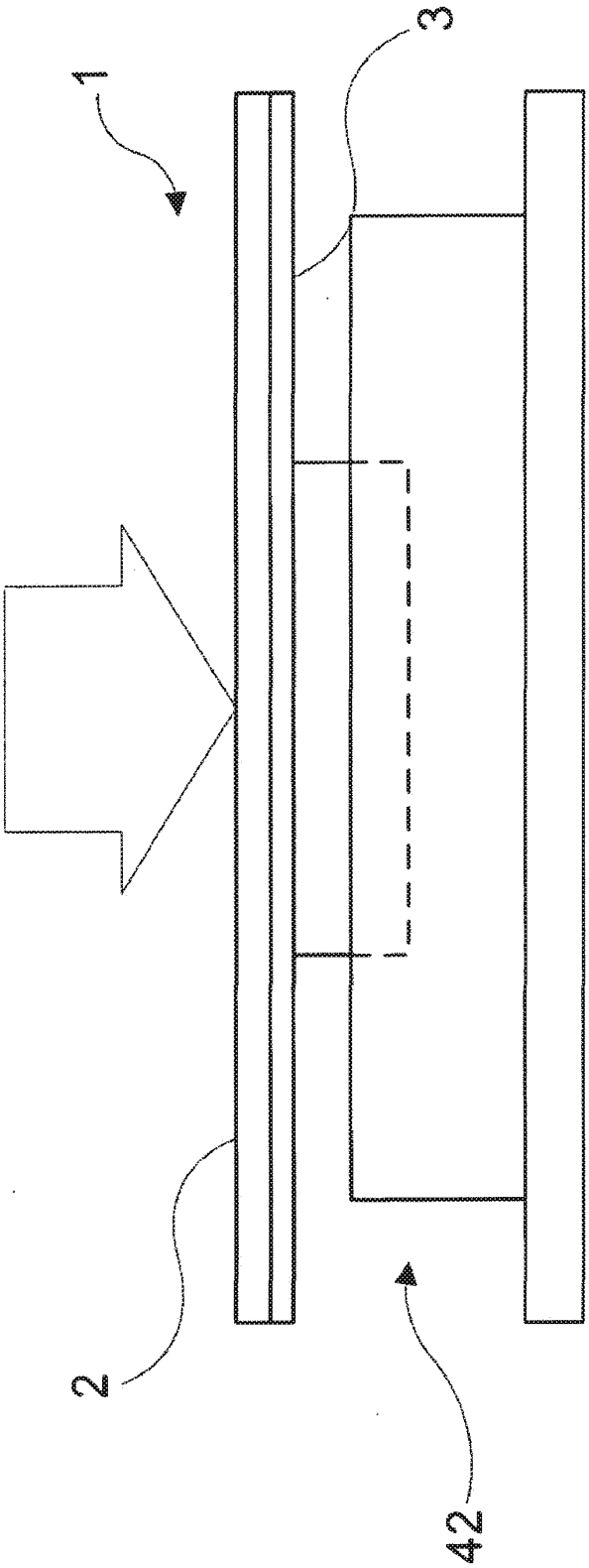


FIG. 4B

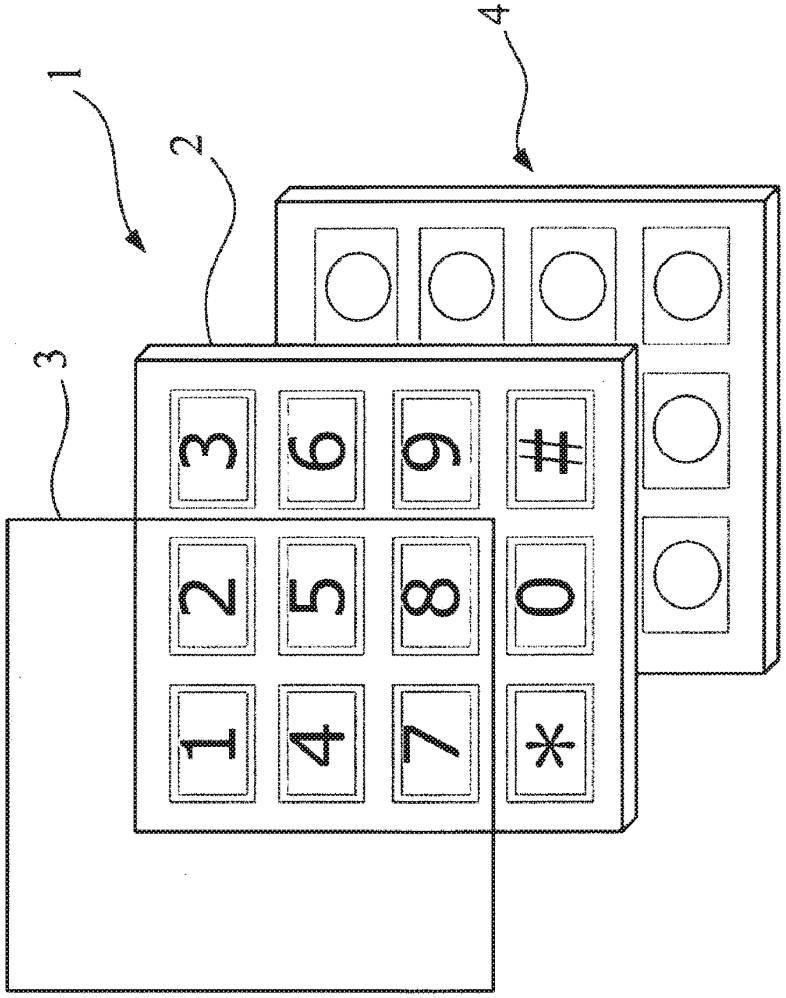


FIG. 5

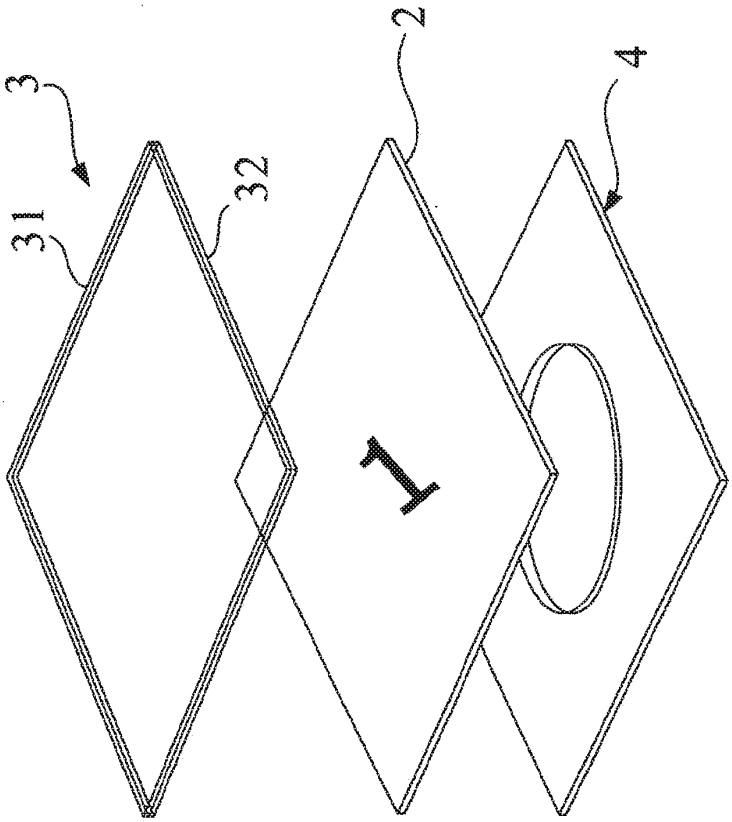


FIG. 6

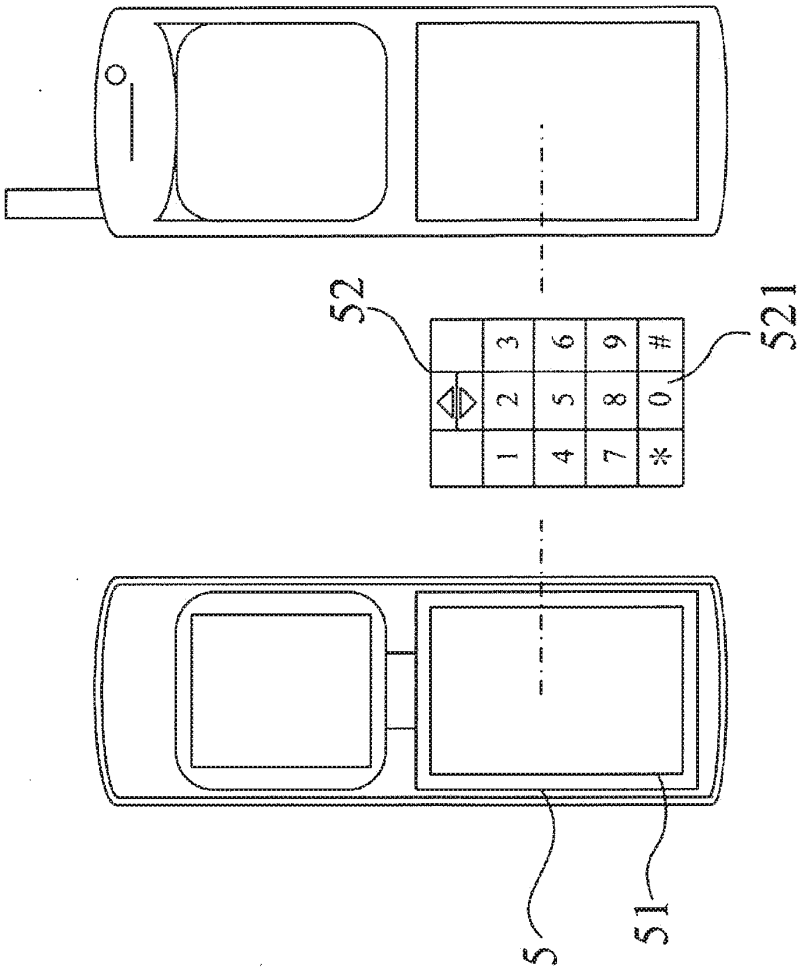


FIG. 7
(Prior Art)

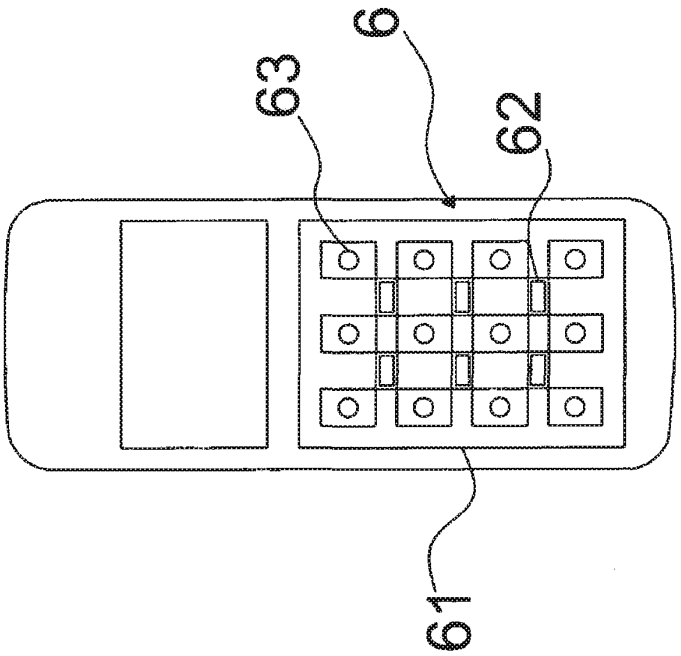


FIG. 8
(Prior Art)

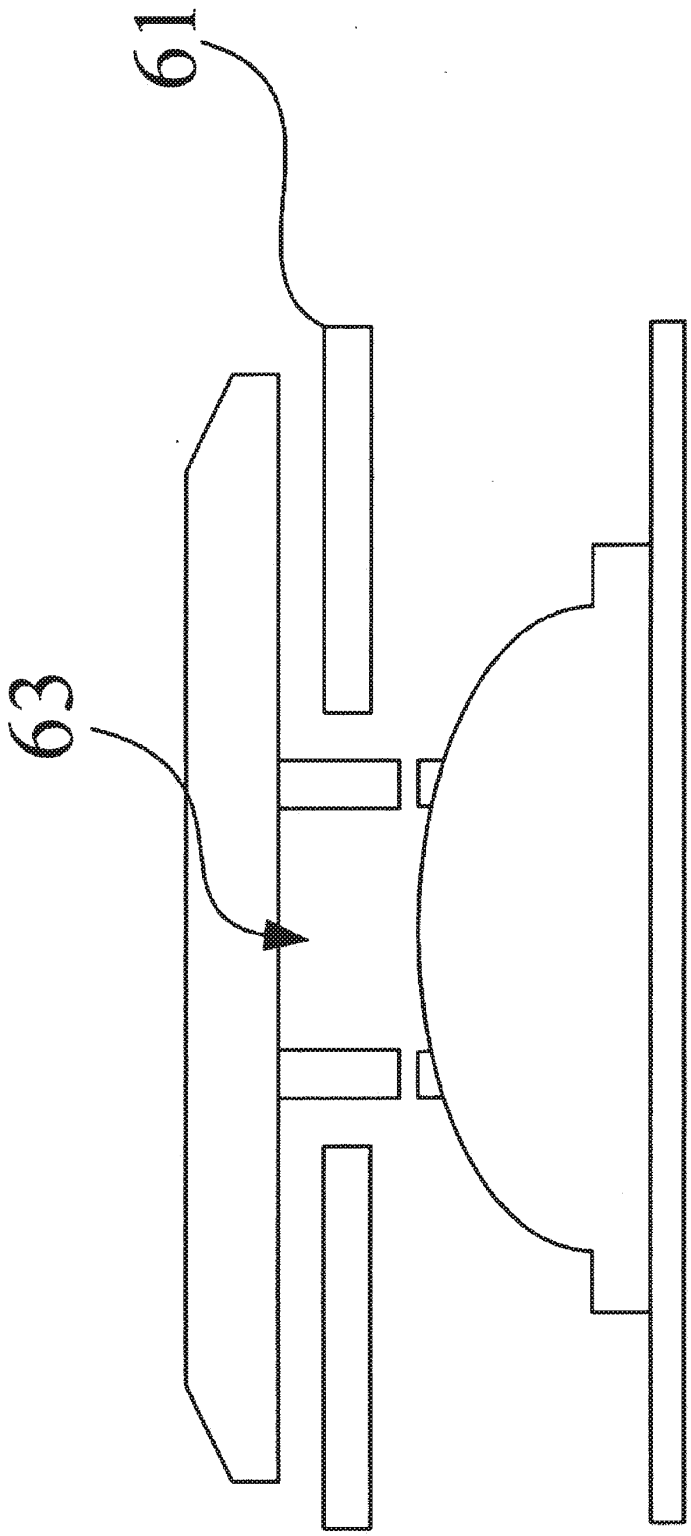


FIG. 9
(Prior Art)

KEY TOUCHPAD MODULE

FIELD OF THE INVENTION

[0001] The present invention relates to a touchpad module; more particularly, relates to obtaining a touching sensibility of a touching feeling, a low non-linearity, and a uniform transmission of light with a key set and a touchpad.

DESCRIPTION OF THE RELATED ART

[0002] Please refer to FIG.7. A prior art, "A touchpad module for handwriting and keying", is proclaimed in Taiwan, where the touchpad module **5** comprises a touchpad **51** to sense touching motion; and a key set **52** stuck to the touchpad **51** and comprised of a plurality of keys **521**. Under a keying mode, a key **521** of the key set **52** is pressed down and is sensed by the touchpad **51** to return a corresponding key value; and, under a coordinate sensing mode, the above touching motion to the touchpad **51** is sensed to return a coordinate value. Thus, the touch pad module **5** obtains a key value under a keying mode or a coordinate value under a coordinate sensing mode.

[0003] Although the prior art comprises a keying function as well as a coordinate sensing function, the user cannot clearly sense the substantiality of the key. Besides, a general touchpad is non-penetrable. An improvement made to the general touchpad is applied to a touching feeling module **6** having a touch pad **61**, as shown in FIG. **8**, where first holes **62** (shaped as a square with an edge of about 5 millimeter) are dug on the touchpad **61** for the light of the LED (light emitting diode) at the bottom to be transmitted out; and second holes **63** (shaped as a circle with a diameter of about 5 millimeter) are inserted with special keys to obtain hand feel (as shown in FIG. **9**). Yet these holes output non-linear touching sensibilities. When a human hand is touching a touchpad, the area occupied comprises a diameter of about 0.8 cm (centimeter). And, for achieving high resolution and linear feeling, a distance between two sensing lines on the touch pad is smaller than 0.4 cm. Hence, the first holes **62** and the second holes **63** directly affect the sensibility of the touchpad. The more the first holes **62**, the more serious the non-linear sensibility and the lower the resolution. In addition, the distribution of the second holes **63** may produce an uneven light-transmission of LEDs. Hence, the prior art does not fulfill users' requests on actual use.

SUMMARY OF THE INVENTION

[0004] The main purpose of the present invention is to provide a touch pad module with a uniform penetrability, a touching feeling and a linear touching sensibility.

[0005] To achieve the above purpose, the present invention is a key touch pad module, comprising an insulating material area, a soft touchpad and a key set, where the soft touch pad is a FPC (flexible printed circuit) and the soft touchpad is stuck to and between the insulating material area and the key set. Accordingly, a novel key touchpad module is obtained.

BRIEF DESCRIPTIONS OF THE DRAWINGS

[0006] The present invention will be better understood from the following detailed description of the preferred embodiment according to the present invention, taken in con junction with the accompanying drawings, in which

[0007] FIG. **1** is a structural view of a first preferred embodiment according to the present invention;

[0008] FIG. **2** is a partial structural view of the first preferred embodiment according to the present invention;

[0009] FIG. **3**A is a partial cross-sectional view of the first preferred embodiment according to the present invention;

[0010] FIG. **3**B is a partial state-of-use view of the first preferred embodiment according to the present invention;

[0011] FIG. **4**A is a partial cross-sectional view of a second preferred embodiment according to the present invention;

[0012] FIG. **4**B is a partial state-of-use view of the second preferred embodiment according to the present invention;

[0013] FIG. **5** is a structural view of a third preferred embodiment according to the present invention;

[0014] FIG. **6** is a partial structural view of the third preferred embodiment according to the present invention;

[0015] FIG. **7** is a perspective view of a prior art;

[0016] FIG. **8** is a view showing a touchpad module of a prior art; and

[0017] FIG. **9** is a partial cross-sectional view showing the touchpad module of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] The following description of the preferred embodiment is provided to understand the features and the structures of the present invention.

[0019] Please refer to FIG. **1** and FIG. **2**, which are a structural view and a partial structural view of a first preferred embodiment according to the present invention. As shown in the figures, the p resent invention is a key touch pad module **1**, comprising an insulating material area **2**, a soft touch pad **3** and a key set **4**. The soft touch pad **3** is covered by the insulating material area **2**; the key set is covered by the soft touch pad **3**; and, each conductive rubber cap **41** of the key set **4** is corresponding to a key area **21** of the insulating material area **2**, as shown in FIG. **2**. With the above structure, a novel key touch pad module is obtained. Therein, the key area **21** comprises at least a print of a digit, a signal, a character or a figure. The key set **4** comprises the conductive rubber cap **41** and a PCB switch **43**; or is substituted with a feel element. The soft touch pad **3** comprises a non-conductive area **31** and a conductive area **32**. The non-conductive area **31** comprises a transmittance between 75% and 100%; and the conductive area **32** comprises a transmittance between 0% and 80%. The soft touchpad **3** is an FPC (flexible printed circuit) or is made of a membrane, which is penetrable, light-weighted and deformable. The soft touchpad **3** is stuck to and between the insulating material area **2** and the key set **4** to be applied in the key touchpad module **1** to obtain a touching feeling, a uniform light transmission, and a linear touching sensibility.

[0020] Please refer to FIG. **3**A and FIG. **3**B, which are a partial cross-sectional view and a partial state-of-use view of the first preferred embodiment according to the present invention. As shown in the figures, when using a key touchpad module **1** according to the present invention, a

finger of a user presses on a key area (not shown in the figures) of an insulating material area **2** to deform a soft touchpad **3** for touching a conductive rubber cap **41** so that a contact on the PCB switch is touched to obtain a circuit, where the conductive rubber cap **41** is corresponding to the key area. The key set outputs a corresponding key value; or, the corresponding key value can be obtained from a coordinate value of the soft touchpad **3**. Hence, a substantiality of the conductive rubber cap **41** is felt by the user; and, a non-linear problem with the touchpad sensibility is improved while a soft touch pad **3** made of a proper material is selected to smoothly and uniformly transmit light of a LED (light emitting diode) from a non-conductive area **31** of the soft touch pad to the key area of the insulating material area **2**. Please refer to FIG. **4**A and FIG. **4**B, which are a partial cross-sectional view and a partial state-of-use view of a second preferred embodiment according to the present invention. As shown in the figures, a key set can be a feel element **42** for a user to obtain a touching feeling on using the present invention.

[0021] Please refer to FIG. **5** and FIG. **6**, which are a structural view and a partial structural view of a third preferred embodiment according to the present invention. As shown in the figures, a key touchpad module **1** comprises a layer of a soft touchpad **3** on top and a layer of a key set **4** at bottom while deposing a layer of an insulating material area **2** between the soft touch pad **3** and the key set **4**. Therein, the soft touchpad **3** comprises a non-conductive area **31** and a conductive area **32**. Each of the non-conductive area **31** and the conductive area **32** comprises a transmittance between 75% and 100%. The soft touch pad **3** further comprises a key-simulation function.

[0022] To sum up, the present invention is a key touch pad module, where a uniform penetrability for keys, a touching feeling and a better linear touching sensibility are obtained.

[0023] The preferred embodiment herein disclosed is not intended to unnecessarily limit the scope of the invention. Therefore, simple modifications or variations belonging to the equivalent of the scope of the claims and the instructions disclosed herein for a patent are all within the scope of the present invention.

What is claimed is:

1. A key touch pad module, comprising:

(a) an insulating material area comprising at least one key area on a surface of said insulating material area;

(b) a soft touchpad being covered by said insulating material area; and

(c) a key set comprising at least one conductive rubber cap and a PCB switch, said key set being covered by said soft touchpad, said conductive rubber cap corresponding to said key area of said insulating material area.

2. The key touchpad module according to claim 1, wherein said key area comprises at least a print selected from a group consisting of a digit, a signal, a character and a figure.

3. The key touch pad module according to claim 1, wherein said soft touchpad is made of a material selected from a group consisting of an FPC (flexible printed circuit) and a membrane.

4. The key touchpad module according to claim 1, wherein said soft touchpad comprises a conductive area and a non-conductive area.

5. The key touch pad module according to claim 4, wherein said conductive area comprises a transmittance between 0% and 80%

6. The key touchpad module according to claim 4, wherein said non-conductive area comprises a transmittance between 75% and 100%.

7. The key touchpad module according to claim 1, wherein said soft touchpad further comprises a key-simulation function.

8. The key touchpad module according to claim 1, wherein said key set outputs a corresponding key value.

9. The key touchpad module according to claim 8, wherein said key value is obtained from a coordinate value of said soft touch pad.

10. The key touch pad module according to claim 1, wherein said key set is a feel element.

11. A key touch pad module, comprising:

(a) a soft touchpad;

b) an insulating material area being covered by said soft touch pad, said insulating material area comprising at least one key area on a surface of said insulating material area; and

(c) a key set comprising at least one conductive rubber cap and a PCB switch, said key set being covered by said insulating material area, said conductive rubber cap corresponding to said key area of said insulating material area.

12. The key touchpad module according to claim 10 wherein said soft touchpad is made of a material selected from a group consisting of an FPC (flexible printed circuit) and a membrane.

13. The key touch pad module according to claim 10, wherein said soft touch pad comprises a conductive area and a non-conductive area.

14. The key touch pad module according to claim 13, wherein said conductive are a comprises a transmittance between 75% and 100%.

15. The key touchpad module according to claim 13, wherein said non-conductive area comprises a transmittance between 75% and 100%.

16. The key touchpad module according to claim 10 wherein said soft touchpad further comprises a key-simulation function.

17. The key touchpad module according to claim 10, wherein said key area comprises at least a print selected from a group consisting of a digit, a signal, a character and a figure.

18. The key touch pad module according to claim 10, wherein said kept set outputs a corresponding key value.

19. The key touch pad module according to claim 18, wherein said key value is obtained from a coordinate value of said soft touch pad.

20. The key touch pad module according to claim 10, wherein said key set is a feel element.

* * * * *

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(54) **METHOD FOR PROVIDING TACTILE FEEDBACK FOR TOUCH-BASED INPUT DEVICE**

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G06F 3/041 (2006.01)

(52) **U.S. Cl.** **345/177**

(57) **ABSTRACT**

A system detects when a user's finger is near a key on a touch screen. When the user's finger is near the key, the touch screen may begin to vibrate. The vibrations may increase in frequency and/or intensity as the user's finger approaches the key. The vibrations may decrease in frequency and/or intensity as the user's finger moves away from the key.

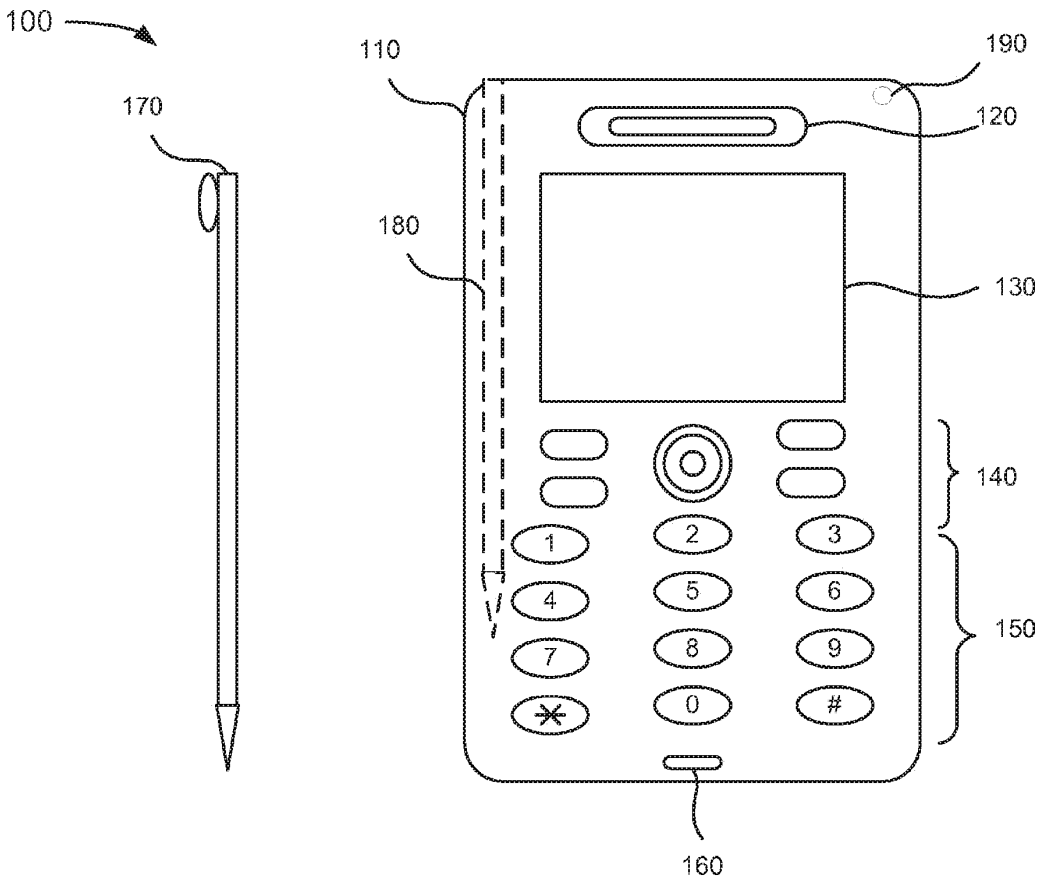
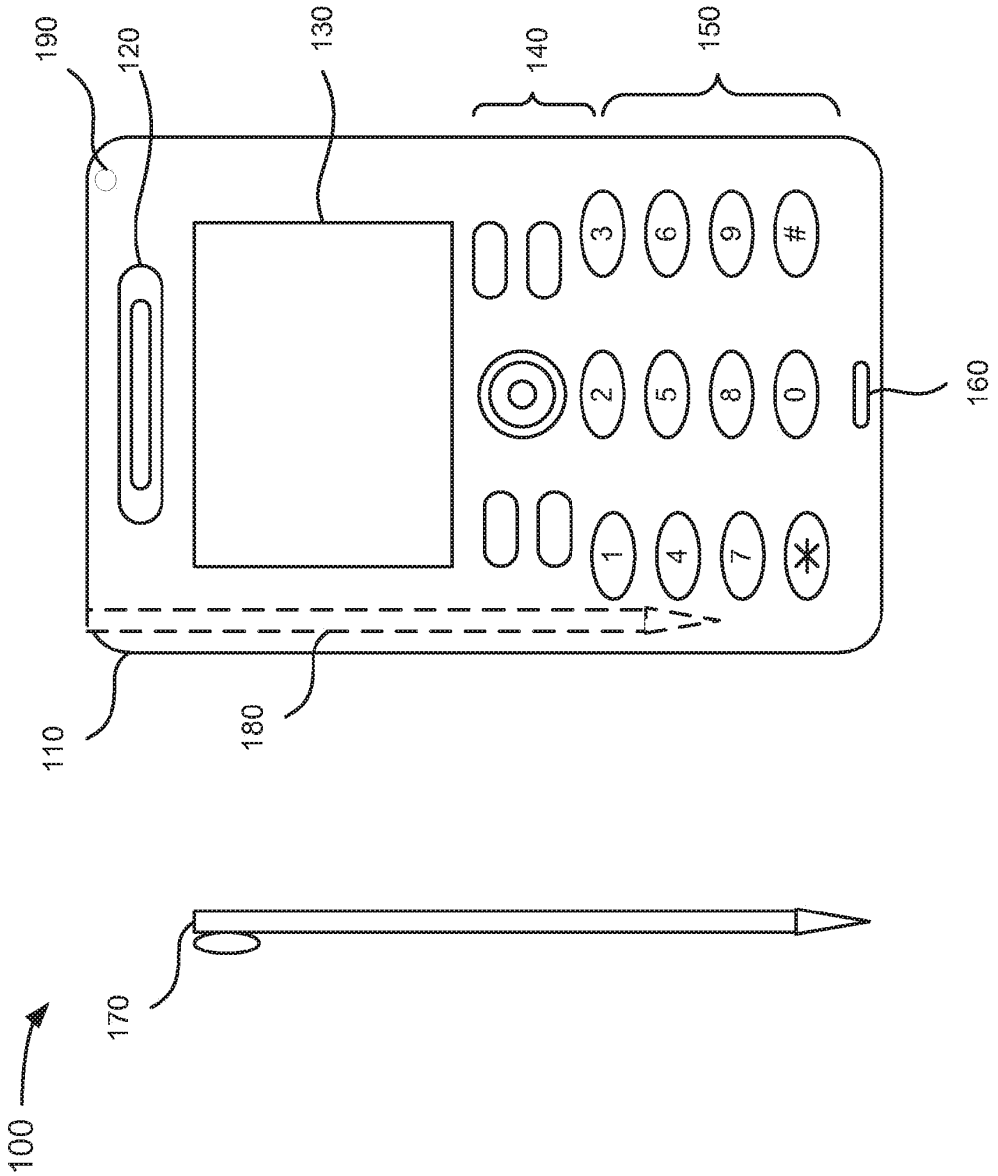


FIG. 1



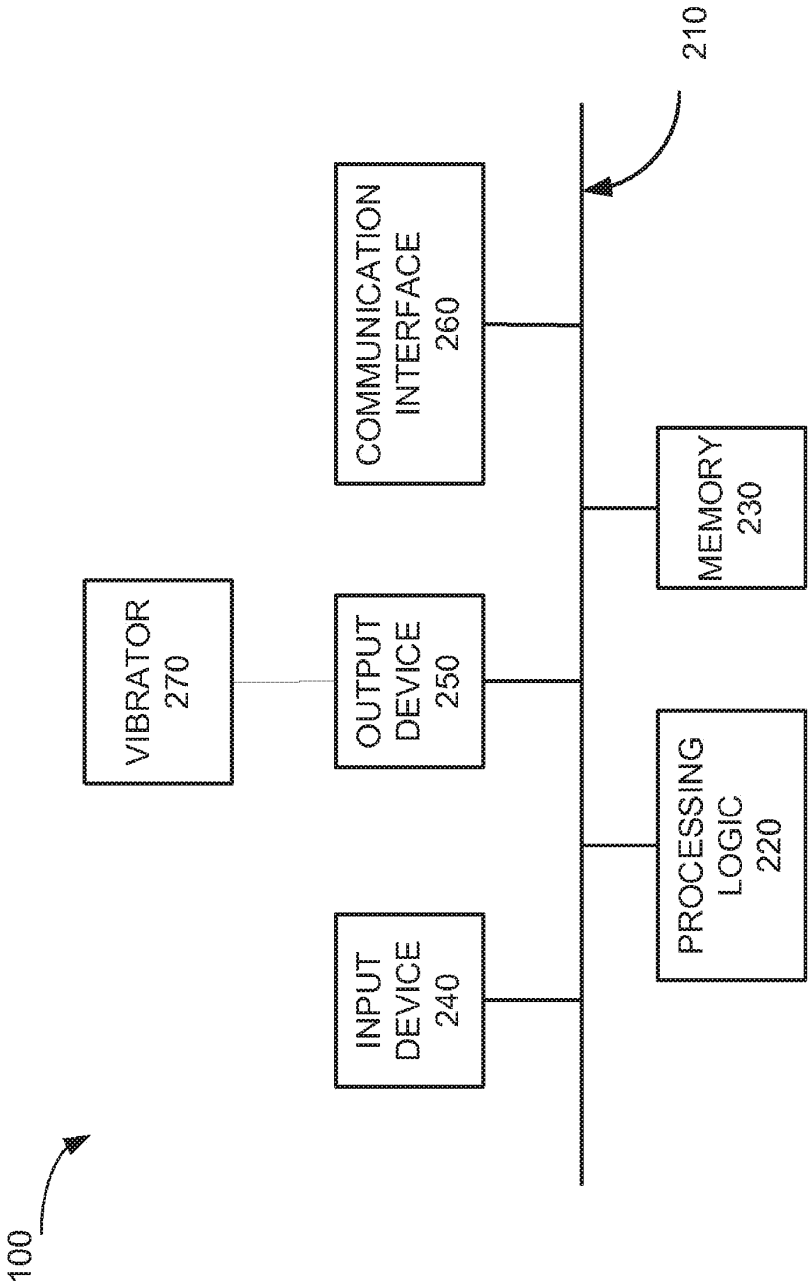

100
210
VIBRATOR 270
OUTPUT DEVICE 250
INPUT DEVICE 240
COMMUNICATION INTERFACE 260
MEMORY 230
PROCESSING LOGIC 220

FIG. 2

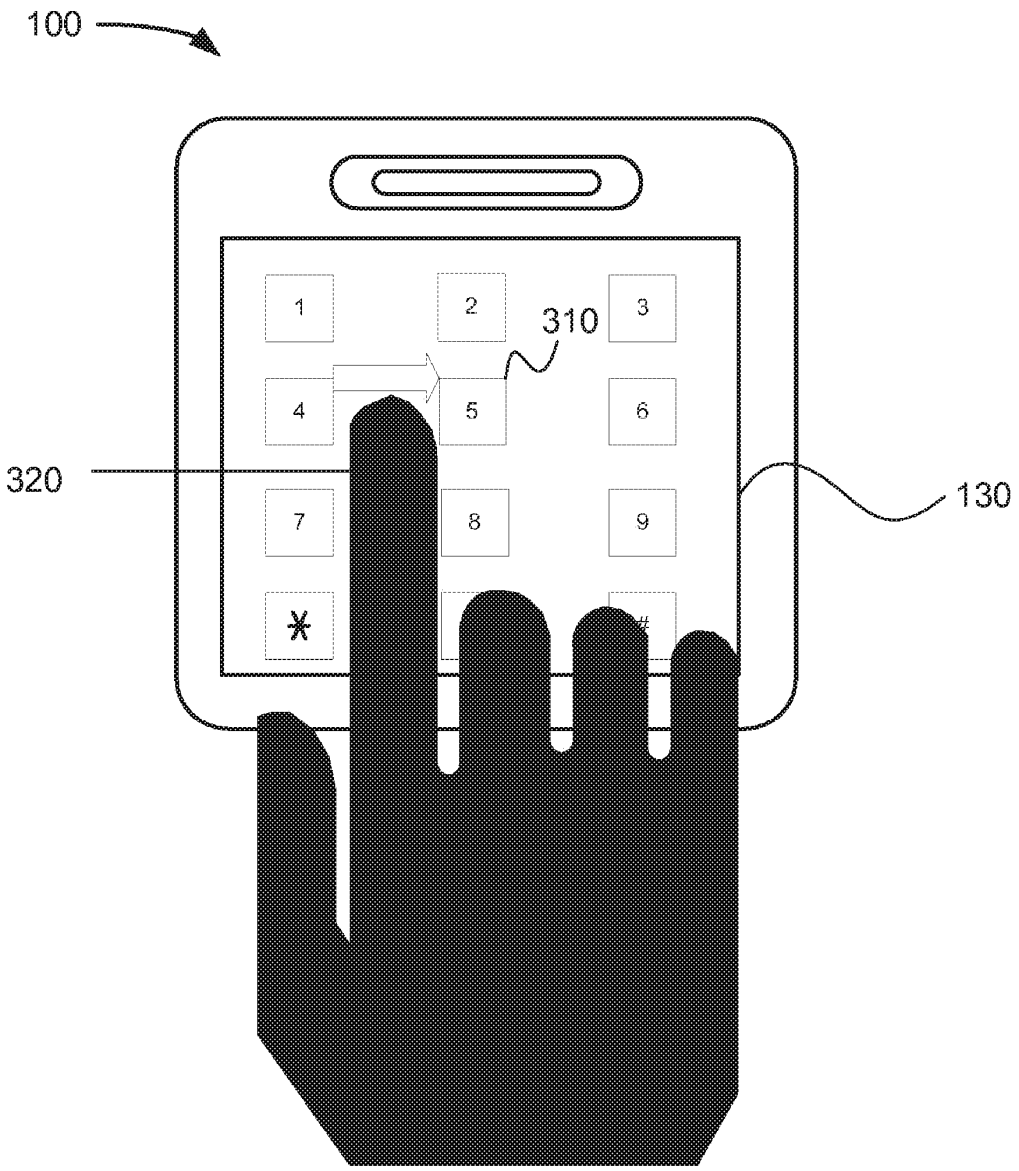


FIG. 3

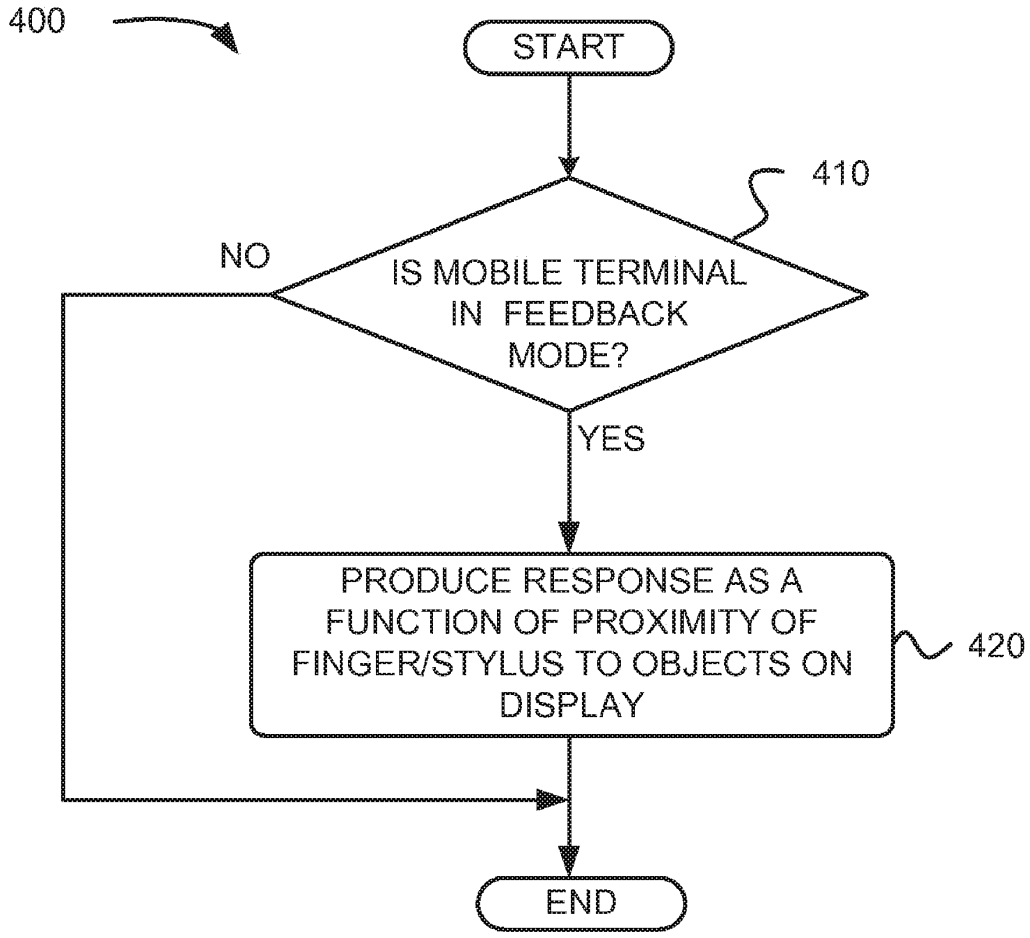

400
START
410
NO
IS MOBILE TERMINAL IN FEEDBACK MODE?
YES
PRODUCE RESPONSE AS A FUNCTION OF PROXIMITY OF FINGER/STYLUS TO OBJECTS ON DISPLAY
420
END

FIG. 4

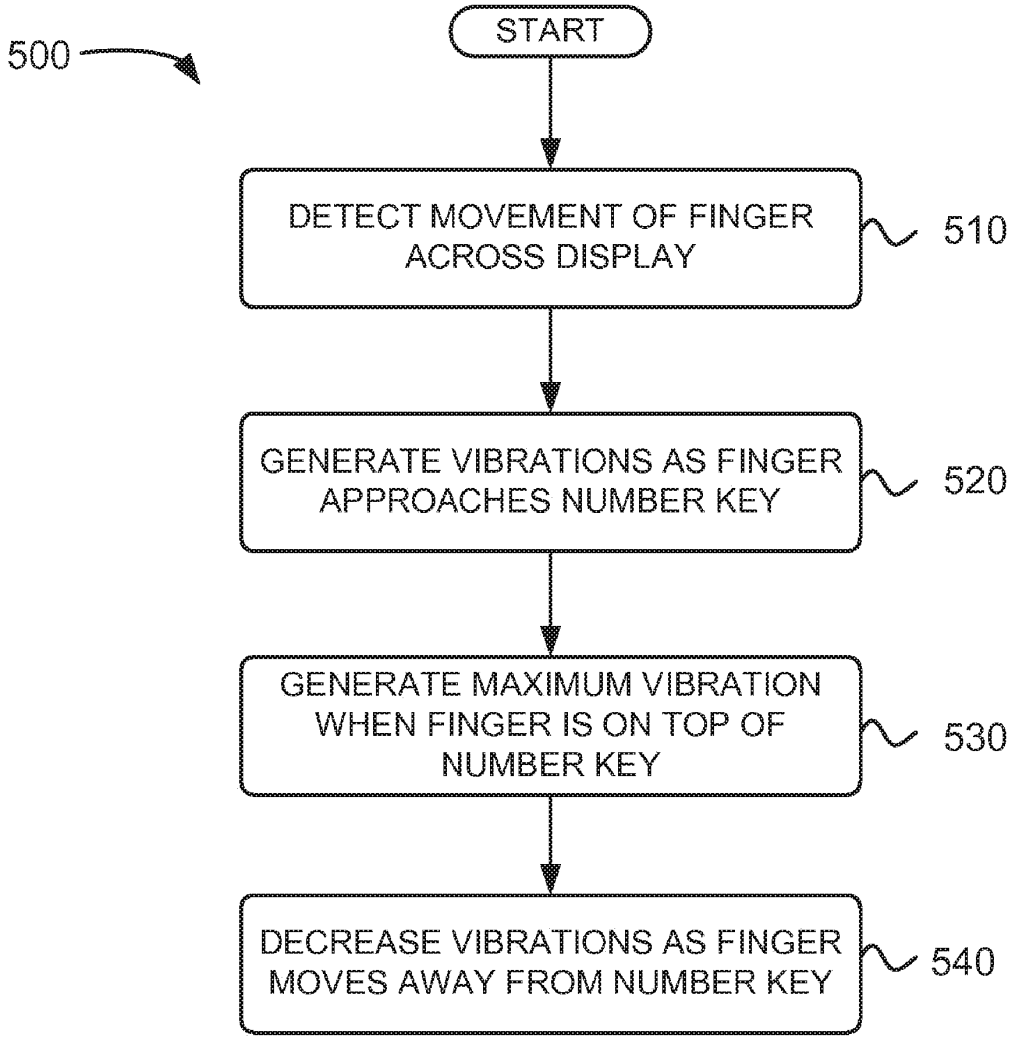

500
START
DETECT MOVEMENT OF FINGER ACROSS DISPLAY
510
GENERATE VIBRATIONS AS FINGER APPROACHES NUMBER KEY
520
GENERATE MAXIMUM VIBRATION WHEN FINGER IS ON TOP OF NUMBER KEY
530
DECREASE VIBRATIONS AS FINGER MOVES AWAY FROM NUMBER KEY
540

FIG. 5

METHOD FOR PROVIDING TACTILE FEEDBACK FOR TOUCH-BASED INPUT DEVICE

RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. § 119 based on U.S. Provisional Application Ser. No. 60/908,907, filed Mar. 29, 2007, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] When using a phone with a keypad, a user may dial a number without looking at the phone. In this situation, the user may feel the keys to determine which key to press. For example, if a user wants to press the 5 key, the user knows it is in the center of the keypad and can feel the surrounding keys to determine which key is the 5 key. The user may then determine the identity of the other keys based on knowing which key is the 5 key. In this manner, the user may, for example, dial a phone number without looking at the keypad.

[0003] If a user is using a device with a touch sensitive display, the user will not be able to physically feel the keys. Therefore, it may be more difficult to identify the keys on the display without looking at the display.

SUMMARY

[0004] According to one aspect, a method may include detecting movement of a finger on a touch screen display of a device, and vibrating the device to indicate proximity of the finger to a plurality of objects displayed on the touch screen display.

[0005] Additionally, the method may include generating increasing vibrations when the finger approaches one of a plurality of objects on the touch screen, and generating decreasing vibrations when the finger moves away from the one of the plurality of objects on the touch screen.

[0006] Additionally, generating increasing vibrations may include generating vibrations with increasing intensity and generating decreasing vibrations may include generating vibrations with decreasing intensity.

[0007] Additionally, generating increasing vibrations may include generating vibrations with increasing frequency and generating decreasing vibrations may include generating vibrations with decreasing frequency.

[0008] Additionally, the method may include generating maximum vibration when the finger is on top of the one of the plurality of objects or in a zone around the top of one of the plurality of objects.

[0009] Additionally, the method may include generating minimum vibration when the finger is equidistant or near equidistant from two adjacent objects.

[0010] Additionally, generating minimum vibration may include generating no vibration.

[0011] Additionally, the method may include generating an audible signal that increases in volume or frequency when the finger approaches one of the plurality of objects on the touch screen, and generating an audible signal that decreases in volume or frequency when the finger moves away from the one of the plurality of objects on the touch screen.

[0012] Additionally, the audible signal may be at maximum volume or frequency when the finger is on top of one of the plurality of objects on the touch screen.

[0013] Additionally, the audible signal may be at a minimum volume or frequency when the finger is equidistant from two adjacent objects.

[0014] Additionally, the method may include generating an visual signal that increases in brightness or frequency when the finger approaches one of the plurality of objects on the touch screen, and generating an visual signal that decreases in brightness or frequency when the finger moves away from the one of the plurality of objects on the touch screen.

[0015] Additionally, the visual signal may be at maximum brightness or frequency when the finger is on top of one of the plurality of objects on the touch screen.

[0016] Additionally, the visual signal may be at a minimum brightness or frequency when the finger is equidistant from two adjacent objects.

[0017] In another embodiment, a device may include a touch screen display, a vibrator, and processing logic configured to determine a location of a finger of a user on the touch screen display, and cause the vibrator to generate vibrations to indicate proximity of the finger to one of a plurality of objects displayed on the touch screen display.

[0018] Additionally, the processing logic may further be configured to cause the vibrator to increase vibrations as the finger approaches one of the plurality of objects, and cause the vibrator to decrease vibrations as the finger moves away from one of the plurality of objects on the touch screen.

[0019] Additionally, the processing logic may further be configured to cause the vibrator to vibrate at a maximum level when the finger is on top of one of the plurality of objects or in a zone around the top of one of the plurality of objects.

[0020] Additionally, the processing logic may further be configured to cause the vibrator to vibrate at a minimum level when the finger is equidistant or near equidistant from two adjacent objects.

[0021] Additionally, the processing logic may further be configured to cause the vibrator to increase the intensity of the vibrations as the finger approaches one of the plurality of objects, and cause the vibrator to decrease the intensity of the vibrations as the finger moves away from one of the plurality of objects.

[0022] Additionally, the processing logic may further be configured to cause the vibrator to increase the frequency of the vibrations as the finger approaches one of the plurality of objects, and cause the vibrator to decrease the frequency of the vibrations as the finger moves away from one of the plurality of objects.

[0023] Additionally, the device may include a speaker, wherein the speaker may emit a signal when the finger is near one of the plurality of objects.

[0024] Additionally, the signal may increase in volume or frequency as the finger approaches one of the plurality of objects and may decrease in volume or frequency as the finger moves away from one of the plurality of objects.

[0025] Additionally, the signal may be at maximum volume or frequency when the finger is on top of one of the plurality of objects or near the top of one of the plurality of objects.

[0026] Additionally, the signal may be at a minimum volume or frequency when the finger is equidistant or near equidistant from two adjacent objects.

[0027] Additionally, a method may include displaying a plurality of graphical objects on a touch screen display of a mobile communication terminal, detecting a position of a finger on the touch screen display, and generating a feedback

response for a user of the mobile communication terminal based on the detected position of the finger.

[0028] Additionally, the graphical objects may include number keys.

[0029] Additionally, the feedback response may include vibration of the mobile communication terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Reference is made to the attached drawings, wherein elements having the same reference number designation may represent like elements throughout.

[0031] FIG. **1** is a diagram of an exemplary mobile terminal in which methods and systems described herein may be implemented;

[0032] FIG. **2** is a diagram illustrating components of the mobile terminal of FIG. **1** according to an exemplary implementation;

[0033] FIG. **3** is a diagram depicting an example of the vibrating feedback;

[0034] FIG. **4** is a flow diagram illustrating exemplary processing by the mobile terminal of FIG. **1**; and

[0035] FIG. **5** is a flow diagram illustrating an example of the exemplary processing of FIG. **4**.

DETAILED DESCRIPTION

[0036] The following detailed description of the invention refers to the accompanying drawings. The same reference numbers in different drawings identify the same or similar elements. Also, the following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims and equivalents.

[0037] FIG. **1** is a diagram of an exemplary mobile terminal **100** in which methods and systems described herein may be implemented. The invention is described herein in the context of a mobile terminal. As used herein, the term "mobile terminal" may include a cellular radiotelephone with or without a multi-line display; a Personal Communications System (PCS) terminal that may combine a cellular radiotelephone with data processing, facsimile and data communications capabilities; a personal digital assistant (PDA) that can include a radiotelephone, pager, Internet/Intranet access, Web browser, organizer, calendar and/or a global positioning system (GPS) receiver; and a conventional laptop and/or palmtop receiver or other appliance that includes a radiotelephone transceiver. Mobile terminals may also be referred to as "pervasive computing" devices. Mobile terminal **100** may also include media playing capability. It should also be understood that systems and methods described herein may also be implemented in other devices that include displays and media playing capability without including various other communication functionality.

[0038] Referring to FIG. **1**, mobile terminal **100** may include a housing **110**, a speaker **120**, a display **130**, control buttons **140**, a keypad **150**, a microphone **160**, a stylus **170**, a slot **180**, and an LED **190**. Housing **110** may include any structure to support the components of mobile terminal **100**. Speaker **120** may include any mechanism(s)/device(s) to provide audible information to a user of mobile terminal **100**.

[0039] Display **130** may include any device that provides visual information to the user. For example, display **130** may provide information regarding incoming or outgoing calls, games, phone books, the current time, etc. Display **130** may include a liquid crystal display (LCD) or some other type of display that displays graphical information to a user while mobile terminal **100** is operating. The LCD may be backlit using, for example, a number of light emitting diodes (LEDs).

[0040] In an exemplary implementation, as described in detail below, display **130** may also include additional elements/components that allow a user to interact with mobile terminal **100** to cause mobile terminal **100** to perform one or more operations, such as place a telephone call, play various media, etc. In one implementation, display **130** may function as a user input interface, such as a touch-screen or panel enabled display. For example, display **130** may include a pressure-sensitive (e.g., resistive), electrically-sensitive (e.g., capacitive), acoustically-sensitive (e.g., surface acoustic wave), photo-sensitive (e.g., infra-red), and/or any other type of display overlay that allows the display to be used as an input device.

[0041] Control buttons **140** may include any function keys that permit the user to interact with mobile terminal **100** to cause mobile terminal **100** to perform one or more operations, such as place a telephone call, play various media, etc. For example, control buttons **140** may include a dial button, hang up button, play button, etc. Control buttons **140** may also include a key-lock button that permits the user to activate/deactivate various input mechanisms, such as display **130**, control buttons **140**, keypad **150**, and microphone **160**, as described in more detail below. Keypad **150** may include a standard telephone keypad, for example, and/or additional function keys. Microphone **160** may receive audible information from the user, for example, to activate commands. LED **190** may blink to signify events, such as an incoming phone call or a user's finger being on top of a key.

[0042] Stylus **170** may include an accessory instrument that may be used to manipulate display **130**, control buttons **140**, and/or keypad **150**, for example, to enter data. In one implementation, stylus **170** may be a pointer or an inkless pen that may be used to "write" information onto or select information from graphics presented on display **130**. The type of stylus **170** used may depend upon the type of touch-screen used for display **130**. For example, where display **130** includes a pressure-sensitive surface, stylus **170** may include an elongated shaft with a pointed end for contacting the surface of display **130**. Additionally, where display **130** includes an electrically-sensitive surface, an acoustically-sensitive surface, or a photo-sensitive surface, stylus **170** may include an end that emits a charge, sound, or light, respectively, that may be directed to the surface of display **130**. Stylus **170** may include one or more surface features and/or be contoured to facilitate grasping and/or handling by a user.

[0043] Slot **180** may include any component to retain stylus **170** such that a user may retrieve stylus **170** from slot **180** for use with mobile terminal **100**. In one implementation, slot **180** may be disposed within housing **110**, for example, integrally formed therein and having a shape and/or size sufficient to receive at least a portion of stylus **170**. In another implementation, slot **180** may be located externally to housing **110**, for example, using retaining components on a surface of housing **110**. In another implementation, stylus **170** may be stowed separately from housing **110**, for example, attached to housing **110** by a tether.

[0044] FIG. **2** is a diagram illustrating components of mobile terminal **100** according to an exemplary implementation. Mobile terminal **100** may include processing logic **220**, memory **230**, input device **240**, output device **250**, communication interface **260**, and a bus **210** that permits communi-

cation among the components of mobile terminal **100**. One skilled in the art would recognize that mobile terminal **100** may be configured in a number of other ways and may include other or different elements. For example, mobile terminal **100** may include one or more power supplies (not shown). Mobile terminal **100** may also include one or more modulators, demodulators, encoders, decoders, etc., for processing data.

[0045] Processing logic **220** may include a processor, microprocessor, an application specific integrated circuit (ASIC), field programmable gate array (FPGA) or the like. Processing logic **220** may execute software instructions/programs or data structures to control operation of mobile terminal **100**.

[0046] Memory **230** may include a random access memory (RAM) or another type of dynamic storage device that stores information and instructions for execution by processing logic **220**; a read only memory (ROM) or another type of static storage device that stores static information and instructions for use by processing logic **220**; a flash memory (e.g., an electrically erasable programmable read only memory (EEPROM)) device for storing information and instructions; and/or some other type of magnetic or optical recording medium and its corresponding drive. Memory **230** may also be used to store temporary variables or other intermediate information during execution of instructions by processing logic **220**. Instructions used by processing logic **220** may also, or alternatively, be stored in another type of computer-readable medium accessible by processing logic **220**. A computer-readable medium may include one or more memory devices and/or carrier waves.

[0047] Input device **240** may include mechanisms that permit an operator to input information to mobile terminal **100**, such as stylus **170**, microphone **160**, keypad **150**, control buttons **140**, display **130**, a keyboard, a mouse, a pen, voice recognition and/or biometric mechanisms, etc.

[0048] Output device **250** may include one or more mechanisms that output information to the user, including a display, such as display **130**, a printer, one or more wired or wireless speakers, such as speaker **120**, LED **190**, etc.

[0049] Output device **250** may further include vibrator **270**. Vibrator **270** may vibrate to indicate an incoming call or message or to provide a tactile feedback to the user when the user's finger is near a key on display **130**.

[0050] Communication interface **260** may include any transceiver-like mechanism that enables mobile terminal **100** to communicate with other devices and/or systems. For example, communication interface **260** may include a modem or an Ethernet interface to a LAN. Communication interface **260** may also include mechanisms for communicating via a network, such as a wireless network. For example, communication interface **260** may include one or more radio frequency (RF) transmitters, receivers and/or transceivers. Communication interface **260** may also include one or more antennas for transmitting and receiving RF data.

[0051] Mobile terminal **100** may provide a platform for a user to place and/or receive telephone calls, access the Internet, play various media, such as music files, video files, multimedia files, games, etc. Mobile terminal **100** may perform these operations in response to processing logic **220** executing sequences of instructions contained in a computer-readable medium, such as memory **230**. Such instructions may be read into memory **230** from another computer-readable medium via, for example, communication interface **260**. A computer-readable medium may include one or more memory devices and/or carrier waves. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement processes consistent with the invention. Thus, implementations described herein are not limited to any specific combination of hardware circuitry and software.

[0052] FIG. **3** is a diagram illustrating display **130** of mobile terminal **100** in which graphical objects are shown that may be selected, via touch, by a user. As depicted in FIG. **3**, a user may select graphical objects, such as number keys **310** or letter keys, by touching keys **310** with finger **320**. Display **130** may be a touch-screen. Keys **310** may be virtual keys that are displayed on display **130**. Keys **310** may be selected using finger **320** or stylus **170**.

[0053] FIG. **4** is a flowchart of exemplary processes according to implementations described herein. The process of FIG. **4** may generally be described as generation of a feedback response when a user runs a finger across a touch sensitive display. As shown in FIG. **4**, process **400** may begin by determining whether mobile terminal **100** is in feedback mode (block **410**). If it is determined that mobile terminal **100** is in feedback mode (block **410**—YES), mobile terminal **100** may provide a response as a function of the proximity of finger **320** or stylus **170** to objects, such as keys **310**, on display **130** (block **420**). In one implementation, the response may include vibration of the mobile terminal **100**. In another implementation, the response may include blinking lights, such as LED **190**, on the mobile terminal **100**. In another implementation, the response may include a combination of vibration of the mobile terminal **100** and blinking lights on the mobile terminal **100**. If it is determined that mobile terminal **100** is not in feedback mode (block **410**—NO), process **400** may end.

[0054] FIG. **5** is a flowchart illustrating operations consistent with one exemplary implementation of block **420**. As shown in FIG. **5**, process **500** may begin as a user moves finger **320** across display **130** (block **510**). Alternatively, instead of using a finger to input information through display **130**, the user may move stylus **170** across display **130**. The user may move finger **320** in any arbitrary direction over display **130**.

[0055] As finger **320** approaches key **310**, display **130** or mobile terminal **100** may begin to vibrate (block **520**). As finger **320** gets closer to key **310**, the intensity and/or frequency of the vibrations may increase.

[0056] In addition to or in the alternative to a vibratory tactile response, other feedback responses may be exhibited by mobile terminal **100**. For example, speaker **120** may emit a sound (for example, beeping) to inform the user that finger **320** is approaching key **310**. The volume and/or frequency of the sound may increase as finger **320** gets closer to key **310**.

[0057] When finger **320** is on top of key **310** or in a zone on top of key **310**, display **130** or mobile terminal **100** may generate maximum vibration (block **530**). In one embodiment, when finger **320** is on top of key **310**, speaker **120** may emit maximum sound.

[0058] As finger **320** moves away from key **310**, the intensity and/or frequency of the vibrations may begin to decrease (block **540**). When finger **320** is equidistant or near equidistant from two adjacent keys **310**, display **130** or mobile terminal **100** may generate minimum vibration. Minimum vibration may be zero vibration. In one embodiment, when finger **320** is equidistant from two adjacent keys **310**, speaker **120** may emit minimum sound, which may be no sound.

[0059] In some implementations, the concepts discussed above may be implemented on tactile keyboards. For example, mobile terminal **100** may vibrate when finger **320** is near a key on keypad **150** or near a control button **140**. In this embodiment, mobile terminal **100** may reach a maximum vibration level when finger **320** is on top of a key on keypad **150** or on top of a control button **140**. Furthermore, mobile terminal **100** may reach minimum vibration, which may be no vibration, when finger **320** is equidistant from keys on keypad **150** or control buttons **140**.

[0060] In some implementations, the concepts discussed above may be implemented using blinking LEDs. For example, LED **190** may blink when finger **320** is near a key on keypad **150** or near a control button **140**. In this embodiment, LED **190** may reach a maximum frequency of blinking or a maximum brightness when finger **320** is on top of a key or in a zone on top of the key on keypad **150**. Furthermore, the frequency of blinking or the brightness of LED **190** may reach a minimum level, which may be no blinking, when finger **320** is equidistant or near equidistant from keys on keypad **150** or control buttons **140**.

[0061] As described above, a device with a touch-sensitive display may generate a tactile feedback response to a user interacting with the touch-sensitive display. Advantageously, this may allow the user to user the touch-sensitive display without necessarily having to look at the display.

[0062] The foregoing description provides illustration and description, but is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention.

[0063] For example, while series of acts have been described with regard to FIG. **4**, the order of the acts may be modified in other implementations. Further, non-dependent acts may be performed in parallel.

[0064] It should be emphasized that the term "comprises/comprising" when used in the this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0065] It will be apparent that aspects, as described above, may be implemented in many different forms of software, firmware, and hardware. The actual software code or specialized control hardware used to implement aspects described herein is not limiting of the invention. Thus, the operation and behavior of the aspects were described without reference to the specific software code—it being understood that one would be able to design software and control hardware to implement the aspects based on the description herein.

[0066] No element, act, or instruction used in the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

What is claimed is:

1. A method comprising:

detecting movement of a finger on a touch screen display of a device; and

vibrating the device to indicate proximity of the finger to one of a plurality of objects displayed on the touch screen display.

2. The method of claim **1**, further comprising:

generating increasing vibrations when the finger approaches the one of the plurality of objects on the touch screen display; and

generating decreasing vibrations when the finger moves away from the one of the plurality of objects on the touch screen.

3. The method of claim **2**, wherein generating increasing vibrations includes generating vibrations with increasing intensity and generating decreasing vibrations includes generating vibrations with decreasing intensity.

4. The method of claim **2**, wherein generating increasing vibrations includes generating vibrations with increasing frequency and generating decreasing vibrations includes generating vibrations with decreasing frequency.

5. The method of claim **1**, further comprising:

generating maximum vibration when the finger is on top of the one of the plurality of objects on the touch screen display or in a zone on top of one of the plurality of objections on the touch screen.

6. The method of claim **1**, further comprising:

generating minimum vibration when the finger is equidistant or near equidistant from two adjacent objects.

7. The method of claim **6**, wherein generating minimum vibration includes generating no vibration.

8. The method of claim **1**, further comprising:

generating an audible signal that increases in volume or frequency when the finger approaches one of the plurality of objects on the touch screen display; and

generating an audible signal that decreases in volume or frequency when the finger moves away from the one of the plurality of objects on the touch screen display.

9. The method of claim **8**, wherein the audible signal is at a maximum volume or frequency when the finger is on top of one of the plurality of objects or in a zone on top of one of the plurality of objects.

10. The method of claim **8**, wherein the audible signal is at a minimum volume or frequency when the finger is equidistant or near equidistant from two adjacent objects.

11. The method of claim **1**, further comprising:

generating an visual signal that increases in brightness or frequency when the finger approaches one of the plurality of objects on the touch screen display; and

generating an visual signal that decreases in brightness or frequency when the finger moves away from the one of the plurality of objects on the touch screen display.

12. The method of claim **11**, wherein the visual signal is at a maximum brightness or frequency when the finger is on top of one of the plurality of objects or in a zone on top of one of the plurality of objects.

13. The method of claim **11**, wherein the visual signal is at a minimum brightness or frequency when the finger is equidistant or near equidistant from two adjacent objects.

14. A device comprising:

a touch screen display;

a vibrator; and

processing logic configured to:

determine a location of a finger of a user on the touch screen display; and

cause the vibrator to generate vibrations to indicate proximity of the finger to one of a plurality of objects displayed on the touch screen display.

15. The device of claim **14**, where in the processing logic is further configured to:

cause the vibrator to increase vibrations as the finger approaches the one of the plurality of objects; and

cause the vibrator to decrease vibrations as the finger moves away from the one of the plurality of objects.

16. The device of claim **14**, wherein the processing logic is further configured to:

cause the vibrator to vibrate at a maximum level when the finger is on top of the one of the plurality of objects.

17. The device of claim **14**, wherein the processing logic is further configured to:

cause the vibrator to vibrate at a minimum level when the finger is equidistant from two adjacent objects.

18. The device of claim **14**, wherein the processing logic is further configured to:

cause the vibrator to increase the intensity of the vibrations as the finger approaches the one of the plurality of objects; and

cause the vibrator to decrease the intensity of the vibrations as the finger moves away from the one of the plurality of objects.

19. The device of claim **14**, wherein the processing logic is further configured to:

cause the vibrator to increase the frequency of the vibrations as the finger approaches the one of the plurality of objects; and

cause the vibrator to decrease the frequency of the vibrations as the finger moves away from the one of the plurality of objects.

20. The device of claim **14**, further comprising a speaker, wherein the speaker emits a signal when the finger is near the one of the plurality of objects.

21. The device of claim **20**, wherein the signal increases in volume or frequency as the finger approaches the one of the plurality of objects and decreases in volume or frequency as the finger moves away from the one of the plurality of objects.

22. The mobile terminal of claim **20**, wherein the signal is at maximum volume or frequency when the finger is on top of one of the plurality of objects or in a zone on top of one of the plurality of objects and the signal is at a minimum volume or frequency when the finger is equidistant or near equidistant from two adjacent objects.

23. A method comprising:

displaying a plurality of graphical objects on a touch screen display of a mobile communication terminal;

detecting a position of a finger on the touch screen display; and

generating a feedback response for a user of the mobile communication terminal based on the detected position of the finger.

24. The method of claim **23**, wherein the graphical objects include one of number keys or letter keys.

25. The method of claim **23**, wherein the feedback response includes vibration of the mobile communication terminal.

* * * * *

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(43) **Pub. Date: Jun. 4, 2009**

(54) **PRESS DETECTION SENSOR, INPUT DEVICE AND ELECTRONIC APPARATUS**

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G06F 3/041 (2006.01)

(52) **U.S. Cl.** **345/173**; 178/18.01

(57) **ABSTRACT**

A press detection sensor contains a base member having predetermined length and width and also having a predetermined shape, a first conductor having predetermined length and being arranged on the base member, and a second conductor that is arranged on the base member with the second conductor being faced to the first conductor. The press detection sensor also contains a conductive contact body that is arranged between the first conductor and the second conductor. The conductive contact body connects the first and second conductors electrically in response to an external force. The press detection sensor further contains a covering member that includes the contact body on the inside thereof. The covering member covers a top of the base member which includes the first and second conductors. The covering member contains at least one of flexibility and elasticity.

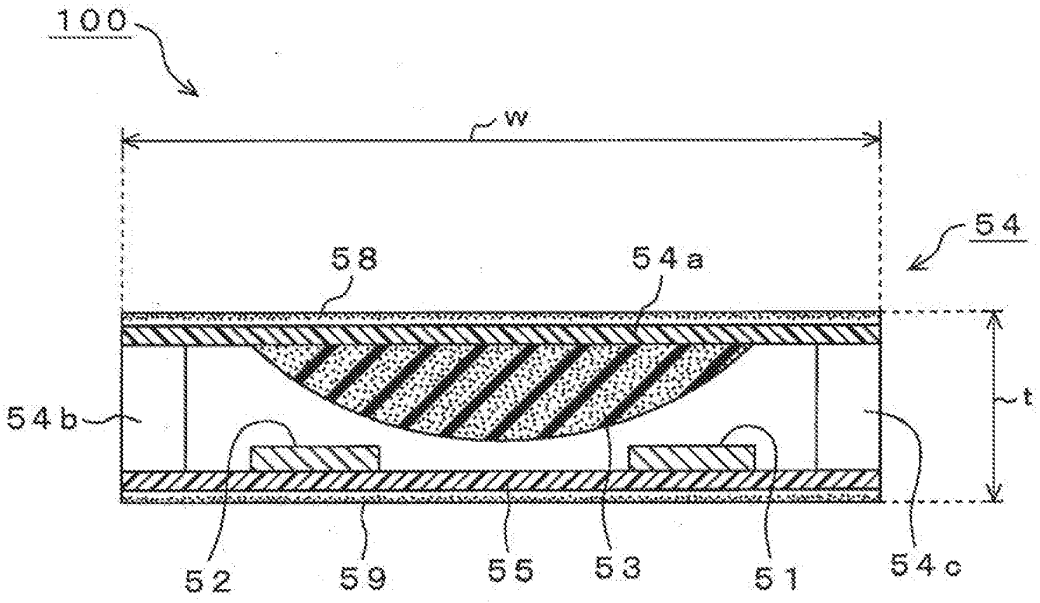


FIG. 1

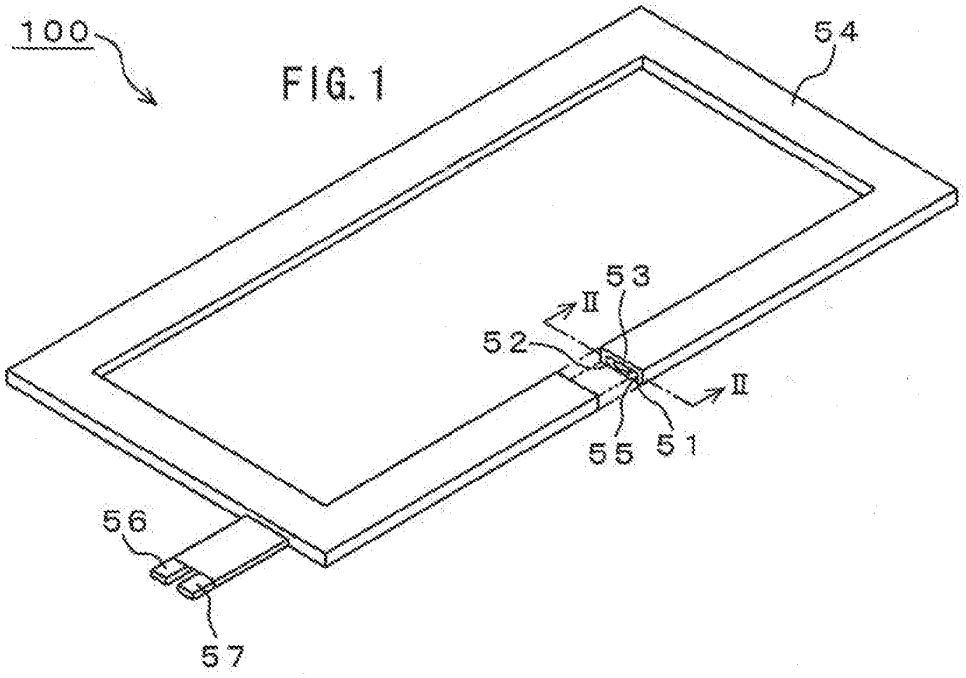


FIG. 2

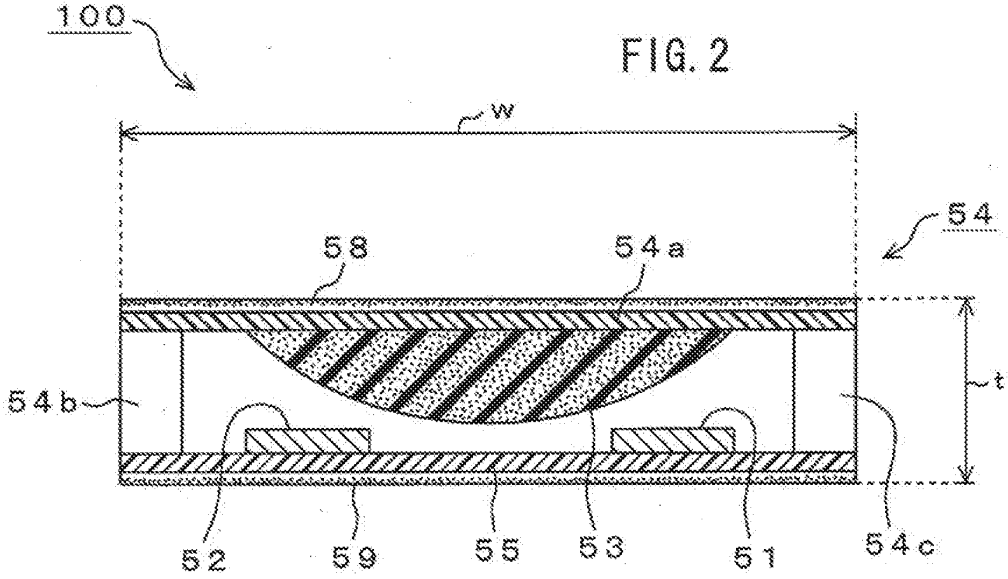
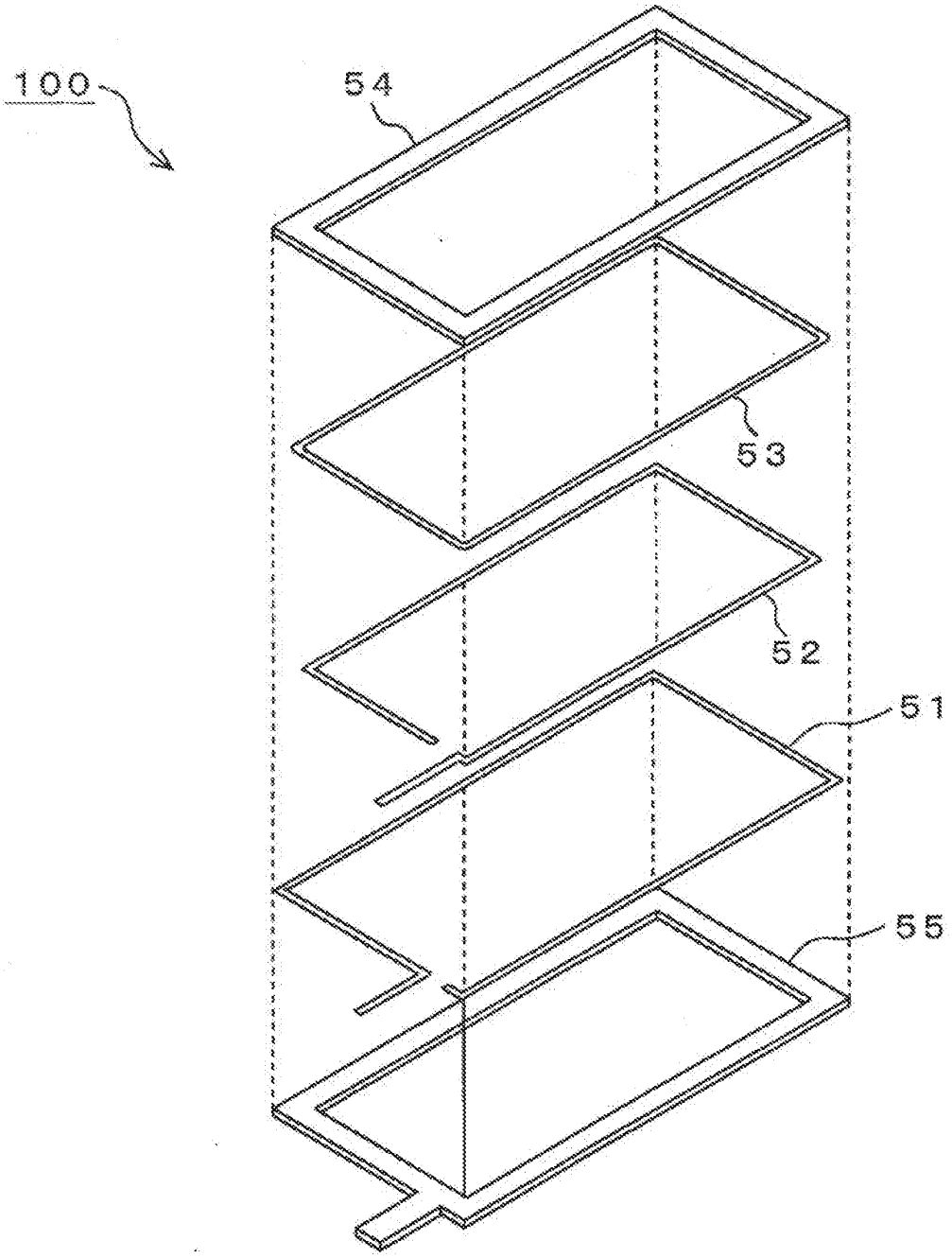


FIG. 3



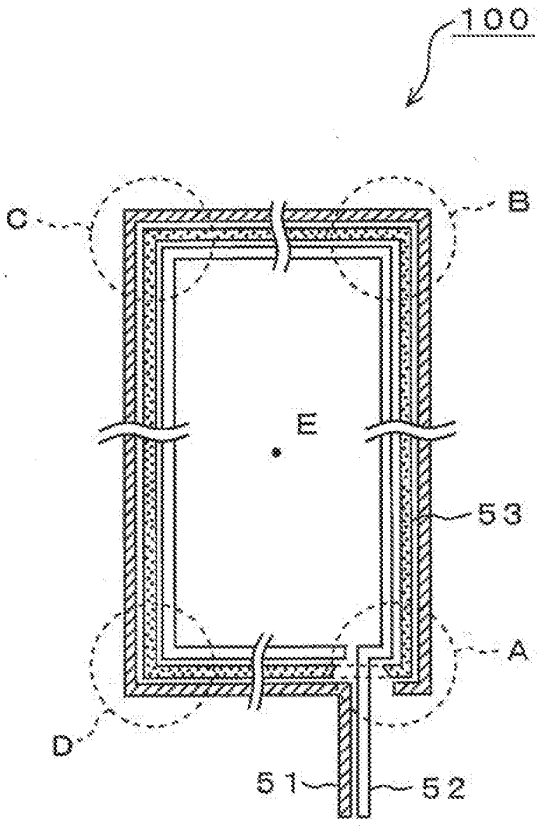


FIG. 4A

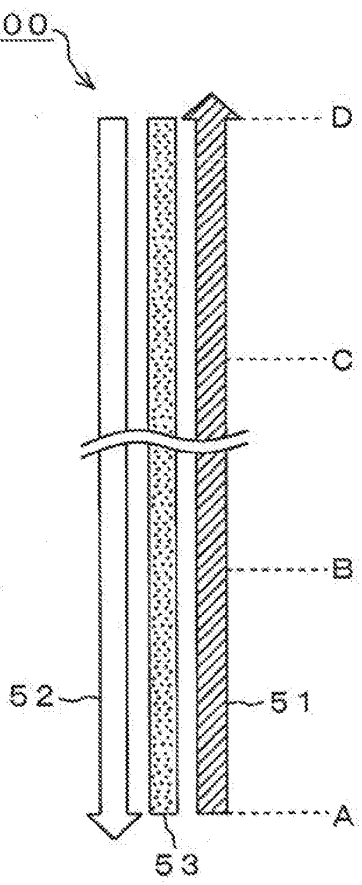


FIG. 4B

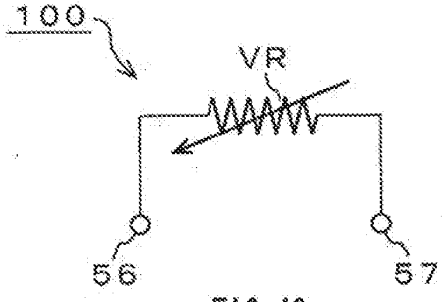
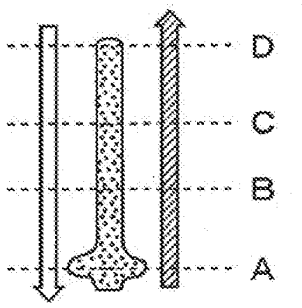
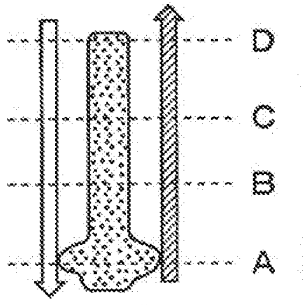
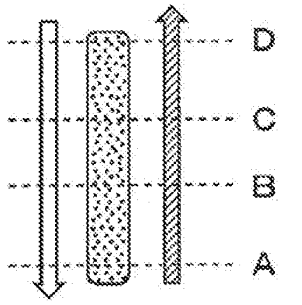
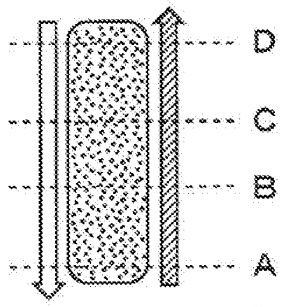


FIG. 4C

FIG. 5

PRESSED STATE	DEFORMED STATE OF CONTACT BODY	RESISTANCE VALUE
IN CASE OF PUSHING DOWN POINT A WEAKLY		R(I)
IN CASE OF PUSHING DOWN POINT A STRONGLY		R(II)
IN CASE OF PUSHING DOWN POINT E WEAKLY		R(I)
IN CASE OF PUSHING DOWN POINT E STRONGLY		R(II)

R(I)>R(II)

FIG. 6

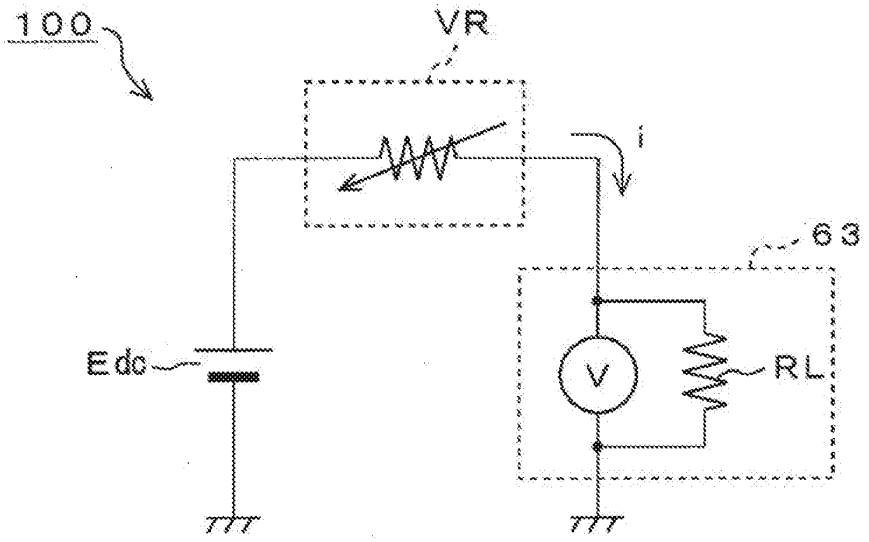


FIG. 7A

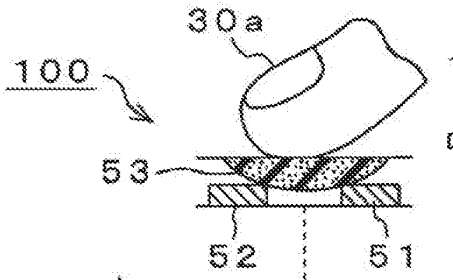
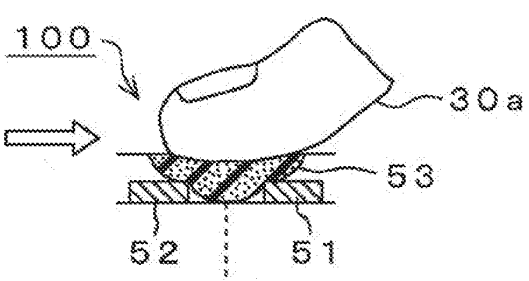


FIG. 7B



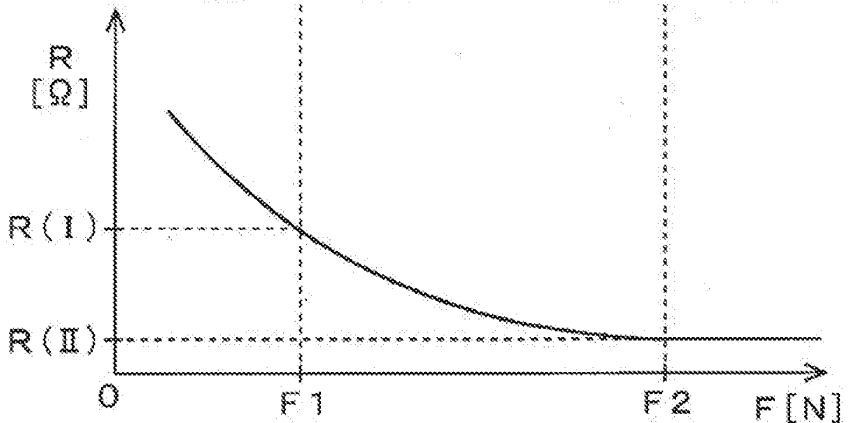


FIG. 7C

FIG. 8A FIG. 8B FIG. 8C FIG. 8D

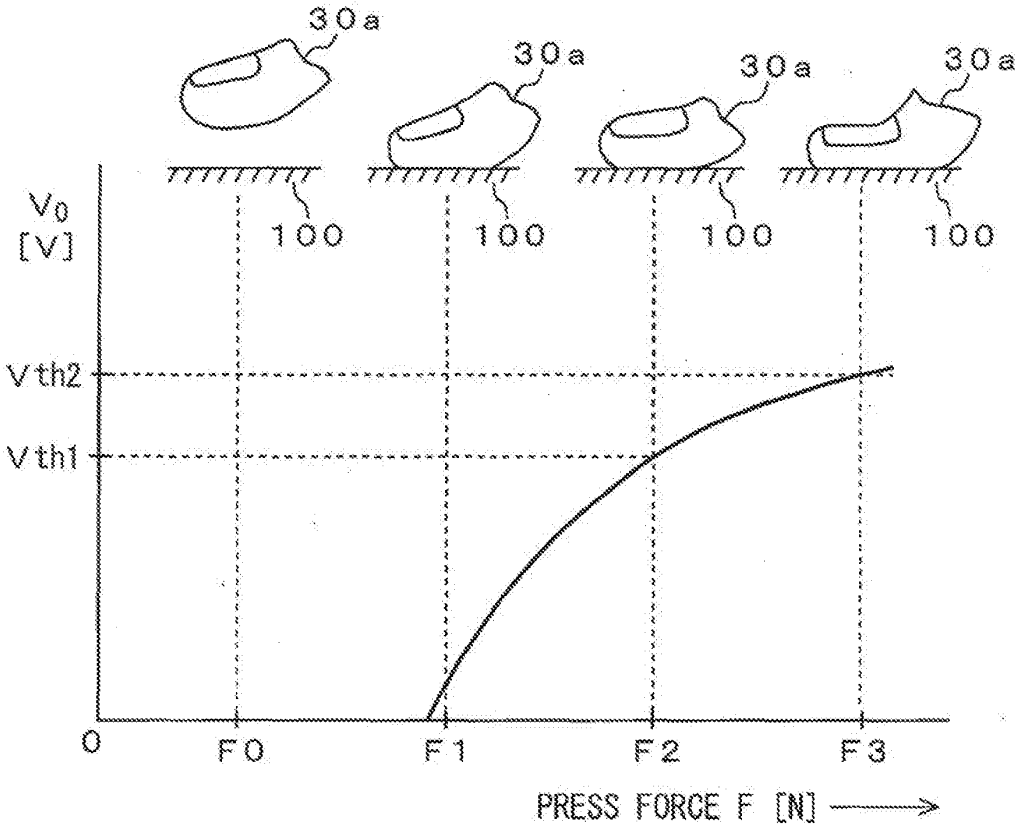


FIG. 8E

FIG. 9A

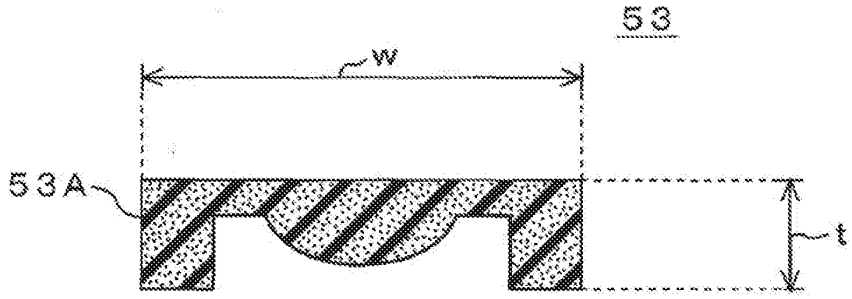


FIG. 9B

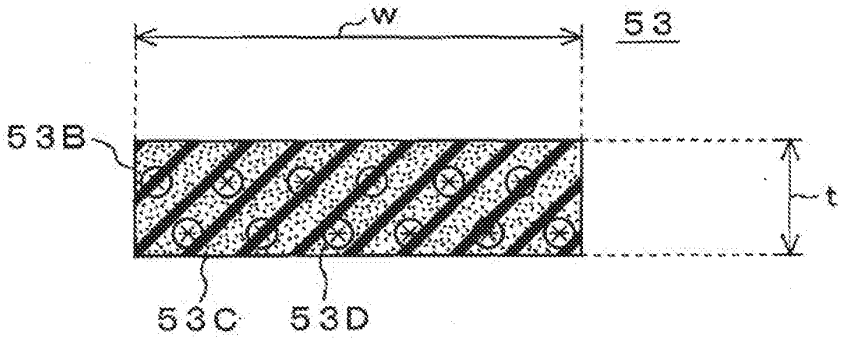


FIG. 9C

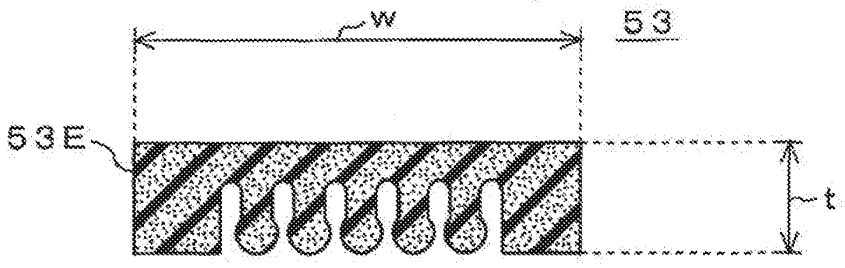


FIG. 10

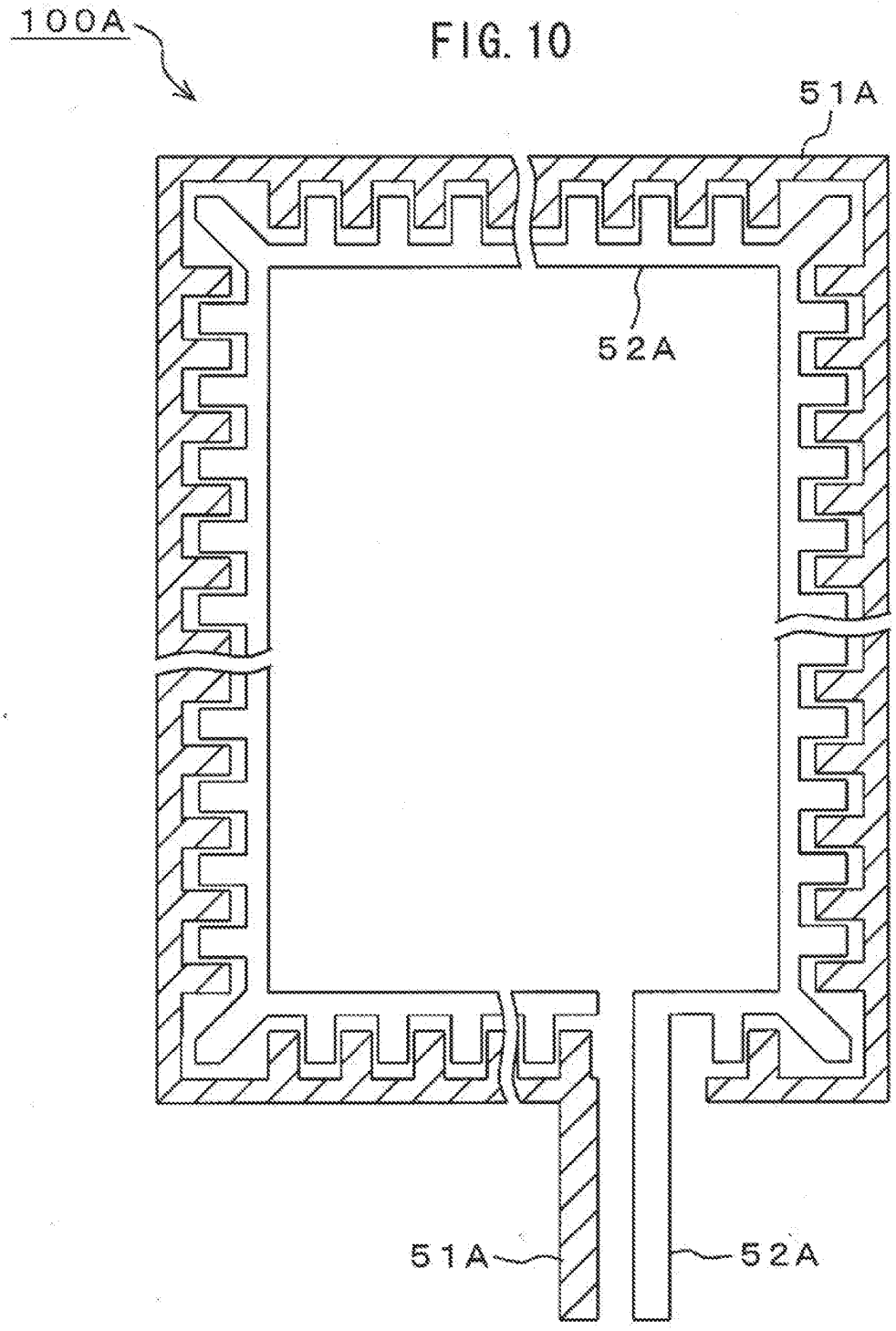


FIG. 11

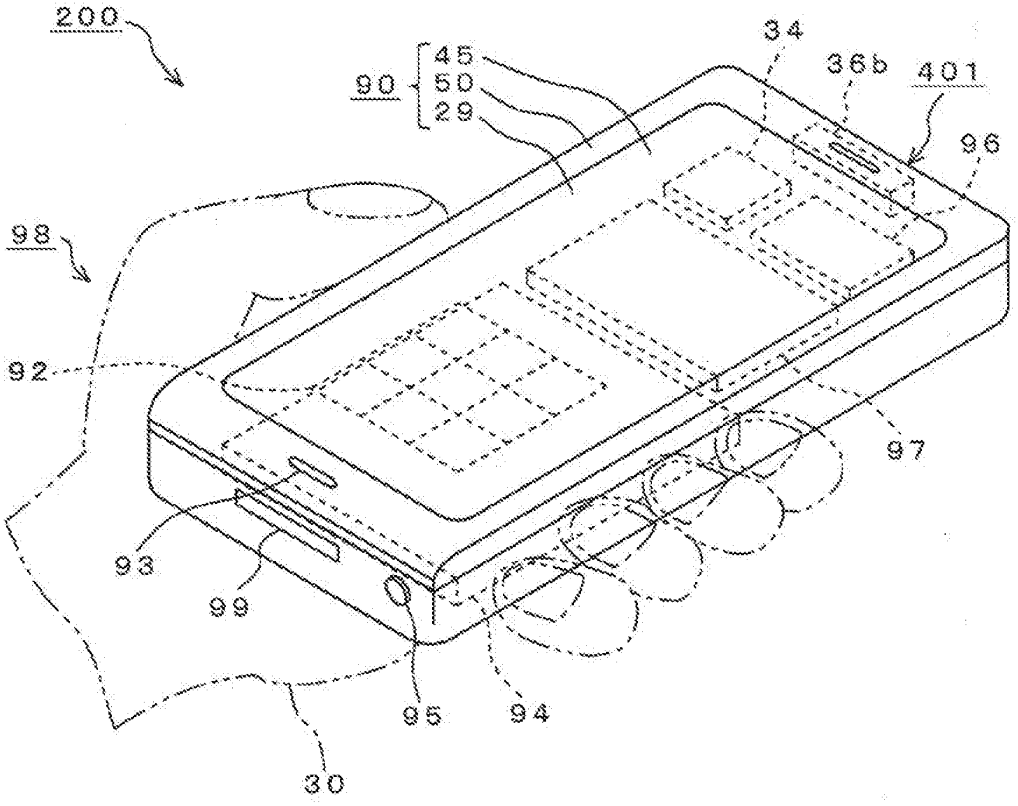


FIG. 12

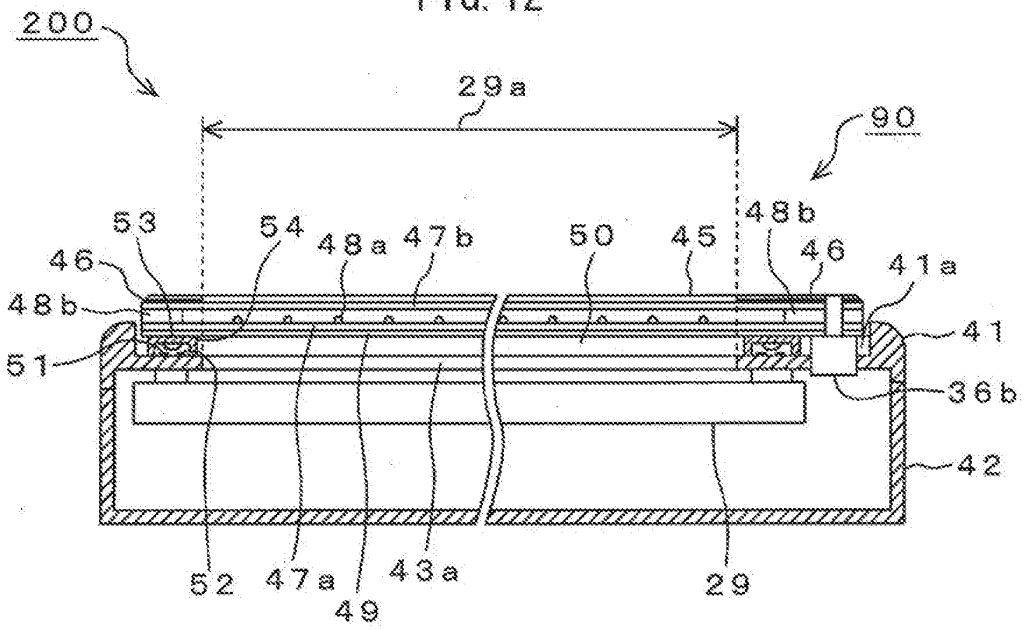
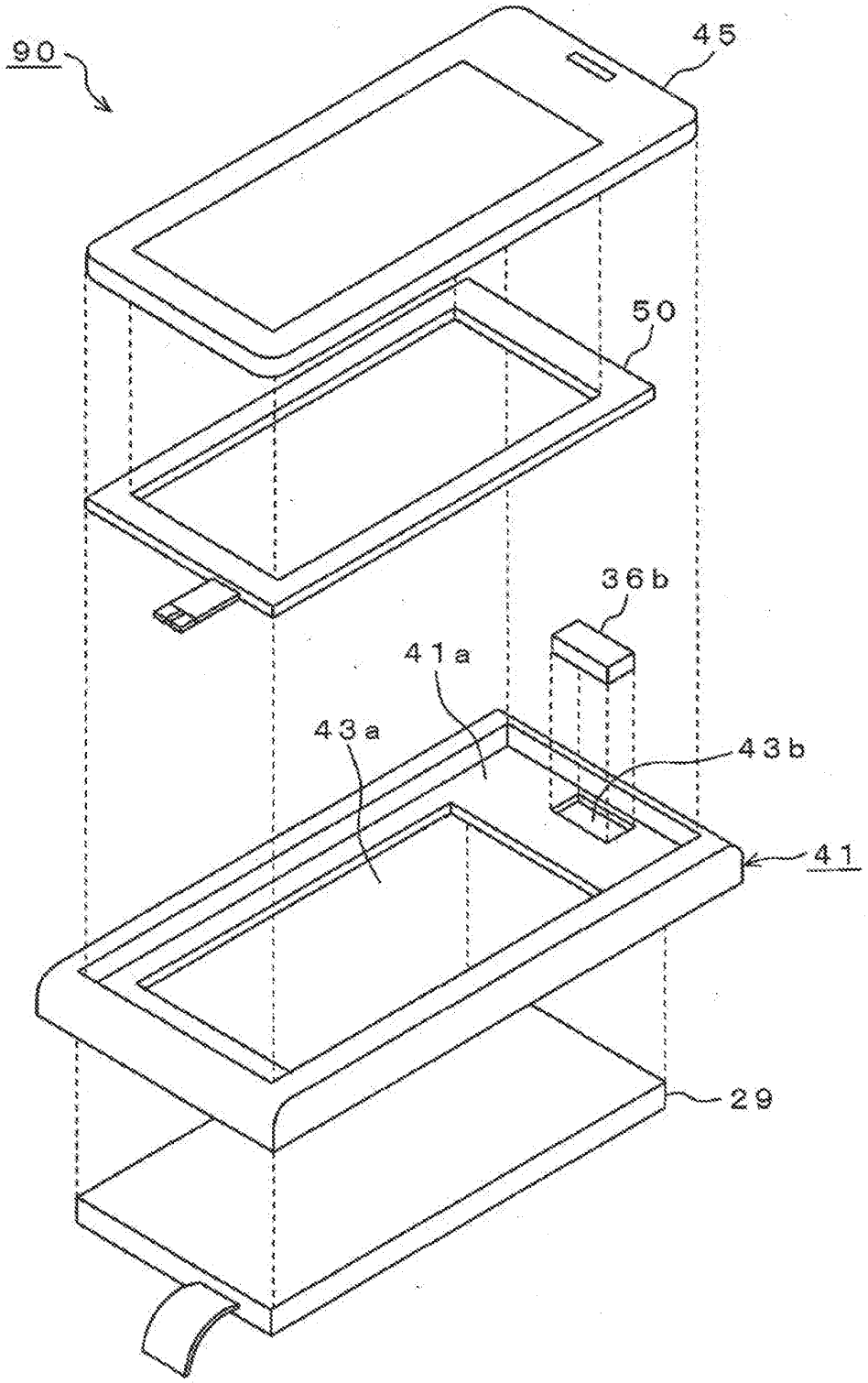

200
29a
90
53
54
48a
47b
50
45
48b
46
46
41a
48b
41
51
36b
42
52
47a
49
43a
29

FIG. 13



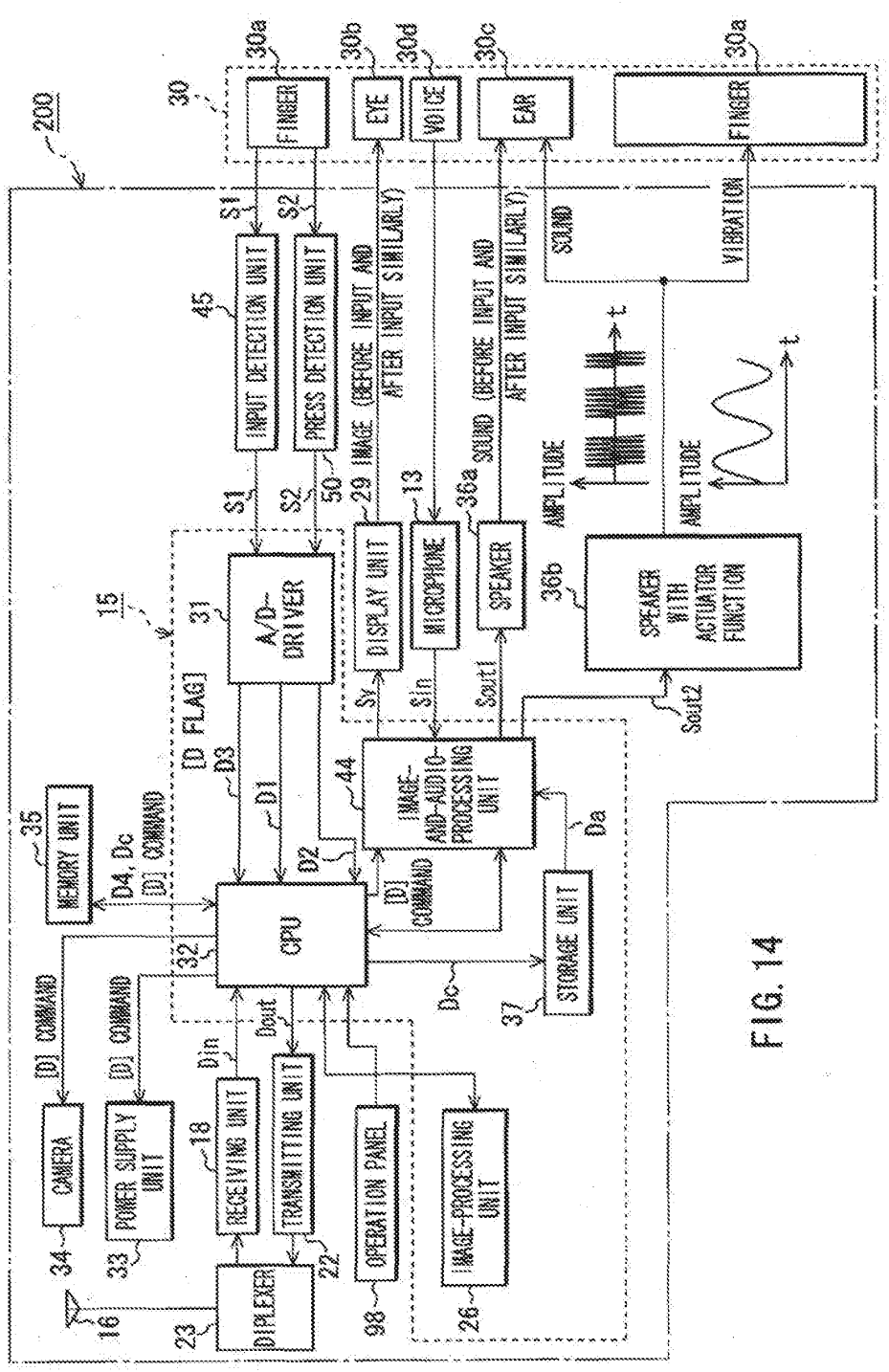

S08P1739
200
30
30a
FINGER
30b
EYE
30d
VOICE
30c
EAR
30a
FINGER
45
INPUT DETECTION UNIT
PRESS DETECTION UNIT
S1
S2
50
29
IMAGE (BEFORE INPUT AND AFTER INPUT SIMILARLY)
13
MICROPHONE
36a
SOUND (BEFORE INPUT AND AFTER INPUT SIMILARLY)
SPEAKER
SOUND
VIBRATION
AMPLITUDE
t
36b
SPEAKER WITH ACTUATOR FUNCTION
15
31
A/D-DRIVER
DISPLAY UNIT
Sy
Sin
Sout1
Sout2
[D FLAG]
D3
D1
D2
44
IMAGE-AND-AUDIO-PROCESSING UNIT
Da
35
MEMORY UNIT
D4, Dc
[D] COMMAND
CPU
32
Dout
Din
Dc
37
STORAGE UNIT
CAMERA
34
POWER SUPPLY UNIT
33
RECEIVING UNIT
18
TRANSMITTING UNIT
22
DIPLEXER
23
16
OPERATION PANEL
98
IMAGE-PROCESSING UNIT
26

FIG. 14

FIG. 15

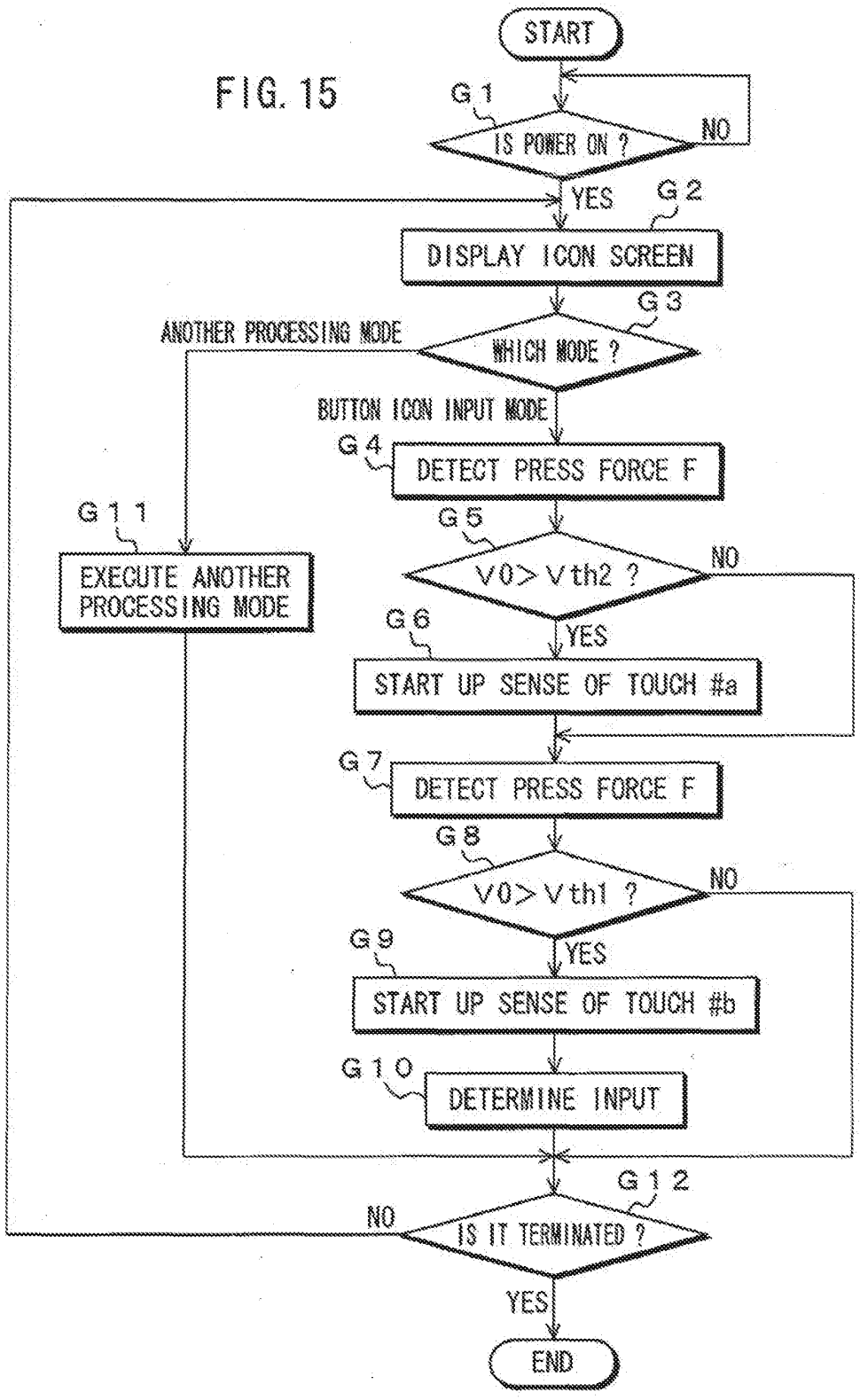

START
G1
IS POWER ON ?
NO
YES
G2
DISPLAY ICON SCREEN
G3
ANOTHER PROCESSING MODE
WHICH MODE ?
BUTTON ICON INPUT MODE
G4
DETECT PRESS FORCE F
G5
V0>Vth2 ?
NO
YES
G6
START UP SENSE OF TOUCH #a
G7
DETECT PRESS FORCE F
G8
V0>Vth1 ?
NO
YES
G9
START UP SENSE OF TOUCH #b
G10
DETERMINE INPUT
G11
EXECUTE ANOTHER PROCESSING MODE
G12
NO
IS IT TERMINATED ?
YES
END

FIG. 16

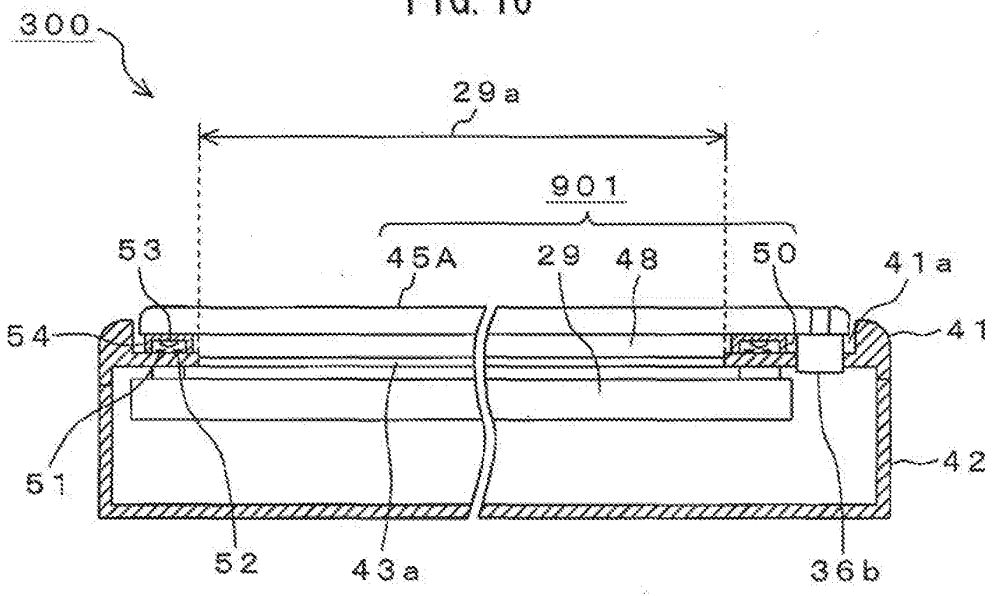


FIG. 17

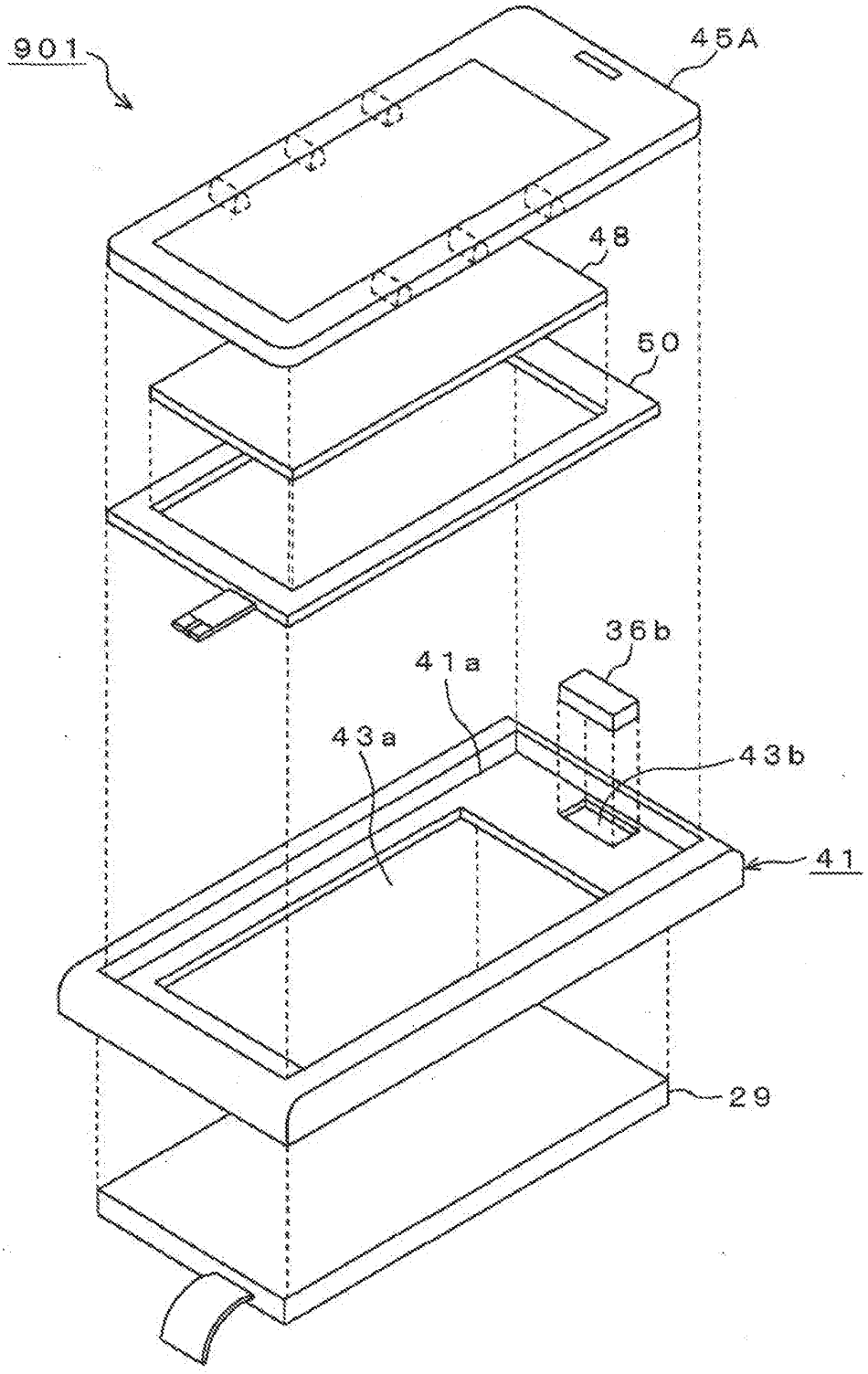


FIG. 18

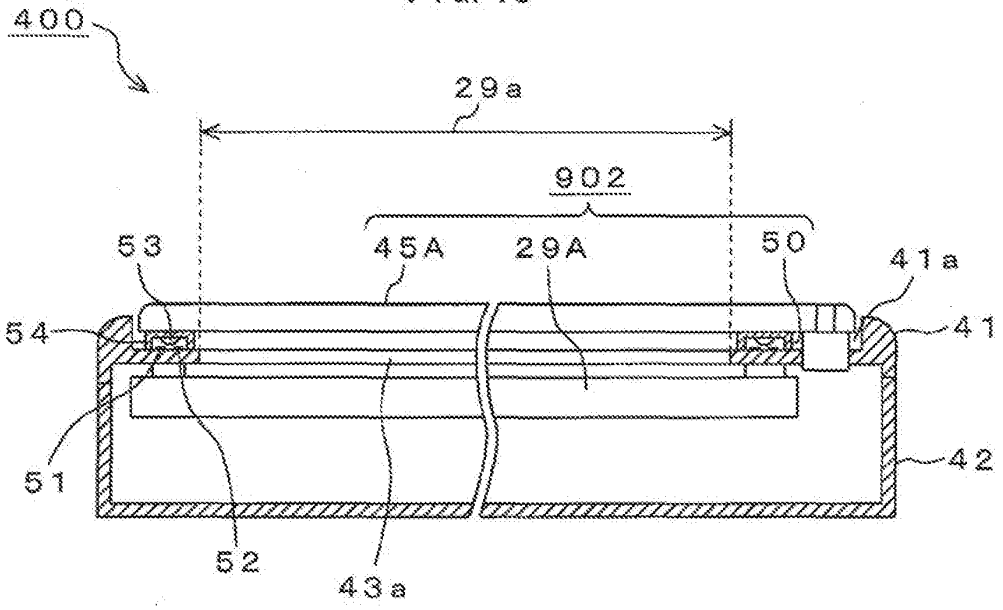


FIG. 19

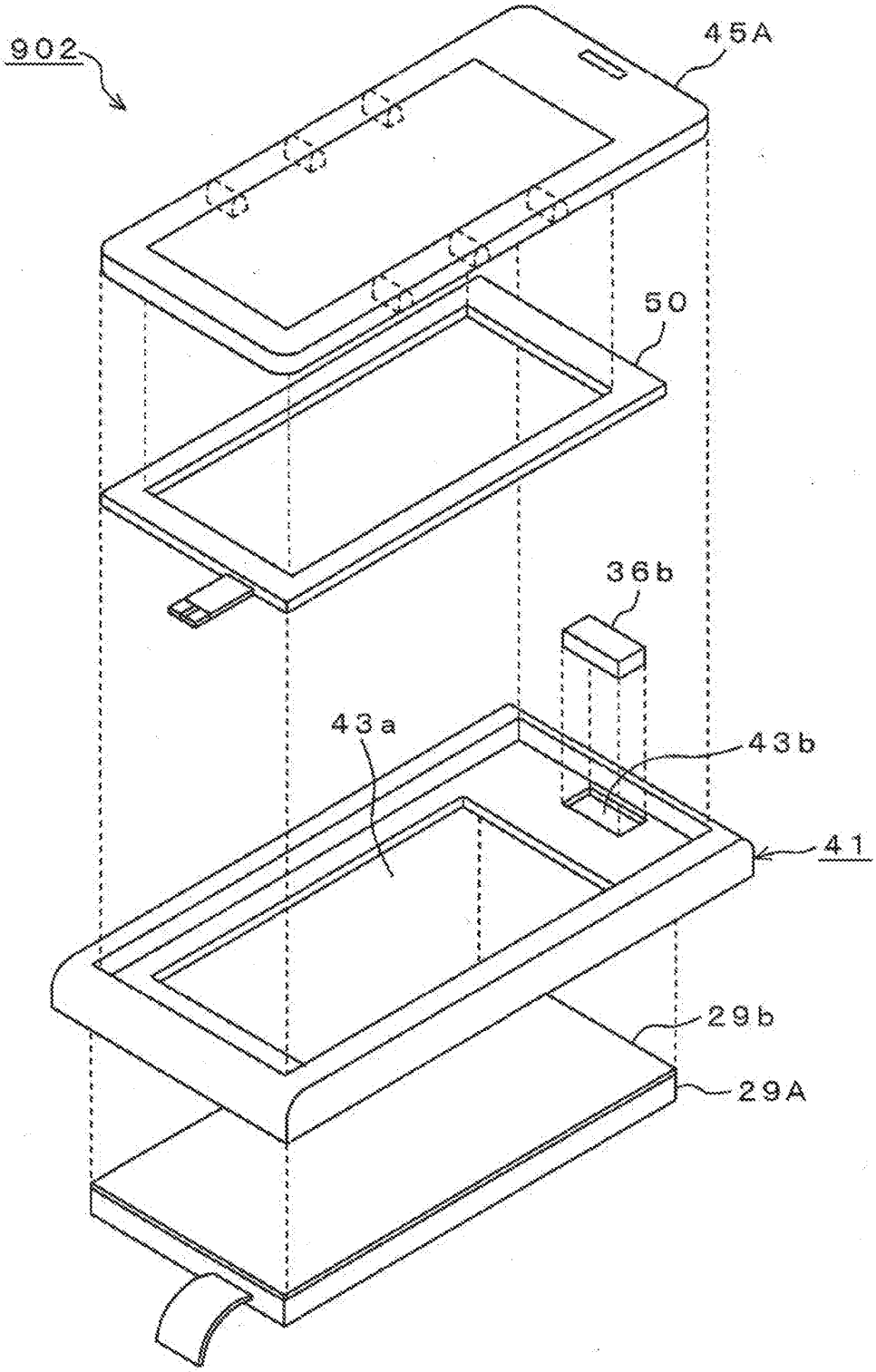


FIG. 20

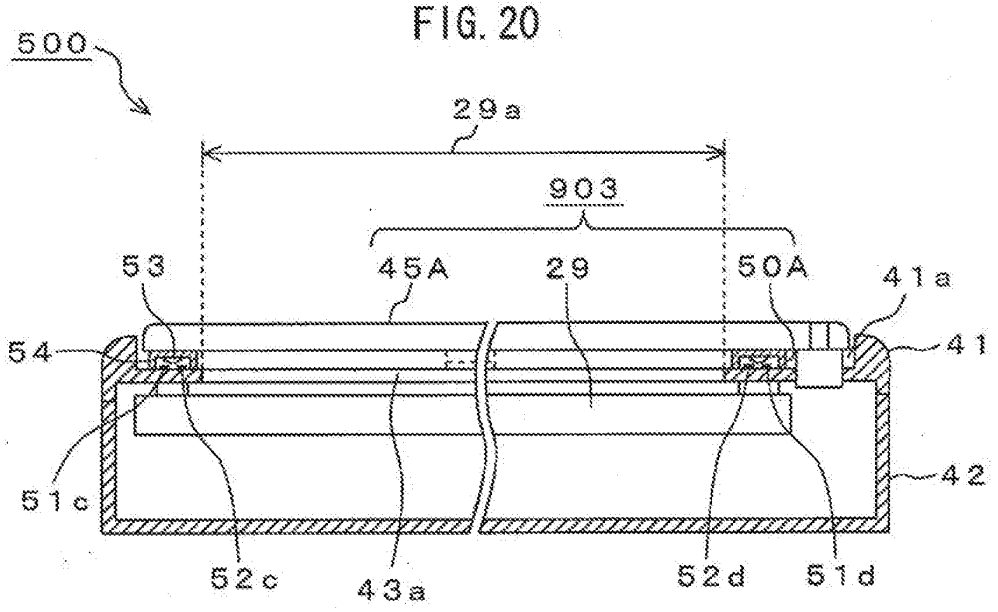


FIG. 21

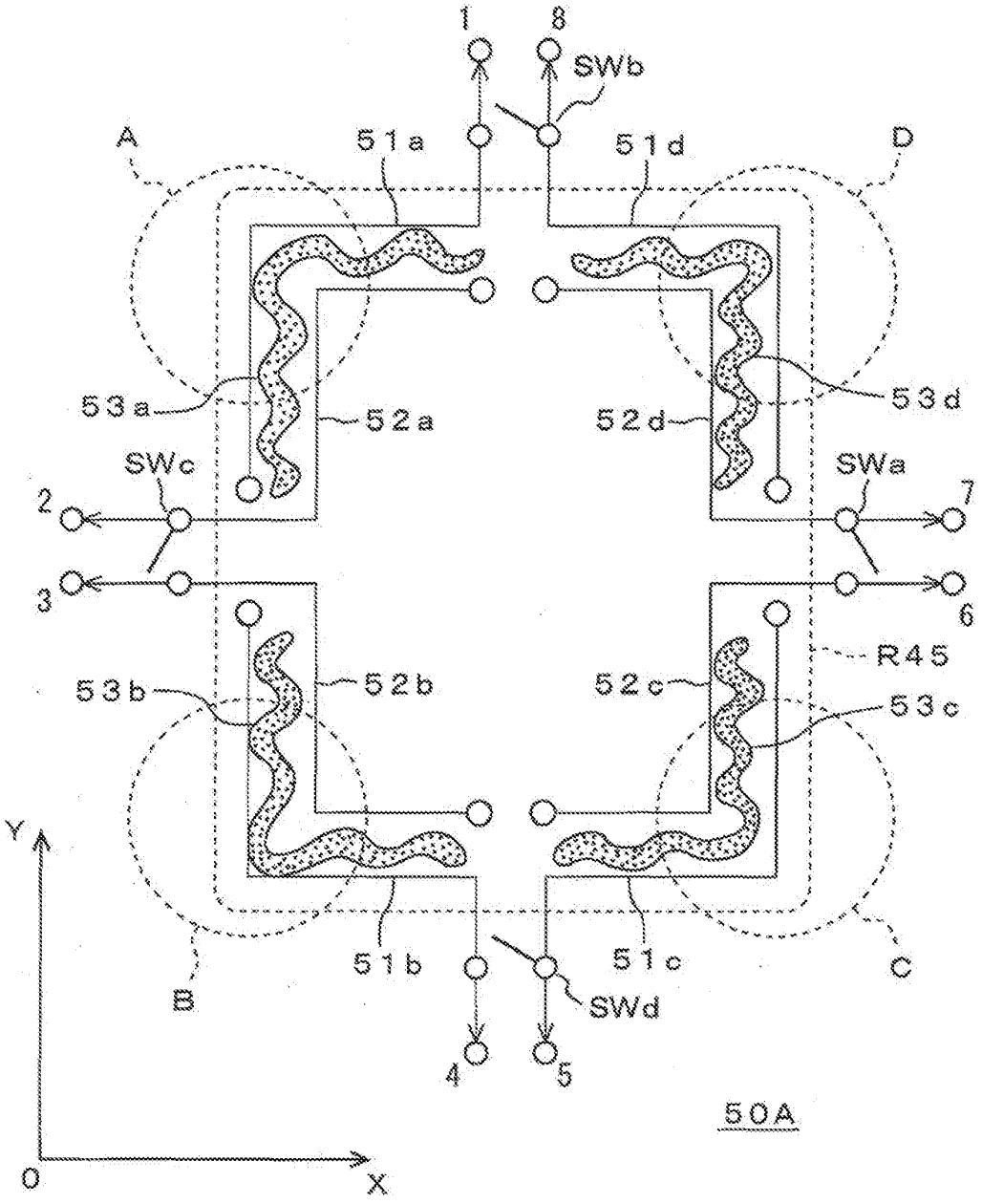

1
8
SWb
A
51a
51d
D
53a
52a
52d
53d
SWc
SWa
2
7
3
6
R45
53b
52b
52c
53c
Y
51b
51c
C
B
SWd
4
5
50A
0
X

FIG. 22

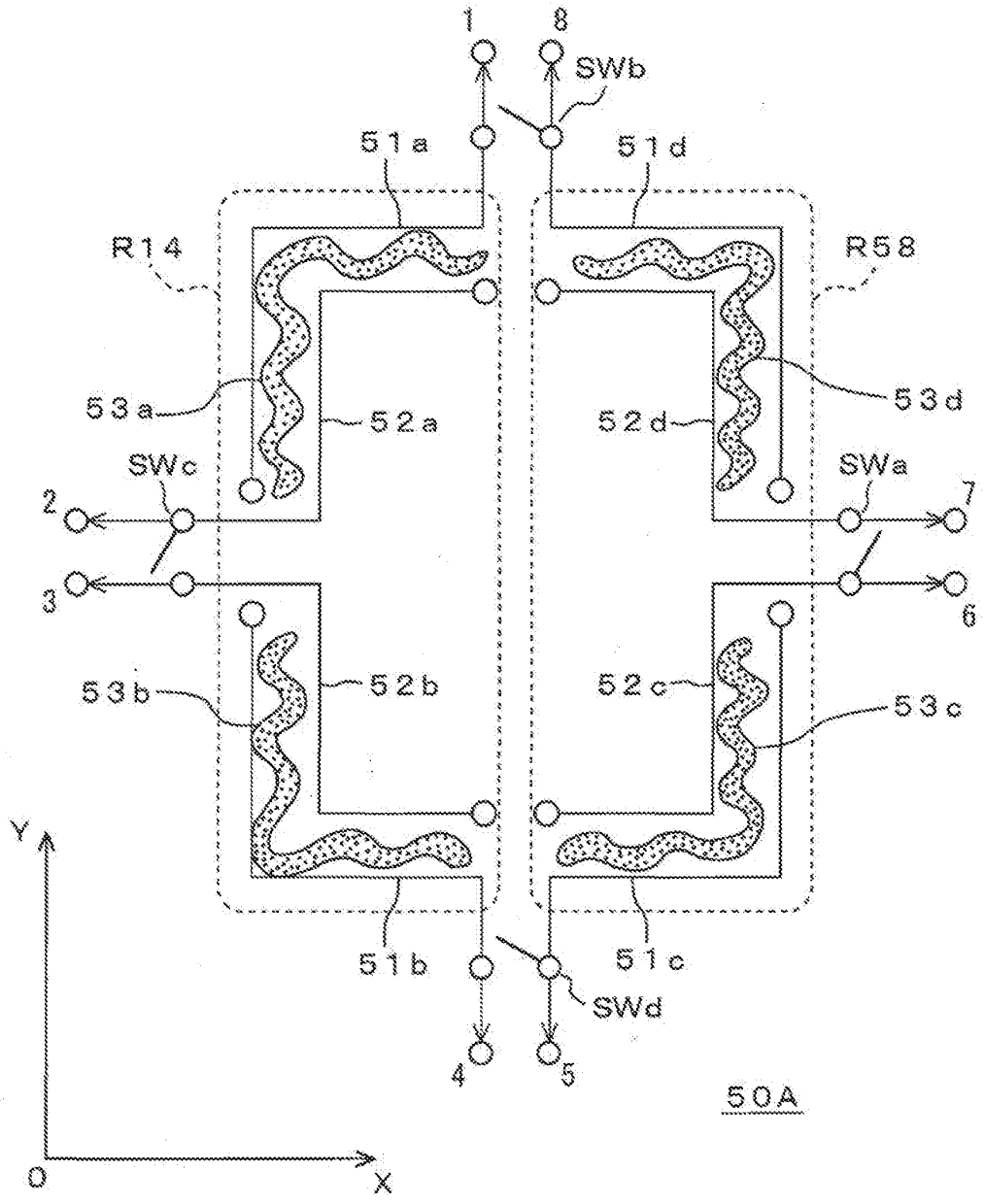

1
8
SWb
51a
51d
R14
R58
53a
52a
52d
53d
SWc
SWa
2
7
3
6
53b
52b
52c
53c
Y
51b
51c
SWd
4
5
50A
0
X

FIG. 23

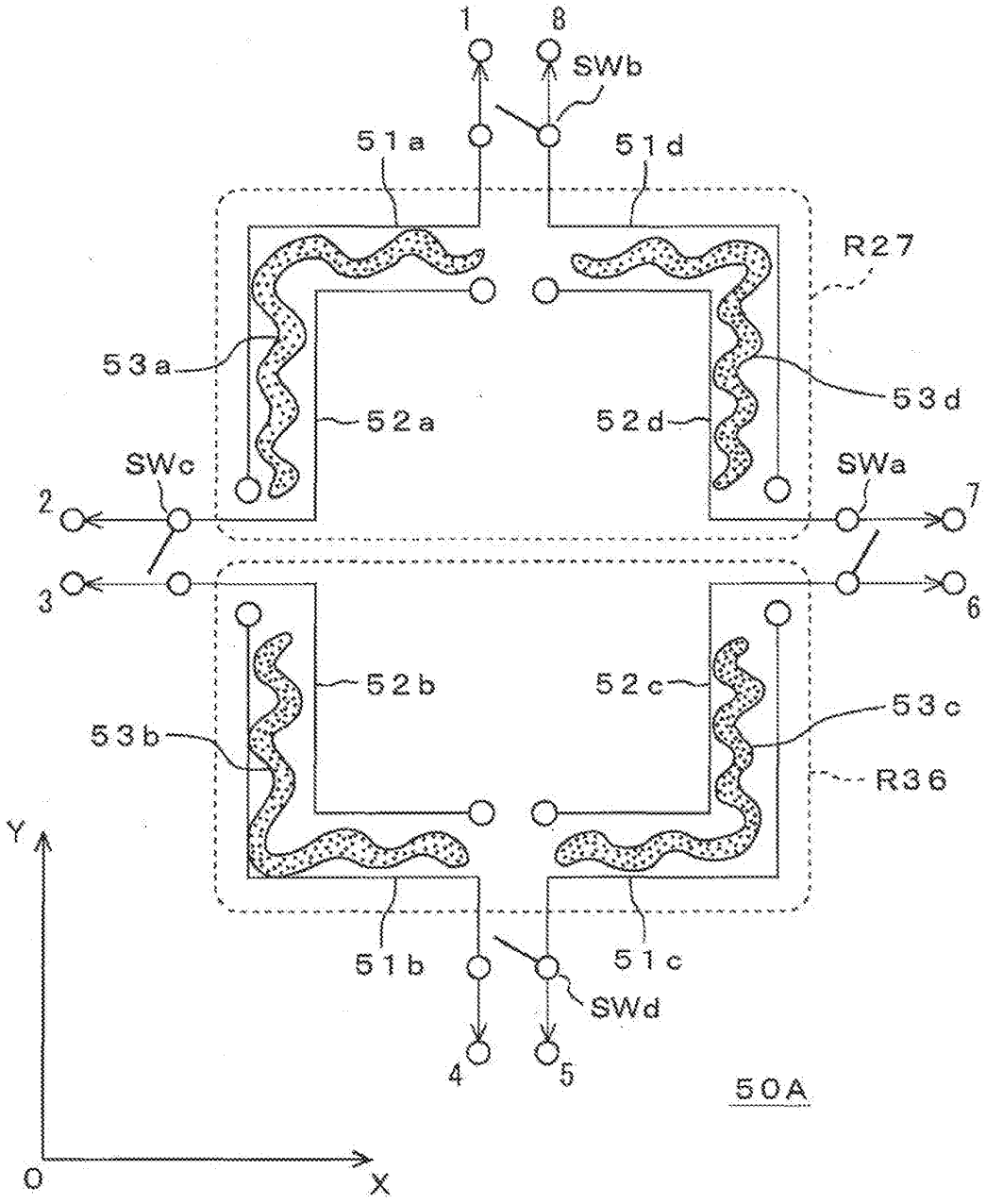

1
8
SWb
51a
51d
R27
53a
53d
52a
52d
SWc
SWa
2
7
3
6
52b
52c
53b
53c
R36
Y
51b
51c
SWd
4
5
50A
O
X

FIG. 24

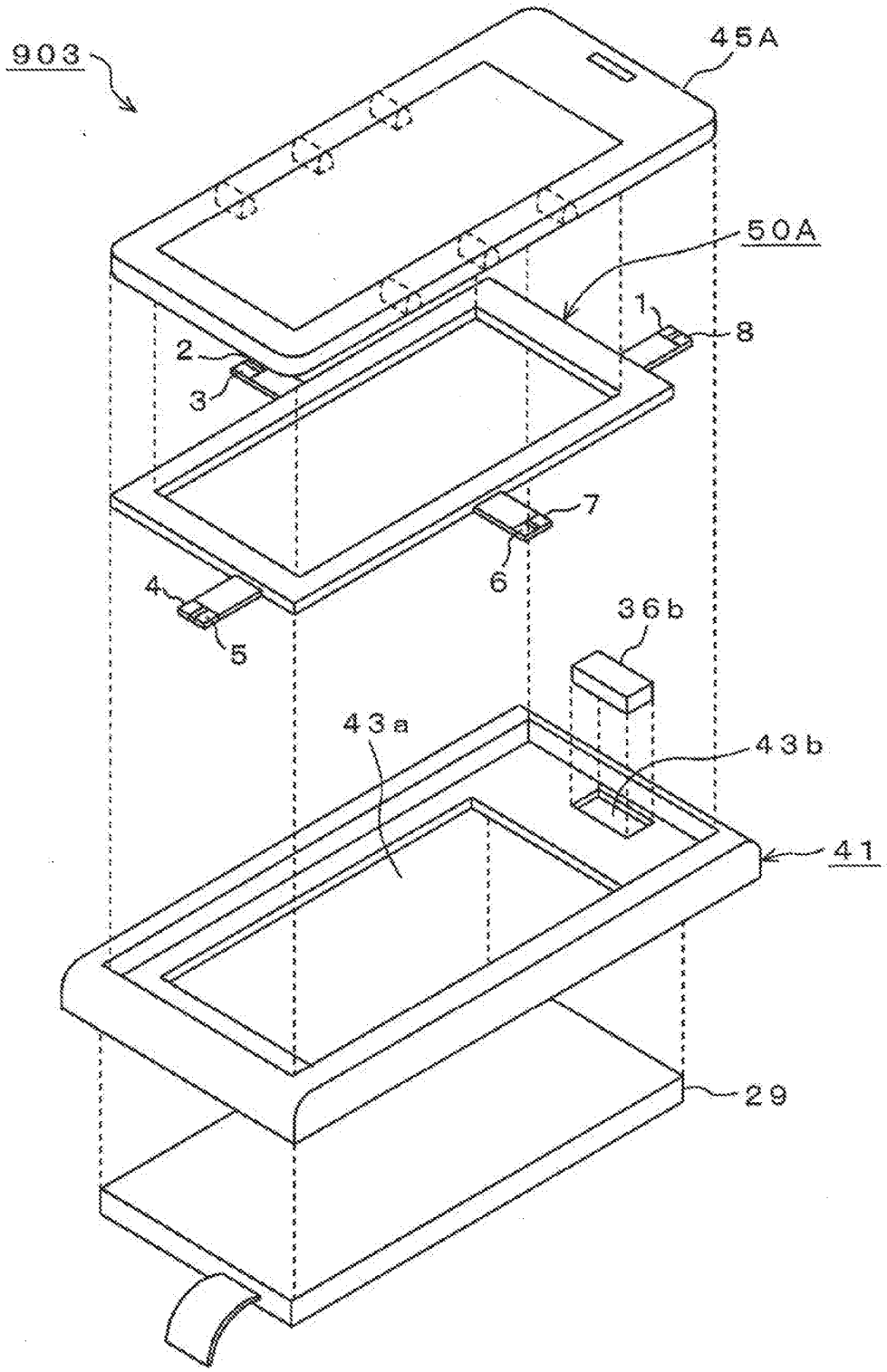


FIG. 25

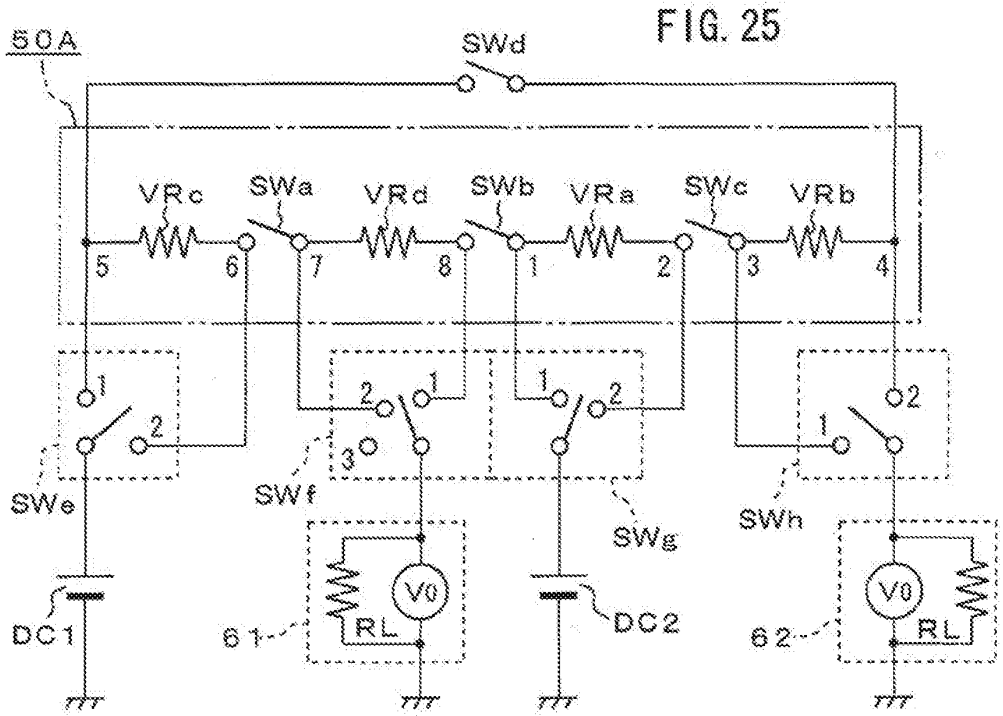

50A
SWd
VRc
SWa
VRd
SWb
VRa
SWc
VRb
5
6
7
8
1
2
3
4
SWe
SWf
SWg
SWh
DC1
DC2
61
62
V0
RL

FIG. 26

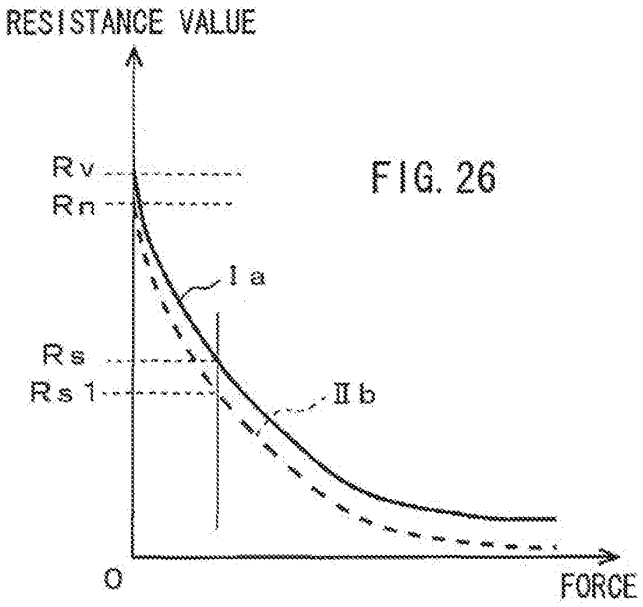
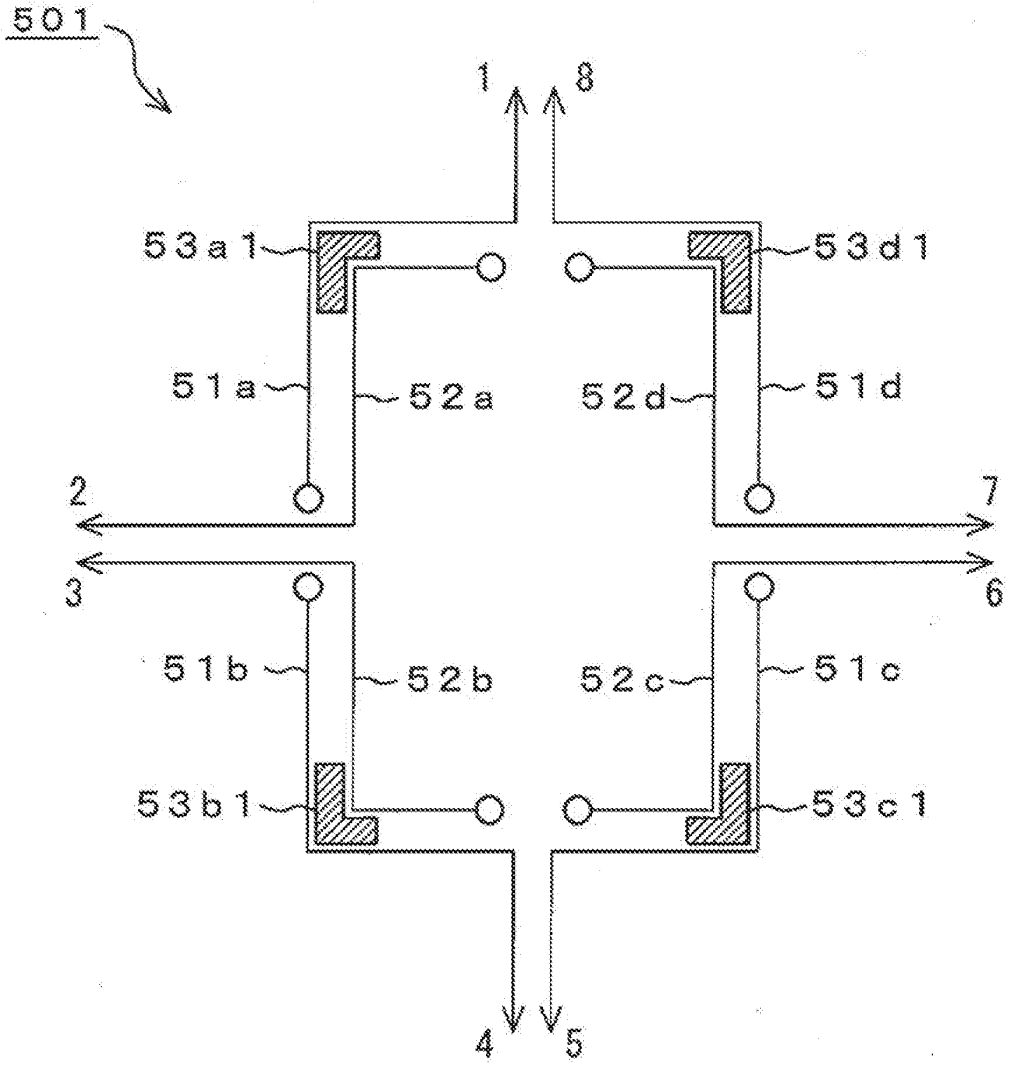

RESISTANCE VALUE
Rv
Rn
Ia
Rs
Rs1
IIb
O
FORCE

FIG. 27


501
1
8
53a1
53d1
51a
52a
52d
51d
2
7
3
6
51b
52b
52c
51c
53b1
53c1
4
5

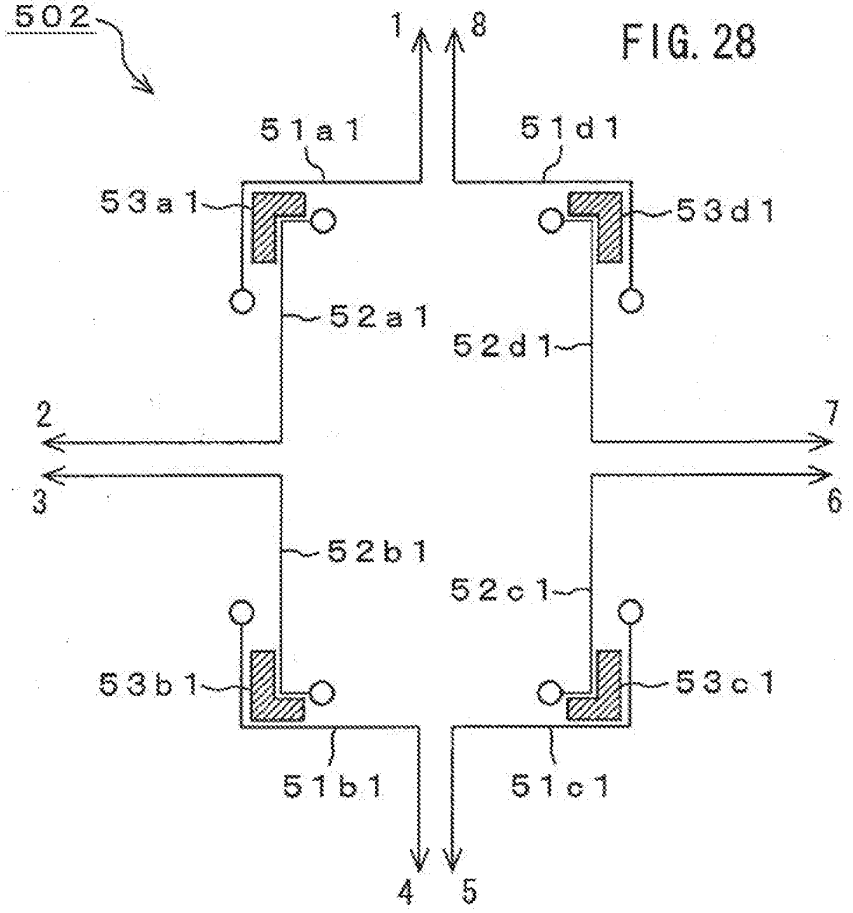

502
1
8
51a1
51d1
53a1
53d1
52a1
52d1
2
7
3
6
52b1
52c1
53b1
53c1
51b1
51c1
4
5

FIG. 28

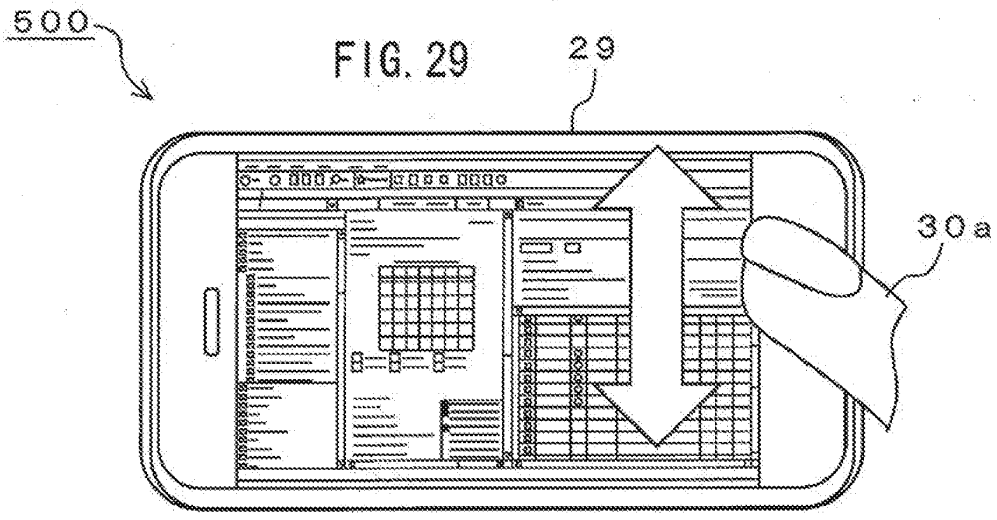

500
29
30a

FIG. 29

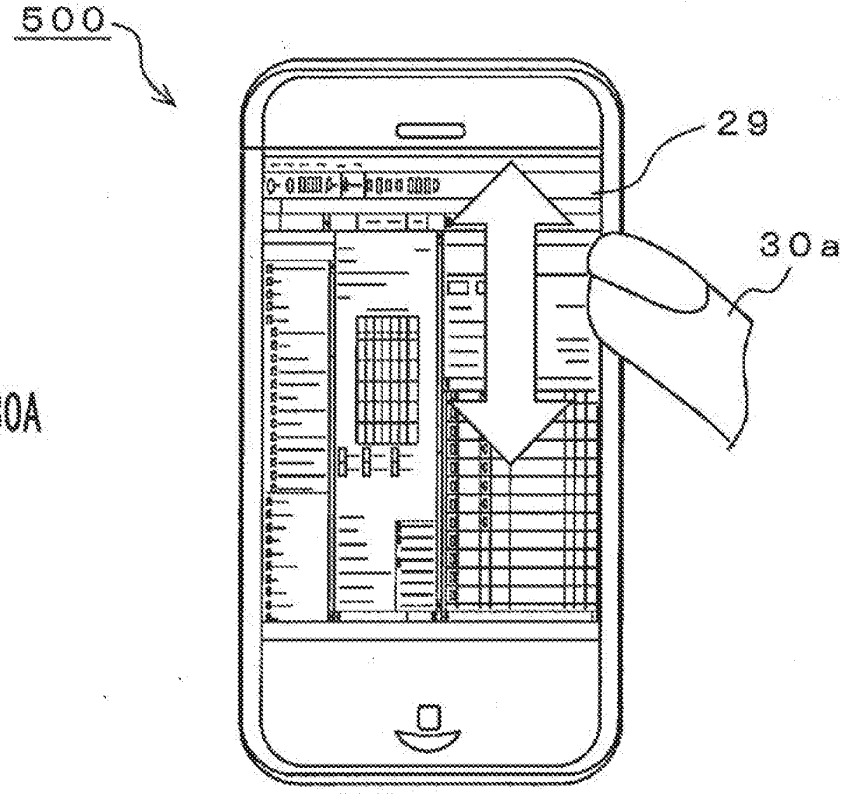


FIG. 30A

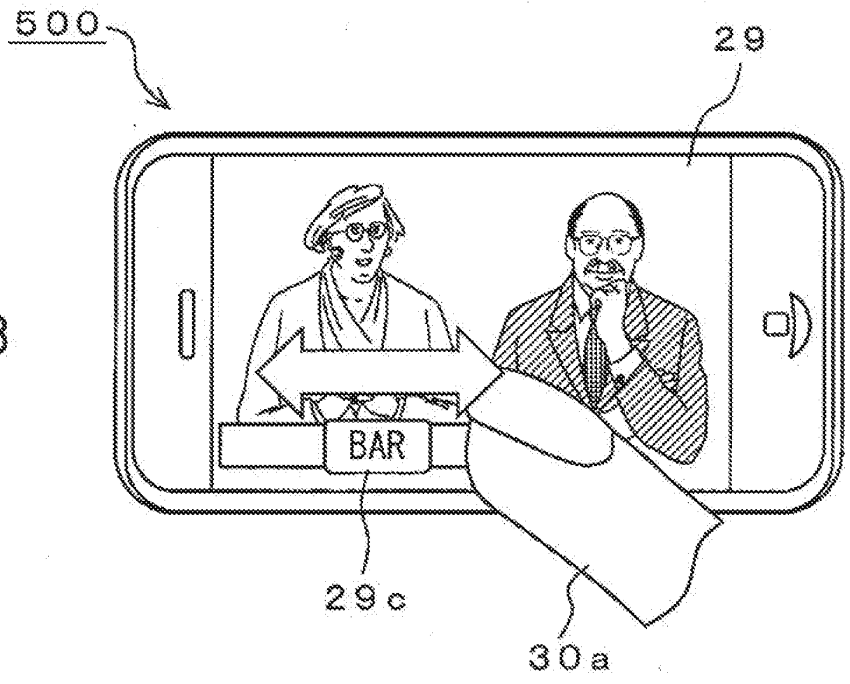


FIG. 30B

FIG. 31

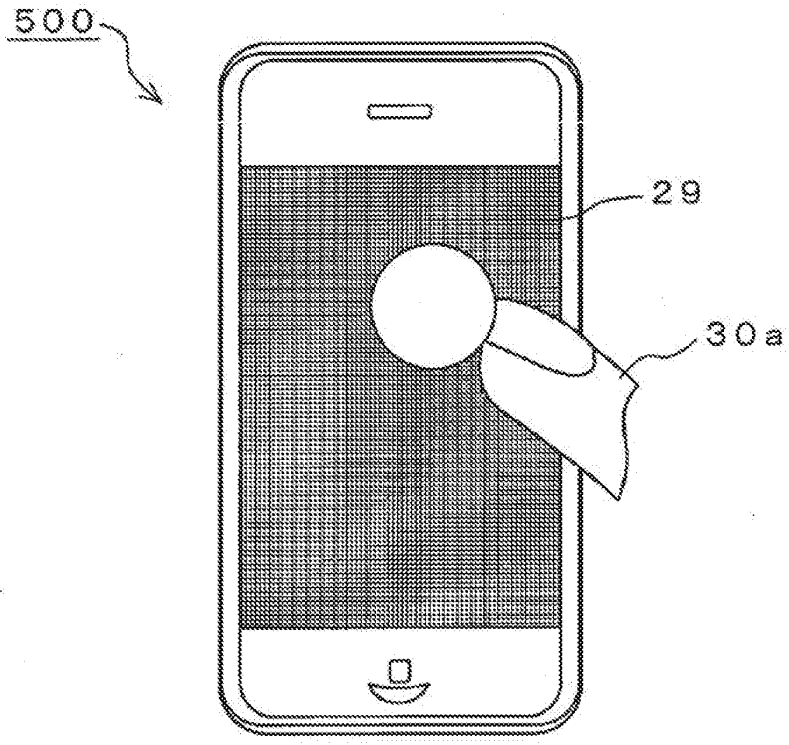


FIG. 32

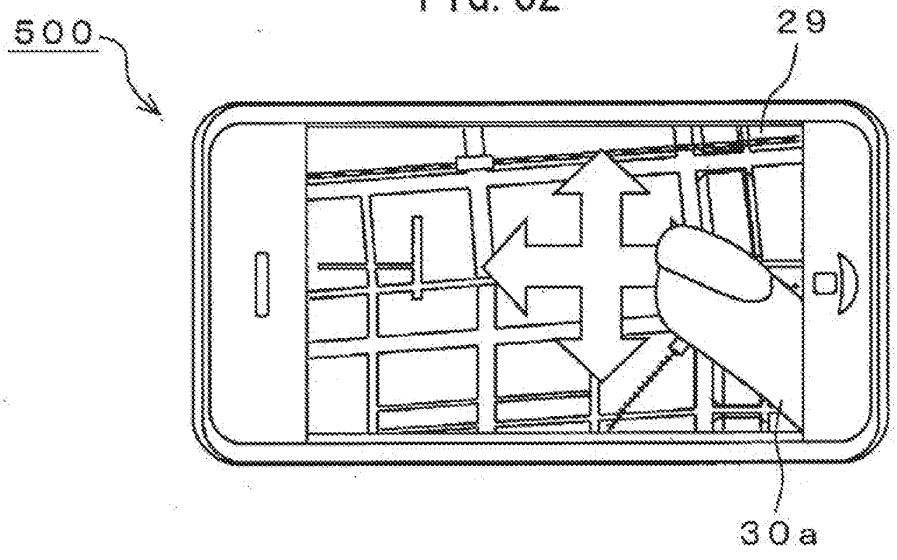


FIG. 33

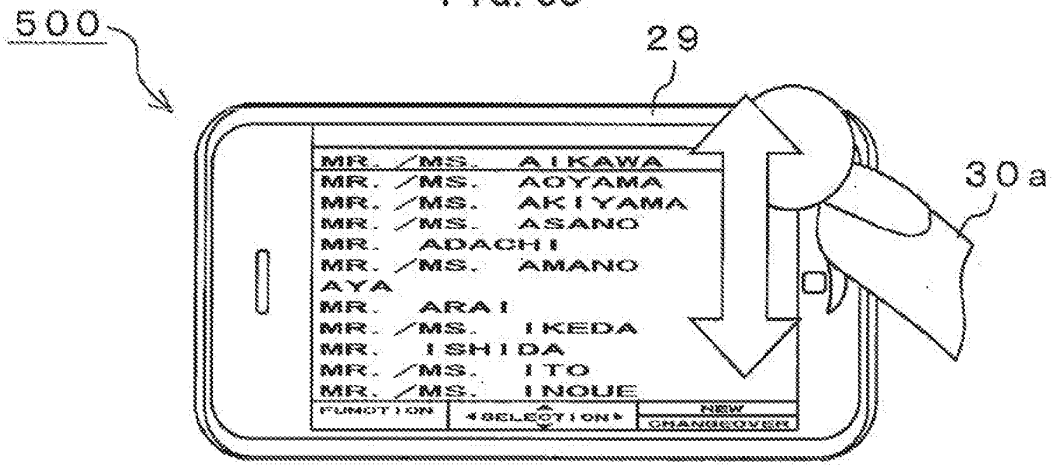

500
29
30a
MR. /MS. AIKAWA
MR. /MS. AOYAMA
MR. /MS. AKIYAMA
MR. /MS. ASANO
MR. ADACHI
MR. /MS. AMANO
AYA
MR. ARAI
MR. /MS. IKEDA
MR. ISHIDA
MR. /MS. ITO
MR. /MS. INOUE
FUNCTION
SELECTION
NEW
CHANGEOVER

FIG. 34

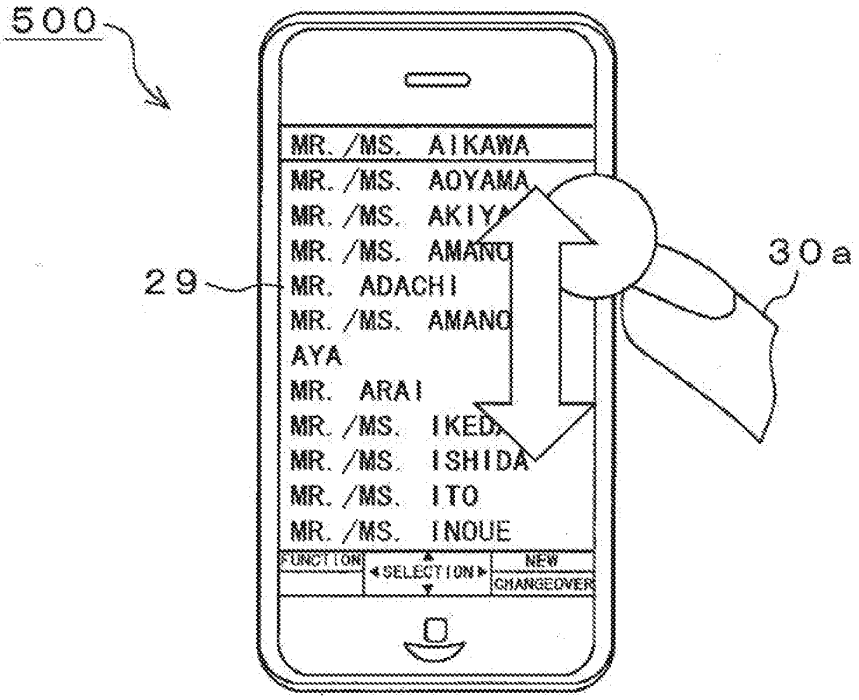

500
29
30a
MR. /MS. AIKAWA
MR. /MS. AOYAMA
MR. /MS. AKIY
MR. /MS. AMANO
MR. ADACHI
MR. /MS. AMANO
AYA
MR. ARAI
MR. /MS. IKED
MR. /MS. ISHIDA
MR. /MS. ITO
MR. /MS. INOUE
FUNCTION
SELECTION
NEW
CHANGEOVER

FIG. 35

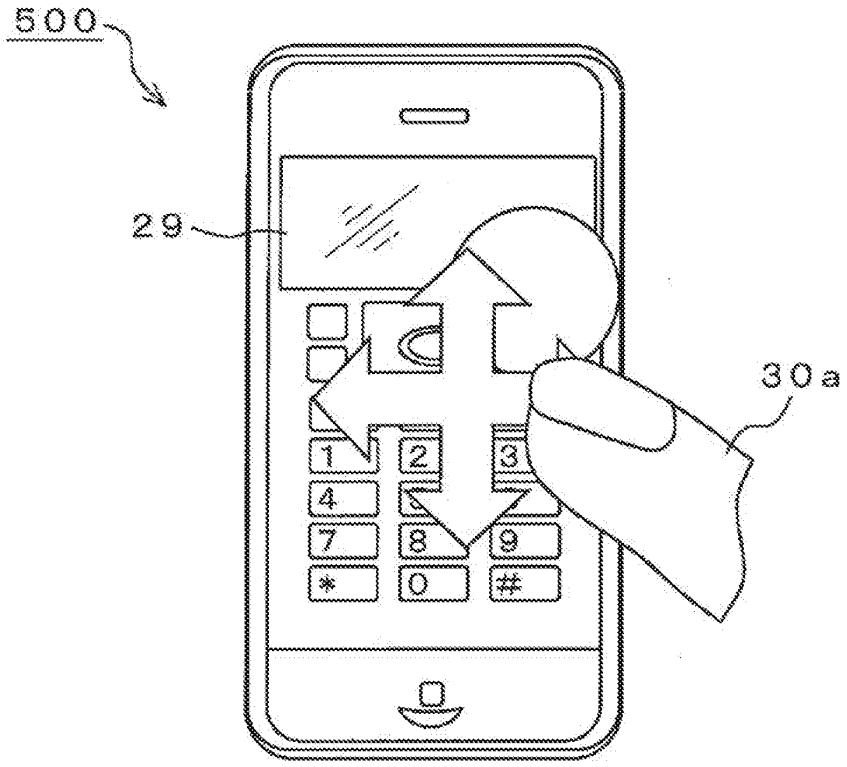


FIG. 36

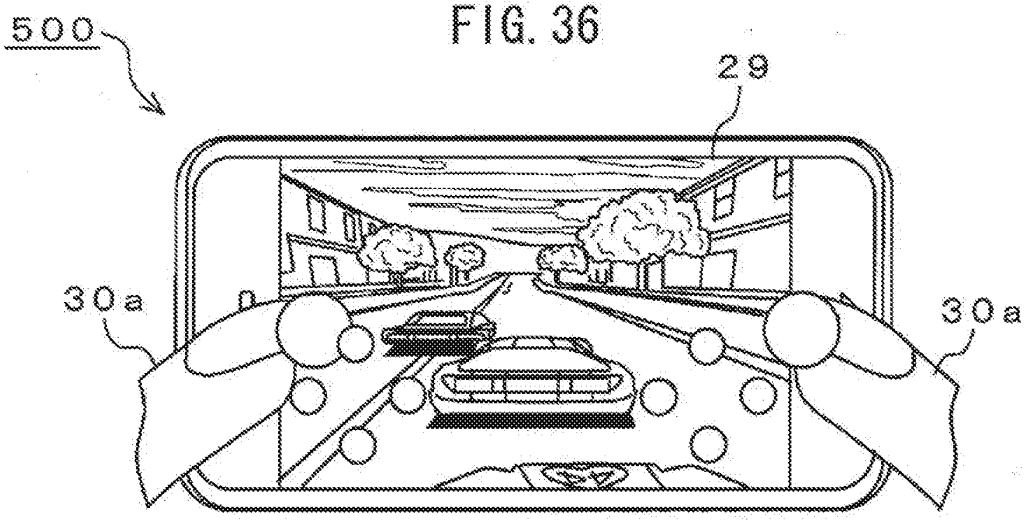


FIG. 37

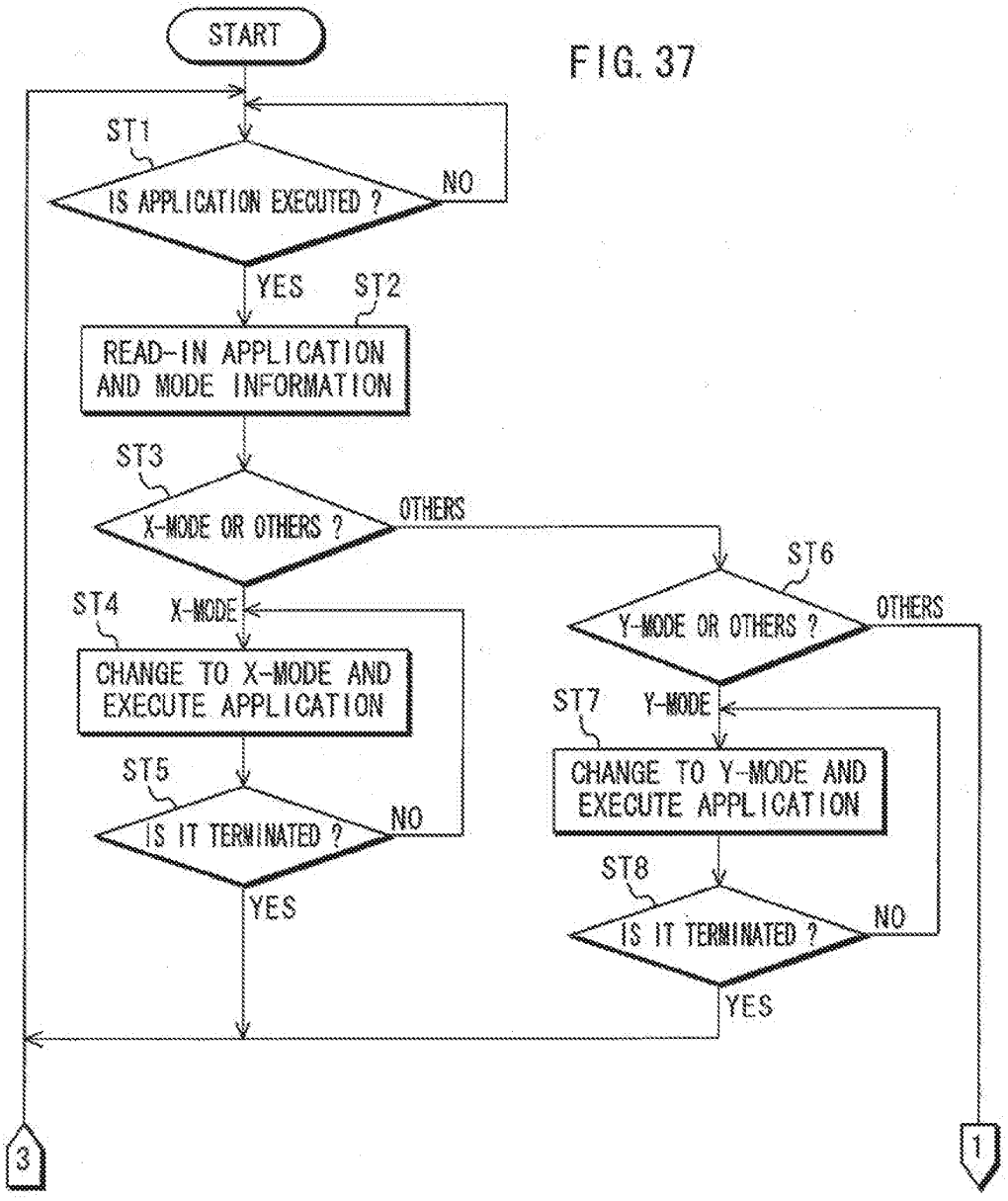

START
ST1
IS APPLICATION EXECUTED ?
NO
YES
ST2
READ-IN APPLICATION AND MODE INFORMATION
ST3
X-MODE OR OTHERS ?
OTHERS
ST4
X-MODE
CHANGE TO X-MODE AND EXECUTE APPLICATION
ST5
IS IT TERMINATED ?
NO
YES
ST6
Y-MODE OR OTHERS ?
OTHERS
ST7
Y-MODE
CHANGE TO Y-MODE AND EXECUTE APPLICATION
ST8
IS IT TERMINATED ?
NO
YES
3
1

FIG. 38

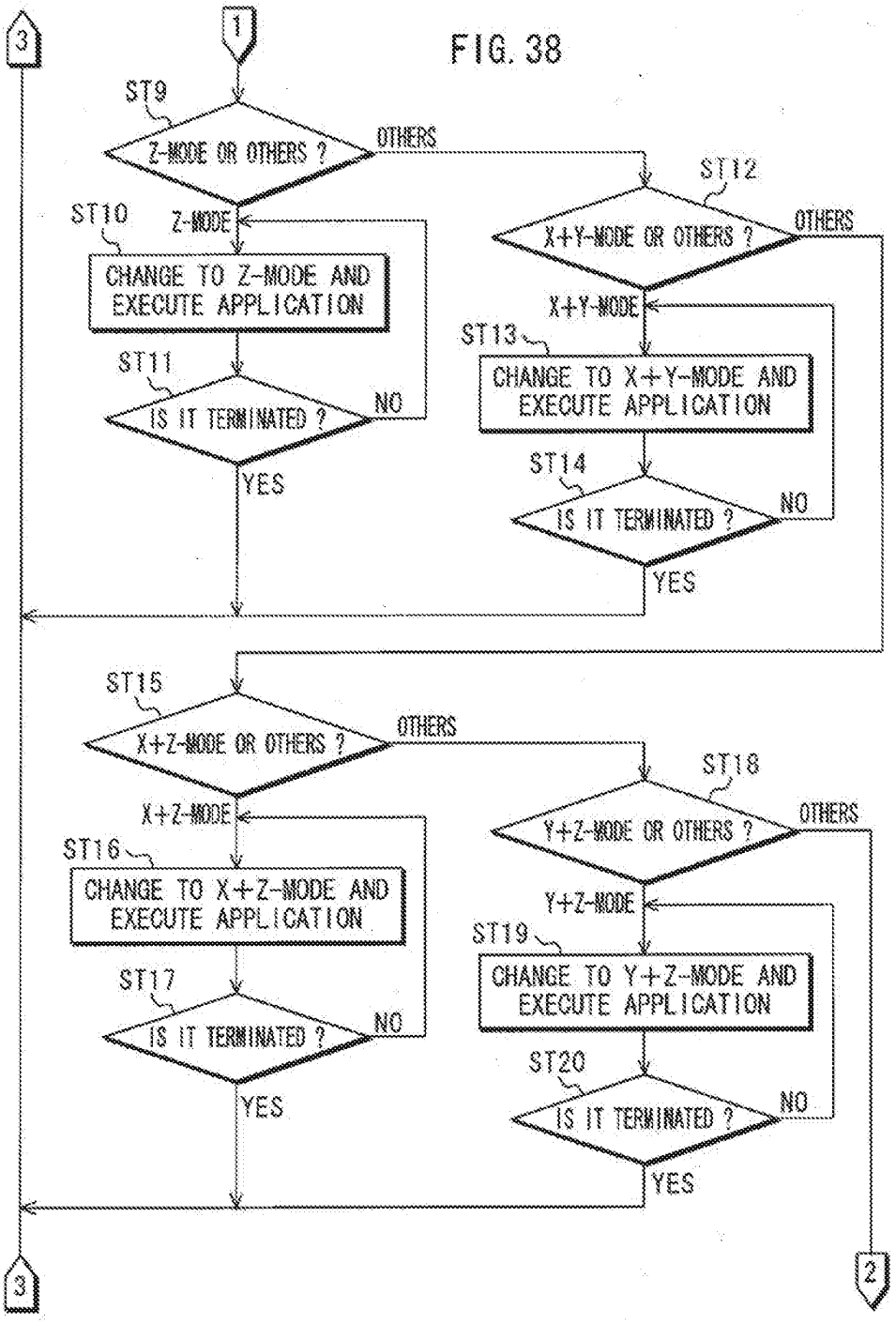
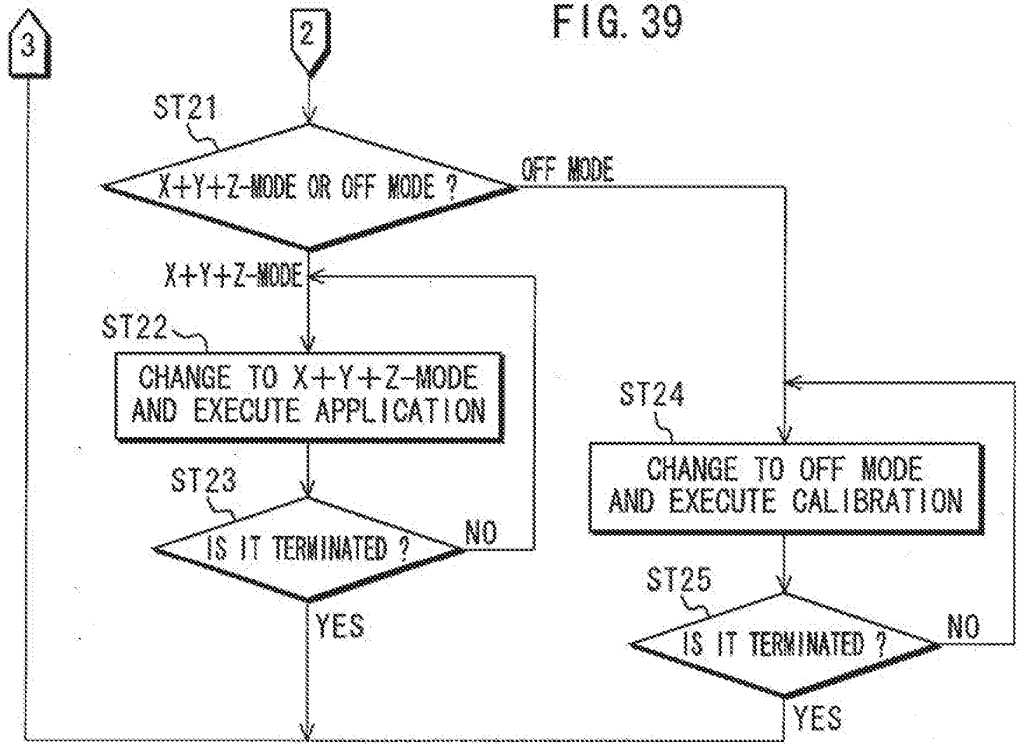

1
3
ST9
Z-MODE OR OTHERS ?
OTHERS
ST10
Z-MODE
CHANGE TO Z-MODE AND EXECUTE APPLICATION
ST11
IS IT TERMINATED ?
NO
YES
ST12
X+Y-MODE OR OTHERS ?
OTHERS
X+Y-MODE
ST13
CHANGE TO X+Y-MODE AND EXECUTE APPLICATION
ST14
IS IT TERMINATED ?
NO
YES
ST15
X+Z-MODE OR OTHERS ?
OTHERS
X+Z-MODE
ST16
CHANGE TO X+Z-MODE AND EXECUTE APPLICATION
ST17
IS IT TERMINATED ?
NO
YES
ST18
Y+Z-MODE OR OTHERS ?
OTHERS
Y+Z-MODE
ST19
CHANGE TO Y+Z-MODE AND EXECUTE APPLICATION
ST20
IS IT TERMINATED ?
NO
YES
3
2

FIG. 39


3
2
ST21
X+Y+Z-MODE OR OFF MODE ?
OFF MODE
X+Y+Z-MODE
ST22
CHANGE TO X+Y+Z-MODE AND EXECUTE APPLICATION
ST23
IS IT TERMINATED ?
NO
YES
ST24
CHANGE TO OFF MODE AND EXECUTE CALIBRATION
ST25
IS IT TERMINATED ?
NO
YES

PRESS DETECTION SENSOR, INPUT DEVICE AND ELECTRONIC APPARATUS

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] The present application claims priority to Japanese Patent Application JP 2007-309451 filed in the Japanese Patent Office on Nov. 29, 2007, the entire contents of which being incorporated herein by reference.

BACKGROUND

[0002] The present application relates to a press detection sensor, an input device and an electronic apparatus, which are preferably applicable to a mobile phone, an information processing apparatus, an information mobile terminal or the like that inputs information by executing a slide operation and a press operation of an input detection surface on a display unit.

[0003] In recent years, a user (operator) has often used a digital camera equipped with various kinds of operation modes to shoot a subject and has often taken various kinds of contents in a mobile phone or an information mobile terminal such as a Personal Digital Assistants (PDA) to utilize them. These digital camera, mobile terminal device and the like have their input devices. An input unit such as a key board and a JOG dial, a touch panel formed by combining a display unit, and the like has been often used for the input device.

[0004] Further, there are disclosed an input device that can input information by moving a finger of the user or the like physically on a touch panel on a display unit (with a detection function in XY-directions) and an input device that can input information by pushing down an operation surface with a user's finger (with a detection function in Z-direction).

[0005] Japanese Patent Application Publication No. 2005-332063 has disclosed on page 4 and FIG. 3 thereof the input device with this kind of detection function in Z-direction, in which a touch-sensitive function is provided. This input device has a resistive touch panel on a display unit of a liquid crystal display device or the like and a pressure detection system on the downward side of the display unit. The pressure detection system includes four pressure detection sensors provided at the four corners on the downward side of the display unit and a driver IC which processes the pressure detection signals thereof.

[0006] According to the pressure detection system, in case of detecting the pressure in Z-direction, the four pressure detection sensors supporting the display unit detect the pressure when a user's finger or the like pushes the touch panel down from the top thereof and output four kinds of pressure detection signals to the driver IC. The driver IC calculates the four kinds of pressure detection signals and obtains an average value among the four pressure detection sensors to be compared with a preset threshold level, which can obtain an input device provided with a detection function in Z-direction in addition to a detection function in X and Y directions.

SUMMARY

[0007] According to an electronic apparatus include the input device with a detection function in Z-direction as disclosed in Japanese Patent Application Publication No. 2005-332063, there is employed a laminated structure in which a display unit of a liquid crystal display device or the like, a surface operation member of a touch panel or the like, an upper portion housing and the like are combined in multiple stages on the four pressure detection sensors. Consequently, the pressure detection system is complicated and the pressure detection sensors mount those members so that an unstable load having nothing to do with the input operation will be not added thereon from those members. More specifically, it is difficult to mount the above-mentioned members with high accuracy.

[0008] Further, a constitution is employed in which the pressure detection sensors are arranged under the display unit and the display unit is supported by only the pressure detection sensors from a view point of the pressure detecting principle. A mechanical gap may be secured on the periphery of the display unit. For this reason, any moisture and dust may invade therethrough into the inside of the electronic apparatus.

[0009] Also, the exclusive driver IC for calculating four kinds of pressure detection signals outputted from the above-mentioned four pressure detection sensors is provided, which results in a cost increase of the pressure detection system.

[0010] It is, thus, desirable to provide a press detection sensor, an input device and an electronic apparatus in which it is possible to detect a press reliably in response to an external force at a pressed position and it is possible to prevent dust, water and the like from invading thereinto.

[0011] According to an embodiment, there is provided a press detection sensor. The press detection sensor contains a base member having predetermined length and width and also having a predetermined shape, a first conductor having predetermined length and being arranged on the base member, and a second conductor that is arranged on the base member with the second conductor being faced to the first conductor. The press detection sensor also contains a conductive contact body that is arranged between the first conductor and the second conductor. The conductive contact body connects the first and second conductors electrically in response to an external force. The press detection sensor further contains a covering member that includes the contact body on the inside thereof. The covering member covers a top of the base member which includes the first and second conductors. The covering member contains flexibility and/or elasticity.

[0012] According to the embodiment, of the press detection sensor, when executing a press operation, it is possible to detect the press reliably in response to the external force at a position at which the contact body connects the first and second conductors electrically. Thus, it is also possible to provide a frame shaped press detection sensor or the like having a thin and simple structure while employing an air-tight structure that can prevent dust, water or the like from invading.

[0013] According to another embodiment, there is provided an input device that inputs information in response to a press operation of an operation body. The input device contains a display-and-detection unit that displays the input information and contains an input detection surface. The display-and-detection unit detects a contact position of the operation body in the input detection surface. The input device also contains a press detection unit that detects a press by the operation body. The press detection unit is provided on a periphery of the display unit. The press detection unit includes a base member having predetermined length and width and also having a predetermined shape, a first conductor having predetermined length and being arranged on the base member, and a second conductor that is arranged on the base member with the second conductor being faced to the

first conductor. The press detection unit also includes a conductive contact body that is arranged between the first conductor and the second conductor. The conductive contact body connects the first and second conductors electrically in response to an external force. The press detection unit further includes a covering member that includes the contact body on the inside thereof. The covering member covers a top of the base member which includes the first and second conductors. The covering member contains flexibility and/or elasticity. Further, the display-and-detection unit may contain a display subunit that displays the input information and a detection subunit that contains an input detection surface on the display subunit, the detection subunit detecting a contact position of the operation body in the input detection surface.

[0014] In the embodiment of the input device, there is provided the embodiment of the press detection sensor, so that when inputting the information in response to the press operation by the operation body into the input detection surface on the display unit, it is possible not only to reliably detect information relative to a position at which the first and second conductors are connected electrically in response to the external force but also to reliably detect a press corresponding to a period of time when the contact body connects the first and second conductors electrically in response to the external force. Thus, it is possible to provide the input device mounted with the frame shaped press detection sensor or the like having a thin and simple structure while employing an air-tight structure that can prevent dust, water or the like from invading thereinto.

[0015] According to further embodiment, there is provided an electronic apparatus that is provided with an input device which inputs information in response to a press operation of an operation body. The input device contains a display unit that displays the input information, a detection unit that includes an input detection surface on the display unit and a press detection unit that detects a press by the operation body. The detection unit detects a contact position of the operation body in the input detection surface. The press detection unit is provided on a periphery of the display unit. The press detection unit includes a base member having predetermined length and width and also having a predetermined shape, a first conductor having predetermined length and being arranged on the base member, a second conductor that is arranged on the base member with the second conductor being faced to the first conductor. The press detection unit also includes a conductive contact body that is arranged between the first conductor and the second conductor. The conductive contact body connects the first and second conductors electrically in response to an external force. The press detection unit further includes a covering member that includes the contact body on the inside thereof. The covering member covers a top of the base member which includes the first and second conductors. The covering member contains flexibility and/or elasticity.

[0016] In the embodiment of the electronic apparatus, there is provided the embodiment of the input device, so that when inputting information in response to the press operation by the operation body into the input detection surface on the display unit, it is possible not only to reliably detect information relative to a position at which the first and second conductors are connectal electrically in response to the external force but also to reliably detect a press corresponding to a period of time when the contact body connects the first and second conductors electrically in response to the external force. Thus, it is possible to provide the electronic apparatus with the input device mounted with the frame shaped press detection sensor or the like having a thin and simple structure while employing an air-tight structure that can prevent dust, water or the like from invading thereinto.

[0017] The concluding portion of this specification particularly points out and directly claims the subject matter. However, those skilled in the art will best understand both the organization and method of operation of the application, together with further advantages and objects thereof, by reading the remaining portions of the specification in view of the accompanying drawing(s) wherein like reference characters refer to like elements.

[0018] Additional features and advantages are described herein, and will be apparent from the following Detailed Description and the figures.

BRIEF DESCRIPTION OF THE FIGURES

[0019] FIG. **1** is a perspective view of a press detection sensor **100** as a first embodiment for showing a configuration thereof;

[0020] FIG. **2** is a cross-section view of one side of the press detection sensor **100** for showing a configuration thereof;

[0021] FIG. **3** is an exploded perspective view of the press detection sensor **100** for showing an assembled example thereof;

[0022] FIG. **4**A is a schematic diagram for showing an arrangement example of electrode patterns **51**, **52** and an elastic electric conductor **53**, FIG. **4**B is a schematic diagram of the electrode patterns **51**, **52** and the elastic electric conductor **53** in a case where they are extended, and FIG. **4**C is a diagram showing an equivalent circuit thereof;

[0023] FIG. **5** is a table showing operation examples of the press detection sensor **100**;

[0024] FIG. **6** is a circuit diagram showing a detection circuit example of the press detection sensor **100**;

[0025] FIGS. **7**A and **7**B are conceptional diagrams showing pushdown states of the elastic electric conductor **53** and FIG. **7**C is a graph showing an example of change in a resistance value between the electrode patterns **51** and **52**;

[0026] FIGS. **8**A to **8**D are conceptional diagrams showing pushdown operation examples of the press detection sensor **100** and FIG. **8**E is a graph showing an output characteristic example of the press detection sensor **100**;

[0027] FIGS. **9**A through **9**C are cross-sectional views of the elastic electric conductor **53** for showing shape examples of cross sections of other configurations thereof;

[0028] FIG. **10** is a plan view of electrode patterns **51**A and **52**A for showing a configuration thereof;

[0029] FIG. **11** is a perspective view of a mobile phone **200** with a touch-sensitive input function as a second embodiment of the application for showing a configuration thereof, in which the mobile phone **200** is provided with an embodiment of an input device;

[0030] FIG. **12** is a cross-sectional view of the mobile phone **200** for showing an internal configuration thereof;

[0031] FIG. **13** is an exploded perspective view of an input device **90** for showing an assembled example thereof;

[0032] FIG. **14** is a block diagram of the mobile phone **200** with a touch-sensitive input function for showing an inside configuration thereof;

[0033] FIG. **15** is a flowchart showing an information-processing example in the mobile phone **200** relating to the second embodiment;

[0034] FIG. **16** is a cross-sectional view of a mobile phone **300** as a third embodiment for showing a configuration thereof;

[0035] FIG. **17** is an exploded perspective view of an input device **901** for showing an assembled example thereof;

[0036] FIG. **18** is a cross-sectional view of a mobile phone **400** as a fourth embodiment for showing a configuration thereof;

[0037] FIG. **19** is an exploded perspective view of an input device **902** for showing an assembled example thereof;

[0038] FIG. **20** is a cross-sectional view of a mobile phone **500** as a fifth embodiment for showing a configuration thereof;

[0039] FIG. **21** is a plan view of a press detection unit **50**A for showing a configuration of electrode patterns therein and a function example (Part one) thereof;

[0040] FIG. **22** is a plan view of a press detection unit **50**A for showing a configuration of electrode patterns therein and a function example (Part two) thereof;

[0041] FIG. **23** is a plan view of a press detection unit **50**A for showing a configuration of electrode patterns therein and a function example (Part three) thereof;

[0042] FIG. **24** is an exploded perspective view of an input device **903** for showing an assembled example thereof;

[0043] FIG. **25** is a circuit diagram showing an equivalent circuit example of the press detection unit **50**A and a detection example of an output voltage Vo thereof;

[0044] FIG. **26** is a graph showing a characteristic example of a resistance value Rv in the press detection unit **50**A at a time of shipment and at a time of calibration;

[0045] FIG. **27** is a plan view of the press detection unit **50**A for showing an arrangement example of elastic electric conductors **553***a* to **553***d* therein;

[0046] FIG. **28** is a plan view of the press detection unit **50**A for showing an arrangement example of electrode patterns **551***a* to **551***d* and electrode patterns **552***a* to **552***d* therein;

[0047] FIG. **29** is a plan view of the mobile phone **500** for showing an X-mode input function example thereof;

[0048] FIGS. **30**A and **30**B are plan views of the mobile phones **500** for showing Y-mode input function examples thereof;

[0049] FIG. **31** is a plan view of the mobile phone **500** for showing a Z-mode input function example thereof;

[0050] FIG. **32** is a plan view of the mobile phone **500** for showing an X+Y-mode input function example thereof;

[0051] FIG. **33** is a plan view of the mobile phone **500** for showing an X+Z-mode input function example thereof;

[0052] FIG. **34** is a plan view of the mobile phone **500** for showing a Y+Z-mode input function example thereof;

[0053] FIG. **35** is a plan view of the mobile phone **500** for showing an X+Y+Z-mode input function example thereof;

[0054] FIG. **36** is a plan view of the mobile phone **500** for showing a multi-point mode input function example thereof;

[0055] FIG. **37** is a flowchart showing an operation mode changeover example (Part one) in the mobile phone **500**;

[0056] FIG. **38** is a flowchart showing an operation mode changeover example (Part two) in the mobile phone **500**; and

[0057] FIG. **39** is a flowchart showing an operation mode changeover example (Part three) in the mobile phone **500**.

DETAILED DESCRIPTION

[0058] An embodiment of the press detection sensor, the input device and the electronic apparatus with reference to the drawings is described as follows.

Embodiment 1

[0059] FIG. **1** shows a configuration of a press detection sensor **100** as a first embodiment. The press detection sensor **100** shown in FIG. **1** contains electrode patterns **51**, **52**, an elastic electric conductor **53**, a cover sheet **54** and a base sheet **55**. The base sheet **55** constitutes one example of a base member and has predetermined length and width and also has a predetermined shape. The base sheet **55** has an insulation property and has, for example, a frame shape that is formed around an opened space provided in the middle thereof. The reason why the press detection sensor **100** has a frame shape is because, if an input device is constituted, a display unit such as a liquid crystal display device is incorporated into the opened space provided in the middle thereof and a display surface of the display unit is used as an operation surface.

[0060] The electrode pattern **51** constitutes one example of a first conductor, has a predetermined length, and is arranged on the base sheet **55**. The electrode pattern **52** constitutes one example of a second conductor and arranged on the base sheet **55** with the electrode pattern **52** being faced to the electrode pattern **51**. The elastic electric conductor **53** constituting one example of a conductive contact body is arranged between the electrode pattern **51** and the electrode pattern **52**. The elastic electric conductor **53** connects the electrode pattern **51** and the electrode pattern **52** electrically in response to an external force. For the elastic electric conductor **53**, there is used, for example, a conductive rubber member.

[0061] The cover sheet **54** constitutes one example of a covering member, includes the elastic electric conductor **53** on the inside thereof, and covers a top of the base sheet **55** which includes the electrode pattern **51** and the electrode pattern **52**. The cover sheet **54** has flexibility and/or elasticity. In this embodiment, the elastic electric conductor **53** and the cover sheet **54** may be made of a same material. For example, the elastic electric conductor **53** and the cover sheet **54** can be molded by using the same die, thereby enabling a process of manufacturing the press detection sensor **100** to be simplified.

[0062] In this embodiment, one terminal of the electrode pattern **51** is connected to a first terminal **56**, one terminal of the electrode pattern **52** is connected to a second terminal **57** and both of the other terminals of the electrode patterns **51** and **52** are opened. Also, the base sheet **55** on which the electrode pattern **51** and the electrode pattern **52** are arranged has a frame shape.

[0063] FIG. **2** shows a configuration of one side of the press detection sensor **100**. In FIG. **2**, supposing that a width of the base sheet **55** is w, the width w is around 3 mm to 5 mm. Supposing that a thickness of the press detection sensor **100** is t, the thickness t is around 0.5 mm to 1.5 mm. Polyimide-based and sheet-shaped resin material having a thickness of around 0.05 mm to 0.3 mm. is used for the base sheet **55**.

[0064] On the base sheet **55**, the electrode pattern **51** and the electrode pattern **52** are arranged in parallel with them keeping a predetermined distance. For the electrode pattern **51** and the electrode pattern **52**, a copper (Cu) foil, a nickel silver foil, a bronze foil or a brass foil is used.

[0065] The cover sheet **54** contains, for example, an upper portion base sheet **54***a*, an inside space sheet **54***b* and an outside space sheet **54***c*. The inside space sheet **54***b* and the outside space sheet **54***c* are provided on both the sides of the base sheet **55** and have functions of spacers between the upper portion base sheet **54***a* and the base sheet **55**. These spacers are provided so that a space is secured (formed) inside a region surrounded by the cover sheet **54** on the base sheet **55**. For the upper portion base sheet **54***a*, polyimide-based and sheet-shaped resin material having a thickness of around 0.05 mm to 0.3 mm. is used.

[0066] In this embodiment, under (on the rear surface of) the upper portion base sheet **54***a*, the elastic electric conductor **53** is hung down. When pressing the upper portion base sheet **54***a*, the elastic electric conductor **53** contacts the electrode pattern **51** and the electrode pattern **52** on the base sheet **55** and maintains the conduction state therebetween. For the elastic electric conductor **53**, electric conductive rubber having a thickness of around 0.05 mm to 0.5 m is used.

[0067] When a user pushes down the upper portion base sheet **54***a* weakly, the elastic electric conductor **53** weakly touches an edge of the electrode pattern **51** and an edge of the electrode pattern **52**. When the user pushes down the upper portion base sheet **54***a* strongly, the elastic electric conductor **53** enters into a space between the electrode pattern **51** and the electrode pattern **52**. In this case, contact resistance becomes considerably low as compared with a case in which the patterns are touched weakly.

[0068] Here, when the upper portion base sheet **54***a* is not pressed, the electrode pattern **51** and the electrode pattern **52** on the base sheet **55** are away from each other so that an electrical insulation state is maintained therebetween. In this embodiment, it is allowed to mold the elastic electric conductor **53**, the upper portion base sheet **54***a*, the inside space sheet **54***b* and the outside space sheet **54***c* by using the same conductive rubber member.

[0069] At the upper portion of the upper portion base sheet **54***a*, for example, an adhesive sheet **58** is provided and is used when the upper portion base sheet **54***a* adheres to an upper component part. For the adhesive sheet **58**, an acrylic-based adhesive agent is used. The thickness thereof is around 25 μm to 300 μm. The adhesive sheet **58** may be omitted if no upper component part is layered.

[0070] With respect to the upper component part to be layered, a surface plate such as a touch-sensitive input sheet, which is described in Japanese Patent Application No. 2007-308089, is illustrated. The touch-sensitive input sheet is referred to as a sheet in which protrusion blocks having cylindrical shapes or conical shapes in order to present concavity and convexity feeling are distributed so as to be provided standingly in the vertical direction with respect to a sheet surface of base sheet which forms base material.

[0071] At the lower portion of the base sheet **55**, an adhesive sheet **59** is provided and is used when the base sheet **55** adheres to a lower component part. With respect to the lower component part, a housing of an electronic apparatus, a substrate, a display panel or the like is illustrated. For the adhesive sheet **59**, an acrylic-based adhesive agent is used. The thickness thereof is around 25 μm to 300 μm. The adhesive sheet **59** may be omitted if no lower component part is arranged.

[0072] FIG. **3** shows an assembled example of the press detection sensor **100**. In connection with the press detection sensor **100** shown in FIG. **3**, the frame shaped base sheet **55** is prepared. For the base sheet **55**, a polyimide-based and sheet-shaped resin material having thickness of around 0.05 mm to 0.3 mm is used.

[0073] Next, the electrode pattern **51** and the electrode pattern **52** are arranged on the base sheet **55** with a predetermined space therebetween. Resist material is coated on a whole surface of a board for the base sheet **55**, which attaches copper foil on one side of the board, the resist material is exposed and developed through a reticle by which the frame shaped electrode pattern **51** and the frame shaped electrode pattern **52** are drawn and then, the unnecessary copper foil pattern is removed from the one-side-copper-foil-attached board using a resist film as a mask with the board soaking in an etching solution. For the electrode pattern **51** and the electrode pattern **52**, a nickel silver foil, a bronze foil or a brass foil is used in addition to the copper foil.

[0074] On the other hand, the elastic electric conductor **53** is attached to the cover sheet **54**. It is allowed to employ a method in which the cover sheet **54** is formed so as to have a sectional shape like a letter of C and the elastic electric conductor **53** with a square ring shape is adhered to the cover sheet **54**, or it is allowed to employ a method in which a die including a core and a cavity by which the cover sheet **54** and the elastic electric conductor **53** are modeled is made and then, the cover sheet **54** and the elastic electric conductor **53** are subject to solid casting by sealing an electric conductive rubber resin into this die. Thereafter, the cover sheet **54** with the elastic electric conductor **53** is thermally bonded so that the cover sheet **54** can cover the base sheet **55**. The temperature condition at that time is set to around 100° C. to 120° C. Thus, the press detection sensor **100** shown in FIG. **1** is completed.

[0075] The following will describe an operation example of the press detection sensor **100**. FIG. **4**A shows an arrangement example of electrode patterns **51**, **52** and an elastic electric conductor **53**, FIG. **4**B schematically shows the electrode patterns **51**, **52** and the elastic electric conductor **53** in a case where they are extended, and FIG. **4**C shows an equivalent circuit thereof. FIG. **5** shows operation examples of the press detection sensor **100**.

[0076] In this embodiment, supposing that four corners of each of the frame shaped electrode pattern **51**, the frame shaped electrode pattern **52** and the frame shaped elastic electric conductor **53** are respectively set to points A, B, C, and D and further, supposing that the gravity center region of the points A, B, C, and D is set to a point E, behaviors of the electrode pattern **51**, the electrode pattern **52** and the elastic electric conductor **53** are shown when pushing down the points A, B, C, D, and E respectively with respective amounts of press.

[0077] According to the arrangement example of the electrode pattern **51**, the electrode pattern **52** and the elastic electric conductor **53** shown in FIG. **4**A, the electrode pattern **51**, shown by diagonal lines, having a frame shape is arranged at the outside, the electrode pattern **52**, shown by an outline, having a frame shape is arranged at the inside, and the elastic electric conductor **53**, shown by dots, having a frame shape is arranged between the electrode pattern **51** and the electrode pattern **52**.

[0078] FIG. **4**B schematically shows the frame shaped electrode pattern **51**, the frame shaped electrode pattern **52** and the frame shaped elastic electric conductor **53** when they are linearly extended. According to an extended example of the electrode pattern **51**, the electrode pattern **52** and the elastic electric conductor **53**, the electrode pattern **52** is arranged on the left side, the elastic electric conductor **53** is arranged in the center region and the electrode pattern **51** is arranged on the right side.

[0079] According to the equivalent circuit example shown in FIG. **4**C, the press detection sensor **100** may constitute a variable resistor VR whose resistance value between the electrode pattern **51** and the electrode pattern **52** varies depending on the pressed state of the elastic electric conductor **53**.

[0080] For example, in the table shown in FIG. **5**, when the point A is pushed down weakly, the elastic electric conductor

53 contacts over the electrode pattern 51 and the electrode pattern 52 and makes the electrode pattern 51 and the electrode pattern 52 conductive. The resistance value at that time is R (I). When the point A is pushed down strongly, the elastic electric conductor 53 contacts the electrode pattern 51 and the electrode pattern 52 with the elastic electric conductor 53 entering into a space between the electrode pattern 51 and the electrode pattern 52 and makes the electrode pattern 51 and the electrode pattern 52 conductive. The resistance value at that time is R (II). Also with respect to other points B, C and D, the resistance value R(I) is obtained when each point is pushed down weakly and the resistance value R(II) is obtained when each point is pushed down strongly.

[0081] Also, when the point E is pushed down weakly, the elastic electric conductor 53 contacts over the electrode pattern 51 and the electrode pattern 52 and makes the electrode pattern 51 and the electrode pattern 52 conductive. The resistance value at that time is R (I), which is similar to that of a case in which the point A, B, C or D is pushed down weakly. When the point E is pushed down strongly, the elastic electric conductor 53 contacts the electrode pattern 51 and the electrode pattern 52 with the elastic electric conductor 53 entering into a space between the electrode pattern 51 and the electrode pattern 52 and makes the electrode pattern 51 and the electrode pattern 52 conductive. The resistance value at that time is R (II), which is similar to that of a case in which the point A, B, C or D is pushed down strongly. Thus, the resistance value R(I) when the point A, B, C, D or E is pushed down weakly and the resistance value R(II) when the point A, B, C, D or E is pushed down strongly have a relationship of R(I)>R(II).

[0082] Owing to such a relation, it has been found that the press detection sensor 100 can detect the press force F only by reading out the resistance values R(I), R(II) without depending on the pressed position and without using the driver IC.

[0083] FIG. 6 shows a detection circuit example of the press detection sensor 100. According to the detection circuit example of the press detection sensor 100 shown in FIG. 6, a direct current power supply Edc and a voltage detection circuit are connected in series with respect to the electrode pattern 51 and the electrode pattern 52. A voltage meter and a load resistance RL constitutes the voltage detection circuit 63.

[0084] In this detection circuit, when pushing down the elastic electric conductor 53, an electric current "I" flown out from the direct current power supply Edc flows into the load resistance RL through a variable resistor VR composed of the electrode pattern 51, the electrode pattern 52 and the elastic electric conductor 53. A voltage drop VL occurs across the load resistance RL. The voltage drop VL becomes an analog voltage depending on the pressed state of the elastic electric conductor 53. By detecting this analog voltage, it becomes possible to detect the press force F (detection principle).

[0085] FIGS. 7A and 7B show pressed states of the elastic electric conductor 53 and FIG. 7C shows an example of change in a resistance value between the electrode patterns 51 and 52. The vertical axis shown in FIG. 7C denotes a resistance value [Ω] between the electrode patterns 51 and 52 when pushing down the elastic electric conductor 53. The horizontal axis shown in FIG. 7C denotes the press force F [N] when pushing down the elastic electric conductor 53.

[0086] According to the example of change in a resistance value between the electrode patterns 51 and 52 in this embodiment, as shown in FIG. 7A, the resistance value R(I) is obtained when the elastic electric conductor 53 is pushed down depending on a press force F1 by an operator's finger 30a or the like. Similarly, when pushing down the elastic electric conductor 53 depending on a press force F2, the resistance value R (II) is obtained. It has been found that the resistance value change curve indicates a characteristic having such an inclination that the more the press force increases, the more the resistance value decreases exponentially.

[0087] FIGS. 8A to 8D show pushdown operation examples of the press detection sensor 100 and FIG. 8E shows an output characteristic example of the press detection sensor 100. The vertical axis shown in FIG. 8E denotes an output voltage Vo [V] when pushing down the press detection sensor 100. The horizontal axis shown in FIG. 8E denotes a press force F [N] when pushing down the press detection sensor 100.

[0088] In this embodiment, it has been found that the output characteristic curve of the press detection sensor 100 indicates a characteristic in which the more the press force F increases, the more the output voltage increases exponentially and becomes saturated. When setting a threshold voltage for judgment with respect to such an output characteristic curve, it becomes possible to judge the press force F from the output voltage Vo. In this embodiment, two judgment threshold voltages Vth1 and Vth2 are set (Vth1<Vth2).

[0089] When the finger 30a does not contact with the press detection sensor 100 as shown in FIG. 8A, in other words, on an occasion of non-operation, naturally, F0=0 is true for the press force F. When operating the press detection sensor 100 and in a case in which the finger 30a contacts with the press detection sensor 100 weakly as shown in FIG. 8B, an output voltage Vo equal to or less than the judgment threshold voltage Vth1 is detected, so that it becomes possible to judge a fact that the press force F thereof is approximately F1.

[0090] When the finger 30a contacts with the press detection sensor 100 strongly as shown in FIG. 8C, for example, in a case in which an output voltage Vo is detected which exceeds the judgment threshold voltage Vth1 and is equal to or less than the judgment threshold voltage Tth2, it becomes possible to judge a fact that the press force F is approximately F2. Further, when the finger 30a contacts the press detection sensor 100 more strongly as shown in FIG. 8D, for example, in a case in which the output voltage Vo is detected which exceeds the judgment threshold voltage Vth2, it is possible to judge a fact that the press force F is approximately F3.

[0091] In this manner, according to the press detection sensor 100 as the first embodiment, the cover sheet 54 for covering a top of the base sheet 55 including the electrode pattern 51 and the electrode pattern 52, the cover sheet 54 having on the inside thereof the elastic electric conductor 53 which electrically connects the electrode pattern 51 and the electrode pattern 52 on the base sheet 55 having predetermined length and width and also having a predeterminal shape, is provided and the cover sheet 54 is designed to have flexibility and/or elasticity.

[0092] Consequently, when executing a pushdown operation, it becomes possible to reliably detect a press force F (press-down force) at a position where the elastic electric conductor 53 connects the electrode pattern 51 and the electrode pattern 52 electrically. This enables to be provided the frame shaped press detection sensor 100 with a thin and simple structure while employing an air-tight structure that can prevent dust, water or the like from invading thereinto. Thus, the press detection sensor 100 is a sensor which can be

provided by such a very simple system that only reads the resistance value of the single variable resistor VR.

[0093] The following will describe other configurations of the press detection sensor **100**. FIGS. **9**A through **9**C show shape examples of cross sections of other configurations of the elastic electric conductor **53**. An elastic electric conductor **53**A shown in FIG. **9**A has an M-shaped cross-section. The elastic electric conductor **53**A is a conductor molded into an almost M-shaped one by integrating the elastic electric conductor **53**, the upper portion base sheet **54***a*, the inside space sheet **54***b* and the outside space sheet **54***c*, which have been explained in the first embodiment. For the raw material thereof, a conductive rubber member such as a silicon rubber is used. The elastic electric conductor **53**A has width "w" and thickness "t". In this embodiment, the elastic electric conductor **53**A is arranged on the base sheet **55** of the press detection sensor **100** with the M-shaped region of the elastic electric conductor **53**A being provided along a frame outer direction (longitudinal direction) of the base sheet **55**. When constituting the elastic electric conductor **53**A in this manner, the formation process of the press detection sensor **100** becomes simplified and the elastic electric conductor **53**A has flexibility and/or elasticity. When pushing down the elastic electric conductor **53**A, a space formed in the M-shaped cross-section thereof will absorb the deformation.

[0094] An elastic electric conductor **53**B shown in FIG. **9**B has a rectangular shaped cross-section. The elastic electric conductor **53**B is a conductor molded into a rectangular shape by integrating the elastic electric conductor **53**, the upper portion base sheet **54***a*, the inside space sheet **54***b* and the outside space sheet **54***c*, which have been explained in the first embodiment. For example, the elastic electric conductor **53**B contains conductive particles (hereinafter, referred to as electric conductive particles **53**D) mixed into the rubber member **53**C. The elastic electric conductor **53**B has width "w" and thickness "t". When constituting the elastic electric conductor **53**B in this manner, the elastic electric conductor **53**B has flexibility and/or elasticity. When the elastic electric conductor **53**B is deformed, the electric conductive particles **53**D make the electrode patterns **51**, **52** conductive. The contact resistance formed by the electrode patterns **51**, **52** and the electric conductive particles **533** will decrease.

[0095] An elastic electric conductor **53**E shown in FIG. **9**C has a comb-shaped cross-section. The elastic electric conductor **53**E is a conductor molded into a comb-shaped one by integrating the elastic electric conductor **53**, the upper portion base sheet **54***a*, the inside space sheet **54***b* and the outside space sheet **54***c*, which have been explained in the first embodiment. For the raw material thereof, a conductive rubber member is used. The tips of the comb-shaped region of the elastic electric conductor **53**E are processed into, for example, spherical shape ones in order to improve the contact with the electrode pattern **51**A and the electrode pattern **52**A, which will be shown in FIG. **10**.

[0096] In this embodiment, the elastic electric conductor **53**E is arranged on the base sheet **55** of the press detection sensor **100**A, which will be shown in FIG. **10**, with the comb-shaped region is provided along the frame outer direction (longitudinal direction) of the base sheet **55**. The elastic electric conductor **53**E has width "w" and thickness "t". When constituting the elastic electric conductor **53**E in this manner, the elastic electric conductor **53**E has flexibility and/or elasticity. When pushing down the elastic electric conductor **53**E, a plurality of space portions in the comb-shaped cross-section thereof will absorb the deformation. Also, the elastic electric conductor **53**E shows a unique movement on the electrode pattern **51**A and the electrode pattern **52**A as compared with the elastic electric conductor **53**A. For example, owing to a fact that any tips of the comb-shaped region of the elastic electric conductor **53**E contact with the electrode pattern **51**A and the electrode pattern **52**A, the contact surface thereof increases and the resistance value decreases.

[0097] FIG. **10** shows a configuration of the electrode patterns **51**A and **52**A. In this embodiment, the press detection sensor **100**A is constituted by combining the elastic electric conductor **53**E having the comb-shaped cross-section shown in FIG. **9**C.

[0098] According to the configuration of the press detection sensor **100**A shown in FIG. **10**, the electrode pattern **51**A and the electrode pattern **52**A are made by patterning them on a base sheet, which is not shown, in a configuration of being notched in plain comb shapes. In this embodiment, the comb-shaped region of the electrode pattern **51**A or the electrode pattern **52**A is made by patterning it into a rectangular shape, so that the rectangular shaped region of the electrode pattern **51**A and the rectangular shaped region of the electrode pattern **52**A are combined in a nested state.

[0099] When constituting the press detection sensor **100**A in this manner, not only the distance by which the electrode pattern **51**A and the electrode pattern **52**A face each other can be increased apparently as compared with a case in which the patterns are parallelly provided linearly such as the electrode patterns **51** and **52** but also the area through which the elastic electric conductor **53**E contacts with the electrode pattern **51**A and the electrode pattern **52**A can be increased as compared with the first embodiment. This enables a detailed contact state to be detected among the electrode pattern **51**A, the electrode pattern **52***a* and the elastic electric conductor **53**E.

[0100] It should be noted that any combinations of the electrode pattern **51**, the electrode pattern **52** and the elastic electric conductor **53** can be set and selected freely and any combinations of the electrode pattern **51**A, the electrode pattern **52**A and the elastic electric conductor **53**E can be set and selected freely.

Embodiment 2

[0101] FIG. **11** shows a configuration of a mobile phone **200** with a touch-sensitive input function as a second embodiment in which the mobile phone **200** is provided with an embodiment of an input device.

[0102] The mobile phone **200** shown in FIG. **11** constitutes one example of an electronic apparatus. The mobile phone **200** is an electronic apparatus with the touch-sensitive input function, which presents sense of touch to an operation body (operator) when executing an information input operation, and is provided with an input device **90** with a press detection function relating to the embodiment. The mobile phone **200** performs various kinds of data processing including sound and image processing, in addition to the telephone processing.

[0103] The mobile phone **200** includes a non-folding type housing **401** having an operation surface and the input device **90** with press detection and touch-sensitive input function. The input device **90** is a device that inputs information in response to a press operation by the operation body onto an input detection surface on a display screen thereof. The housing **401** includes an upper operation frame body (cabinet) **41**

and a lower housing **42** (case). The lower housing **42** forms a box body with a bottom plate.

[0104] The input device **90** is fitted together the upper operation frame body **41** and inputs three dimensional information in X, Y, Z directions depending on the sliding and/or press operations by the operator's finger **30***a* or the like. The input device **90** contains, for example, a display unit **29**, an input detection unit **45** and a press detection unit **50**. On the display unit **29**, input information such as an icon image is displayed. The input detection unit **45** is provided on the display unit **29** having the operation surface and detects the slide position of the finger **30***a* of the operator **30** or the like. For the input detection unit **45**, a resistive-film type touch panel, for example, is used. In this embodiment, as the press detection unit **50**, the press detection sensor **100** or **100**A explained as the first embodiment relating is provided (see FIG. **12**).

[0105] A very small sized speaker **36***b* with an actuator function is provided on an upward middle portion of the front surface of the upper operation frame body **41** and concurrently functions as a receiver for phone call (phone receiver) and an actuator for presenting sense of touch. The speaker **36***b* receives an audio signal and a 200 Hz vibration control signal for presenting the sense of touch.

[0106] In this embodiment, with respect to the display unit **29**, A display region thereof is divided into two parts. Any input information of a plurality of button icons or the like is displayed on the display region of the upper part thereof and an operation panel **98** is displayed on the display region of the lower part thereof. In this embodiment, when the icon image for the input operation displayed on the display unit **29** is operated by the finger, it is constituted so as to present clicking sound (cyber switch operation sound) from the speaker **36***b* and at the same time, so as to present the sense of touch to the operator's finger touching the display screen.

[0107] In this embodiment, the operation panel **98** displayed on the display unit **29** includes a plurality of push button switches **92**. For example, the push button switches **92** are constituted by numeral keys of "0" to "9", symbol keys of "*", "#" and the like, hook buttons of "ON", "OFF" and the like, and a mem key or the like. A camera **34** is mounted on the back surface of the display unit **29** and is operated so as to shoot a subject image. A microphone **93** for phone call is mounted on a downward portion of the upper surface of the upper operation frame body **41**, and functions as a telephone transmitter.

[0108] It should be noted that a connector **99** such as a USB terminal is arranged on a side surface of the lower housing **42** and can execute a communication process to an external. A module type antenna **96** is mounted on the inside of lower housing **42**, a speaker for loud sound, which is not shown, is provided at the inner periphery thereof and is constituted so as to sound-emit the incoming melody or the sound (music) or the like which is added to image data. A circuit board **97** is provided on the inside of the lower housing **42**. Further, a battery **94** is built in the housing and the power is supplied to the circuit board **97**, the display unit **29** and the like.

[0109] FIG. **12** shows an internal configuration of the mobile phone **200**. The mobile phone **200** shown in FIG. **12** is mounted so that the upper operation frame body **41** forming a lid can be fitted into the lower housing **42** forming a box body with a bottom plate.

[0110] In this embodiment, the upper operation frame body **41** is provided with a concave portion (step-shaped portion) **41***a* for mounting a component part. In the concave portion **41***a*, an opening portion **43***a* for a display window portion is opened. A display area **29***a* of the display unit **29** is set by the opening portion **43***a*. The display unit **29** is mounted, for example, on the rear surface of the upper operation frame body **41** with the peripheral portion thereof and is mounted so as to be hung down in the lower housing **42**. This enables the display unit **29** to be arranged in the lower housing **42** with the display screen thereof facing upward, thereby displaying the input information. For the display unit **29**, a color liquid crystal display device having thickness of around 1.65 mm. is used.

[0111] In this embodiment, the press detection unit **50** as explained in the first embodiment is mounted on the step-shaped surface of the concave portion **41***a* of the upper operation frame body **41**. The press detection unit **50** includes the frame shaped base sheet **55** having predetermined length and width and also forming an opening portion in the center region thereof, the electrode pattern **51** having predetermined length and being arranged on the base sheet **55**, the electrode pattern **52** that is arranged on the base sheet **55** with it being faced to the electrode pattern **51**, and the elastic electric conductor **53** that is arranged between the electrode pattern **51** and the electrode pattern **52**. The cover sheet **54** including the elastic electric conductor **53** on the inside thereof is provided so that the cover sheet **54** covers the top of the base sheet **55** which includes the electrode pattern **51** and the electrode pattern **52**. The cover sheet **54** has flexibility and/or elasticity.

[0112] The press detection unit **50** is, for example, adhered to the step-shaped surface of the concave portion **41***a* through an adhesive agent. The press detection unit **50** is set so as to form a frame shape on the periphery of the display unit **29**, connects the electrode pattern **51** and the electrode pattern **52** electrically in response to the press force F of the operation body and detects the press force F of the operation body. The inside opening portion of the press detection unit **50** corresponds to the display area **29***a*. The press detection unit **50** also has a coupling function of the upper and lower members.

[0113] The input detection unit **45** is provided at the upper portion of the press detection unit **50**. The input detection unit **45** is provided at the upper portion of the display unit **29** and on the frame shaped press detection unit **50**. The input detection unit **45** is, for example, adhered to the frame shaped region of the press detection unit **50** through an adhesive agent. The input detection unit **45** has an input detection surface on the display unit **29** and detects the contact position of the operation body on the input detection surface.

[0114] For the input detection unit **45**, a touch panel in which a front surface plate and a resistive film are incorporated having thickness of around 1.1 mm to 1.5 mm is used. For the touch panel forming the input detection unit **45**, a touch panel is used, which includes, for example, an electric conductive film **47***a* for a resistive film that is provided on a base sheet **49**, spacers **48***a*, **48***b* that is provided on the electric conductive film **47***a*, and an electric conductive film **47***b* for resistive film selection that is provided at the upper portion of these spacers **48***a*, **48***b*. In a predetermined region of the electric conductive film **47***b*, a black silk print **46** is applied, which enables display light to be shut off. A space occurs between the display unit **29** and the input detection unit **45**, and it is allowed to fill up this space with a transparent member as disclosed in Japanese Patent Application Publication No. 2004-77887.

[0115] Also, it is satisfactory if, for example, a touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089 is used for the front surface plate. Here, the touch-sensitive input sheet means a touch sheet by which an input operation accompanied by a concavity and convexity feeling is available when touching the icon image displayed on the display unit **29** by a finger or the like. It is needless to say that the operator's finger **30***a* is not limited and any input operation using an operation body such as a pen and a stylus is allowed.

[0116] FIG. **13** shows an assembled example of the input device **90**. According to the input device **90** shown in FIG. **13**, there are prepared the display unit **29**, the speaker **36***b* with actuator function, the upper operation frame body **41**, the input detection unit **45** and the press detection unit **50**. As the upper operation frame body **41**, a frame body formed by injection die molding is used. For example, a die including a core and a cavity, in which the opening portion **43***a* for the display window and the opening portion **43***b* for attachment of the speaker **36***b* are molded, is made and the upper operation frame body **41** is molded into one body by sealing an ABC resin or the like into this die.

[0117] First, the press detection unit **50** is mounted on the upper operation frame body **41**. For example, an adhesive agent is coated in a frame shape on the step-shaped surface of the concave portion **41***a* thereof. Thereafter, the press detection unit **50** is position-aligned with respect to the concave portion **41***a* and the press detection unit **50** is adhered so as to be fallen into the concave portion **41***a* thereof. For the press detection unit **50**, the detection unit explained in the first embodiment is used.

[0118] Then, the input detection unit **45** is mounted on the press detection unit **50**. For example, an adhesive agent is coated on the frame shaped region of the press detection unit **50**. Thereafter, the input detection unit **45** is position-aligned with respect to the concave portion **41***a* and the input detection unit **45** is adhered on the press detection unit **50** so as to be fallen into the concave portion **41***a* thereof. For the input detection unit **45**, a touch panel in which a front surface plate and a resistive film are incorporated is used.

[0119] Next, the speaker **36***b* with actuator function is mounted on the input detection unit **45**. For example, the speaker **36***b* is arranged at a predetermined position of the input detection unit **45** through the opening portion **43***b* of the upper operation frame body **41** and is fixed through an adhesive agent. Further, the display unit **29** is mounted on the rear side of the upper operation frame body **41**. For example, an adhesive agent is coated on the rear surface of the upper operation frame body **41** along the periphery portion of the opening portion **43***a* thereof. Thereafter, the display area **29***a* of the display unit **29** is position-aligned corresponding to the opening portion **43***a* and the display unit **29** is fixed on the rear surface side of the upper operation frame body **41** at the periphery portion of the opening portion **43***a* thereof by adhesion and/or by screw fixation with the display unit **29** being hung down. For the display unit **29**, a color liquid crystal display device is used.

[0120] On the other hand, the lower housing **42**, which is not shown, is prepared. For the lower housing **42**, a housing mounted with the circuit board, the connector and the like, which are not shown, is used. For example, a die including a core and a cavity, by which the opening portion for a connector and the opening portion for the battery exchange, which are not shown, are modeled is made and the lower housing **42** is molded into one body by sealing an ABC resin or the like into this die. In the lower housing **42**, a circuit board, a memory and the like are mounted. Then, when engaging the lower housing **42** with the upper operation frame body **41** including the touch panel in which the front surface plate and the resistive film are incorporated and the press detection unit **50** so to be fitted, the mobile phone **200** with the input device as shown in FIG. **12** is completed.

[0121] The following will describe an internal configuration and a touch-sensitive feedback input method of the mobile phone **200** with a touch-sensitive input function. FIG. **14** shows an internal configuration of the mobile phone **200** with the touch-sensitive input function.

[0122] The mobile phone **200** shown in FIG. **14** is constituted by allowing respective function blocks to be mounted on the circuit board **97** of the lower housing **42**. It should be noted that the components shown in FIG. **14** corresponding to the respective components shown in FIG. **11** to FIG. **13** are shown by the same numeral numerals as those shown in FIG. **11** to FIG. **13**. The mobile phone **200** includes a control unit **15**, a receiving unit **18**, a transmitting unit **22**, an antenna diplexer **23**, an input detection unit **45**, the press detection unit **50**, the speaker **36***b* with actuator function, the display unit **29**, a microphone **13**, a power supply unit **33**, a camera **34**, a memory unit **35** and an operation panel **98** on an image screen.

[0123] With respect to the input detection unit **45** shown in FIG. **14**, an input device in which a front surface plate and a resistive film are incorporated has been explained in FIG. **11** to FIG. **13**, but everything is available only if the input device is a device in which cursoring and selection functions can be distinguished. For example, an input device such as an electrostatic-capacity type, a surface acoustic wave method (SAW), an optical method, and a tact switch of a multi stage system is available therefor. Preferably, an input device having a constitution in which position information can be applied to the control unit **15** is available therefor. The above-mentioned input detection unit **45** detects the slide position of the finger **30***a* of the operator **30** and outputs at least a position detection signal S1 to an A/D-driver **31**.

[0124] In this embodiment, the press detection unit **50** is provided other than the input detection unit **45**, detects a press-down amount by the finger **30***a* of the operator **30** at the slide position, and outputs a press detection signal S2 for obtaining the press force F (input amount) to the A/D-driver **31**. The press detection signal S2 is constituted by an analog output voltage Vo showing a change in the resistance value of the variable resistor VR of the press detection unit **50**.

[0125] The control unit **15** includes the A/D-driver **31**, a CPU **32**, an image-processing unit **26**, an image-and-audio-processing unit **44**, and a storage unit **37**. The A/D-driver **31** receives the position detection signal S1 from the input detection unit **45** and also receives the press detection signal S2 from the press detection unit **50**. The A/D-driver **31** converts an analog signal composed of the position detection signal S1 and the press detection signal S2 to digital data in order to distinguish the function of the cursoring and the function of the icon selection. Further, the A/D-driver **31** calculates this digital data, detects which is the cursoring input or the icon selection information, and supplies flag data D3 by which the cursoring input or the icon selection is distinguished, the position information D1 or the press detection information D2 to the CPU **32**. These calculations may be executed in the CPU **32**.

[0126] The A/D-driver **31** is connected with the CPU **32**. The CPU **32** controls the whole mobile phone based on a system program. The memory unit **35** stores system program data for controlling the whole mobile phone. A RAM, which is not shown, is used as a work memory. The CPU **32** reads the system program data out of the memory unit **35** when turning the power ON, expands the system program data in the RAM, turns on the system, and controls the whole mobile phone. For example, the CPU **32** receives the input information D1 to D3 from the A/D driver **31**, supplies predetermined instruction data D to the devices such as the power supply unit **33**, the camera **34**, the memory unit **35**, the storage unit **37**, and the image-and-audio-processing unit **44**, takes-in the reception data from the receiving unit **21**, and transfers the transmission data to the transmitting unit **22**.

[0127] In this embodiment, the CPU **32** compares the press detection information D2 obtained from the press detection unit **50** and two judgment threshold voltages Vth1 and Vth2 which become preset press judgment references and controls the storage unit **37** so as to vibrate the speaker **36***b* with actuator function based on the comparison result thereof.

[0128] For example, when the sense of touch propagated from the input detection surface at the pressed position of the input detection unit **45** are assumed to be A and B, a sense of touch #*a* is obtained by changing the input detection surface in response to the press force F of the operator's finger **30***a* in the pressed position thereof from a low frequency and also small amplitude vibration pattern to a high frequency and also large amplitude vibration pattern. Also, a sense of touch #b is obtained by changing the input detection surface in response to the press force F of the operator's finger **30***a* at the pressed position thereof from a high frequency and also large amplitude vibration pattern to a low frequency and also small amplitude vibration pattern.

[0129] For example, the CPU **32** controls the storage unit **37** such that the sense of touch #a is started up when the press detection unit **50** detects the press detection information D2 which exceeds the judgment threshold voltage Vth2 and thereafter, the sense of touch #b is to be started up when the press detection information D2 less than the judgment threshold voltage Vth1 is detected. By doing in this manner, it is possible to generate different vibration patterns in conformity with "press force" by the operator's finger **30***a* or the like.

[0130] The CPU **32** is connected with the storage unit **37** in which vibration control data Da is generated based on the control information Dc from the CPU **32**. The vibration control data Da includes output waveform data composed of a sinusoidal waveform. The storage unit **37** is connected with the image-and-audio processing unit **44**. The image-and-audio-processing unit **44** is connected with the speaker **36***a* and the speaker **36***b* with actuator function. The speaker **36***b* vibrates based on the respective items of the vibration control data Da.

[0131] In this embodiment, the memory unit **35** stores the judgment threshold voltages Vth1 and Vth2 corresponding to each application. For example, the judgment threshold voltages Vth1, Vth2 are stored beforehand in a ROM or the like provided in the memory unit **35** as trigger parameter. The CPU **32** expands the press detection information D2 in the RAM, which is not shown or the like and compares the predetermined judgment threshold voltages Vth1, Vth2 with the information of the output voltage Vo of the press detection unit **50** obtained from the press detection information D2. As shown in FIG. **8**A, when the finger **30***a* does not contact with the press detection unit **50**, specifically at a time of the non-operation, the press force F is set to zero (F0=0), naturally.

[0132] When operating the press detection unit **50**, when the finger **30***a* contacts the press detection unit **50** weakly as shown in FIG. **8**B, the output voltage Vo that is equal to or less than the judgment threshold voltage Vth1 is detected, so that it is possible to judge a fact that the press force F is approximately F1. Also, when the finger **30***a* contacts the press detection unit **50** strongly as shown in FIG. **8**C, for example, when the output voltage Vo exceeding the judgment threshold voltage Vth1 and being equal to or less than the judgment threshold voltage Tth2 is detected, it is possible to judge a fact that the press force F is approximately F2. Further, when the finger **30***a* contacts the press detection unit **50** more strongly as shown in FIG. **8**D, for example, when the output voltage Vo exceeding the judgment threshold voltage Vth2 is detected, it is possible to judge a fact that the press force F is approximately F3.

[0133] In this embodiment, it is constituted with respect to the press judgment reference such that "first press judgment reference=100 [gf]" is set corresponding to the judgment threshold voltage Vth2 and the input detection surface vibrates based on a vibration pattern for obtaining sense of touch like a classic switch. Also, it is constituted such that "second press judgment reference=20 [gf]" is set corresponding to the judgment threshold voltage Vth1 and the input detection surface vibrates based on a vibration pattern for obtaining sense of touch like a cyber switch.

[0134] The CPU **32** is connected with the image-processing unit **26**, other than the storage unit **37**, in which the display information D4 for displaying the button icon or the like three-dimensionally is image-processed. The image-processed display information D4 is supplied to the display unit **29**.

[0135] The operator **30** feels vibration for every button icon as the sense of touch by receiving vibration to the finger **30***a* thereof. Also, it is constituted such that each function is judged by the sense of sight depending on the eyes of the operator for the display contents of the display unit **29** and by the sense of hearing depending on the ears of the operator for the sound release from the speakers **36***a*, **36***b* or the like. The above-mentioned CPU **32** is connected with the operation panel **98** (function) constituted by images of the ten-key or the like on the display screen, which is used for example, when a telephone number of the partner is inputted manually. The display unit **29** may display a received picture based on an image signal Sv other than the above-mentioned icon selection screen.

[0136] Also, the antenna **16** shown in FIG. **14** is connected with the antenna diplexer **23** and receives a radio wave of the partner from a base station or the like when receiving calls. The antenna diplexer **23** is connected with the receiving unit **18** which receives the reception data introduced from the antenna **16**, demodulates the image and audio or the like, and outputs the demodulated image and audio data Din to the CPU **32** or the like. The receiving unit **18** is connected through the CPU **32** with the image-and-audio-processing unit **44** which outputs an audio signal Sout by digital-analog-converting digital audio data and/or outputs an image signal Sv by digital-analog-converting digital image data.

[0137] The image-and-audio-processing unit **44** is connected with the speaker **36***a* for a big sound which constitutes a receiver. The speaker **36***a* outputs sounds of a receiving sound, an incoming melody and the like when receiving calls.

The speaker **36***b* performs the actuator function, receives an audio signal Sout1, and magnifies the talking voice **30***d* of the partner or the like. This image-and-audio-processing unit **44** is connected with the microphone **13** constituting a telephone transmitter other than the speakers **36***a*, **36***b* and outputs an audio signal Sin by sound-collecting the operator's voice. The image-and-audio-processing unit **44** outputs digital audio data by analog-to-digital converting the analog audio signal Sin for being transmitted to the partner and/or outputs digital image data by analog-digital converting the analog image signal Sv.

[0138] In this manner, it is constituted such that each function is judged by the sense of sight depending on the operator's eyes **30***b* for the display contents of the display unit **29** and by the sense of hearing depending on the operator's ears **30***c* for the sound release from the speakers **36***a*, **36***b* or the like.

[0139] The CPU **32** is connected other than the receiving unit **18** with the transmitting unit **22** in which the image and audio data Dout or the like for transmitting to the partner is modulated and the modulated transmission data is supplied to the antenna **16** through the antenna diplexer **23**. the antenna **16** radiates a radio wave received from the antenna diplexer **23** toward a base station or the like.

[0140] The above-mentioned CPU **32** is connected other than the transmitting unit **22** with the camera **34** which shoots a subject and transmits, for example, still image information or moving image information to the partner through the transmitting unit **22**. The power supply unit **33** includes the battery **94** which supplies a DC power to the receiving unit **18**, the transmitting unit **22**, the display unit **29**, the CPU **32**, the input detection unit **45**, the speaker **36***b* with actuator function, the camera **34** and the memory unit **35**.

[0141] The following will describe an information processing example in the mobile phone **200**. FIG. **15** shows an information processing example in the mobile phone **200** relating to the second embodiment. In this embodiment, it is assumed that information is inputted by pressing down the input detection surface on the display screen of the mobile phone **200** by means of the operator's finger **30***a*. The mobile phone **200** is provided with a function (algorithm) for processing a waveform using the press force F by the operator's finger **30***a* or the like as parameter in the same vibration mode. The CPU **32** reads an output voltage Vo showing the press force F from the press detection information D2 and executes the judgment based on two judgment threshold voltages Vth1, Vth2 as the references, thereby enabling the sense of touch corresponding to the movement during the input operation to be generated in the same vibration mode based on the judgment result thereof with respect to any kinds of inputs.

[0142] By setting these as the information processing conditions, the CPU **32** waits for power ON in step G1 of a flowchart shown in FIG. **15**. For example, the CPU **32** detects power-ON information and starts up the system. The power-ON information is generated normally when a power switch of the mobile phone or the like which is in a sleeping state is turned on under a situation that a time function or the like is in operation.

[0143] Then, the process shifts to step G2 where the CPU **32** controls the display unit **29** so as to display the icon screen. For example, the CPU **32** supplies the display information D34 to the display unit **29** which displays input information such as ten-keys and icon images on the display screen thereof. The input information displayed on the display screen may be seen by the operator's eyes through the input detection unit **45** having the input detection surface. Then, the process shifts to step G3 where the CPU **32** branches its control into a button icon input mode or another process mode. The button icon input mode is refereed to as an input operation for pushing down a button icon on the input detection surface when selecting an icon image.

[0144] In case of setting the button icon input mode, a button icon or the like is pushed down, so that the process shifts to step G4 where the CPU **32** reads the output voltage Vo showing the press detection information D2 (press force F) out of the press detection unit **50** and detects the press force F based on this output voltage Vo. At that time, the press detection unit **50** detects the press force F at the pressed position by the operator's finger **30***a* in the input detection surface and outputs the press detection signal S2 to the A/D-driver **31**. The A/D-driver **31** converts the press detection signal S2 from analog signal to digital data and transfers the converted digital press detection information D2 to the CPU **32**.

[0145] Then, the process shifts to step G5 where the CPU **32** compares the output voltage Vo of the press detection unit **50**, which the press detection information D2 denotes, with the judgment threshold voltage Vth2 and judges whether or not these relation becomes Vo>Vth2. If these relation becomes Vo>Vth2, then the process shifts to step G6 where the sense of touch #a is started up. The sense of touch #a is obtained by vibrating the input detection surface based on the vibration pattern Pa corresponding to the press force F by the operator's finger **30***a* by means of the speaker **36***b* with actuator function. For example, when a frequency is set as fx, an amplitude is set as Ax and the number of times is set as Nx, with respect to this, the sense of touch #a is obtained by vibration according to a vibration pattern [fx, Ax, Nx]=[50, 5, 2] during a time period of approximately 0.1 second and in next step, a vibration pattern [fx, Ax, Nx]=[100, 10, 2] during a time period of approximately 0.1 second. By doing in this manner, it is possible to generate the different vibration patterns in conformity with the "press force" of the operator.

[0146] Thereafter, the process shifts to step G7 where the CPU **32** further detects the press force F. The press force F is detected by the press detection unit **50** under a state where the finger **30***a* of the operator is apart from the button icon after the button icon is pressed down. At that time, the press detection unit **50** detects the press force F when leaving the operator's finger **30***a* from the pressed position thereof in the input detection surface and outputs a press detection signal S2 to the A/D-driver **31**. The A/D-driver **31** converts the press detection signal S2 from analog signal to digital data and transfers the converted digital press detection information D2 thereof to the CPU **32**.

[0147] Then, the process shifts to step G8 where the CPU **32** compares the output voltage Vo of the press detection unit **50**, which the press detection information D2 denotes, with the judgment threshold voltage Vth1 and judges whether or not these relation is Vo>Vth1. If these relation becomes Vo>Vth1, the sense of touch #b is started up. The sense of touch #b is obtained by vibrating the input detection surface based on the vibration pattern Pb corresponding to the press force F by the operator's finger **30***a* by means of the speaker **36***b* with actuator function. The sense of touch #b when the button icon thereof is released is obtained by vibration according to, for example, a vibration pattern [fx, Ax, Nx]=[80, 8, 2] during a time period of approximately 0.1 second

and in next step, a vibration pattern [fx, Ax, Nx]=[40, 8, 2] during a time period of approximately 0.1 second. By doing in this manner, it is possible to generate the different vibration patterns in conformity with the "press force" by the operator.

[0148] Thereafter, the process shifts to step G10 where the input is determined. At that time, the input detection unit **45** inputs the input information displayed on the pressed position. Then, the process shifts to step G12. It should be noted that if another processing mode is selected in the step G3, then the process shifts to step G11 where the above-mentioned another processing mode is executed. The above-mentioned another processing mode includes a telephone mode, a mail making mode, and a transmission display mode. The telephone mode contains an operation for transmitting calls to the partner. The button icon includes a character input item when selecting telephone mode. After the above-mentioned another processing mode is executed, the process shifts to the step G12.

[0149] The CPU **32** makes termination-judgment at the step G12. For example, the power OFF information is detected and the information processing is terminated. If the power-OFF information is not detected, then the process returns to the step G2 where an icon screen of the menu or the like is displayed and the above-mentioned processing is repeated.

[0150] In this manner, according to the mobile phone **200** as the second embodiment, the embodiment of the press detection sensor **100** or **100**A relating is included in the press detection unit **50**, so that when the information is inputted with respect to the press operation by the operator's finger **30***a* into the input detection surface on the display screen, it is possible to reliably detect the information relating to a position at which the conductors of the electrode pattern **51** and the electrode pattern **52** are electrically coupled. Further, it is possible to detect the press force F (press-down force) corresponding to a period of time when electrically coupling the elastic electric conductor **53** to the conductors of the electrode pattern **51** and the electrode pattern **52** in response to the press operation.

[0151] Furthermore, though the press detection unit **50** has a simple structure, the press force detection function is stabilized without depending on the pushdown position. The press detection unit **50** is near the operation surface as compared with the input device of past system, so that it is possible to reduce the number of parts intervening between the press detection unit **50** and the operation surface. Also, the press detection unit **50** is constituted by a single variable resistor and there is employed a structure in which the resistor is formed in a frame shape and adhered to the concave portion frame of the upper operation frame body **41**, so that at any position of the input plain, it is possible to detect the press force F stably and also accurately.

[0152] Further, the press detection unit **50** is not affected by the circumferential illumination environment as compared with the input device of past system, and when the press-down operation is executed after touching the front surface by the operation body (object) of the finger **30***a* or the like, any change occurs reliably in the press detection data so that it is possible to detect the press force F stably.

[0153] Also, in the press detection system, there is no driver IC of past system because when judging the press force F, the press detection information D2 that the output voltage Vo of the press detection unit **50** is digitalized is outputted to the CPU **32** and when judging the press force F, the CPU **32** compares only the output voltage Vo and the judgment threshold voltage Vth1 or Vth2. There is no driver IC, so that it is possible to attempt the cost down.

[0154] Further, the input device **90** including the press detection unit **50** can be provided cheaply as compared with the input device including the display device with image pickup element relating to past system, so that it is possible to realize the cost down of the input device and the electronic apparatus including the input device.

[0155] Also, the input device **90** has the display unit **29** of the air-tight structure which is completely shut off from the outside. In the above-mentioned embodiments, the press detection unit **50** has adhered the upper operation frame body **41** itself, not the display unit **29**, and the input detection unit **45** so that it is possible to realize such an air-tight structure that an inside of the operation surface member such as the touch panel in which the front surface plate and the resistive film are incorporated, the display unit **29** and the like have no gap from the outside. This enables the waterproof property and the dustproof property to be improved. Thus, it is possible to assemble the mobile phone **200** excellent in the waterproof property and the dustproof property.

[0156] The upper operation frame body **41** employs a structure for supporting the transparent input detection unit **45**. In the input device of past system which is not equipped with a press detection function, a surface member is provided at the upper portion of the display unit **29** through an adhesive tape, but in this embodiment, it is possible to replace at this position the press detection unit **50** including a function of an adhesive tape concurrently, so that assembling of the input device **90** becomes also easy as compared with the constitution of the input device of past system.

[0157] Thus, it is possible to reduce numbers of the components positioned at the upper portion of the press detection unit **50** as compared with those of the input device of past system, so that the design for avoiding the load imposed on the press detection unit **50** from the other members can be omitted. Consequently, it is possible to increase the degree of freedom in the design of the input device **90**. This enables assembling of the mobile phone **200** to be made easy as compared with those of past system. Consequently, it becomes possible to provide the mobile phone **200** with a touch-sensitive input function having the frame shaped press detection unit **50** with a thin-shaped and simple structure while it has an air-tight structure in which the invasion of the dust, water or the like is preventable.

Embodiment 3

[0158] FIG. **16** shows a configuration of a mobile phone **300** as a third embodiment. In this embodiment, it is constituted such that a capacitive touch panel **48** is used under the front surface plate **45**A.

[0159] The mobile phone **300** shown in FIG. **16**, similarly as the second embodiment, is mounted so that the upper operation frame body **41** forming a lid can be fitted into the lower housing **42** forming a box body with a bottom plate. Also in this embodiment, the press detection unit **50** having flexibility and/or elasticity as explained in the first embodiment is arranged on the step-shaped surface of the concave portion **41***a* of the upper operation frame body **41**.

[0160] At the upper portion of the press detection unit **50**, the front surface plate **45**A is provided. The front surface plate **45**A is an upper portion of a display unit **29** and is provided on the frame shaped press detection unit **50**. As the front surface

plate **45**A, the touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089, may be used. It is needless to say that it is not limited to the touch-sensitive input sheet, and a transparent member, for example, an acrylic system transparent resin film may be used.

[0161] The front surface plate **45**A is adhered to, for example, the frame shaped region of the press detection unit **50** through an adhesive agent. On the downward (rear surface side) of the front surface plate **45**A, the touch panel **48** is provided and has the input detection surface on the display unit **29**, and it is constituted such that a contact position of the operation body in the input detection surface can be detected. For the touch panel **48**, a capacitive touch panel with the thickness of around 1.1 mm to 1.5 mm is used. It should be noted that components in the third embodiment having the same name and the same numeral as those of the second embodiment have the same function and the same material as those of the second embodiment, so that the explanation thereof will be omitted.

[0162] FIG. **17** shows an assembled example of an input device **901**. According to the input device **901** shown in FIG. **17**, the display unit **29**, the speaker **36***b* with actuator function, the upper operation frame body **41**, a front surface plate **45**A, the capacitive touch panel **48**, and the press detection unit **50** are prepared. For the upper operation frame body **41**, an injection die molded one explained in the second embodiment is used.

[0163] First, as explained in the second embodiment, the press detection unit **50** is mounted on the upper operation frame body **41**. For the press detection unit **50**, the press detection sensor **100** explained in the first embodiment is used. Then, the front surface plate **45**A is mounted on the press detection unit **50**. For the front surface plate **45**A, for example, an adhesive agent is coated on the frame shaped region of the press detection unit **50**. Thereafter, the front surface plate **45**A is position-aligned with respect to the concave portion **41***a* and the front surface plate **45**A is adhered on the press detection unit **50** in a manner so as to be fallen into the concave portion **41***a* thereof. As the front surface plate **45**A, a touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089, may be used. The touch-sensitive input sheet may include protrusion blocks each having cylindrical shape or conical shape for presenting a concavity and convexity feeling, which are distributed so as to be provided standingly in the vertical direction with respect to a sheet surface of the base sheet forming the base material.

[0164] For example, there is prepared a base member in which a transparent silicon rubber member of the hardness 20° to 40° is formed in a sheet shape. The base member is obtained by molding a silicon rubber member in the thickness t=0.01 [mm] to 5 [mm] around, by using a heat roll molding or by an injection die molding. Next, on the base member, there are formed aperture portions or hole potions for demarcating the region in which a concavity and convexity for the sense of touch feeling is formed. The aperture portions or the hole potions are formed on the positions corresponding to key-images on the icon screen. The aperture portions are formed by a punch process. It is needless to say that a core and a cavity in which reversal patterns of the aperture portions or the hole potions are modeled are made so that the base member and the hole portions or the like can be molded at once when injection die molding.

[0165] Thereafter, components for the sense of touch are buried into the aperture portions or the hole potions. For the components, for example, there is used a transparent silicon rubber member of the hardness 60° to 80°. A method of burying the components into the aperture portions or the hole potions is executed by a two-colors mold (double mold) depending on the injection die molding or by a coating process. According to the two-colors mold, the different material properties (materials) forming a base member and a component are combined together and the base member and the component are molded in one body. Thus, the touch-sensitive input sheet, which is not shown, is obtained.

[0166] Next, the front surface plate **45**A is installed with the speaker **36***b* with actuator function. The speaker **36***b*, similarly as the second embodiment, is arranged at a predetermined position of the front surface plate **45**A through the opening portion **43***b* of the upper operation frame body **41** and is fixed thereto through an adhesive agent.

[0167] Further, the display unit **29** is mounted on the rear side of the upper operation frame body **41**, similarly as the second embodiment. For example, an adhesive agent is coated on the rear surface side of the upper operation frame body **41** along a periphery portion of the opening portion **43***a*. Thereafter, the display area **29***a* of the display unit **29** is position-aligned relative to the opening portion **43***a* and the display unit **29** is fixed to the upper operation frame body **41** with the display unit **29** being hung down on the rear surface side of the upper operation frame body **41** at the periphery portion of the opening portion **43***a* thereof by adhesion and/or by screw fixation. For the display unit **29**, a color liquid crystal display device is used.

[0168] On the other hand, similarly as the second embodiment, the lower housing **42**, which is not shown, is prepared. On the lower housing **42**, a circuit board, a memory and the like are mounted. Then, when the upper operation frame body **41** including the front surface plate **45**A, the capacitive touch panel **48**, and the press detection unit **50** is engaged with the lower housing **42** so as to be fitted to each other, the mobile phone **300** with the input device as shown in FIG. **16** is completed.

[0169] In this manner, according to the mobile phone **300** as the third embodiment, the capacitive touch panel **48** is provided on the downward side of the front surface plate **45**A and at the same time, the embodiment of the press detection unit **50** is provided, so that when information is inputted in response to the press operation by the operator's finger **30***a* into the input detection surface on the display screen, it is possible to detect information of the pressed position on the touch panel **48** surely. Further, it is possible to reliably detect the press forces F (press-down force) of the position at which the elastic electric conductor **53** is electrically connected with the electrode pattern **51** and the electrode pattern **52** in response to the press operation.

[0170] Also, the input device **901** has the display unit **29** of the air-tight structure which is completely shut off from the outside, so that it is possible to assemble the mobile phone **300** excellent in the waterproof property and the dustproof property. The upper operation frame body **41** has a structure for supporting the front surface plate **45**A such as a transparent touch-sensitive input sheet, so that the assembly easiness of the mobile phone **300** is improved. Thus, it is possible to provide the mobile phone **300** with a touch-sensitive input function having the frame shaped press detection unit **50** with

a thin-shaped and simple structure while it has an air-tight structure in which the invasion of the dust, water or the like is preventable.

Embodiment 4

[0171] FIG. **18** shows a configuration of a mobile phone **400** including an input device **902** as a fourth embodiment. In this embodiment, as the display unit **29**A, a liquid crystal display device equipped with a touch panel is used.

[0172] The mobile phone **400** shown in FIG. **18**, similarly as the second and third embodiments, is mounted so that the upper operation frame body **41** forming a lid can be fitted into the lower housing **42** forming a box body with a bottom plate. In this embodiment, a press detection unit **50** having flexibility and/or elasticity as explained in the first embodiment is also arranged on the step-shaped surface of the concave portion **41***a* of the upper operation frame body **41**.

[0173] At the upper portion of the press detection unit **50**, the front surface plate **45**A is provided. The front surface plate **45**A is an upper portion of a display unit **29**A and is provided on the frame shaped press detection unit **50**. As the front surface plate **45**A, the touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089, may be used as explained in the third embodiment. Instead of the touch-sensitive input sheet, an acrylic system transparent resin film may be used. The front surface plate **45**A is adhered to the frame shaped region of the press detection unit **50** through an adhesive agent.

[0174] On the downward (rear surface side) of the front surface plate **45**A, the display unit **29**A is mounted. As the display unit **29**A, the liquid crystal display device equipped with the touch panel is used. The display unit **29**A has a touch panel portion **29***b* in the upper layer region of the liquid crystal display device and it is constituted such that a contact position of an operation body is detected in the input detection surface of the touch panel portion **29***b*. For the display unit **29**A, a color liquid crystal display device having the thickness of around 1.5 mm to 2.0 mm is used. It should be noted that components in the fourth embodiment having the same name and the same numeral as those of the second and third embodiments have the same function and the same material as those of the second and third embodiments, so that the explanation thereof will be omitted.

[0175] FIG. **19** shows an assembled example of the input device **902**. According to the input device **902** shown in FIG. **19**, the touch panel built-in type display unit **29**A, the speaker **36***b* with actuator function, the upper operation frame body **41**, the front surface plate **45**A and the press detection unit **50** are prepared. As the upper operation frame body **41**, an injection die molded one explained in the second or third embodiment is used.

[0176] First, as explained in the second and third embodiments, the press detection unit **50** is mounted on the upper operation frame body **41**. For the press detection unit **50**, the press detection sensor **100** or **100**A or the like explained in the first embodiment is used. Then, the front surface plate **45**A is mounted on the press detection unit **50**. F of example, an adhesive agent is coated on the frame shaped region of the press detection unit **50** and thereafter, the front surface plate **45**A is position-aligned with respect to the concave portion **41***a* and the front surface plate **45**A is adhered to the press detection unit **50** in a manner so as to be fallen into the concave portion **41***a* thereof. As the front surface plate **45**A, a touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089, may be used. The touch-sensitive input sheet may include protrusion blocks each having cylindrical shape or conical shape for presenting a concavity and convexity feeling, which are distributed so as to be provided standing in the vertical direction with respect to a sheet surface of the base sheet forming the base material.

[0177] Next, the front surface plate **45**A is installed with the speaker **36***b* with actuator function. The speaker **36***b*, similarly as the second and third embodiments, is arranged at a predetermined position of the front surface plate **45**A through the opening portion **43***b* of the upper operation frame body **41** and is fixed to the upper operation frame body **41** through an adhesive agent. Further, the touch panel built-in type display unit **29**A is attached to the rear side of the upper operation frame body **4**. For example, an adhesive agent is coated the rear surface side of the upper operation frame body **41** along a periphery portion of the opening portion **43***a*. Thereafter, the display area **29***a* of the display unit **29**A is position-aligned relating to the opening portion **43***a* and the display unit **29**A is fixed to the upper operation frame body **41** with the display unit **29**A being hung down on the rear surface side of the upper operation frame body **41** at the periphery portion of the opening portion **43***a* thereof by adhesion and/or by screw fixation. For the display unit **29**A, a color liquid crystal display device is used.

[0178] On the other hand, similarly as the second and third embodiments, a lower housing **42**, which is not shown, is prepared. On the lower housing **42**, a circuit board, a memory and the like are mounted. Then, when the upper operation frame body **41** including the touch panel built-in type display unit **29**A, the front surface plate **45**A and the press detection unit **50** is engaged with the lower housing **42** so as to be fitted to each other, the mobile phone **400** with the input device as shown in FIG. **18** is completed.

[0179] In this manner, according to the mobile phone **400** as the fourth embodiment, the touch panel built-in type display unit **29**A is provided on the downward side of the front surface plate **45**A and at the same time, the embodiment of the press detection unit **50** is provided, so that when information is inputted in response to the press operation by the operator's finger **30***a* into the input detection surface on the display screen, it is possible to detect information of the pressed position by the touch panel portion **29***b* of the display unit **29**A. Further, it is possible to reliably detect the press forces F (press-down force) of the position at which the elastic electric conductor **53** is electrically connected with the electrode pattern **51** and the electrode pattern **52** in response to the press operation.

[0180] Also, the input device **902** has the display unit **29**A of the air-tight structure which is completely shut off from the outside, so that it is possible to assemble the mobile phone **400** excellent in the waterproof property and the dustproof property. The upper operation frame body **41** has a structure for supporting the front surface plate **45**A of a transparent touch-sensitive input sheet or the like, so that the assembly easiness of the mobile phone **400** is improved. Thus, it is possible to provide the mobile phone **400** with a touch-sensitive input function having the frame shaped press detection unit **50** with a thin-shaped and simple structure while it has an air-tight structure in which the invasion of the dust, water or the like is preventable.

Embodiment 5

[0181] FIG. **20** shows a configuration of a mobile phone **500** including an input device **903** as a fifth embodiment. In

this embodiment, the input device **903** includes a press detection unit **50**A provided with a programmable electrode pattern structure and changes position information detection and press detection function. In this embodiment, it is possible to judge the press force F individually with respect to the input operations of a plurality of points by linking a connection program of electrode patterns of the press detection unit **50**A with applications.

[0182] The mobile phone **500** shown in FIG. **20**, similarly as the second and third embodiments, is mounted so that the upper operation frame body **41** forming a lid can be fitted into the lower housing **42** forming a box body with a bottom plate. In this embodiment, a press detection unit **50**A having a structure that is different from those of the first to fourth embodiments is arranged on the step-shaped surface of the concave portion **41***a* of the upper operation frame body **41**. The press detection unit **50**A has flexibility and/or elasticity similarly as the press detection units **50** of the first to fourth embodiments.

[0183] At the upper portion of the press detection unit **50**A, the front surface plate **45**A is provided. The front surface plate **45**A is an upper portion of a display unit **29** and is provided on the frame shaped press detection unit **50**A. As the front surface plate **45**A, the touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089, may be used as explained in the third embodiment. Instead of the touch-sensitive input sheet, an acrylic system transparent resin film may be used. The front surface plate **45**A is adhered to the frame shaped region of the press detection unit **50**A through an adhesive agent. On the downward (rear surface side) of the front surface plate **45**A, the display unit **29** is mounted. As the display unit **29**, a liquid crystal display device is used. For the display unit **29**, a color liquid crystal display device having the thickness of around 1.1 mm to 1.7 mm is used.

[0184] The above-mentioned press detection unit **50**A includes a programmable electrode pattern structure and has a position information detection function and a press detection function. The press detection unit **50**A includes the input operation surface and detects a contact position of an operation body in the input operation surface. It should be noted that the configuration explained in the second embodiment can be applied to a constitution example of an appearance shape and a control system of the mobile phone **500** as it is, so that the explanation thereof will be omitted.

[0185] The following will describe a configuration and the function example of the press detection unit **50**A with reference to FIG. **21** to FIG. **23**.

[0186] FIG. **21** to FIG. **23** show the configuration and the function example (part one to three) of the electrode patterns in the press detection unit **50**A.

[0187] According to the configuration of the press detection unit **50**A shown in FIG. **21**, in L-shaped regions A, B, C, D each for equally dividing one side of the four sides of a frame shaped substrate, which is not shown, there are arranged electrode patterns **51***a*, **51***b*, **51***c*, **51***d* constituting one example of a first conductor, electrode patterns **52***a*, **52***b*, **52***c*, **52***d* constituting one example of a second conductor and elastic electric conductors **53***a*, **53***b*, **53***c* and **53***d*. For example, in the region A, there are arranged the electrode patterns **51***a*, **52***a* and the elastic electric conductor **53***a*. In the region B, there are arranged the electrode patterns **51***b*, **52***b* and the elastic electric conductor **53***b*. In the region C, there are arranged the electrode patterns **51***c*, **52***c* and the elastic electric conductor **53***c*. In the region D, there are arranged the electrode patterns **51***d*, **52***d* and the elastic electric conductor **53***d*.

[0188] One end of the electrode pattern **51***a* is opened and the other end thereof is connected to a terminal **1**. One end of the electrode pattern **51***b* is opened and the other end thereof is connected to a terminal **4**. One end of the electrode pattern **51***c* is opened and the other end thereof is connected to a terminal **5**. One end of the electrode pattern **51***d* is opened and the other end thereof is connected to a terminal **8**. Also, one end of the electrode pattern **52***a* is opened and the other end thereof is connected to a terminal **2**. One end of the electrode pattern **52***b* is opened and the other end thereof is connected to a terminal **3**. One end of the electrode pattern **52***c* is opened and the other end thereof is connected to a terminal **6**. One end of the electrode pattern **52***d* is opened and the other end thereof is connected to a terminal **7**.

[0189] In this embodiment, a switch SWa is positioned between two neighboring electrode patterns **52***c* and **52***d*, namely, it stays between the terminals **6** and **7**, a switch SWb is positioned between two neighboring electrode patterns **51***a* and **51***d*, namely, it stays between the terminals **1** and **8**, a switch SWc is positioned between two neighboring electrode patterns **52***a* and **52***b*, namely, it stays between the terminals **2** and **3**, and a switch SWd is positioned between two neighboring electrode patterns **51***b* and **51***c*, namely, it stays between the terminals **4** and **5**. In this embodiment, it is constituted such that the press detection function varies by controlling these switches SWa to SWd to switch ON or OFF based on a sampling frequency.

[0190] Here, an XY coordinates system is set in an arrangement plain of the electrode patterns **51***a*, **51***b*, **51***c*, **51***d* and the electrode pattern **52***a*, **52***b*, **52***c*, **52***d* which are shown in FIG. **21**. When the pushdown (press) direction of the press detection unit **50**A is defined in the Z-direction perpendicular to the XY coordinates, in case of reading the press force F in the Z-direction, the switch Swa between the terminals **6** and **7** is turned on, the electrode patterns **52***c* and **52***d* are connected in series, the switch SWb between the terminals **1** and **8** is turned on and the electrode patterns **51***a* and **51***d* are connected in series, the switch SWc between the terminals **2** and **3** is turned on and the electrode pattern **52***a* and **52***b* are connected in series. The switch SWc between the terminals **4** and **5** is, however, turned off.

[0191] When executing the press operation, the elastic electric conductor **53***a* is connected to the electrode patterns **51***a*, **52***a* and becomes an ON-state, the elastic electric conductor **53***b* is connected to the electrode patterns **51***b*, **52***b* and becomes an ON-state, the elastic electric conductor **53***c* is connected to the electrode patterns **51***c*, **52***c* and becomes an ON-state or the elastic electric conductor **53***d* is connected to the electrode patterns **51***d*, **52***d* and becomes an ON-state. It is possible to detect the press force F of the Z-direction by measuring a resistance value R**45** between the terminals **4** and **5** in any of these four ON-states.

[0192] The press force F in the Z-direction is obtained by reading out the resistance value R**45** (**4**→**3**→**2**→**1**→**8**→**7**→**6**→**5**), but in this embodiment, the content of the resistance value detected by the press detection unit **50**A comes to be changed by the ON-OFF control based on the sampling frequency of the switches SWa, SWb, SWc, SWd by the CPU **32** shown in FIG. **14** or by turning on or off those switches SWa, SWb, SWc, SWd depending on kinds of the application or situation.

[0193] Also, in case of reading the press force F in the X-direction by the press detection unit **50**A shown in FIG. **22**, the switch SWc between the terminals **2** and **3** is turned on, the electrode patterns **52***a*, **52***b* are connected in series, and the switch Swa between the terminals **7** and **6** is turned on and the electrode patterns **52***c* and **52***d* are connected in series. However, the switch SWb between the terminals **1** and **8** and the switch SWd between the terminals **4** and **5** are turned off. In this manner, when the electrode patterns **51***a*, **51***b*, **51***c*, **51***d* and the electrode patterns **52***a*, **52***b*, **52***c*, **52***d* are divided into two press detection regions, it is possible to detect position information in the X-direction.

[0194] When executing the press operation, the elastic electric conductor **53***a* is connected to the electrode patterns **51***a*, **52***a* and becomes an ON-state, the elastic electric conductor **53***b* is connected to the electrode patterns **51***b*, **52***b* and becomes an ON-state, the elastic electric conductor **53***c* is connected to the electrode patterns **51***c*, **52***c* and becomes an ON-state or the elastic electric conductor **53***d* is connected to the electrode patterns **51***d*, **52***d* and becomes an ON-state. It is possible to detect the press force F in the X-direction by measuring a resistance value R**14** between the terminals **1** to **4** and a resistance value R**58** between the terminals **5** to **8** in any of these four ON-states. In this manner, the press force F in the X-direction is obtained by reading-out the resistance value R**14** (1→2→3→4) and also by reading-out the resistance value R**58** (5→6→7→8).

[0195] In this embodiment, a left end point, which is defined on a product of the mobile phone **500** or the like on the X-axis in the XY coordinates system shown in FIG. **22**, is made as a starting point, the coordinate thereof is set as "0", the coordinate of a right end point is set as an Xmax and also when a constant is set as α, a position detection coordinate Xd is calculated by the following formula (1).

$$Xd=Xmax\times\alpha\times R14/(R14+R58) \quad (1)$$

[0196] The formula (1) is calculated by the CPU **32** or the exclusive driver IC.

[0197] Also, in case of reading the press force F in the Y-direction by the press detection unit **50**A shown in FIG. **23**, the switch SWb between the terminals **1** and **8** is turned on and the electrode patterns **51***a*, **51***d* are connected in series, and the switch SWd between the terminals **4** and **5** is turned on and the electrode patterns **51***b* and **51***c* are connected in series. The switch SWc between the terminals **2** and **3** and the switch SWa between the terminals **6** and **7** are turned off. In this manner, when the electrode patterns **51***a*, **51***b*, **51***c*, **51***d* and the electrode patterns **52***a*, **52***b*, **52***c*, **52***d* are divided into two press detection regions, it is possible to detect position information in the Y-direction.

[0198] When executing the press operation, the elastic electric conductor **53***a* is connected to the electrode patterns **51***a*, **52***a* and becomes an ON-state, the elastic electric conductor **53***b* is connected to the electrode patterns **51***b*, **52***b* and becomes an ON-state, the elastic electric conductor **53***c* is connected to the electrode patterns **51***c*, **52***c* and becomes an ON-state or the elastic electric conductor **53***d* is connected to the electrode patterns **51***d*, **52***d* and becomes an ON-state. It is possible to detect the press force F in the Y-direction by measuring an electric conductive resistance R**36** between the terminals **3** and **6** and an electric conductive resistance value R**27** between the terminals **2** and **7** in any of these four ON-states. In this manner, the press force F in the Y-direction is obtained by reading-out the resistance value R**36** (3→4→5→6) and also by reading-out the resistance value R**27** (2→1→8→7).

[0199] In this embodiment, a lower end point, which is defined on a product of the mobile phone **500** or the like on the Y axis in the XY coordinates system shown in FIG. **22**, is made as a starting point, the coordinate thereof is set as "0", the coordinate of an upper end point is set as a Ymax and also when a constant is set as β, a position detection coordinate Yd is given by the following formula (2).

$$Yd=Ymax\times\beta\times R36/(R36+R27) \quad (2)$$

[0200] The formula (2) is calculated by the CPU **32** or the exclusive driver IC.

[0201] It should be noted that if two or more points of the press operation are detected (multi points press-down mode), two kinds of the press detection data can be obtained by reading two items of press detection data obtained from the press detection unit **50**A individually with respect to the X and Y directions. It is needless to say that it is also allowed to obtain four or more kinds of the press detection data by further reading-out the press detection data individually.

[0202] For example, when reading the press force F in the XY-directions by the press detection unit **50**A, while all four of the switch Swa between the terminals **6** and **7**, the switch SWb between the terminals **1** and **8**, the switch SWc between the terminals **2** and **3** and the switch SWd between terminals **4** and **5** are turned off, there is detected the ON-state of each pair of the electrode patterns **51***a*, **52***a*, the electrode patterns **51***b*, **52***b*, the electrode patterns **51***c*, **52***c* and the electrode patterns **51***d*, **52***d*. In this manner, when the electrode patterns **51***a*, **51***b*, **51***c*, **51***d* and the electrode patterns **52***a*, **52***b*, **52***c*, **52***d* are divided into four press detection regions, it is possible to detect position information in the X and Y directions.

[0203] When executing the press operation, the elastic electric conductor **53***a* is connected to the electrode patterns **51***a*, **52***a* and becomes an ON-state, the elastic electric conductor **53***b* is connected to the electrode patterns **51***b*, **52***b* becomes an ON-state, the elastic electric conductor **53***c* is connected to the electrode patterns **51***c*, **52***c* becomes an ON-state or the elastic electric conductor **53***d* is connected to the electrode patterns **51***d*, **52***d* and becomes an ON-state. It is possible to detect the press force F in the X and Y directions by measuring a resistance value R**12** between the terminals **1** and **2**, a resistance value R**34** between the terminals **3** and **4**, a resistance value R**56** between the terminals **5** and **6** and a resistance value R**78** between the terminals **7** and **8** respectively in these four ON-states. It should be noted that ones of the fifth embodiment having the same name and the same numeral as the ones of the second to fourth embodiments have the same function and the same material as those of the second to fourth embodiments, so that the explanation thereof will be omitted.

[0204] The following will describe an assembled example of an input device **903**. FIG. **24** shows an assembled example of the input device **903**. According to the input device **903** shown in FIG. **24**, there are prepared the display unit **29**, the speaker **36***b* with actuator function, the upper operation frame body **41**, the front surface plate **45**A and the press detection unit **50**A. As the upper operation frame body **41**, the injection-die-molded ones as explained in the second to fourth embodiments is used.

[0205] First, as explained in the second to fourth embodiments, the press detection unit **50**A is mounted on the upper operation frame body **41**. As the press detection unit **50**A, a

unit having the electrode pattern structure explained in the FIG. **21** to FIG. **23** is used. Then, on the press detection unit **50**A, the front surface plate **45**A is mounted. For example, an adhesive agent is coated on the frame shaped region of the press detection unit **50**A and thereafter, the front surface plate **45**A is position-aligned with respect to the concave portion **41***a* and the front surface plate **45**A is adhered to the press detection unit **50**A in a manner so as to be fallen into the concave portion **41***a* thereof. As the front surface plate **45**A, the touch-sensitive input sheet for icon touch, which is described in Japanese Patent Application No. 2007-308089, may be used. The touch-sensitive input sheet may include protrusion blocks each having cylindrical shape or conical shape for presenting a concavity and convexity feeling, which are distributed so as to be provided standing in the vertical direction with respect to a sheet surface of the base sheet forming the base material.

[0206] Next, the front surface plate **45**A is installed with the speaker **36***b* with actuator function. The speaker **36***b*, similarly as the second to fourth embodiments, is arranged at a predetermined position of the front surface plate **45**A through the opening portion **43***b* of the upper operation frame body **41** and is fixed thereto through an adhesive agent. Further, the display unit **29** is mounted on the rear side of the upper operation frame body **41**. For example, an adhesive agent is coated on the rear surface side of the upper operation frame body **41** along a periphery portion of the opening portion **43***a*. Thereafter, the display area **29***a* of the display unit **29** is position-aligned relative to the opening portion **43***a* and the display unit **29** is fixed to the upper operation frame body **41** with the display unit **29** being hung down on the rear surface side of the upper operation frame body **41** at the periphery portion of the opening portion **43***a* thereof by adhesion and/or by screw fixation. As the display unit **29**, a color liquid crystal display device is used.

[0207] On the other hand, similarly as the second to fourth embodiments, the lower housing **42**, which is not shown, is prepared. On the lower housing **42**, a circuit board, a memory and the like are mounted. Then, when the upper operation frame body **41** including the touch panel built-in type display unit **29**, the front surface plate **45**A and the press detection unit **50**A is engaged with the lower housing **42** so as to be fitted to each other, the mobile phone **500** with the input device as shown in FIG. **19** is completed.

[0208] The following will describe an example for detecting a change in the resistance as an output voltage Vo when executing a press operation in the press detection unit **50**A. FIG. **25** shows an example of an equivalent circuit example of the press detection unit **50**A and a detection example of the output voltage Vo thereof.

[0209] The equivalent circuit example of the press detection unit **50**A shown in FIG. **25** includes four variable resistors VRa, VRb, VRc, VRd and four switches SWa, SWb, SWc, SWd for turning on/off. These are connected to the terminals **4** and **5** in series in order of the variable resistor VRc, the switch SWa, the variable resistor VRd, the switch SWb, the variable resistor VRa, the switch SWc and the variable resistor VRb, and the switch SWd and a switch SWd is connected to the terminals **4** and **5**.

[0210] The variable resistor VRa is constituted by the electrode patterns **51***a*, **52***a* and the elastic electric conductor **53***a* in between the terminals **1** and **2**, the variable resistor VRb is constituted by the electrode patterns **51***b*, **52***b* and the elastic electric conductor **53***b* in between the terminals **3** and **4**, the variable resistor VRc is constituted by the electrode patterns **51***c*, **52***c* and the elastic electric conductor **53***c* in between the terminals **5** and **6** and the variable resistor VRd is constituted by the electrode patterns **51***d*, **52***d* and the elastic electric conductor **53***d* in between the terminals **7** and **8**.

[0211] Also, according to the voltage detection example of the press detection unit **50**A, it is constituted by including the four switches SWe to SWh for changeovers, two direct current power supplies DC**1** and DC**2** and two voltage detection circuits **61**, **62**. The terminals **5** and **6** are connected with, for example, the switch SWe for changeover. For the switch SWe, there is used a two-circuits-one-selection switch. A mid point of the switch SWe is connected to the direct current power supply DC**1**. The contact point **1** thereof is connected to the terminal **5** and a contact point **2** is connected to the terminal **6**, respectively.

[0212] To the terminals **7** and **8**, the switch SWf for changeover is connected. For the switch SWf, a three-circuits-one-selection switch is used. A mid point of the switch SWf is connected to the first voltage detection circuit **61**. The contact point **1** thereof is connected to the terminal **8** and a contact point **2** is connected to the terminal **7**, respectively. The contact point **3** thereof is a vacancy, that is, a non-connection OFF.

[0213] To the terminals **1** and **2**, the switch SWg for changeover is connected. For the switch SWg, a two-circuits-one-selection switch is used. A mid point of the switch SWg is connected to the direct current power supply DC**2**. The contact point **1** thereof is connected to the terminal **1** and a contact point **2** is connected to the terminal **2**, respectively.

[0214] To the terminals **3** and **4**, the switch SWh for changeover is connected. For the switch SWh, a two-circuits-one-selection switch is used. A mid point of the switch SWh is connected to the second voltage detection circuit **62**. The contact point **1** thereof is connected to the terminal **3** and a contact point **2** is connected to the terminal **4**, respectively. The above-mentioned voltage detection circuit **61** is constituted by a load resistance RL and a voltage detector Va, and the voltage detection circuit **62** is constituted by a load resistance RL and a voltage detector Vb. The respective voltage detectors Va, Vb measures a voltage drop generated in the load resistance RL.

[0215] The following will describe the voltage detection example when executing the press operation in the press detection unit **50**A shown in FIG. **25** with reference to table 1.

TABLE 1

Switch	When Reading Z	When Reading X	When Reading Y
SWa	ON	ON	OFF
SWb	ON	OFF	ON
SWc	ON	ON	OFF
SWd	OFF	OFF	ON
SWe	1	1	2
SWf	3(OFF)	2	1
SWg	3(OFF)	1	2
SWh	2	2	1

[0216] According to the table 1, in case of reading the press force P in the Z-direction by the press detection unit **50**A, the switches SWa, SWb, SWc are turned on and the switch SWd is turned off. The switch SWe selects the "1" side and connects the terminal **5** with the direct current power supply DC**1**. The switch SWf selects the "3" side and is turned off. The

switch SWg selects the "3" side and is turned off. The switch SWh selects the "2" side and connects the terminal **4** with the voltage detection circuit **62**. Thus, it is possible to read-out the resistance value R**45** (4→3→2→1→8→7→6→5) and it is possible to judge a change in the resistance value R**45** from the output voltage Vo of the voltage detection circuit **62**.

[0217] Also, in case of reading the press force F in the X-direction by the press detection unit **50**A, the switches SWa, SWc are turned on and the switch SWb, SWd are turned off. The switch SWe selects the "1" side and connects the terminal **5** with the direct current power supply DC**1**. The switch SWf selects the "2" side and connects the terminal **8** with the voltage detection circuit **61**. The switch SWg selects the "1" side and connects the terminal **1** with the direct current power supply DC**2**. The switch SWh selects the "2" side and connects the terminal **4** with the voltage detection circuit **62**.

[0218] Thus, it is possible to read-out the resistance value R**14** (1→2→3→4) and the resistance value R**58** (5→6→7→8). It is possible to judge the change of the resistance value R**14** from the output voltage Vo of the voltage detection circuit **62** and it is possible to judge the change of the resistance value R**58** from the output voltage Vo of the voltage detection circuit **61**.

[0219] Further, in case of reading the press force F in the Y-direction by the press detection unit **50**A, the switches SWa, SWc are turned off and the switch SWb, SWd are turned on. The switch SWe selects the "2" side and connects the terminal **6** with the direct current power supply DC**1**. The switch SWf selects the "1" side and connects the terminal **7** with the voltage detection circuit **61**. The switch SWg selects the "2" side and connects the terminal **2** with the direct current power supply DC**2**. The switch SWh selects the "1" side and connects the terminal **3** with the voltage detection circuit **62**. Thus, it is possible to read-out the resistance value R**36** (3→4→5→6) and the resistance value R**27** (2→1→8→7). It is possible to judge the change of the resistance value R**36** from the output voltage Vo of the voltage detection circuit **62** and it is possible to judge the change of the resistance value R**27** from the output voltage Vo of the voltage detection circuit **61**.

[0220] FIG. **26** shows a characteristics example of a resistance value Rv at a time of calibration in the press detection unit **50**A. In this embodiment, an OFF-mode is provided for updating a resistance value Rs**1** for the judgment threshold level in the press detection unit **50**A judgment threshold voltage Vth is also allowed).

[0221] A vertical axis shown in FIG. **26** is the resistance value Rv in the press detection unit **50**A and is any of the values of the variable resistors VRa, VRb, VRc, VRd or the like which are constituted by the electrode patterns **51***a*, **51***b*, **51***c*, **51***d*, the electrode patterns **52***a*, **52***b*, **52***c*, **52***d* and the elastic electric conductors **53***a*, **53***b*, **53***c* and **53***d*. A horizontal axis shown in FIG. **26** is the press force F and is the external force added to any of the elastic electric conductors **53***a*, **53***b*, **53***c* and **53***d* when executing the press operation.

[0222] A solid line indicates a resistance value versus press characteristic curve Ia at a time of shipment. A broken line indicates a resistance value versus press characteristic curve IIb at a time of calibration. In this embodiment, the resistance value versus press characteristic curve IIb at a time of calibration is shifted to the downward side of the graph thereof as compared with the resistance value versus press characteristic curve Ia at the time of shipment. Such a shift of the resistance value versus press characteristic curve IIb at the time of calibration to the downward side in the graph is because the electrode patterns **51***a*, **52***a* and the elastic electric conductor **53***a* or the like could be plastic deformed when keeping the product in the long time in a state in which the load is added on the press detection unit **50**A constantly, and in a state before operation, the resistance value Rv is lowered in the certain amount.

[0223] Consequently, the resistance value Rs**1** for judgment threshold level is updated by executing the OFF-mode in the press detection unit **50**A. In the OFF-mode, for example, at a time of factory shipment, when the resistance between the terminals at the no-load is made as Rv, the resistance value for judgment threshold level of the ON/OFF of the input function decided on the application side (side) is also made as Rs, the resistance value between the terminals at a time of execution of the OFF-mode is made as Rn and the resistance value for judgment threshold level after updating is made as Rs**1**, the value of Rs**1** is calculated and updated by a following calculation formula (3).

$$Rs1=Rs\times Rn/Rv \tag{3}$$

[0224] However, it is constituted such that the resistance value Rn between the terminals is obtained by measuring the resistance value between the respective terminals **1** and **2**, **3** and **4**, **5** and **6**, **7** and **8** at a time of execution of the OFF-mode.

[0225] In this manner, by updating the resistance value Rs for judgment threshold level to the resistance value Rs**1** by the calibration, even if it is a case in which the resistance value Rn thereof is less than the resistance value Rs for judgment threshold level provided on the application side, the miss-operation does not occur. Thus, it is possible to prevent for unreasonable input, shifted input position or the like. It should be noted that the resistance value update process at a time of calibration is not executed in every time. Also, the update is not limited to the resistance value Rs for judgment threshold level, but the update can be subject to the judgment threshold voltage Vth**1**, Vth**2** or the like.

[0226] FIG. **27** shows an arrangement example of the elastic electric conductor **53***a***1** to **53***d***1** in a press detection unit **501**. In the following variations, the press detection unit **501** of every variation has a frame shape (picture frame shape) and the arrangement position thereof in the electronic apparatus does not change.

[0227] According to the arrangement example of the elastic electric conductors **53***a***1** to **53***d***1** shown in FIG. **27**, wirings of the electrode patterns **51***a*, **52***a*, the electrode patterns **51***b*, **52***b*, the electrode patterns **51***c*, **52***c* and the electrode patterns **51***d*, **52***d* are eight pieces and the press detection regions are four or more and the elastic electric conductors **53***a***1**, **53***b***1**, **53***c***1**, **53***d***1** are arranged only at the four corners. When the elastic electric conductors **53***a***1** to **53***d***1** are made by patterning in this manner, it is possible to omit the conductive rubber member as compared with the elastic electric conductors **53***a* to **53***d* shown in FIG. **21** and also, it is possible to improve press detection accuracy at a time of execution of the X and Y mode input function.

[0228] FIG. **28** shows an arrangement example of the electrode patterns **51***a***1** to **51***d***1** and the electrode patterns **52***a***1** to **52***d***1** in a press detection unit **502**. According to the arrangement example of the electrode patterns shown in FIG. **28**, the electrode patterns **51***a***1**, **51***b***1**, **51***c***1**, **51***d***1**, the electrode patterns **52***a***1**, **52***b***1**, **52***c***1**, **52***d***1** and the elastic electric conductors **53***a***1**, **53***b***1**, **53***c***1**, **53***d***1** are arranged only in the periphery of each of the four corners.

[0229] When the electrode patterns **51***a***1** to **51***d***1**, the electrode patterns **52***a***1** to **52***d***1** and the elastic electric conductors **53***a***1** to **53***d***1** are made by patterning in this manner, it is possible to omit the conductive rubber member as compared with the elastic electric conductors **53***a* to **53***d* shown in FIG. **21** and also, it is possible to improve press detection accuracy at a time of execution of the X-and-Y mode input function of the electrode patterns **51***a***1** to **51***d***1** and the electrode patterns **52***a***1** to **52***d***1**.

[0230] The following will describe eight operation modes when executing the press operation in the mobile phone **500**. In the following examples, there is cited a case in which the operation mode when executing the press operation and the application are made corresponding therebetween beforehand.

[0231] FIG. **29** shows an X-mode input function example in the mobile phone **500**. According to the X-mode input function example shown in FIG. **29**, the display unit **29** is displayed in the horizontally wide by placing the mobile phone **500** in the horizontally long or by holding it in the horizontally long (horizontally wide style). When executing a WEB circulation application in this horizontally wide style, the press detection unit **50**A executes the sliding detection operation in the X-direction as a vertical scroll function. When the CPU **32** or the exclusive driver IC executes the X-mode, it is constituted such that the coordinate state in the X-direction is read-in in every sampling frequency. An operation example of the press detection unit **50**A should be referred to FIG. **22** and FIG. **25** and the description concerning them.

[0232] FIGS. **30**A and **30**B show Y-mode input function examples in the mobile phone **500**. According to the Y-mode input function example shown in FIG. **30**A, the display unit **29** is displayed in the vertically wide by placing the mobile phone **500** in the vertically long or by holding it in the vertically long (vertically wide style). When executing the WEB circulation application in the vertically wide style, the press detection unit **50**A executes a vertical scroll function thereof.

[0233] Alternatively, as shown in FIG. **30**B, the display unit **29** is displayed in the horizontally wide by placing the mobile phone **500** in the horizontally long or by holding it in the horizontally long. At a time of execution of an image reproduction application in this horizontally wide style, the press detection unit **50**A executes the sliding detection operation in the Y-direction as a reproduction position operation function. On the display unit **29**, for example, a bar **29***c* for audio volume adjustment is displayed and when the user slides this bar **29***c* from the left to the right, the sound volume is increased and reversely, when the user slides this bar **29***c* from the right to the left, the sound volume is decreased. In either case, when the CPU **32** or the exclusive driver IC executes the Y-mode, it is constituted such that the coordinate state in the Y-direction is read-in in every sampling frequency. An operation example of the press detection unit **50**A should be referred to FIG. **23** and FIG. **25** and the description concerning them.

[0234] FIG. **31** shows a Z-mode input function example in the mobile phone **500**. According to the Z-mode input function example shown in FIG. **31**, by placing the mobile phone **500** in the vertically long or by holding it in the vertically long, the press detection unit **50**A executes the detection operation of the press force F in the Z-direction as a start-up switch function from a waiting state thereof. When the CPU **32** or the exclusive driver IC executes the Z-mode, it is constituted such that the coordinate state in the Z-direction is read-in in every sampling frequency. An operation example of the press detection unit **50**A should be referred to FIG. **21** and FIG. **25** and the description concerning them.

[0235] FIG. **32** shows an X+Y-mode input function example in the mobile phone **500**. According to the X+Y-mode input function example shown in FIG. **32**, the display unit **29** is displayed in the horizontally wide by placing the mobile phone **500** in the horizontally long or by holding it in the horizontally long. In the horizontally wide style, for example, when executing a map circulation application, the press detection unit **50**A executes the detection operation of the sliding and the press force F in the X and Y directions as a cross scroll function in the X and Y directions for the position movement operation or the like. When the CPU **32** or the exclusive driver IC executes the X+Y-mode, the coordinate state in the X-direction and the coordinate state in the Y-direction are read-in in every sampling frequency.

[0236] FIG. **33** shows an X+Z-mode input function example in the mobile phone **500**. According to the X+Z-mode input function example shown in FIG. **33**, the display unit **29** is displayed in the horizontally wide by placing the mobile phone **500** in the horizontally long or by holding it in the horizontally long. In the horizontally wide style, for example, when executing a selection application of various kinds of items (application for selecting a musical piece from a list display by a phone book or a music creation function), the press detection unit **50**A executes the detection operation of the sliding in the X-direction and the press force F in the Z-direction as a selection determination function. When the CPU **32** or the exclusive driver IC executes the X+Z-mode, the coordinate state in the X-direction and the coordinate state in the Z-direction are read-in in every sampling frequency.

[0237] FIG. **34** shows a Y+Z-mode input function example in the mobile phone **500**. According to the Y+Z-mode input function example shown in FIG. **34**, by placing the mobile phone **500** in the vertically long or by holding it in the vertically long, when executing the selection application of various kinds of items in the vertically wide style (application for selecting a musical piece from a list display by a phone book or a music creation function), the press detection unit **50**A executes the detection operation of the sliding in the Y direction and the press force F in the Z-direction as the selection determination function. When the CPU **32** or the exclusive driver IC executes the Y+Z-mode, the coordinate state in the Y-direction and the coordinate state in the Z-direction are read-in in every sampling frequency.

[0238] FIG. **35** shows an X+Y+Z-mode input function example in the mobile phone **500**. According to the X+Y+Z-mode input function example shown in FIG. **35**, by placing the mobile phone **500** in the vertically long or by holding it in the vertically long, the press detection unit **50**A executes the detection operation of the sliding in the X and Y directions and the press force F in the Z-direction as the operation function of the ten-key, the cross key or the like in the vertically wide style. When the CPU **32** or the exclusive driver IC executes the X+Y+Z-mode, the coordinate state in the X-direction, the coordinate state in the Y-direction and the coordinate state in the Z-direction are read-in in every sampling frequency.

[0239] FIG. **36** shows a multi-point mode input function in the mobile phone **500**. According to the multi-point mode input function shown in FIG. **36**, by placing the mobile phone **500** in the horizontally long or by holding it in the horizontally long, when executing a game application in the horizon-

tally wide style, the press detection unit **50**A executes the detection operation of the press force F in the Z-direction on the right/left as a both-hands-selection operation function. When the CPU **32** or the exclusive driver IC executes the multi-point mode, each individual resistance value is read-in in every sampling frequency.

[0240] The following will describe an operation mode changeover example in the mobile phone **500**. FIG. **37** to FIG. **39** show the operation mode changeover example (part one to three thereof) in the mobile phone **500**. In this embodiment, a case is illustrated in which if there is an execution instruction of the application, a selection candidate is changed over in order of the X-mode→the Y-mode→the Z-mode→the X+Y-mode→the X+Z-mode→the Y+Z-mode→the X+Y+Z-mode→an OFF mode, with respect to the operation mode.

[0241] Under these changeover conditions, the execution instruction of the application is waited at step ST**1** in the flowchart shown in FIG. **37**. when obtaining an execution instruction of the application, the process shifts to step ST**2** where the corresponding application and the operation mode information are read-in. The operation mode information is made corresponding to the application beforehand. When obtaining an execution instruction, it is constituted such that operation mode information which is made corresponding to this application can be judged.

[0242] Thereafter, the process shifts to step ST**3** where the control is branched according to whether an X-mode or the other mode is set. If the operation mode information of the corresponding application is an X-mode, the process shifts to step ST**4** where the CPU **32** changes over the operation mode to an X-mode and the display unit **29** executes the corresponding application. For example, according to the X-mode input function example shown in FIG. **29**, the display unit **29** displays the image in the horizontally wide by placing the mobile phone **500** in the horizontally long or by holding it in the horizontally long. The CPU **32** executes the WEB circulation application in this horizontally wide style. The press detection unit **50**A executes the sliding detection operation in the X-direction as the vertical scroll function. The CPU **32** or the exclusive driver IC reads-in the coordinate state of X-direction in every sampling frequency.

[0243] Then, the process shifts to step ST**5** where the CPU **32** judges an end of the corresponding application. When obtaining no end instruction of the corresponding application, the process returns to the step ST**4** where the display unit **29** continues the corresponding application. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where the display unit **29** waits an execution instruction of the next application.

[0244] If a mode other than the X-mode is set at the above-mentioned step ST**3**, the process shifts to step ST**6** where the CPU **32** branches the control thereof depending on the Y-mode or the other mode, except for the X-mode. If the operation mode information of the corresponding application is the Y-mode, the process shifts to step ST**7** where the CPU **32** changes over the operation mode to the Y-mode and the display unit **29** executes the corresponding application.

[0245] For example, according to the Y-mode input function example shown in FIG. **30**A, the display unit **29** displays the image in the vertically wide style by placing the mobile phone **500** in the vertically long or by holding it in the vertically long. The CPU **32** executes the WEB circulation application in this vertically wide style. The press detection unit **50**A executes the sliding detection operation in the Y-direction as the vertical scroll function. Alternatively, the CPU **32** executes the image reproduction application in the horizontally wide style shown in FIG. **30**B. The press detection unit **50**A executes the sliding detection operation in the Y-direction as the reproduction position operation function. In both of cases, the CPU **32** or the exclusive driver IC reads-in the coordinate state in the Y-direction in every sampling frequency.

[0246] Then, the process shifts to step ST**8** where the CPU **32** judges an end of the corresponding application. When obtaining no an end instruction of the corresponding application, the process returns to the step ST**7** where the display unit **29** continues the display based on the corresponding application. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where the display unit **29** waits an execution instruction of the next application.

[0247] If a mode other than X and Y modes is set at the above-mentioned step ST**6**, the process shifts to step ST**9**, shown in FIG. **38**, where the CPU **32** branches the control depending on the Z-mode or the other mode, except for X and Y modes. If the operation mode information of the corresponding application is a Z-mode, the process shifts to step ST**10** where the CPU **32** changes over the operation mode to a Z-mode and the display unit **29** executes the corresponding application.

[0248] For example, according to the Z-mode input function example shown in FIG. **31**, the press detection unit **50**A executes the detection operation of the press force F in the Z-direction as a start-up switch function from a waiting state in the vertically wide style of the mobile phone **500**. The CPU **32** or the exclusive driver IC reads-in the coordinate state in the Z-direction in every sampling frequency.

[0249] Then, the process shifts to step ST**11** where the CPU **32** judges an end of the corresponding application. When obtaining no end instruction of the corresponding application, the process returns to the step ST**10** where the corresponding application is continued. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where an execution instruction of the next application is waited.

[0250] If a mode other than the X, Y, and Z modes is set at the above-mentioned step ST**9**, the process shifts to step ST**12** where the CPU **32** branches the control thereof depending on the X+Y-mode or the other mode, except for the X, Y, and Z modes, is set. If the operation mode information of the corresponding application is the X+Y-mode, the process shifts to step ST**13** where the CPU **32** changes over the operation mode to the X+Y-mode and the display unit **29** executes the corresponding application.

[0251] For example, according to the X+Y-mode input function example shown in FIG. **32**, when the CPU **32** executes the map circulation application in the horizontally wide style of the mobile phone **500**, the press detection unit **50**A executes the detection operation of the sliding and the press force F in the X and Y directions as the cross scroll function in the X and Y directions of the position movement operation or the like. The CPU **32** or the exclusive driver IC reads-in the coordinate state in the X-direction and the coordinate state in the Y-direction in every sampling frequency.

[0252] Then, the process shifts to step ST**14** where the CPU **32** judges an end of the corresponding application. When obtaining no end instruction of the corresponding application, the process returns to the step ST**13** where the display

unit **29** continues the corresponding application. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where the display unit **29** waits an execution instruction of the next application.

[0253] If a mode other than the X, Y, Z, and X+Y-modes is set at the above-mentioned step ST**12**, the process shifts to step ST**15** where the CPU **32** branches the control thereof depending on the X+Z-mode or the other mode, except for the X, Y, Z, X+Y-modes. If the operation mode information of the corresponding application is the X+Z-mode, the process shifts to step ST**16** where the CPU **32** changes over the operation mode to the X+Z-mode and the display unit **29** executes the corresponding application.

[0254] For example, according to the X+Z-mode input function example shown in FIG. **33**, when the CPU **32** executes the selection application of various kinds of item in the horizontally wide style of the mobile phone **500**, the press detection unit **50**A executes the detection operation of the sliding in the X-direction and the press force F in the Z-direction as the selection determination function. The CPU **32** or the exclusive driver IC reads-in the coordinate state in the X-direction and the coordinate state in the Z-direction in every sampling frequency.

[0255] Then, the process shifted to step ST**17** where the CPU **32** judges an end of the corresponding application. When obtaining no end instruction of the corresponding application, the process returns to the step ST**16** where the display unit **29** continues the display based on the corresponding application. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where the display unit **29** waits an execution instruction of the next application.

[0256] If a mode other than the X, Y, Z, X+Y, and X+Z-modes is set at the above-mentioned step ST**15**, the process shifts to step ST**18** where the CPU **32** branches the control thereof depending on the Y+Z-mode or the other mode, except for the X, Y, Z, X+Y, and X+Z-modes. If the operation mode information of the corresponding application is the Y+Z-mode, the process shifts to step ST**19** where the CPU **32** changes over the operation mode to the Y+Z-mode and executes the corresponding application. For example, according to the Y+Z-mode input function example shown in FIG. **34**, when the CPU **32** executes the selection application of various kinds of items in the vertically wide style of the mobile phone **500**, the press detection unit **50**A executes the detection operation of the sliding in the Y-direction and the press force F in the Z-direction as the selection determination function. The CPU **32** or the exclusive driver IC reads-in the coordinate state in the Y-direction and the coordinate state in the Z-direction in every sampling frequency.

[0257] Then, the process shifts to step ST**20** where the CPU **32** judges an end of the corresponding application. When obtaining no end instruction of the corresponding application, the process returns to the step ST**19** where the display unit **29** continues the display based on the corresponding application. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where the display unit **29** waits an execution instruction of the next application.

[0258] If a mode other than the X, Y, Z, X+Y, X+Z, and Y+Z-modes is set at the above-mentioned step ST**18**, the process shifts to step ST**21**, shown in FIG. **39**, where the CPU **32** branches the control thereof depending on the X+Y+Z-mode or the other mode, except for the X, Y, Z, X+Y, X+Z, and Y+Z-modes. If the operation mode information of the corresponding application is the X+Y+Z-mode, the process shifts to step ST**22** where the CPU **32** changes over the operation mode to the X+Y+Z-mode and the display unit **29** executes the corresponding application.

[0259] For example, according to the X+Y+Z-mode input function example shown in FIG. **35**, in the vertically wide style of the mobile phone **500**, the press detection unit **50**A executes the detection operation of the sliding in the X and Y directions and the press force F in the Z-direction as the operation function of the ten-key, the cross key or the like. The CPU **32** or the exclusive driver IC reads-in the coordinate state in the X-direction, the coordinate state in the Y-direction and the coordinate state in the Z-direction in every sampling frequency.

[0260] Then, the process shifts to step ST**23** where the CPU **32** judges an end of the corresponding application. When obtaining no end instruction of the corresponding application, the process returns to the step ST**22** where the display unit **29** continues the corresponding application. When obtaining an end instruction of the corresponding application, the process returns to the step ST**1** where the display unit **29** waits an execution instruction of the next application.

[0261] If an OFF-mode other than the X, Y, Z, X+Y, X+Z, Y+Z, and X+Y+Z-modes is set at the above-mentioned step ST**18**, the process shifts to step ST**24** where the CPU **32** changes over the operation mode to the OFF mode and executes the calibration. For example, the resistance value Rn between terminals is obtained by measuring the resistance value between the respective terminals **1** and **2**, **3** and **4**, **5** and **6**, **7** and **8** of the press detection unit **50**A. Then, according to the update example of the resistance value Rs**1** for judgment threshold level at time of the calibration shown in FIG. **26**, at a time of factory shipment, the resistance value Rs**1** for judgment threshold level after updating is calculated by substituting the resistance value Rv between terminals in the no-load, the resistance value Rs for judgment threshold level of the ON/OFF of the input function decided on the application side and the resistance value Rn between the terminals when executing the OFF mode for the formula (3).

[0262] Then, the process shifts to step ST**25** where the CPU **32** judges an end of the calibration. When obtaining no end instruction of the calibration, the process returns to the step ST**24** where the CPU **32** continues the calibration. When obtaining an end instruction of the calibration, the process returns to the step ST**1** where the CPU **32** waits an execution instruction of the next application.

[0263] In this manner, according to the mobile phone **500** as the fifth embodiment, the display unit **29** is provided on the downward side of the front surface plate **45**A and at the same time, the embodiment of the press detection unit **50**A is provided, so that when the information is inputted with respect to the press operation by the operator's finger **30***a* in the input detection surface on the display unit, it is possible to reliably detect information of the pressed position by the press detection unit **50**A. Further, it is possible to reliably detect the press forces F (press-down force) at the positions where the elastic electric conductor **53***a* electrically connects the electrode pattern **51***a* and the electrode pattern **52***a*, the elastic electric conductor **53***b* electrically connects the electrode pattern **51***b* and the electrode pattern **52***b*, the elastic electric conductor **53***c* electrically connects the electrode pattern **51***c* and the electrode pattern **52***c* or/and the elastic elec-

tric conductor **53***d* electrically connects the electrode pattern **51***d* and the electrode pattern **52***d* in response to the press operation.

[0264] Also, the input device **903** has the display unit **29** of the air-tight structure which is completely shut off from the outside, so that it is possible to assemble the mobile phone **500** excellent in the waterproof property and the dustproof property. The upper operation frame body **41** has a structure for supporting the front surface plate **45**A such as a transparent touch-sensitive input sheet, so that the assembly easiness of the mobile phone **500** is improved. Thus, it is possible to provide the mobile phone **500** with a touch-sensitive input function having the frame shaped press detection unit **50**A of a thin-shaped and simple structure while it has an air-tight structure by which the invasion of the dust, water or the like is preventable.

[0265] Although, in the above-mentioned embodiments, the mobile phones **200** to **500** have been described as the electronic apparatus, the electronic apparatus is not limited to this; if an electronic apparatus such as a digital camera, a video camera, a game machine, a personal computer, an auto teller machine, which includes any one of the input devices **90**, **901** to **903**, is employed, the similar effect is obtained.

[0266] The embodiments may be very preferably applied to a mobile phone or an information mobile terminal which inputs the information by sliding and/or pressing the input detection surface on the display unit.

[0267] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present subject matter and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

The invention is claimed as follows:

1. A press detection sensor comprising:

a base member having predetermined length and width and also having a predetermined shape;

a first conductor having predetermined length and being arranged on the base member;

a second conductor that is arranged on the base member with the second conductor being faced to the first conductor;

a conductive contact body that is arranged between the first conductor and the second conductor, the conductive contact body connecting the first and second conductors electrically in response to an external force; and

a covering member that includes the contact body on the inside thereof, the covering member covering a top of the base member which includes the first and second conductors,

wherein the covering member contains at least one of flexibility and elasticity.

2. The press detection sensor according to claim **1**, wherein

one terminal of the first conductor is connected to a first terminal,

one terminal of the second conductor is connected to a second terminal, and

both of the other terminals of the first and second conductors are opened.

3. The press detection sensor according to claim **1**, wherein the base member on which the first conductor and the second conductor are arranged has a frame shape.

4. The press detection sensor according to claim **1**, wherein an adhesive agent is arranged on at least one of a lower surface of the base member and an upper surface of the covering member.

5. The press detection sensor according to claim **1**, wherein the contact body contains a conductive rubber member.

6. An input device that inputs information in response to a press operation of an operation body, the input device comprising:

a display-and-detection unit that displays the input information and contains an input detection surface, the display-and-detection unit detecting a contact position of the operation body in the input detection surface; and

a press detection unit that detects a press by the operation body, the press detection unit being provided on a periphery of the display unit,

wherein the press detection unit includes:

a base member having predetermined length and width and also having a predetermined shape;

a first conductor having predetermined length and being arranged on the base member;

a second conductor that is arranged on the base member with the second conductor being faced to the first conductor;

a conductive contact body that is arranged between the first conductor and the second conductor, the conductive contact body connecting the first and second conductors electrically in response to an external force; and

a covering member that includes the contact body on the inside thereof, the covering member covering a top of the base member which includes the first and second conductors, and

wherein the covering member contains at least one of flexibility and elasticity.

7. The input device according to claim **6**, wherein the display-and-detection unit contains a display subunit that displays the input information and a detection subunit that contains an input detection surface on the display subunit, the detection subunit detecting a contact position of the operation body in the input detection surface.

8. The input device according to claim **7**, wherein the base member on which the first conductor and the second conductor are arranged has a frame shape.

9. The input device according to claim **7**, wherein the detection subunit contains a resistive touch panel.

10. The input device according to claim **7**, wherein the detection unit contains a capacitive touch panel.

11. The input device according to claim **6**, wherein the display-and-detection unit contains a touch panel built-in liquid crystal display device.

12. The input device according to claim **8**, wherein the first and second conductors are arranged at each L-shaped region which equally divides each side of the four sides of the frame shaped base member and a switching device connects the first and second conductors which are adjacent to each other, and

wherein the input device has a programmable configuration that changes a press detection function by switching the switching device on or off.

13. The input device according to claim **7** wherein a touch-sensitive sheet member is provided on the press detection unit, and

wherein the touch-sensitive sheet member includes a base member for a base material of the touch-sensitive sheet member and the base member for the base material of the

touch-sensitive sheet member contains a protrusion block that presents a concavity and convexity feeling, the protrusion block having a predetermined shape.

14. An electronic apparatus that is provided with an input device which inputs information in response to a press operation of an operation body, the input device:

a display unit that displays the input information;

a detection unit that includes an input detection surface on the display unit, the detection unit detecting a contact position of the operation body in the input detection surface; and

a press detection unit that detects a press by the operation body, the press detection unit being provided on a periphery of the display unit,

wherein the press detection unit includes:

a base member having predetermined length and width and also having a predetermined shape;

a first conductor having predetermined length and being arranged on the base member;

a second conductor that is arranged on the base member with the second conductor being faced to the first conductor;

a conductive contact body that is arranged between the first conductor and the second conductor, the conductive contact body connecting the first and second conductors electrically in response to an external force; and

a covering member that includes the contact body on the inside thereof, the covering member covering a top of the base member which includes the first and second conductors, and

wherein the covering member contains at least one of flexibility and elasticity.

* * * * *

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(54) DISTINGUISHING INPUT SIGNALS DETECTED BY A MOBILE TERMINAL

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(57) ABSTRACT

A method of distinguishing input signals detected by a mobile terminal is provided. The method comprises detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and outputting a combined vibration signal corresponding to at least the first and second input signals. The first and second input signals may be proximity signals, touch signals, or a combination thereof. The combined vibration signal may be outputted according to a characteristic of at least the first and second input signals.

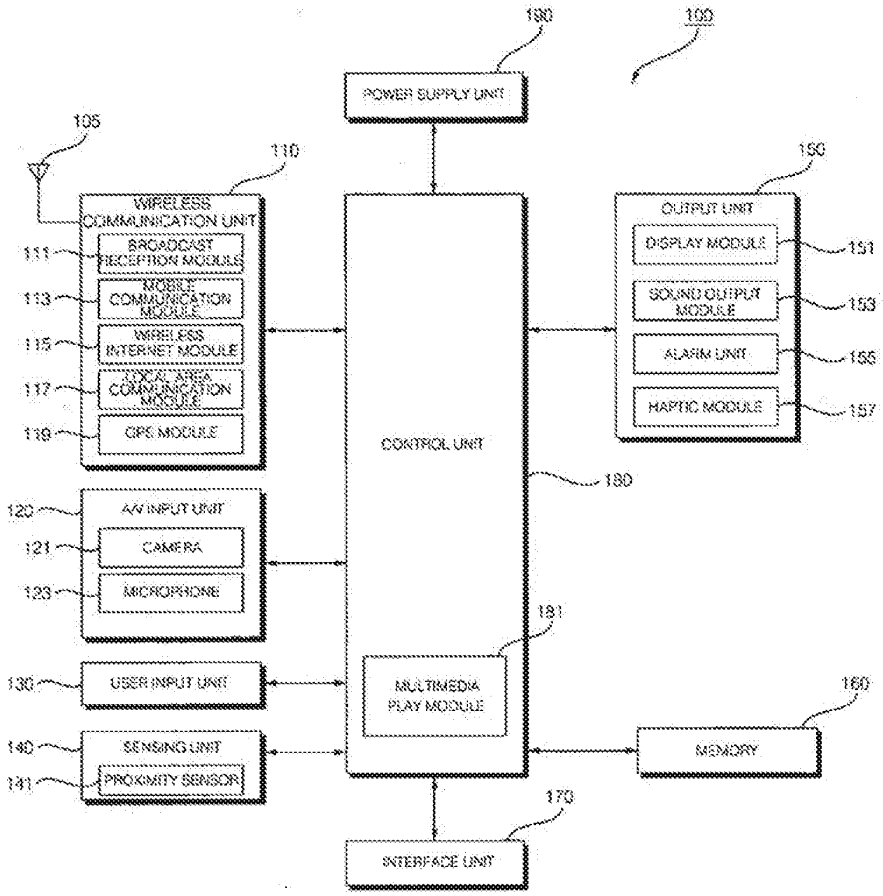


FIG. 1

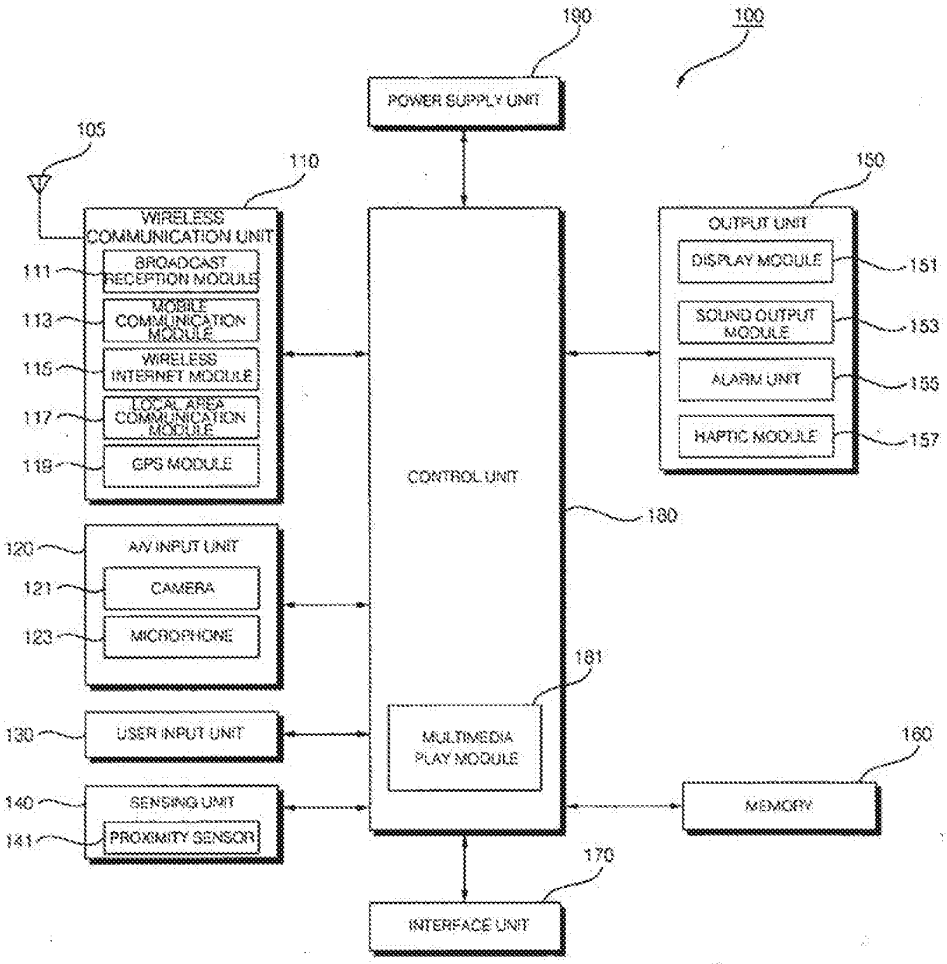

190
100
POWER SUPPLY UNIT
105
110
150
WIRELESS COMMUNICATION UNIT
OUTPUT UNIT
111
BROADCAST RECEPTION MODULE
DISPLAY MODULE
151
113
MOBILE COMMUNICATION MODULE
SOUND OUTPUT MODULE
153
115
WIRELESS INTERNET MODULE
ALARM UNIT
155
117
LOCAL AREA COMMUNICATION MODULE
HAPTIC MODULE
157
119
GPS MODULE
CONTROL UNIT
180
120
A/V INPUT UNIT
121
CAMERA
123
MICROPHONE
181
130
USER INPUT UNIT
MULTIMEDIA PLAY MODULE
160
140
SENSING UNIT
MEMORY
141
PROXIMITY SENSOR
170
INTERFACE UNIT

FIG. 2

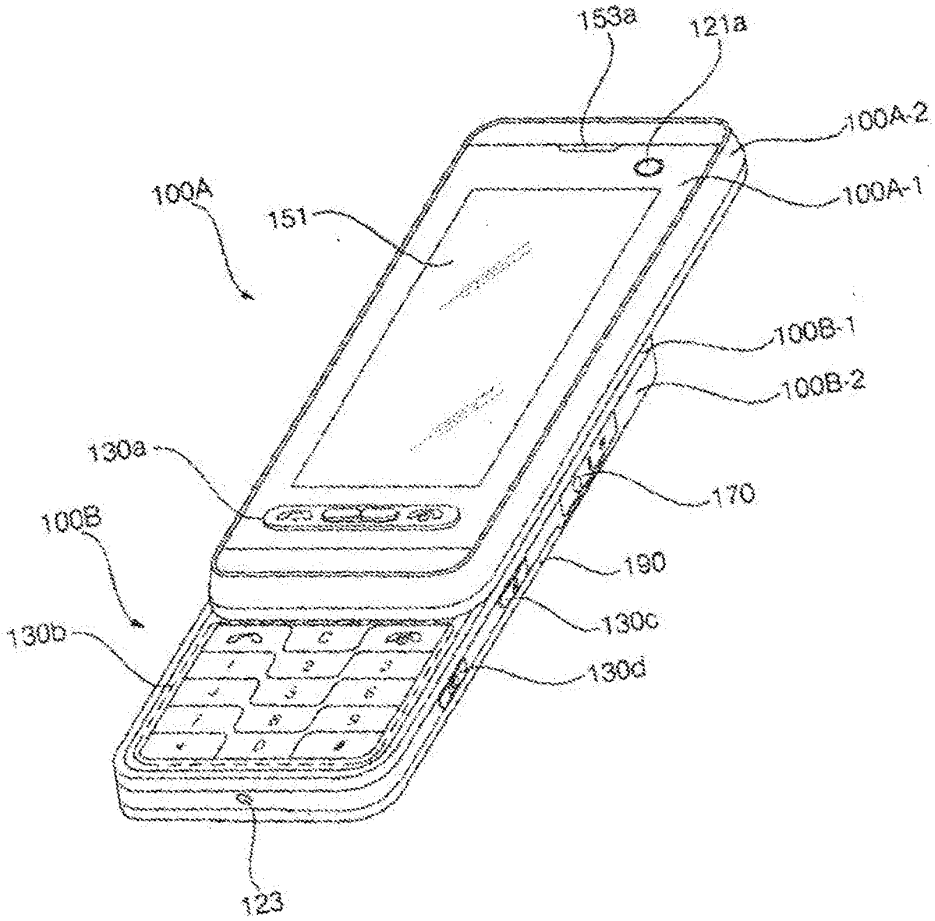

153a
121a
100A-2
100A-1
100A
151
100B-1
100B-2
130a
170
100B
150
130c
130b
130d
123

FIG. 3

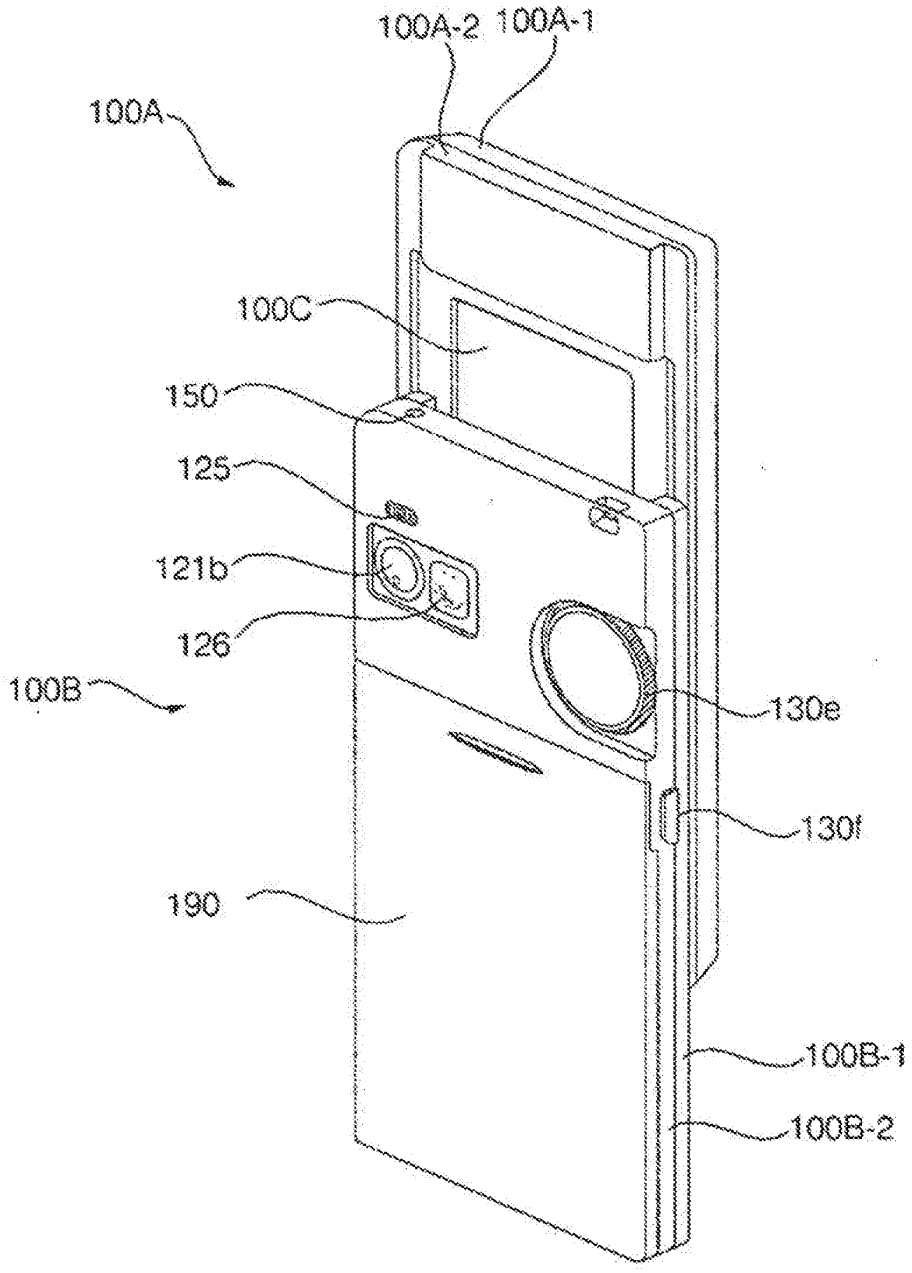

100A-2
100A-1
100A
100C
150
125
121b
126
100B
130e
130f
190
100B-1
100B-2

FIG. 4

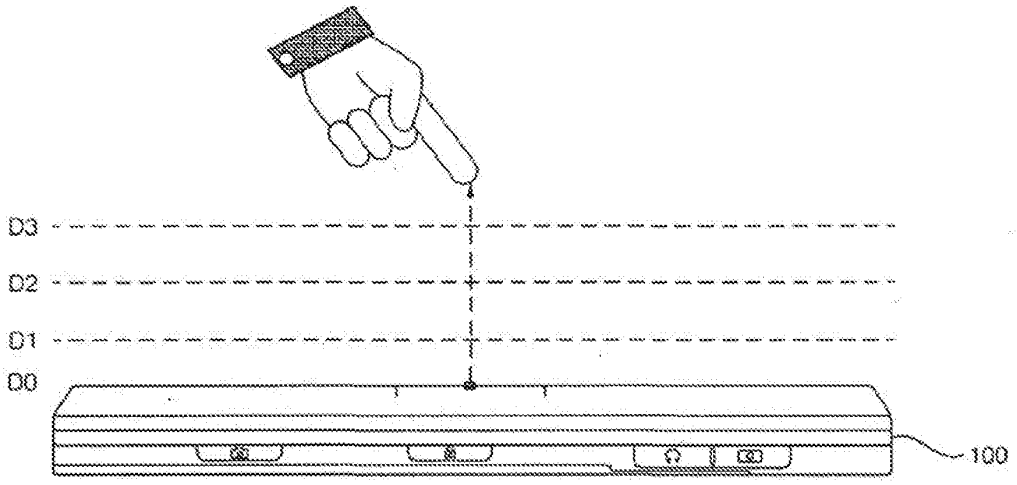


FIG. 5a

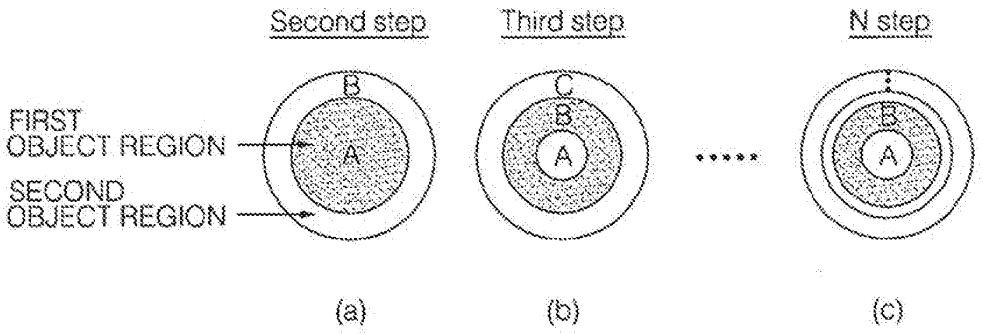

Second step
Third step
N step
FIRST OBJECT REGION
SECOND OBJECT REGION
B
A
C
B
A
B
A
(a)
(b)
(c)

FIG. 5b

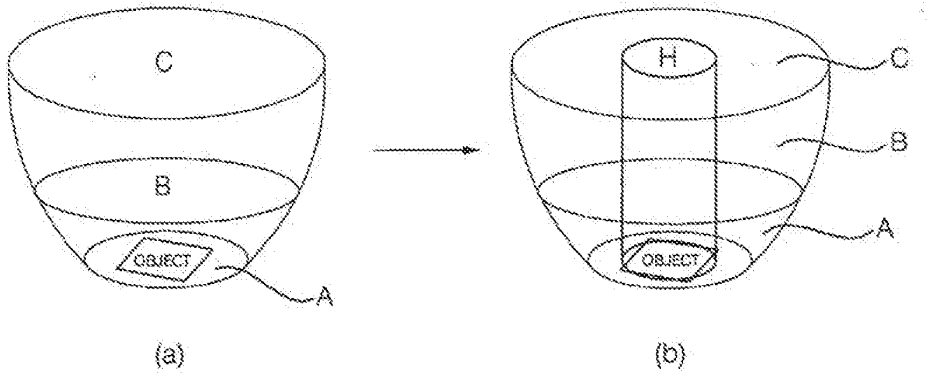

C
B
OBJECT
A
H
C
B
A
OBJECT
(a)
(b)

FIG. 6

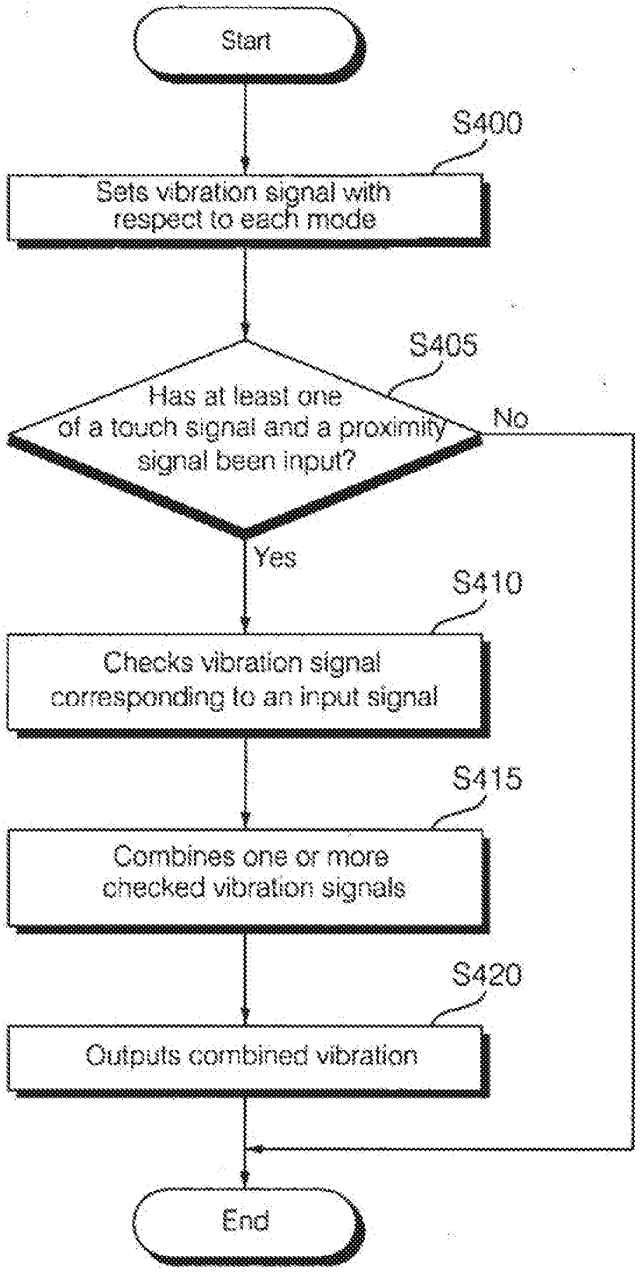

Start
S400
Sets vibration signal with respect to each mode
S405
Has at least one of a touch signal and a proximity signal been input?
No
Yes
S410
Checks vibration signal corresponding to an input signal
S415
Combines one or more checked vibration signals
S420
Outputs combined vibration
End

FIG. 7

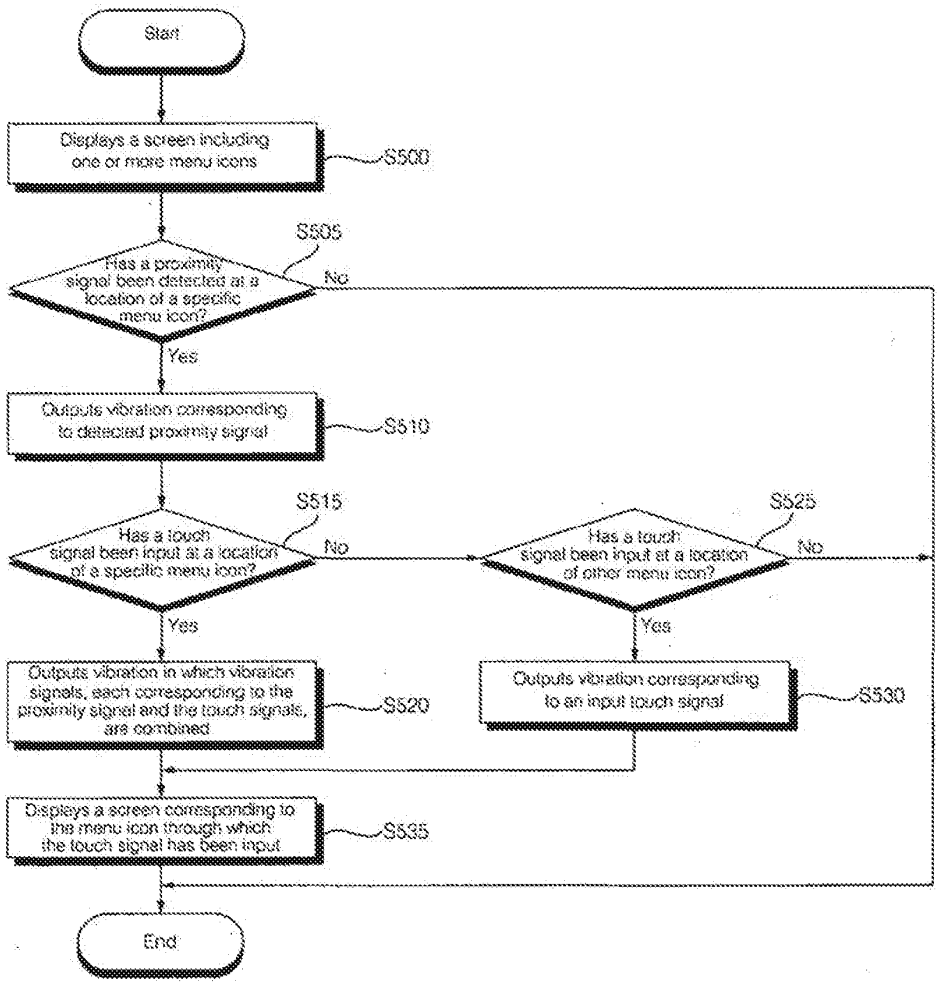

Start
Displays a screen including one or more menu icons
S500
Has a proximity signal been detected at a location of a specific menu icon?
S505
No
Yes
Outputs vibration corresponding to detected proximity signal
S510
Has a touch signal been input at a location of a specific menu icon?
S515
No
Yes
Has a touch signal been input at a location of other menu icon?
S525
No
Yes
Outputs vibration in which vibration signals, each corresponding to the proximity signal and the touch signals, are combined
S520
Outputs vibration corresponding to an input touch signal
S530
Displays a screen corresponding to the menu icon through which the touch signal has been input
S535
End

FIG. 8

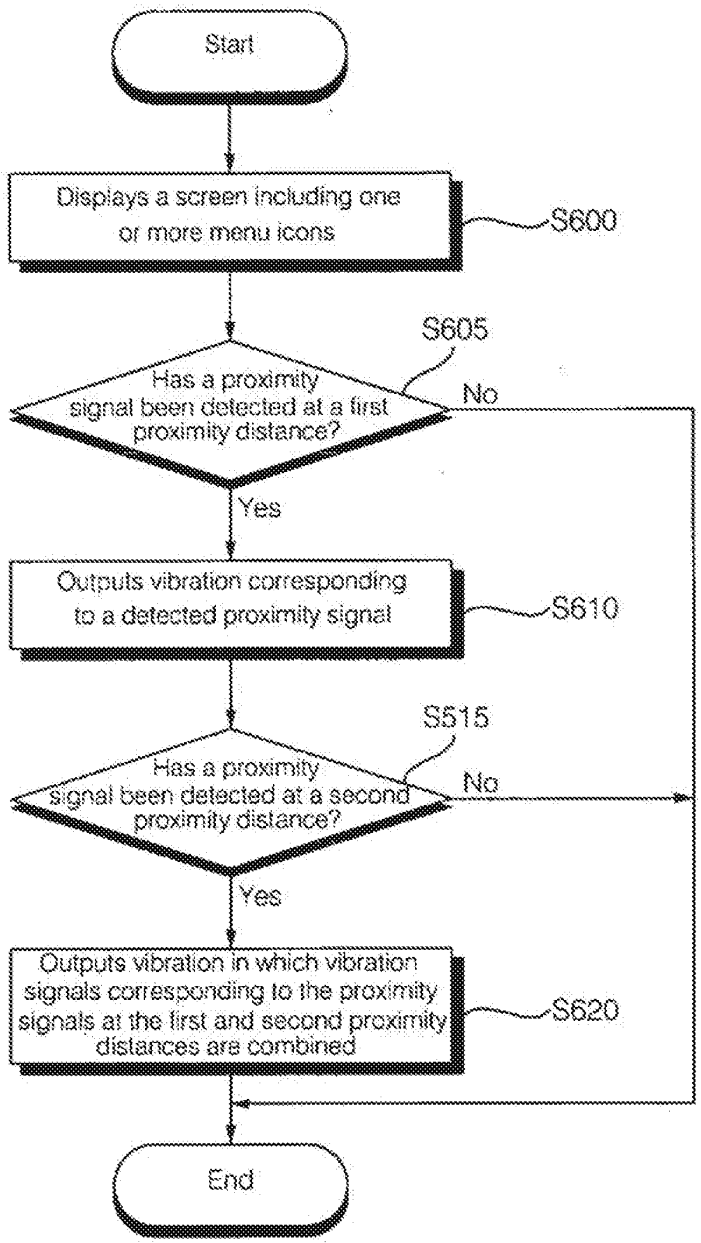

Start
Displays a screen including one or more menu icons
S600
S605
Has a proximity signal been detected at a first proximity distance?
No
Yes
Outputs vibration corresponding to a detected proximity signal
S610
S515
Has a proximity signal been detected at a second proximity distance?
No
Yes
Outputs vibration in which vibration signals corresponding to the proximity signals at the first and second proximity distances are combined
S620
End

FIG. 9

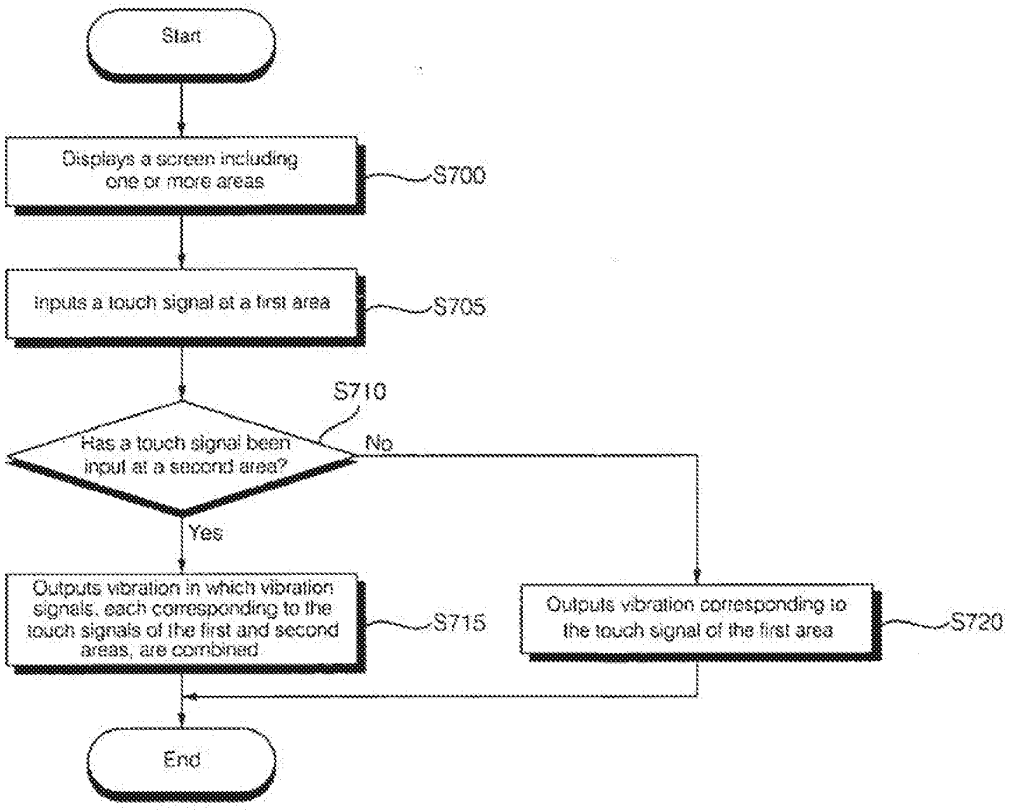

Start
Displays a screen including one or more areas
S700
Inputs a touch signal at a first area
S705
S710
Has a touch signal been input at a second area?
No
Yes
Outputs vibration in which vibration signals, each corresponding to the touch signals of the first and second areas, are combined
S715
Outputs vibration corresponding to the touch signal of the first area
S720
End

FIG. 10

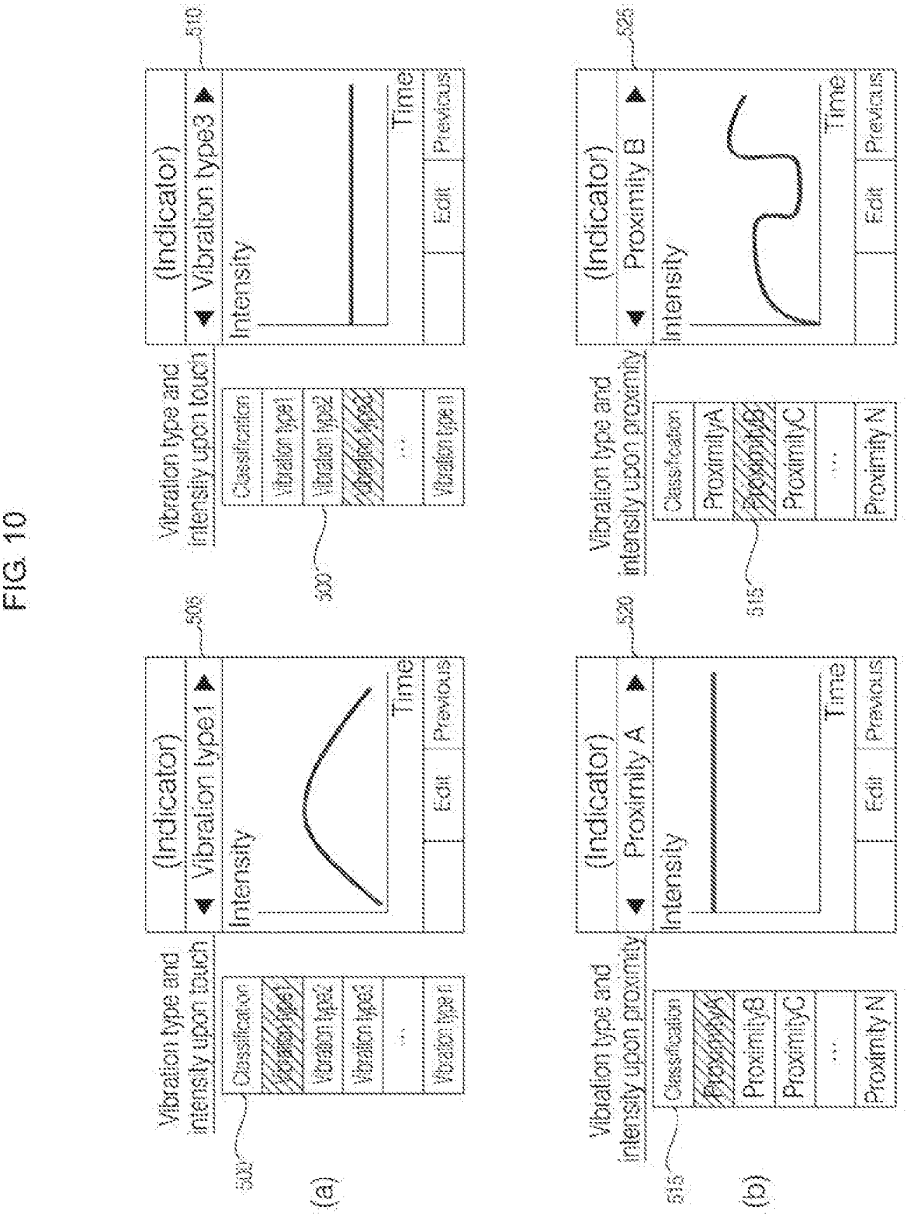

(a)
Vibration type and intensity upon touch
Classification
Vibration type1
Vibration type2
Vibration type3
...
Vibration type n
500
(Indicator)
Vibration type1
Intensity
Time
Edit
Previous
505
(Indicator)
Vibration type3
Intensity
Time
Edit
Previous
510
(b)
Vibration type and intensity upon proximity
Classification
ProximityA
ProximityB
ProximityC
...
Proximity N
515
(Indicator)
Proximity A
Intensity
Time
Edit
Previous
520
(Indicator)
Proximity B
Intensity
Time
Edit
Previous
525

FIG. 11

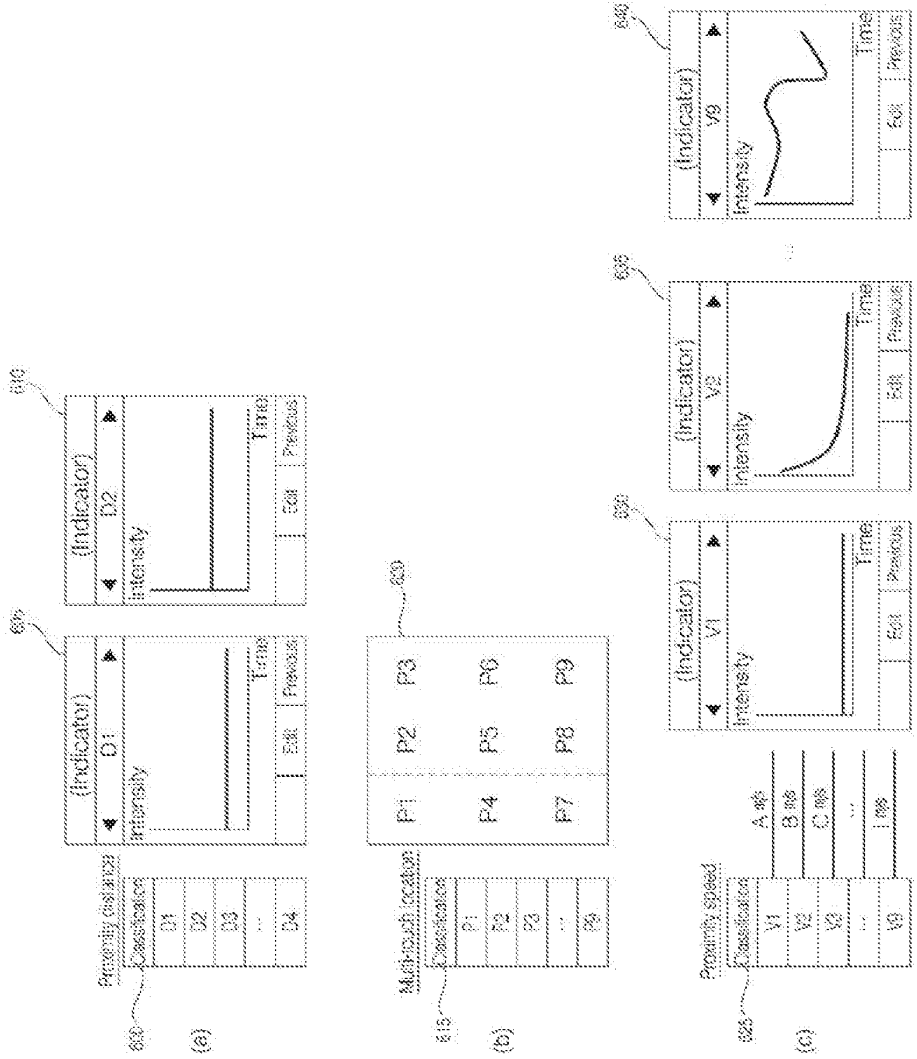

(Indicator)
D1
D2
Intensity
Time
Edit
Previous
Proximity distance
Classification
D1
D2
D3
D4
620
(a)
(Indicator)
D2
Intensity
Time
Edit
Previous
610
Multi-touch location
Classification
P1
P2
P3
P4
P5
P6
P7
P8
P9
615
(b)
(Indicator)
V1
V2
V9
Intensity
Time
Edit
Previous
630
635
640
Proximity speed
Classification
V1
V2
V9
A ms
B ms
C ms
ms
(c)

FIG.12

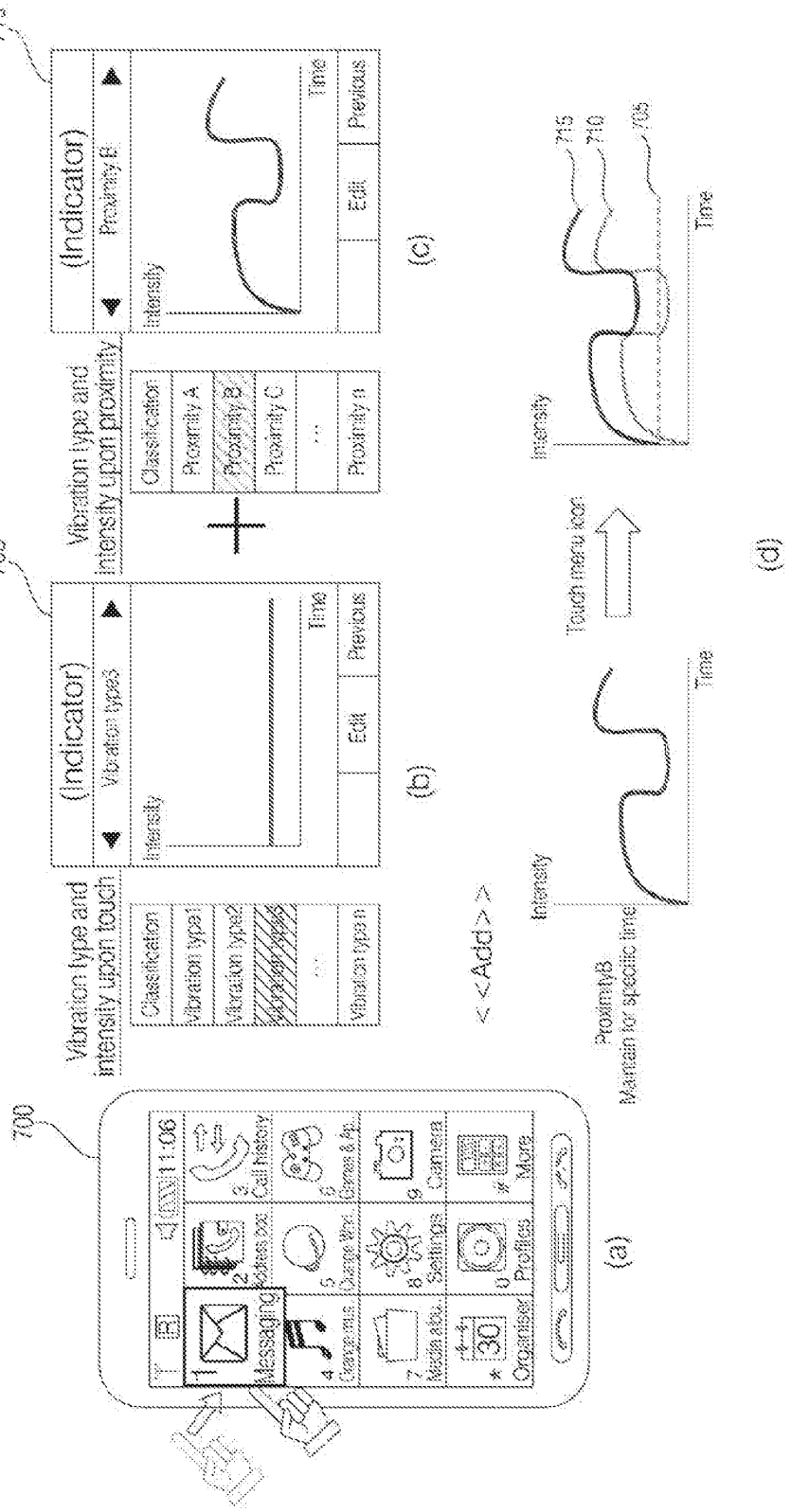

700
11:06
Messaging
Organiser
Media Alb.
Settings
Profiles
Camera
More
Vibration type and intensity upon touch
Classification
Vibration type1
Vibration type2
Vibration type n
705
(Indicator)
Vibration types
Intensity
Time
Edit
Previous
(b)
Vibration type and intensity upon proximity
Classification
Proximity A
Proximity B
Proximity C
Proximity n
710
(Indicator)
Proximity B
Intensity
Time
Edit
Previous
(c)
< <Add > >
Proximity B
Maintain for specific time
Intensity
Time
Touch menu icon
715
710
705
Intensity
Time
(d)
(a)

FIG. 13

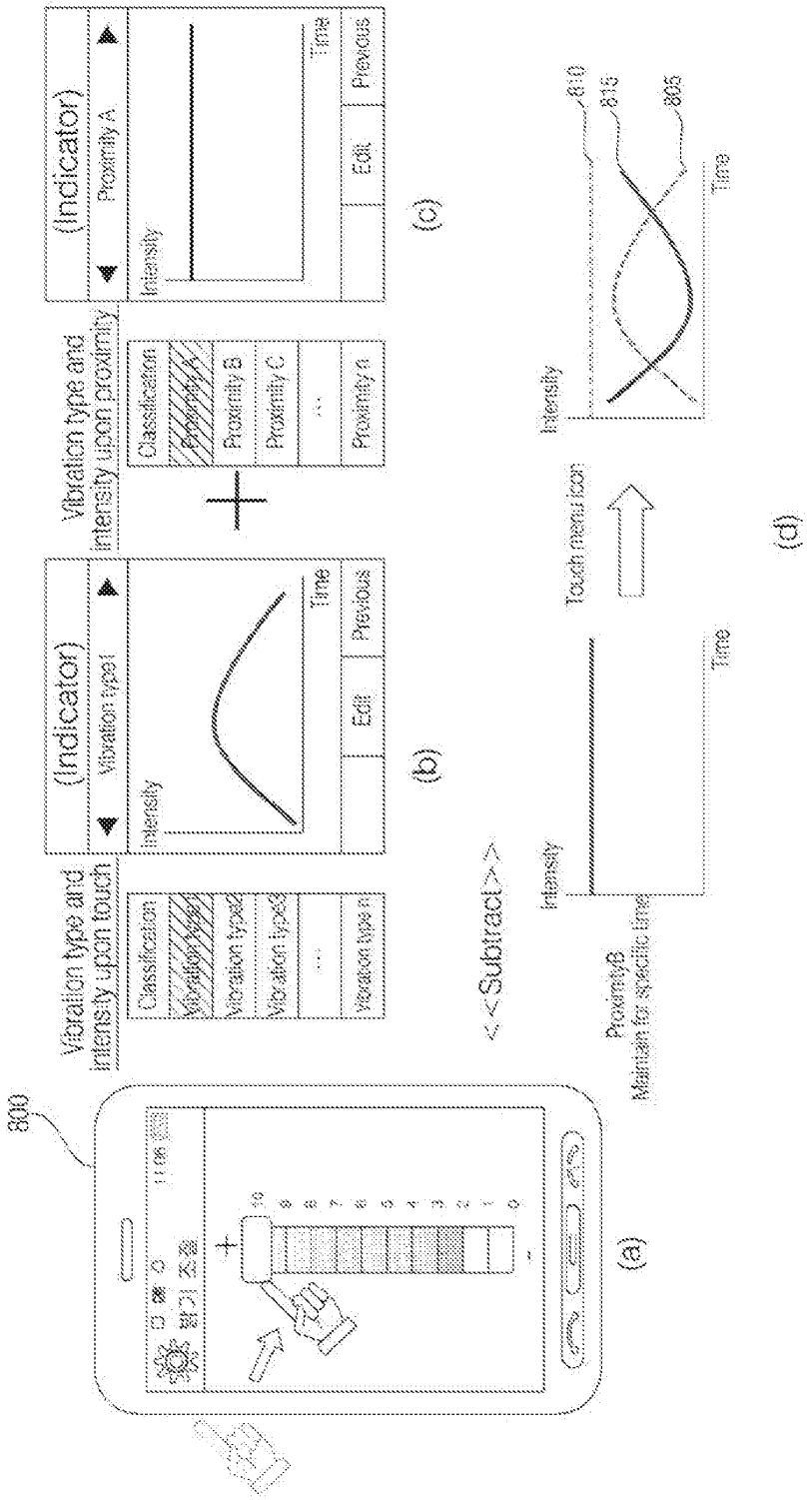

800
(a)
Proximity B
Maintain for specific time
Intensity
Time
<<Subtract>>
Touch menu icon
(b)
(Indicator)
Vibration type1
Intensity
Time
Edit
Previous
Vibration type and intensity upon touch
Classification
Vibration type2
Vibration type3
Vibration type n
(c)
(Indicator)
Proximity A
Intensity
Time
Edit
Previous
Vibration type and intensity upon proximity
Classification
Proximity B
Proximity C
Proximity n
(d)
810
815
805
Intensity
Time

FIG.14

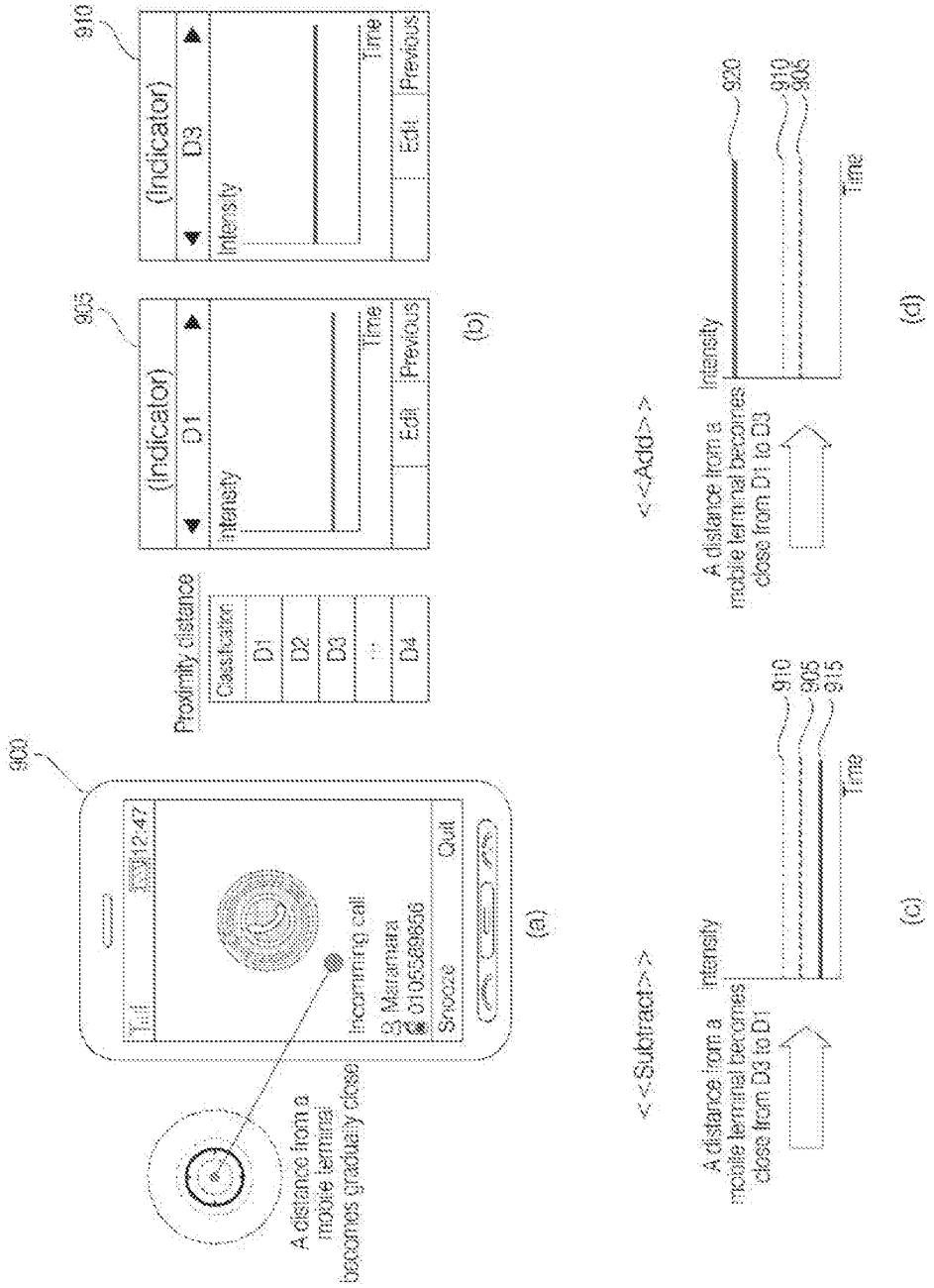
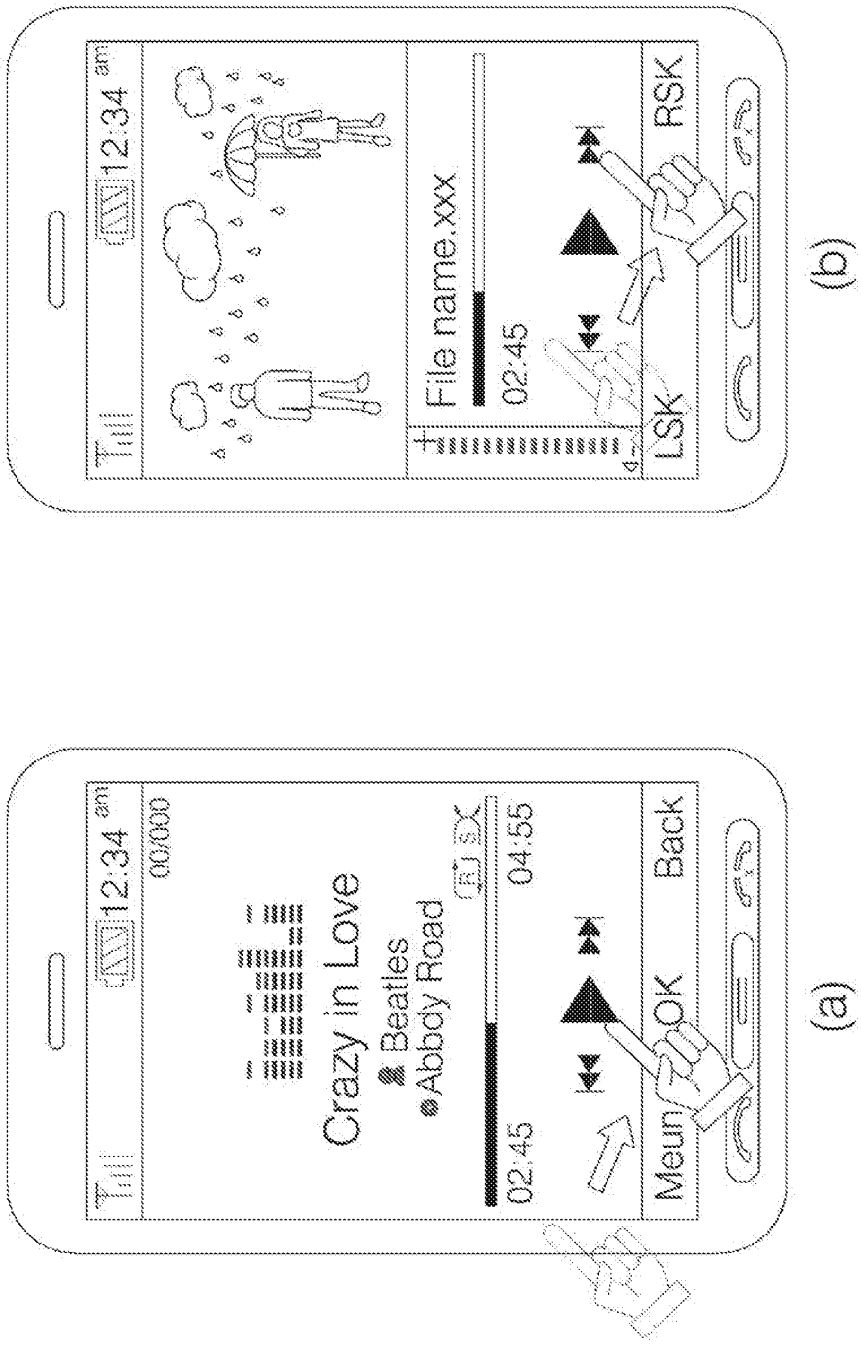

900
12:47
Incoming call
Q. Maramara
010-5555-8656
Snooze
Quit
A distance from a mobile terminal becomes gradually close
(a)
Proximity distance
Classification
D1
D2
D3
D4
905
(Indicator)
D1
Intensity
Time
Edit
Previous
(b)
910
(Indicator)
D3
Intensity
Time
Edit
Previous
<<Subtract>>
A distance from a mobile terminal becomes close from D3 to D1
Intensity
910
905
915
Time
(c)
<<Add>>
A distance from a mobile terminal becomes close from D1 to D3
Intensity
920
910
905
Time
(d)

FIG. 15



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FIG. 16

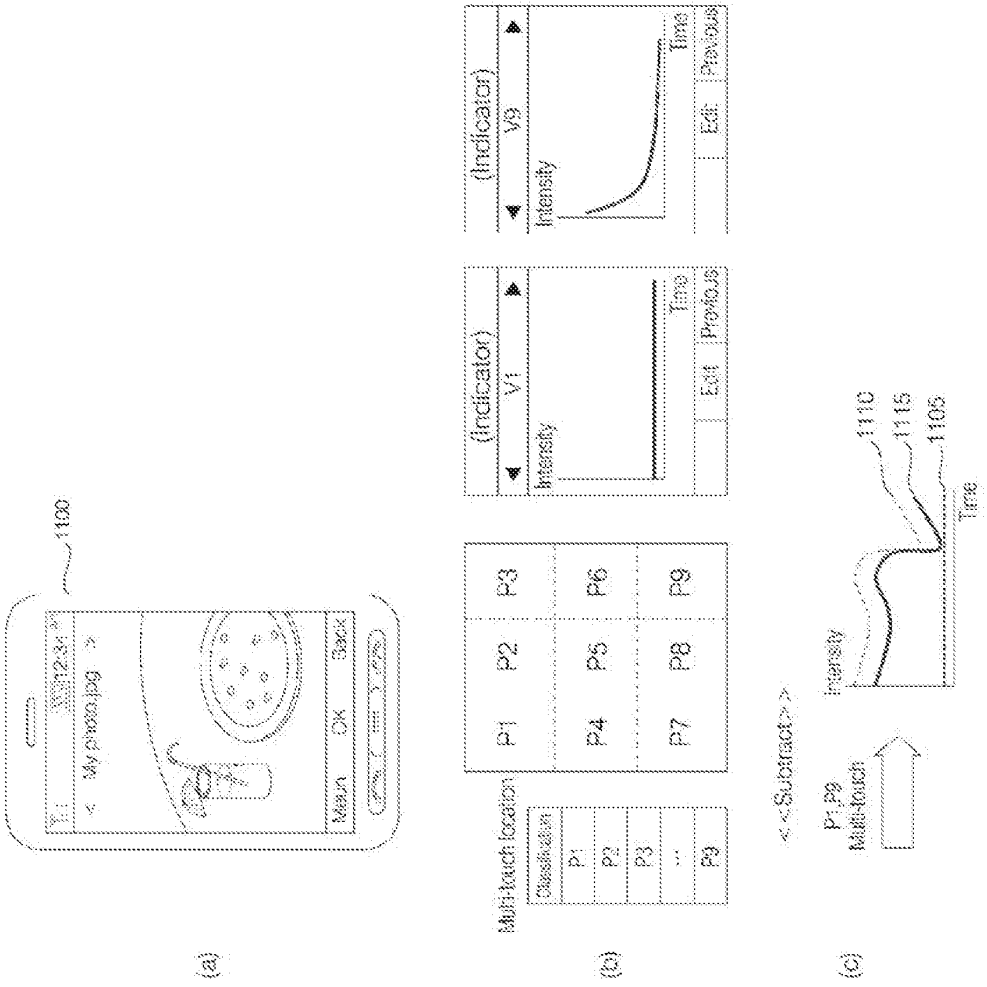

1100
My photo.jpg
Main
OK
Back
(a)
Multi-touch location
Destination
P1
P2
P3
P4
P5
P6
P7
P8
P9
(b)
(Indicator)
V1
Intensity
Time
Edit
Prev/Jump
(Indicator)
V9
Intensity
Time
Edit
Previous
<<Subtract>>
P1,P9
Multi-touch
Intensity
1110
1115
1105
Time
(c)

FIG.17

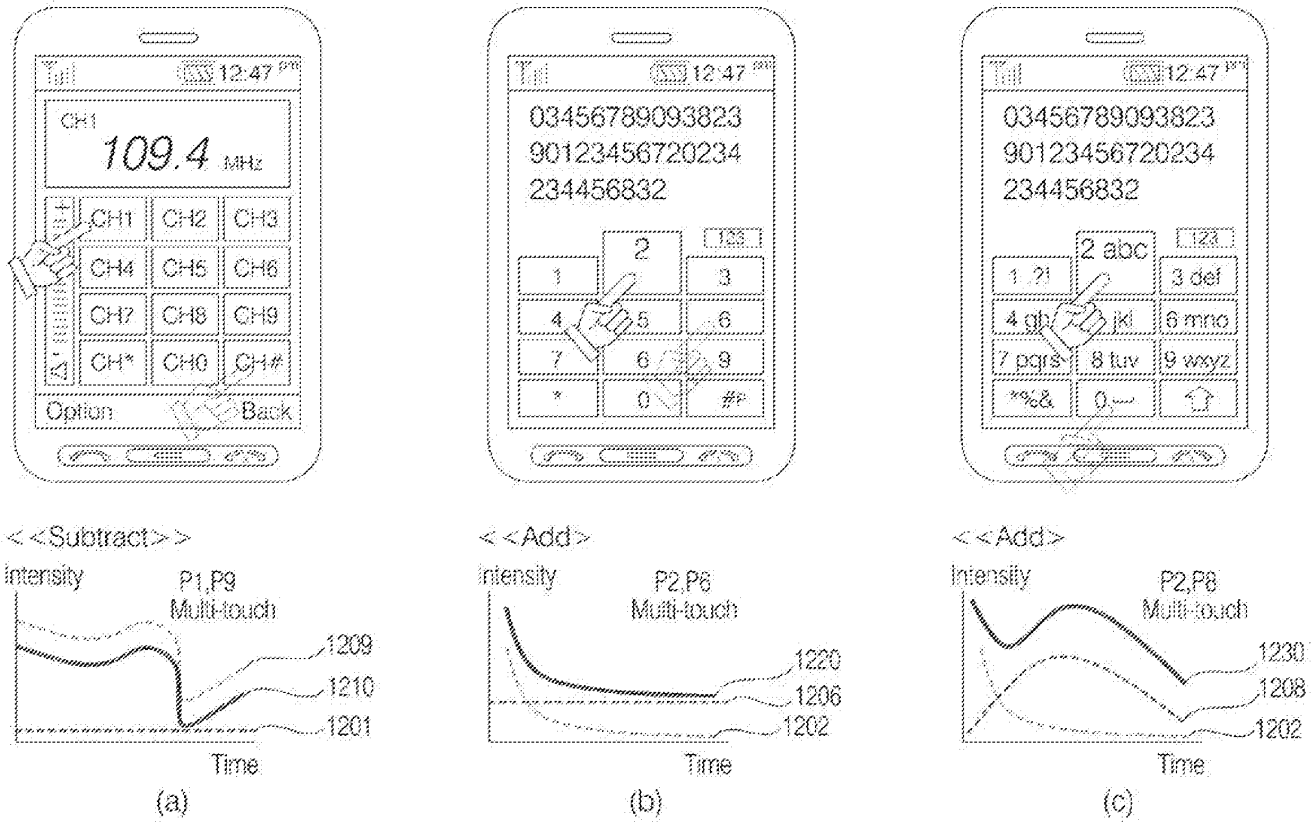
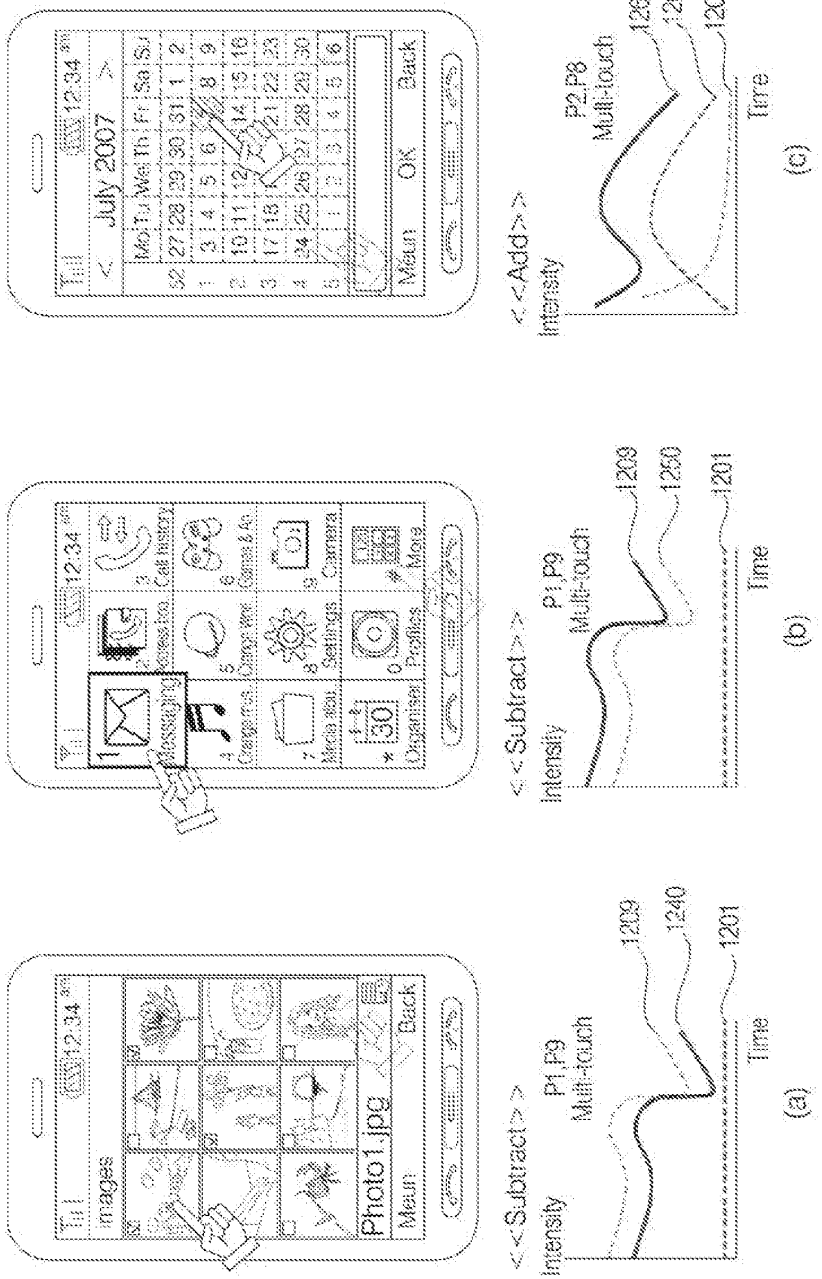

12:47 PM
CH1
109.4 MHz
CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH*
CH0
CH#
Option
Back
03456789093823
90123456720234
234456832
2 abc
3 def
4 ghi
jkl
6 mno
7 pqrs
8 tuv
9 wxyz
<<Subtract>>
Intensity
P1,P9
Multi-touch
1209
1210
1201
Time
(a)
<<Add>>
Intensity
P2,P6
Multi-touch
1220
1206
1202
Time
(b)
<<Add>>
Intensity
P2,P8
Multi-touch
1230
1208
1202
Time
(c)

FIG. 18



EX1002 - Page 408

FIG. 19

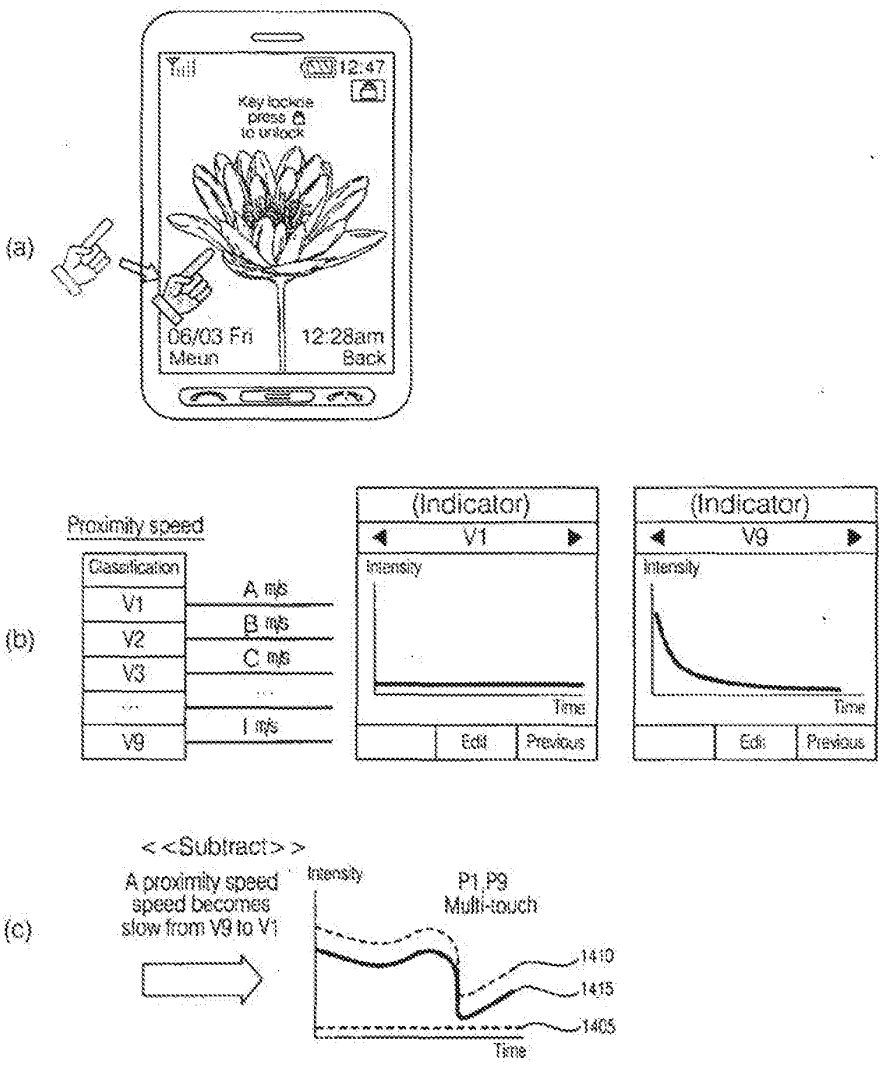

(a)
12:47
Key lockde
press
to unlock
06/03 Fri
Menu
12:28am
Back
(b)
Proximity speed
Classification
V1
V2
V3
...
V9
A m/s
B m/s
C m/s
...
I m/s
(Indicator)
V1
Intensity
Time
Edit
Previous
(Indicator)
V9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
A proximity speed
speed becomes
slow from V9 to V1
Intensity
P1,P9
Multi-touch
1410
1415
1405
Time

FIG. 20

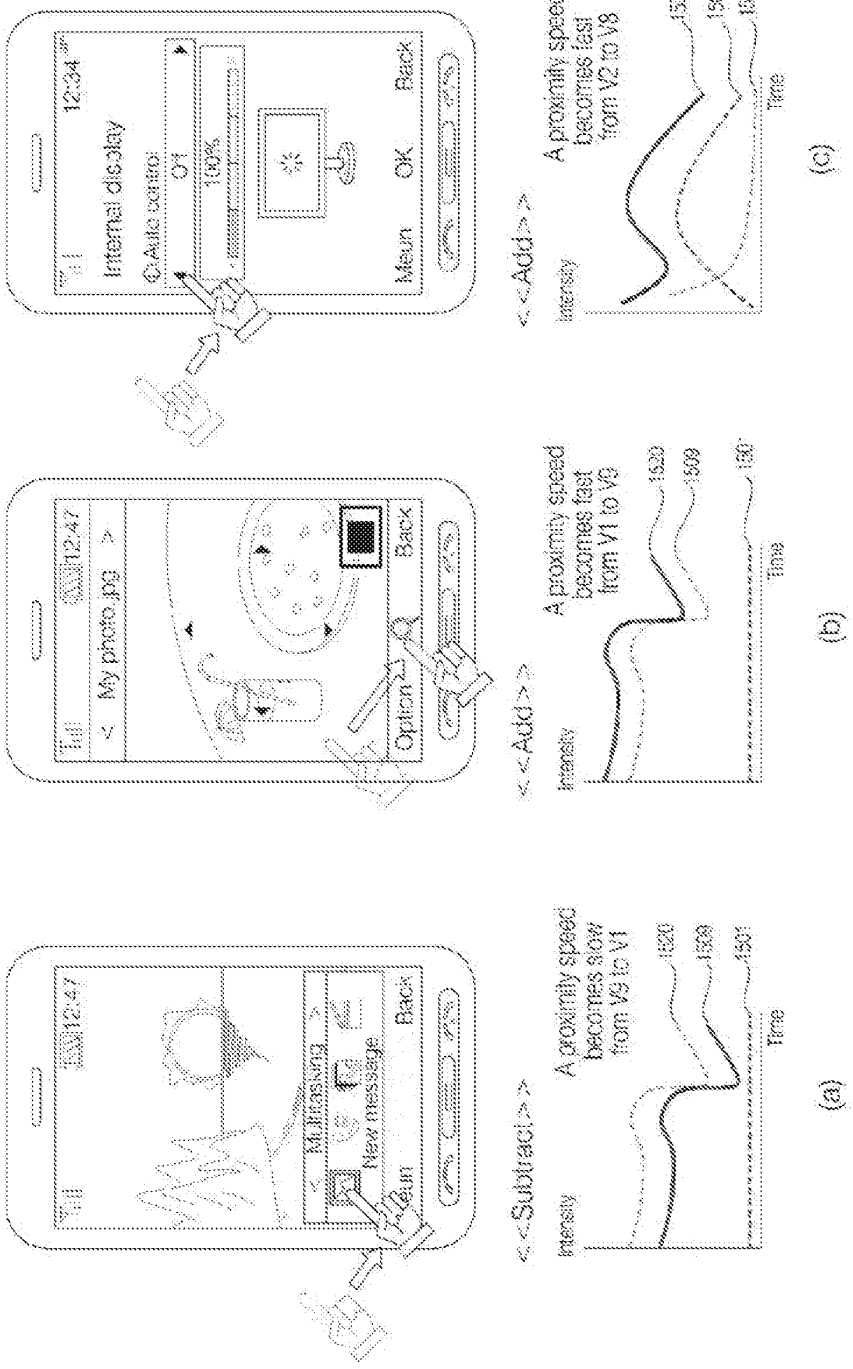

12:47
New message
Menu
Back
<<Subtract>>
Intensity
A proximity speed becomes slow from V6 to V1
1520
1509
1501
Time
(a)
My photo.jpg
Option
Back
<<Add>>
Intensity
A proximity speed becomes fast from V1 to V6
1520
1509
1501
Time
(b)
12:34
Internal display
Auto control
Off
100%
Menu
OK
Back
<<Add>>
Intensity
A proximity speed becomes fast from V2 to V8
1530
1506
1502
Time
(c)

FIG. 21

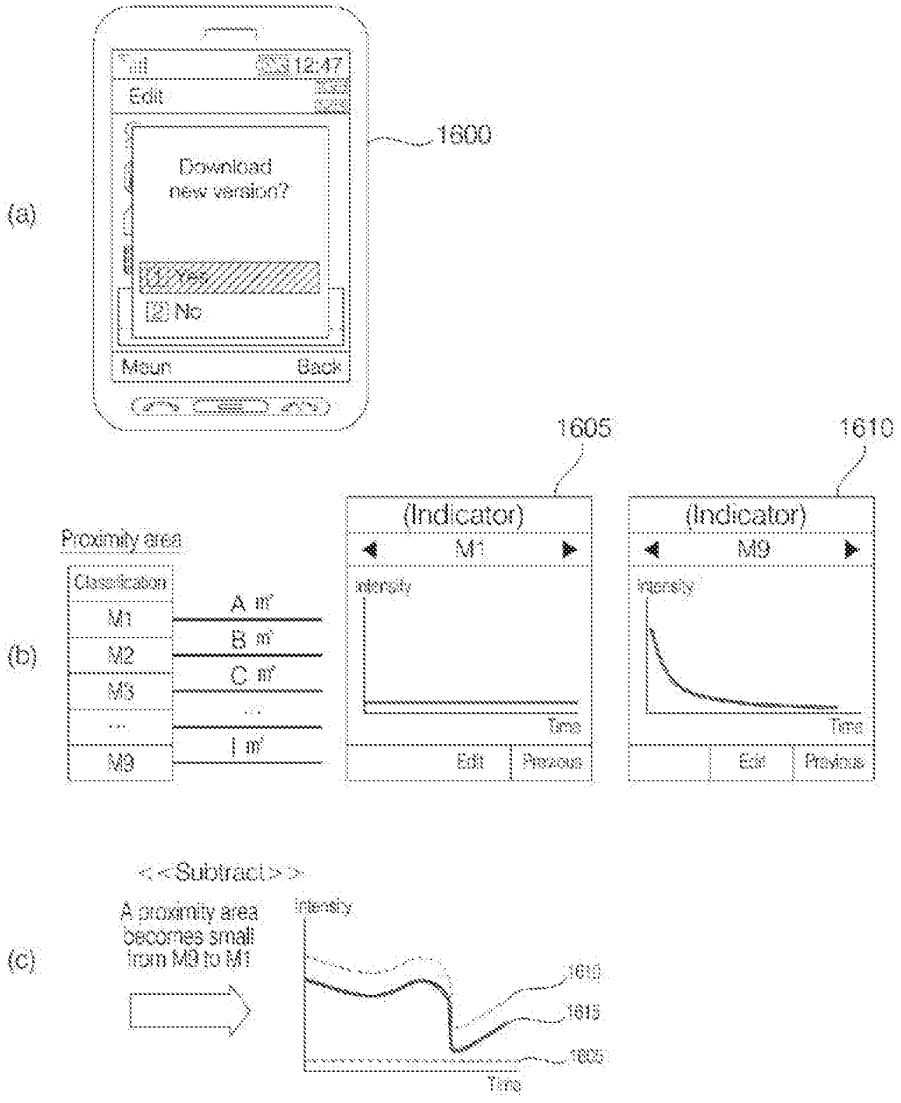
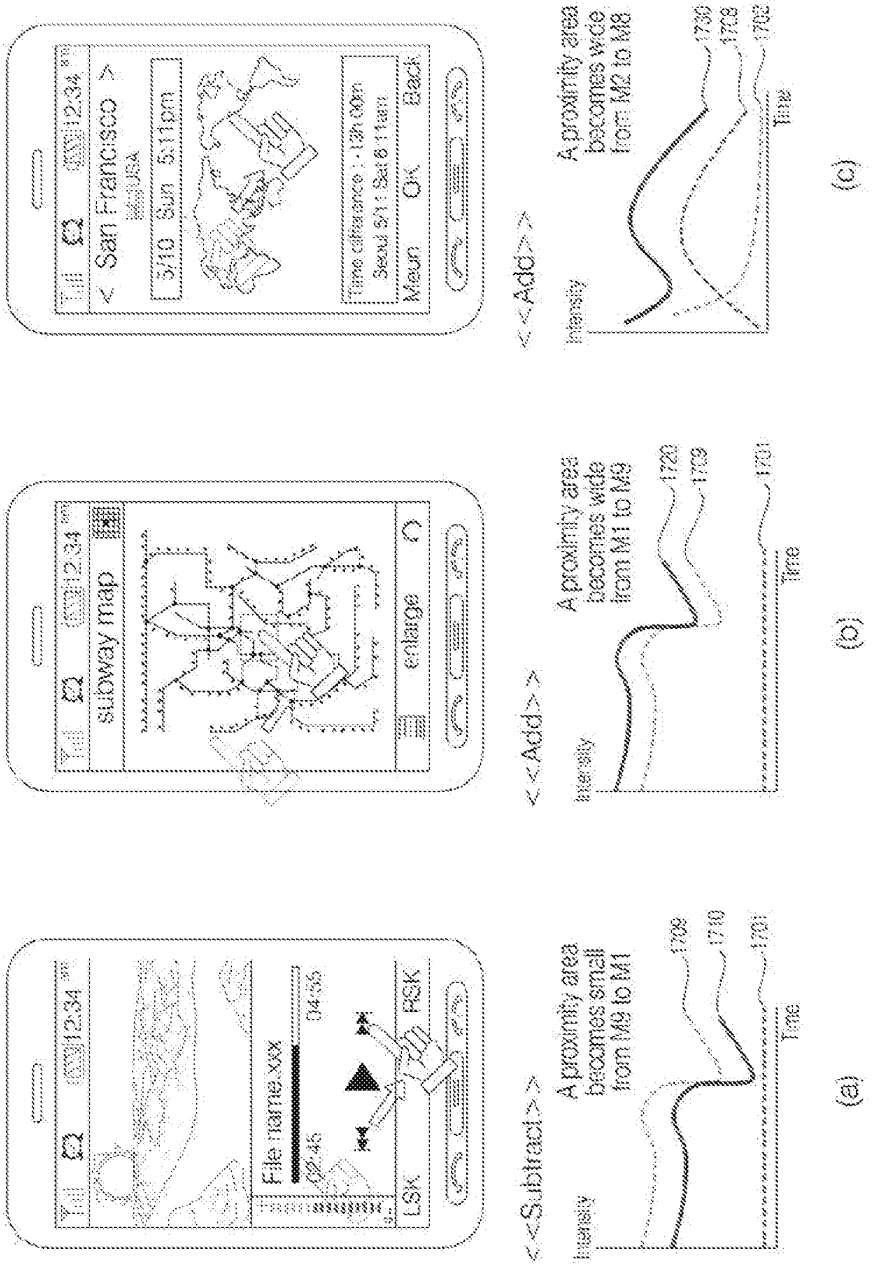

(a)
12:47
Edit
Download new version?
[1] Yes
[2] No
Menu
Back
1600
(b)
Proximity area
Classification
M1
M2
M3
...
M9
A ㎡
B ㎡
C ㎡
...
I ㎡
1605
(Indicator)
M1
Intensity
Time
Edit
Previous
1610
(Indicator)
M9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
A proximity area becomes small from M9 to M1
Intensity
1610
1615
1620
Time

FIG. 22


12:34
File name.xxx
04:55
00:45
LSK
RSK
subway map
enlarge
Back
< San Francisco >
USA
5/10 Sun 5:11pm
Time difference : -13h 00m
Seoul 5/11 Sat 6:11am
Menu
OK
<<Subtract>>
<<Add>>
Intensity
A proximity area becomes small from M9 to M1
A proximity area becomes wide from M1 to M9
A proximity area becomes wide from M2 to M8
1709
1710
1701
1720
1719
1730
1739
1702
Time
(a)
(b)
(c)

DISTINGUISHING INPUT SIGNALS DETECTED BY A MOBILE TERMINAL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Pursuant to 35 U.S.C. §119, this application claims the benefit of earlier filing data and right of priority to Korean Application No. 10-2008-0062800, filed Jun. 30, 2008, the content of which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present invention relates generally to mobile terminals, and, more particularly, to distinguishing input signals detected by a mobile terminal.

BACKGROUND

[0003] A mobile terminal is a portable device capable of performing voice and video communication, inputting and outputting information, storing data, or other functions. In order to enable complex multimedia functions, a mobile terminal may be modified using hardware or software to output vibration signals, in addition to audio and video signals.

[0004] Usually, a mobile terminal outputs a vibration signal in response to receiving touch signal or a proximity signal. Unfortunately, there are a limited number of vibration signals, and the same vibration signal may be outputted for different types of touch signals and proximity signals.

[0005] Accordingly, systems and methods are needed to easily distinguish between different types of touch signals and proximity signals that are detected by a mobile terminal.

SUMMARY

[0006] The present disclosure is directed to systems and corresponding methods that facilitate detecting potential deadlocks across different test runs in an execution environment.

[0007] For purposes of summarizing, certain aspects, advantages, and novel features have been described herein. It is to be understood that not all such advantages may be achieved in accordance with any one particular embodiment. Thus, the claimed subject matter may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages without achieving all advantages as may be taught or suggested herein.

[0008] In accordance with one embodiment, a method of distinguishing input signals detected by a mobile terminal is provided. The method comprises detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and outputting a combined vibration signal corresponding to at least the first and second input signals. The first and second input signals may be proximity signals, touch signals, or a combination thereof. The combined vibration signal may be outputted according to type or characteristic of at least the first and second input signals.

[0009] In accordance with another embodiment, a method of distinguishing input signals detected by a mobile terminal is provided. The method comprises detecting a proximity signal and a touch signal inputted to the mobile terminal, wherein a first vibration signal is associated with the proximity signal and a second vibration is associated with the touch signal; determining a first location through which the proximity signal is inputted and a second location through which the touch signal is inputted; and outputting a combined vibration signal corresponding to the proximity signal and the touch signal, in response to determining that the first and second locations are the same.

[0010] In accordance with yet another embodiment, a method of distinguishing proximity signals detected by a proximity sensor of a mobile terminal is provided. The method comprises detecting a first proximity signal at a first proximity distance from the proximity sensor and a second proximity signal at a second proximity distance from the proximity sensor, wherein a first vibration signal is associated with the first proximity signal and a second vibration signal is associated with the second proximity signal; and outputting a combined vibration signal corresponding to the first and second proximity signals.

[0011] In accordance with yet another embodiment, method of distinguishing touch signals detected by a touch screen of a mobile terminal is provided. The method comprises detecting a first touch signal inputted at a first area of the touch screen and a second touch signal inputted at a second area of the touch screen, wherein a first vibration signal is associated with the first touch signal and a second vibration signal is associated with the second touch signal; and outputting a combined vibration signal corresponding to the first and second touch signals.

[0012] In accordance with yet another embodiment, a system comprising one or more logic units is provided. The one or more logic units are configured to perform the functions and operations associated with the above-disclosed methods.

[0013] In accordance with yet another embodiment, a computer program product comprising a computer useable medium having a computer readable program is provided. The computer readable program when executed on a computer causes the computer to perform the functions and operations associated with the above-disclosed methods.

[0014] One or more of the above-disclosed embodiments in addition to certain alternatives are provided in further detail below with reference to the attached figures. The invention is not, however, limited to any particular embodiment disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Embodiments of the present invention are understood by referring to the figures in the attached drawings, as provided below.

[0016] FIG. **1** is a block diagram of a mobile terminal, in accordance with one embodiment.

[0017] FIG. **2** is a front perspective view of a mobile terminal, in accordance with one embodiment.

[0018] FIG. **3** is a rear perspective view of a mobile terminal, in accordance with one embodiment.

[0019] FIG. **4** illustrates operation of a proximity sensor, in accordance with one embodiment.

[0020] FIGS. **5***a* and **5***b* illustrate a proximity area and a haptic area, in accordance with one embodiment.

[0021] FIG. **6** is a flowchart illustrating a method of distinguishing input signals detected by the mobile terminal, in accordance with one embodiment.

[0022] FIG. **7** is a flowchart illustrating a method of distinguishing input signals inputted from different display locations, in accordance with one embodiment.

[0023] FIG. **8** is a flowchart illustrating a method of distinguishing input signals inputted from different distances from a proximity sensor, in accordance with one embodiment.

[0024] FIG. **9** is a flowchart illustrating a method of distinguishing input signals inputted from different display areas, in accordance with one embodiment.

[0025] FIGS. **10** and **11** are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0026] FIGS. **12** and **13** are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0027] FIGS. **14** and **15** are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0028] FIGS. **16** to **18** are diagrams showing vibration signals outputted by the mobile terminal, in accordance with one or more embodiments.

[0029] FIGS. **19** to **22** are diagrams to which reference is made to illustrate a method of distinguishing signals received by the mobile terminal, in accordance with one or more embodiments.

[0030] Features, elements, and aspects of the invention that are referenced by the same numerals in different figures represent the same, equivalent, or similar features, elements, or aspects, in accordance with one or more embodiments.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0031] In the following, numerous specific details are set forth to provide a thorough description of various embodiments of the invention. Certain embodiments of the invention may be practiced without these specific details or with some variations in detail. In some instances, certain features are described in less detail so as not to obscure other aspects of the invention. The level of detail associated with each of the elements or features should not be construed to qualify the novelty or importance of one feature over the others.

[0032] As used herein, the terms "module," "unit," and "part" are used for purposes of facilitating disclosure. Therefore, significant meanings or roles should not be imputed to the terms themselves and it should be understood that the terms "module," "unit," and "part" may be used together or interchangeably.

[0033] By way of non-limiting example only, the embodiments are described with reference to the mobile terminal **100** shown in FIG. **1**. However, such teachings apply equally to mobile phones, smart phones, notebook computers, terminals for digital broadcasting, personal digital assistants (PDAs), portable multimedia players (PMPs), navigation devices for GPS, and other types of terminals. Also, FIG. **1** shows the mobile terminal **100** having various components, but it should be understood that implementing all of the illustrated components is not a requirement. Greater or fewer components may alternatively be implemented.

[0034] Referring to FIG. **1**, a mobile terminal **100** may comprise a wireless communication unit **110**, an audio/video (A/V) input unit **120**, a user input unit **130**, a sensing unit **140**, an output unit **150**, memory **160**, an interface unit **170**, a controller **180**, and a power supply unit **190**. When the constituent elements are implemented in actual applications, two or more of the constituent elements may be combined into one constituent element or one constituent element may be divided into two or more constituent elements, if appropriate.

[0035] The wireless communication unit **110** may comprise a broadcasting receiving module **111**, a mobile communication module **113**, a wireless Internet module **115**, a local area communication module **117**, a global positioning system (GPS) module **119**, or other communication module.

[0036] The broadcasting receiving module **111** receives at least one of broadcasting signals and broadcasting-related information from an external broadcasting management server through broadcasting channels. The broadcasting channels can include a satellite channel, a terrestrial wave channel and the like. The broadcasting management server may refer to a server for creating and transmitting at least one of broadcasting signals and broadcasting-related information or a sever for receiving at least one of previously generated broadcasting signals and previously generated broadcasting-related information and transmitting it to a terminal.

[0037] The broadcasting-related information may refer to information pertinent to a broadcasting channel, a broadcasting program and/or a broadcasting service provider. The broadcasting signal may comprise not only TV broadcasting signals, radio broadcasting signals, and data broadcasting signals, but also broadcasting signals in which TV broadcasting signals or radio broadcasting signals are combined with data broadcasting signals. The broadcasting-related information may be provided over a mobile communication network. In this case, the broadcasting-related information can be received by the mobile communication module **113**. The broadcasting-related information may exist in various forms. For example, the broadcasting-related information may exist in the form of the electronic program guide (EPG) of the digital multimedia broadcasting (DMB), the electronic service guide (ESG) of the digital video broadcast-handheld (DVB-H) or the like.

[0038] The broadcasting receiving module **111** receives broadcasting signals using various broadcasting systems. In particular, the broadcasting receiving module **111** can receive broadcasting signals using a digital broadcasting system, such as the digital multimedia broadcasting-terrestrial (DMB-T), the digital multimedia broadcasting-satellite (DMB-S), the media forward link only (MediaFLO), the digital video broadcast-handheld (DVB-H), and the integrated services digital broadcast-terrestrial (ISDB-T). The broadcasting receiving module **111** may be constructed to be suitable for not only the digital broadcasting systems, but also all broadcasting systems providing broadcasting signals. At least one of broadcasting signals and/or broadcasting-related information, received through the broadcasting receiving module **111**, may be stored in the memory **160**.

[0039] The mobile communication module **113** transmits and receives radio signals to and from at least one of a base station, an external terminal, and a server over a mobile communication network. Here, the radio signals may comprise voice call signals, video call signals, or various forms of data according to transmission/reception of text/multimedia messages.

[0040] The wireless Internet module **115** refers to a module for wireless Internet access. The wireless Internet module **115** may be built in the mobile terminal **100** or external to the mobile terminal **100**. Wireless Internet technologies may employ wireless LAN (WLAN) (Wi-Fi), wireless broadband (Wibro), world interoperability for microwave access (Wimax), high-speed downlink packet access (HSDPA), and so on.

[0041] The local area communication module **117** refers to a module for local area communication. Local area communication technology can employ Bluetooth, radio frequency identification (RFID), infrared data association (IrDA), ultra wideband (UWB), ZigBee or the like. The GPS module **119** receives position information from a plurality of GPS satellites.

[0042] The A/V input unit **120** is adapted to input audio signals or video signals and can include a camera **121**, a microphone **123**, and so on. The camera **121** processes image frames, such as still images or motion images, which are captured by an image sensor in the video call mode or the capturing mode. The processed image frames may be displayed on a display unit **151**.

[0043] The image frames processed by the camera **121** may be stored in the memory **160** or transmitted to the outside through the wireless communication unit **110**. The camera **121** may be provided in plural numbers according to the configuration of a terminal.

[0044] The microphone **123** receives external sound signals in the call mode, the recording mode, the voice recognition mode, etc. and converts the received sound signals into electrical voice data. In the call mode, the processed voice data may be converted into a format, which can be transmitted to a mobile communication base station through the mobile communication module **113**, and then output. The microphone **123** may employ a variety of noise removal algorithms for removing noise occurring in the process of receiving external sound signals.

[0045] The user input unit **130** generates key entry data, which is input by a user in order to control the operation of the terminal. The user input unit **130** may comprise the keypad, the dome switch, the touch pad (static pressure/constant electricity), the jog wheel, the jog switch, the finger mouse or the like. In particular, a mutually layered structure of the touch pad and the display unit **151**, which will be described later on, may be referred to as a touch screen.

[0046] The sensing unit **140** senses a current status of the mobile terminal **100**, such as a closed state of the mobile terminal **100**, the position of the mobile terminal **100**, whether a user touches the mobile terminal **100** or not, and so on and generates a sensing signal for controlling the operation of the mobile terminal **100**. For example, when the mobile terminal **100** is a slide phone type, the sensing unit **140** can sense whether the slide phone is opened or not. The sensing unit **140** may also have the functions of sensing whether the power supply unit **190** supplies power or not, whether the interface unit **170** is connected to an external device, and so on.

[0047] The sensing unit **140** can include a proximity sensor **141**. The proximity sensor **141** may detect an approaching object, whether objects exist nearby, etc. without mechanical contact. The proximity sensor **141** may detect neighboring objects by employing a change of AC magnetic field, a change of static magnetic field, the rate of capacitance or the like. Two or more proximity sensors **141** may be used according to the aspect of a configuration.

[0048] The output unit **150** is constructed to output audio signals, video signals or alarm signals and may comprise the display unit **151**, a sound output module **153**, an alarm unit **155**, a haptic module **157**, and so on.

[0049] The display unit **151** displays information processed in the mobile terminal **100**. For example, when the mobile terminal is in the call mode, the display unit **151** displays a user interface (UI) or a graphic user interface (GUI), which is pertinent to a call. When the mobile terminal **100** is in the video call mode or the capturing mode, the display unit **151** displays captured or received images individually or simultaneously and also displays a UI or a GUI.

[0050] Meanwhile, in the case in which the display unit **151** and the touch pad form the mutually layered structure and construct a touch screen as described above, the display unit **151** may also be used as an input device as well as the output device. If the display unit **151** comprises a touch screen, the display unit **151** may also comprise a touch screen panel, a touch screen panel controller, or other touch screen component. In one embodiment, the touch screen panel is a transparent panel attached to the outside and may be connected to an internal bus within the mobile terminal **100**. The touch screen panel continues to monitor whether there is a touch input and, when there is a touch input, sends corresponding signals to the touch screen panel controller. The touch screen panel controller processes the corresponding signals received from the touch screen panel and transmits the corresponding data to the controller **180**, so that the controller **180** may determined whether there has been a touch input or which area of the touch screen has been touched.

[0051] The display unit **151** may comprise at least one of a liquid crystal display, a thin film transistor-liquid crystal display, an organic light-emitting diode, a flexible display, and a 3D display. Two or more display units **151** may exist according to the implementation type of the mobile terminal **100**. For example, the mobile terminal **100** may be equipped with both an external display unit (not shown) and an internal display unit (not shown).

[0052] The sound output module **153** outputs audio data, which is received from the wireless communication unit **110** in the incoming call mode, the call mode, the record mode, the voice recognition mode, the incoming broadcasting mode or the like or stored in the memory **160**. The sound output module **153** also outputs sound signals pertinent to the functions performed in the mobile terminal **100**, for example, sound of a received call signal and sound of a received message. The sound output module **153** can include a speaker, a buzzer or the like.

[0053] The alarm unit **155** outputs signals to inform the occurrence of events in the mobile terminal **100**. For example, the events occurring in the mobile terminal **100** may comprise an incoming call signal, a received message, an entered key signal input and so on. The alarm unit **155** may also output signals to inform the occurrence of events in different ways other than the audio or video signals. For example, the alarm unit **155** can output the signals in vibration form.

[0054] When a call signal is received or a message is received, the alarm unit **155** may generate a signal in order to inform the reception of the call signal or message. Alternatively, when a key signal is input, the alarm unit **155** may generate a signal as a feedback to the input key signal. A user may notice the occurrence of an event through the output of the signal. It should be understood that signals, informing the occurrence of events, from the mobile terminal **100** may also be output through the display unit **151** or the sound output module **153**.

[0055] The haptic module **157** generates a variety of haptic effects which may be felt by a user. A representative example of the haptic effects, which are generated by the haptic module **157**, is a vibration signal. When the haptic module **157** generates a vibration signal, the intensity, pattern, or other

characteristic of the vibration signal generated by the haptic module **157** may be converted, and different pieces of vibration signals may be composed or output or sequentially output.

[0056] The haptic module **157** may generate various haptic effects, such as an effect caused by a stimulus of the arrangement of pins, which move vertically to a contact skin surface, an effect caused by a stimulus through spraying force or suction force by the air through an injection nozzle or an inlet, an effect caused by a stimulus passing over the skin surface, an effect caused by a stimulus through the contact of an electrode, an effect caused by a stimulus employing electrostatic force, and an effect caused by the reappearance of a feeling of cold and warmth employing an element that may absorb or generate heat, as well as a vibration signal.

[0057] The haptic module **157** may be implemented to not only transfer the haptic effects through a direct contact, but also make the haptic effects felt through myasthenia such as a user's finger, arm, etc. In one embodiment, the mobile terminal **100** may comprise a plurality of haptic modules **157**. The memory **160** may store programs necessary to process and control the controller **180** and also function to temporarily store input or output data (for example, a phonebook, messages, still images, motion images and the like).

[0058] The memory **160** may comprise at least one type of storage media, including a flash memory type, a hard disk type, a multimedia card micro type, card type memory (for example, SD memory, XD memory, and so on), RAM, and ROM. The mobile terminal **100** may also manage a web storage serving as the storage function of the memory **160** on an Internet.

[0059] The interface unit **170** functions as an interface with all external devices connected to the mobile terminal **100**. Examples of the external devices connected to the mobile terminal **100** can include a wired/wireless headset, an external charger, wired/wireless data ports, a memory card, a card socket such as subscriber identification module (SIM)/user identity module (UIM) cards, an audio input/output (I/O) terminal, a video I/O terminal, an earphone, and so on. The interface unit **170** can receive data or can be supplied with power from the external devices, transfer the data or power to respective constituent elements of the mobile terminal **100**, and transmit data of the mobile terminal **100** to the external devices.

[0060] The interface unit **170** may become a passage in which power source from external cradles is supplied to the mobile terminal **100** when the mobile terminal **100** is coupled to the cradles or a passage in which a variety of command signals input from cradles by a user are transferred to the mobile terminal **100**.

[0061] The controller **180** typically controls the operation of each of the elements and controls an overall operation of the mobile terminal **100**. For example, the controller **180** may perform pertinent controls and processes for voice call, data communication, video telephony, and so on. The controller **180** may comprise a multimedia play module **181** for playing multimedia. The multimedia play module **181** may be constructed in hardware within the controller **180** or constructed in software separately from the controller **180**.

[0062] The power supply unit **190** is supplied with external power source or internal power source and supplies power source necessary for the operation of the each constituent element under the control of the controller **180**. The mobile terminal **100** may be configured to be operable in a communication system, which transmits data through frames or packets, including a wired/wireless communication system and a satellite-based communication system.

[0063] The mobile terminal pertinent to the present invention has been described so far from a viewpoint of the constituent elements according to its functions. Hereinafter, the mobile terminal pertinent to the present invention is further described from a viewpoint of the constituent elements according to its external shape with reference to FIGS. **2** and **3**. Hereinafter, of several types of mobile terminals such as the folding type, the bar type, the swing type, and the sliding type, a sliding type mobile terminal equipped with a touch screen is described as an example, for convenience of description. However, it should be understood that the present invention is not limited to the sliding type mobile terminal, but instead may be applied to all types of mobile terminals, including the above types.

[0064] FIG. **2** is a front perspective view of the mobile terminal **100**, in accordance with an embodiment. Referring to FIG. **2**, the mobile terminal **100** comprises a first body **100**A, and a second body **100**B configured to slide in at least one direction in the first body **100**A.

[0065] A state where the first body **100**A is overlapped with the second body **100**B can be called a closed configuration, and a state where at least part of the second body **100**B is exposed through the first body **100**A, as shown in FIG. **2**, may be called an open configuration.

[0066] In the closed configuration of the mobile terminal **100**, the mobile terminal **100** generally operates in a standby mode, but the standby mode may be released by user interaction with the mobile terminal **100**. In the open configuration of the mobile terminal **100**, the mobile terminal **100** generally operates in a call mode, etc., but the call mode may be switched to the standby mode through user interaction with the mobile terminal **100** or after a lapse of a certain time period.

[0067] A casing constituting an external shape of the first body **100**A is comprised of a first front casing **100**A-**1** and a first rear casing **100**A-**2**. A variety of electronic components are embedded in space formed by the first front casing **100**A-**1** and the first rear casing **100**A-**2**. At least one middle casing can be further disposed between the first front casing **100**A-**1** and the first rear casing **100**A-**2**. The casings may be formed by injecting synthetic resin or can be formed from metal, such as stainless steel (STS) or titanium (Ti).

[0068] The display unit **151**, a first sound output module **153***a*, a first camera **121***a*, and a first user input unit **130** may be further disposed in the first body **100**A, more particularly, the first front casing **100**A-**1**.

[0069] The display unit **151** includes a liquid crystal display (LCD), an organic light emitting diode (OLED) and the like, which visually display information. A touch pad may be overlapped with the display unit **151** in a layered structure and, therefore, the display unit **151** operates as a touch screen, enabling the input of information by a user's touch. The first sound output module **153***a* may be implemented in the form of a receiver or speaker. The first camera **121***a* may be implemented appropriately to capture still images or motion images of a user, etc.

[0070] In the same manner as the first body **100**A, a casing, constituting an external appearance of the second body **100**B, is constituted by a second front casing **100**B-**1** and a second rear casing **100**B-**2**. A second user input unit **130***b* may be disposed on the front face of the second body **100**B, more

particularly, the second front casing **100B-1**. Third and fourth user input units **130***c* and **130***d*, the microphone **123**, and the interface unit **170** may be disposed in at least one of the second front casing **100B-1** and the second rear casing **100B-2**.

[0071] The first to fourth user input units **130***a*, **130***b*, **130***c*, and **130***d* may be collectively called the user input unit **130** and may adopt any kind of a method as long as it is a tactile manner, which allows a user to manipulate the user input unit **130** while feeling a tactile sense.

[0072] For example, the user input unit **130** may be implemented using a dome switch or a touch pad, which is able to receive commands or information through a user's push or touch manipulation, or may be implemented using a wheel or jog method of rotating a key or a method using a joystick.

[0073] From a viewpoint of the function, the first user input unit **130***a* is adapted to input commands such as start, end, and scrolling. The second user input unit **130***b* is adapted to input numbers, text, symbols and so on. Further, the third and fourth user input units **130***c* and **130***d* may operate as hot keys for activating special functions within the mobile terminal **100**.

[0074] The microphone **123** may be implemented in an adequate fashion, which is appropriate to receive a user's voice, other sound and so on. The interface unit **170** becomes a passage through which the mobile terminal according to the present invention may exchange data, etc. with external devices. For example, the interface unit **170** may be at least one of a connector for connecting to an earphone in a wired or wireless manner, a port for local area communication, and a power supply terminal for supplying power source to the mobile terminal **100**. The interface unit **170** may be a card socket for accommodating external cards, such as a subscriber identification module (SIM), a user identity module (UIM), and a memory card for information storage.

[0075] The power supply unit **190** for supplying power source to the mobile terminal is disposed on the part of the second rear casing **100B-2**. The power supply unit **190** may be, for example, a rechargeable battery, and may be detachably attached to the second body **100B** for recharging, and so on.

[0076] FIG. **3** is a rear perspective view of the mobile terminal **100**, in accordance with one embodiment. Referring to FIG. **3**, a fifth user input unit **130***e* of a wheel type and a second camera **121***b* may be further disposed on the rear face of the second rear casing **100B-2** of the second body **100B**. A sixth user input unit **130***f* may be arranged on the side of the second body **100B**.

[0077] The second camera **121***b* has a photographing direction substantially opposite to that of the first camera **121***a* and may have different pixels from that of the first camera **121***a*. For example, the first camera **121***a* may have low pixels sufficiently enough to capture an image of a user's face and transmit the captured image to a counterpart in a video call or the like. The second camera **121***b* may have high pixels since general subjects are photographed and are not generally transmitted immediately.

[0078] A flash **125** and a mirror **126** may be further disposed adjacent to the second camera **121***b*. The flash **125** illuminates light to a subject when the subject is photographed by the second camera **121***b*. The mirror **126** reflects a user's face, etc. when the user tries to have his picture taken (self-photographing) using the second camera **121***b*.

[0079] A second sound output module (not shown) may be further disposed in the second rear casing **100B-2**. The second sound output module may implement a stereo function together with the first sound output module **153***a* and may also be used for a call in a speakerphone mode.

[0080] An antenna (not shown) for receiving broadcasting signals as well as an antenna for a call, etc., may be disposed on one side of the second rear casing **100B-2**. The antenna may be drawn out from the second body **100B**. A part of a sliding module **100C**, which slidingly couples the first body **100A** and the second body **100B**, may be disposed on the part of the first rear casing **100A-2** of the first body **100A**. The other part of the sliding module **100C** may be disposed on the part of the second front casing **100B-1** of the second body **100B** and may not be exposed to the outside, as shown in FIG. **3**.

[0081] It has been described above that the second camera module **121***b*, and so on are disposed in the second body **100B**, but the present invention is not necessarily limited to the above arrangement. For example, at least one of the constituent elements, which are described to be arranged in the second rear casing **100B-2**, such as the second camera module **121***b*, may be disposed in the first body **100A**, mainly, in the first rear casing **100A-2**.

[0082] In this configuration, the closed configuration has an advantage in that the constituent elements arranged in the first rear casing **100A-2** are protected by the second body **100B**. Further, although the second camera module **121***b* is not separately included, the first camera module **121***a* may be rotatably disposed in such a way as to photograph even photographing directions of the second camera module **121***b*.

[0083] The power supply unit **190** for supplying power source to the mobile terminal is mounted on the part of the rear casing **100A-2**. The power supply unit **190** may be, for example, a rechargeable battery and may be detachably coupled to the rear casing **100A-2** for charging, and so on.

[0084] FIG. **4** illustrates operation of a proximity sensor **141**, in accordance with one embodiment. As shown in FIG. **4**, when a user's finger approaches the display unit **151**, the proximity sensor **141** senses such approach and outputs a proximity signal. In one embodiment, the proximity sensor **141** may output different proximity signals when the user's finger is placed at a location D3 and when the user's finger is located at a location D2 or D1.

[0085] In other words, assuming that a distance in which the proximity sensor approaches a detection object and outputs a proximity signal is a detection distance Sn, if proximity signals output from a plurality of the proximity sensors having different detection distances are compared with each other, it may be known how near the object approaches the proximity sensors **141**.

[0086] Further, if a plurality of proximity sensors **141** having different detection areas is disposed and which proximity signal is output from which one of the proximity sensors **141** is understood, it may be known that a detection object approaches which area of the display unit **151**, whether a detection object moves close to the display unit **151**, and so on. Accordingly, the controller **180** may perform a variety of operation controls according to a degree in which a user's finger, etc. approaches the display unit **151**, a proximity location thereof, and so on.

[0087] FIGS. **5***a* and **5***b* are diagrams illustrating a proximity area in which the proximity sensor outputs a proximity signal and a haptic area in which a haptic effect is generated. In the case in which an object, such as an icon or menu item as shown in (a) of FIG. **5***a*, is displayed in the display unit **151**,

an area in which the object is displayed may be divided into a first area A at the center of the display unit **151** and a second area B adjacent to the boundary of the display unit **151**, and haptic effects with different intensity and patterns may be generated from the first area A and the second area B. For example, the proximity sensor may be configured to output a vibration signal when the first area A is touched rather than when the second area B is touched.

[0088] In the case in which a proximity signal is used together with a haptic effect, a haptic area from which the haptic effect is generated and a proximity area in which the proximity signal is sensed may be defined differently. In other words, the haptic area may be set to be narrower than the proximity area, or the haptic area may be set to be wider than the proximity area. For example, in (a) of FIG. **5***a*, an area, including the first area A and the second area B, may be defined as the proximity area, and the first area A may be defined as the haptic area.

[0089] Further, an area in which an object is displayed may be divided into three areas A, B, and C as shown in (b) of FIG. **5***a* and may be divided into n areas as shown in (c) of FIG. **5***a* such that haptic effects with different intensity and patterns may be generated from the respective areas. Even in the case in which the area is divided as described above, the proximity area and the haptic area may be defined differently.

[0090] The size of the proximity area may be constructed to vary according to a degree in which an object approaches the display unit **151**. In other words, as shown in (a) of FIG. **5***b*, the size of the proximity area may be constructed to gradually decrease in order of C, B, and A or gradually increase in order of A, B, and C according to a degree in which an object approaches the display unit **151**. Even in this case, as in an area "H" shown in (b) of FIG. **5***b*, a haptic area from which a haptic effect has been generated may be constructed to have a constant size irrespective of a degree in which an object approaches the display unit **151**.

[0091] FIG. **6** is a flowchart illustrating a method of distinguishing signals received by the mobile terminal **100**, in accordance with one embodiment.

[0092] As shown in FIG. **6**, the controller **180** assigns vibration signals to touch signals and proximity signals (S**400**). The vibration signals may be automatically assigned by the controller **180** or may be generated by a user. In one embodiment, a first vibration signal may be assigned to touch signals and a second vibration signal may be assigned to proximity signals. In another embodiment, vibration signals may be assigned according to characteristics of touch signals and proximity signals.

[0093] For example, different vibration signals may be assigned to touch signals input within a certain area, touch signals input with a specific pressure, and touch signals input through multiple points. Further, different vibration signals may be assigned to proximity signals input within a certain area, proximity signals input within a certain distance, proximity signals input at a certain speed, and proximity signals input at multiple points.

[0094] Next, the controller **180** determines whether at least one of a touch signal and a proximity signal has been input (S**405**). For example, one or more touch signals may be inputted, one or more proximity signals may be inputted, or one or more proximity signals and touch signals may be inputted simultaneously. Touch signals may be determined based on values detected in a touch screen, and proximity signals may be determined based on values detected by the proximity sensor **141**. If, as a result of the determination in S**405**, at least a touch signal or a proximity signal has not been inputted, the controller **180** does not output a vibration signal.

[0095] On the other hand, if, as a result of the determination in step S**405**, at least one of a touch signal and a proximity signal has been inputted, the controller **180** analyzes the inputted signal and looks up the vibration signal assigned to the input signal (S**410**). If there is more than one inputted signal, the controller **180** combines the vibration signals assigned to the inputted signals (S**415**).

[0096] The controller **180** may combine one or more vibration signals through addition and subtraction. The combination method of the vibration signals may be automatically defined by the controller **180** according to an analyzed signal, or a user may select the combination method. Next, the controller **180** outputs the combined vibration signals through the haptic module **157** (S**420**).

[0097] FIG. **7** is a flowchart illustrating a method of distinguishing input signals associated with different display locations, in accordance with one embodiment.

[0098] As shown in FIG. **7**, a screen, including one or more menu icons, is displayed on the display unit **151** (S**500**). The menu icon may be a menu icon that may be selected to enter a down menu, an icon for performing a specific function or one or more images.

[0099] Next, the controller **180** determines whether a proximity signal has been detected at the location of a specific one of the one or more menu icons through the proximity sensor **141** (S**505**). If, as a result of the determination in S**505**, the proximity signal has not been detected at the location of a specific menu icon, the controller **180** does not output a vibration signal. On the other hand, if, as a result of the determination in S**505**, the proximity signal has been detected at the location of a specific menu icon, the controller **180** outputs a vibration signal, corresponding to the detected proximity signal, through the haptic module **157** (S**510**). Here, a single vibration signal corresponding to the detected proximity signal is output as vibration. Next, the controller determines whether a touch signal has been input through the specific menu icon of the location where the proximity signal was detected in step S**505** (S**515**). Here, the touch signal may be input through a touch screen.

[0100] If, as a result of the determination in S**515**, the touch signal has not been input through the specific menu icon, the controller **180** determines whether the touch signal has been input through a menu icon different from the specific menu icon (S**525**). If, as a result of the determination in S**525**, the touch signal has not been input through the different menu icon, the controller **180** does not output a vibration signal.

[0101] Meanwhile, if, as a result of the determination in step S**525**, the touch signal has been input through the different menu icon, the controller **180** outputs a vibration signal, corresponding to the input touch signal, through the haptic module **157** (S**530**). Next, the controller **180** displays a screen, corresponding to the menu icon through which the touch signal has been input, on the display unit **151** (S**535**).

[0102] On the other hand, if, as a result of the determination in S**515**, the touch signal has been input through the specific menu icon, the controller **180** outputs vibration in which a vibration signal corresponding to the proximity signal, which has been detected in step S**505**, and a vibration signal corresponding to the touch signal, which has been input in step S**515**, are combined through the haptic module **157** (S**520**). The respective vibration signals may be added or subtracted and then output as vibration. The controller **180** then displays a screen corresponding to the menu icon through which the touch signal has been input on the display unit **151** (S**535**).

[0103] FIG. **8** is a flowchart illustrating a method of distinguishing input signals associated with different distances from the proximity sensor **141**, in accordance with one

embodiment. As shown in FIG. **8**, the controller **180** displays a screen, including one or more menu icons, on the display unit **151** (S**600**).

[0104] The controller **180** determines whether a proximity signal whose distance from the proximity sensor **141** is a first proximity distance has been detected through the proximity sensor **141** (S**605**). If, as a result of the determination in S**605**, the proximity signal having the first proximity distance has not been detected, the controller **180** does not output a vibration signal.

[0105] On the other hand, if, as a result of the determination in S**605**, the proximity signal having the first proximity distance has been detected, the controller **180** outputs a vibration signal, corresponding to the detected proximity signal having the first proximity distance, through the haptic module **157** (S**610**). Next, the controller **180** determines whether a proximity signal whose distance from the proximity sensor **141** is a second proximity distance has been detected (S**615**). If, as a result of the determination in S**615**, the proximity signal having the second proximity distance has not been detected, the controller **180** does not output a vibration signal.

[0106] On the other hand, if, as a result of the determination in S**615**, the proximity signal having the second proximity distance has been detected, the controller **180** outputs vibration in which a vibration signal, corresponding to the proximity signal of the first proximity distance, which has been detected in S**605**, and a vibration signal corresponding to the proximity signal of the second proximity distance, which has been detected in S**615**, are combined through the haptic module **157**.

[0107] FIG. **9** is a flowchart illustrating a method of distinguishing input signals associated with different display areas, in accordance with one embodiment. As shown in FIG. **9**, the controller **180** displays a screen, including one or more areas, on the display unit **151** (S**700**). Each of the one or more areas may comprise of an image, a document, a keypad or a menu icon. The areas may be set by a user, and the screen may be divided equally and then designated as specific areas. As a touch signal or a proximity signal is input through two or more areas, vibration may be output through multi-touch.

[0108] A touch signal is input through a first area (S**705**). Here, a signal input through the first area and a second area may be not only a touch signal, but also a proximity signal detected through the proximity sensor **141**.

[0109] Next, the controller **180** determines whether a touch signal has been input through the second area (S**710**). If, as a result of the determination in step S**710**, the touch signal has not input through the second area, the controller **180** outputs a vibration signal, corresponding to the touch signal of the first area, through the haptic module **157**. A touch signal input through the first area and a touch signal input through the second area may be performed at the same time.

[0110] On the other hand, if, as a result of the determination in S**710**, the touch signal has input through the second area, the controller **180** outputs vibration in which a vibration signal corresponding to the touch signal of the first area and a vibration signal corresponding to the touch signal of the second area are combined through the haptic module **157**.

[0111] The combined vibration signal may be output differently depending on a method in which a touch signal is input through the first area and a touch signal is input through the second area. For example, the combined vibration signal may be output differently according to a distance between the first area and the second area. When a distance between the first area and the second area is less than a specific distance, vibration may be output by subtracting respective vibration signals. When a distance between the first area and the second area is larger than a specific distance, vibration in which respective vibration signals are summed may be output.

[0112] Further, in the case in which a distance between areas in which respective touch signals are input is changed in real time, vibration may be output differently according to the changed distance. For example, in the case in which, after touch signals are input through a first area and a second area, touch signals are input through a third area and a fourth area, it is assumed that the first area and the third area are entered using the same finger and the second area and the fourth area are entered using the same finger.

[0113] It corresponds to a case where multi-touch with different distances is repeatedly generated using a thumb and a index finger. This is because a case where multi-touch is entered using two fingers is general. At this time, in the case in which a distance between the third area and the fourth area becomes wider than a distance between the first area and the second area, a last vibration signal in which first vibration, wherein a vibration signal corresponding to a touch signal in the first area and a vibration signal corresponding to a touch signal in the second area are combined, and second vibration.

[0114] In one embodiment, a vibration signal corresponding to a touch signal in the third area and a vibration signal corresponding to a touch signal in the fourth area are combined, have been added may be output. In the case in which a distance between the third area and the fourth area becomes narrower than a distance between the first area and the second area, a last vibration signal in which the first vibration has been subtracted from the second vibration may be output.

[0115] As another embodiment, vibration may be output differently according to a speed in which a distance between areas through which respective touch signals are input is changed. In the case in which, after touch signals are input through a first area and a second area, touch signals are input through a third area and a fourth area, it is assumed that the first area and the third area are entered using the same finger and the second area and the fourth area are entered using the same finger. in other words, it corresponds to a case where multi-touch with different speeds is repeatedly generated using a thumb and a index finger.

[0116] The speed is calculated in relation to the time and distance from where the touch signals are input through the first area and the second area to where the touch signals are input through the third area and the fourth area. When the speed is greater than a specific speed, a vibration signal corresponding to the touch signal in the first area and a vibration signal corresponding to the touch signal in the second area are combined.

[0117] In some embodiments, a vibration signal corresponding to the touch signal in the third area and a vibration signal corresponding to the touch signal in the fourth area are combined, and outputted. When the speed is lower than a specific speed, a last vibration signal in which the first vibration has been subtracted from the second vibration may be output.

[0118] As still another embodiment, in the case in which a distance between respective touch signals, which may be input through a touch screen, becomes a maximum, it is necessary to inform information about the distance. Here, a maximum distance of the each touch signal may be identical to or shorter than a maximum straight-line distance in which a touch signal may be input in a touch screen.

[0119] For example, in the case in which an image is enlarged by each input touch signal and then displayed as a maximum size that may be displayed on the display unit **151**, information, indicating that further enlargement of the image is difficult, should be known. Accordingly, first alarm vibra-

tion other than vibration in which vibration signals corresponding to touch signals are combined in respective areas may be further output, and vibration in which vibration signals corresponding to touch signals are combined in respective areas may not be output, but only first alarm vibration may be output.

[0120] Further, in the case in which a distance between respective touch signals, which may be input through a touch screen, becomes a minimum, it is necessary to inform information about the distance. Here, a minimum distance of the each touch signal may be identical to or longer than a minimum straight-line distance in which a touch signal may be input in a touch screen.

[0121] For example, in the case in which an image is reduced by each input touch signal and then displayed as a minimum size that may be displayed on the display unit **151**, information, indicating that further reduction of the image is difficult, should be known. Accordingly, second alarm vibration other than vibration in which vibration signals corresponding to touch signals are combined in respective areas may be further output.

[0122] Touch signals used in the multi-touch may be applicable to proximity signals detected by the proximity sensor. That is, even in the event of a distance difference between areas in which the proximity signals are detected, a distance change of an area, and a speed change, the various vibration patterns may be output.

[0123] The controller **180** may display an execution screen of a menu icon displayed in a first area on the display unit **151** according to a touch signal input in the first area, and may display an enlargement screen of an image displayed in a second area on the display unit **151** according to a touch signal input in the second area.

[0124] FIGS. **10** and **11** are diagrams showing vibration signals outputted by the mobile terminal **100**, in accordance with one or more embodiments.

[0125] As shown in (a) of FIG. **10**, there appear a screen **505**, displaying a vibration signal with respect to vibration type**1**, which may be selected when a touch signal is input, and a screen **510** displaying a vibration signal with respect to vibration type**3**. In other words, one of vibration signals with respect to vibration type**1** to vibration type**n** may be set as a vibration signal with respect to an input touch signal according to classification **500** of a vibration type. Here, the pressure and area of an input touch signal and whether the touch signal has been input through multi-touch are not taken into consideration. Further, a vibration signal newly generated by a user may be selected.

[0126] As shown in (b) of FIG. **10**, there appear a screen **520**, displaying a vibration signal in the case of proximityA, which may be selected when a proximity signal is input, and a screen **525** displaying a vibration signal in the case of proximityB. In other words, one of vibration signals with respect to proximityA to proximityN may be set as a vibration signal with respect to an input proximity signal according to vibration type classification **515** of the proximity signal. Here, a proximity speed, a proximity area, and a proximity distance of an input proximity signal, and whether the proximity signal has been input through multi-touch are not taken into consideration.

[0127] In the case in which a proximity distance of a proximity signal is considered, there appear a screen **605**, displaying a vibration signal with respect to a proximity distance D**1**, and a screen **610** displaying a vibration signal with respect to a proximity distance D**2** as shown in (a) of FIG. **11**. In other words, vibration signals with respect to proximity distances D**1** to D**4** are set as vibration signals with respect to the respective proximity distances according to classification **600** of the proximity distances. Here, the classification **600** with respect to the proximity distances D**1** to D**4** may be set automatically or set by a user. For example, the proximity distance D**1** may be set to 0 to 10 meters, and the proximity distance D**2** may be set to 10 to 20 meters. Alternatively, the proximity distance D**1** may be set to 0 to 20 meters, and the proximity distance D**2** may be set to 20 to 40 meters.

[0128] In the case in which multi-touch of a proximity signal is taken into consideration, there appears a screen **620**, displaying an area in which a proximity signal is input in the display unit **151**, that is, a multi-touch area is divided into plural areas, as shown in (b) of FIG. **11**. Since an area in which a proximity signal is input into plural areas, an area in which a proximity signal may be input in the display unit **151** is divided into plural areas.

[0129] In other words, vibration signals with respect to multi-touch areas P**1** to P**9** are set as vibration signals with respect to the respective multi-touch areas according to classification **615** of multi-touch. Here, the classification **615** with respect to the multi-touch areas P**1** to P**9** may be set automatically or set by a user. For example, the multi-touch areas P**1** to P**9** may be set by dividing an area in which a proximity signal is input into nine equal areas or may be set by randomly dividing the area.

[0130] In the case in which a proximity speed of a proximity signal is taken into consideration, there appear a screen **630** displaying a vibration signal with respect to a proximity speed V**1**, a screen **635** displaying a vibration signal with respect to a proximity speed V**2**, and a screen **640** displaying a vibration signal with respect to a proximity speed V**3**, as shown in (c) of FIG. **11**.

[0131] That is, vibration signals with respect to proximity speeds V**1** to V**9** are set as vibration signals with respect to the respective proximity speeds according to classification **625** of the proximity speeds. Here, the classification **625** with respect to the proximity speeds V**1** to V**9** may be set automatically or set by a user. For example, the proximity speed V**1** may be set to 0 to 10 cm/s and the proximity speed V**2** may be set to 10 to 20 cm/s. Alternatively, the proximity speed V**1** may be set to 0 to 20 cm/s, and the proximity speed V**2** may be set to 20 to 40 cm/s.

[0132] FIGS. **12** and **13** are diagrams showing vibration signals outputted by the mobile terminal **100**, in accordance with one or more embodiments. As shown in (a) of FIG. **12**, there appears a screen **700** displaying a plurality of menu icons for menu selection. In the case in which a signal for selecting a menu is input, the controller **180** analyzes the input signal. As a result of the analysis, the input signal may have a type, which includes a proximity signal and a touch signal and in which after the proximity signal is detected, the touch signal is input.

[0133] A vibration signal set with respect to the touch signal is a vibration signal **705** with respect to vibration type**3**, as shown in (b) of FIG. **12**, and a vibration signal set with respect to the proximity signal is a vibration signal **710** with respect to proximity B, as shown in (c) of FIG. **12**.

[0134] Accordingly, in the case in which, after the proximity signal is maintained for a specific period of time, a menu icon is touched, vibration **715** in which the vibration signal **705** with respect to the vibration type**3** and the vibration signal **710** with respect to the proximity B have been added is output, as shown in (d) of FIG. **12**. Here, the vibration may be output by subtracting the respective vibration signals, and a combination method of the vibration signals may be set automatically or set by a user.

[0135] As shown in (a) of FIG. **13**, there is displayed a screen **800**, displaying a brightness control menu for controlling the brightness of the display unit **151**. When a signal for selecting brightness is input, the controller **180** analyzes the input signal. As a result of the analysis, the input signal may have a type which includes a proximity signal and a touch signal and in which, after the proximity signal is detected, the touch signal is input.

[0136] A vibration signal set with respect to the touch signal is a vibration signal **805** regarding vibration type1 as shown in (b) of FIG. **13**, and a vibration signal set with respect to the proximity signal is a vibration signal **810** regarding proximity A as shown in (c) of FIG. **13**. Accordingly, in the case in which the proximity signal is maintained for a specific period of time and a menu icon is then touched, vibration **815** in which the vibration signal **805** regarding the vibration type1 has been subtracted from the vibration signal **810** regarding the proximity A is output as shown in (d) of FIG. **13**.

[0137] FIGS. **14** and **15** are diagrams showing vibration signals outputted by the mobile terminal **100**, in accordance with one or more embodiments. As shown in (a) of FIG. **14**, in the case in which a user's hands, ear or face becomes gradually close to or distant from a screen **900** displayed on the display unit **151**, the proximity sensor **141** detects a proximity signal, and the controller **180** analyzes the detected proximity signal.

[0138] As a result of the analysis, the input signal includes a proximity signal input at a proximity distance D1 and a proximity signal input at a proximity distance D3. As shown in (b) of FIG. **14**, a vibration signal **905** with respect to the proximity distance D1 and a vibration signal **910** with respect to the proximity distance D3 are set. In the case in which a distance from the screen **900** is changed from the proximity distance D3 to the proximity distance D1, vibration **910** in which the vibration signal **905** with respect to the proximity distance D1 has been subtracted the vibration signal **910** with respect to the proximity distance D3 is output, as shown in (c) of FIG. **14**.

[0139] Meanwhile, in the case in which a distance from the screen **900** is changed from the proximity distance D1 to the proximity distance D3, vibration **920** in which the vibration signal **910** with respect to the proximity distance D3 and the vibration signal **905** with respect to the proximity distance D1 have been added is output, as shown in (d) of FIG. **14**. A combination method of adding or subtracting the vibration signals may be exchanged.

[0140] In (a) of FIG. **15**, a signal, including a proximity signal input at a first proximity distance and a proximity signal input at a second proximity distance, is input and a vibration signal is output by combining vibration signals with respect to the respective proximity distances, when an operation button is selected through the display unit **151** to play music.

[0141] Since a vibration signal is output separate from audio output, the a user may determine that the operation button has been entered correctly through the vibration signal without being hindered by the music play. The same applies to motion image play, as shown in (b) of FIG. **15**. A user may check that that the operation button has been entered correctly through the vibration signal without being hindered by the motion image play.

[0142] FIGS. **16** to **18** are diagrams showing vibration signals outputted by the mobile terminal **100**, in accordance with one or more embodiments. As shown in (a) of FIG. **16**, in the case in which a touch signal is input as a multi-touch signal through several areas on a screen **1100** displaying an image, the controller **180** analyzes the input touch signal.

[0143] As a result of the analysis, the input signal includes a touch signal input through an area P1 of the multi-touch area and a touch signal input through an area P9 of the multi-touch area. As shown in (b) of FIG. **16**, a vibration signal **1105** with respect to the multi-touch area P1 and a vibration signal **1110** with respect to the multi-touch area P9 are set. Accordingly, as shown in (c) of FIG. **16**, vibration **1115** in which the vibration signal **1105** with respect to the multi-touch area P1 has been subtracted from the vibration signal **1110** with respect to the multi-touch area P9 is output.

[0144] Another embodiment in which a touch signal is input as a multi-touch signal through several areas of a multi-touch area is described with reference to FIGS. **17** and **18**.

[0145] As shown in (a) of FIG. **17**, upon receipt of radio, an area of the display unit **151**, displaying twelve operation buttons, may be set as nine multi-touch areas. In the case in which touch signals are input through an area P1 and an area P9 of the nine areas, vibration **1210** in which a vibration signal **1201** with respect to the multi-touch area P1 has been subtracted from a vibration signal **1209** with respect to the multi-touch area P9 is output.

[0146] In the case in which an area of the display unit **151**, displaying a keypad through which numerals may be input, is set as nine multi-touch areas and touch signals are input through areas P2 and P6, vibration **1220** in which a vibration signal **1202** with respect to the multi-touch area P2 and a vibration signal **1206** with respect to the multi-touch area P6 have been added is output, as shown in (b) of FIG. **17**. In the case in which an area of the display unit **151**, displaying a keypad through which numerals and text may be input, is set as nine multi-touch areas and touch signals are input through areas P2 and P8, vibration **1230** in which a vibration signal **1202** with respect to the multi-touch area P2 and a vibration signal **1206** with respect to the multi-touch area P8 have been added is output, as shown in (c) of FIG. **17**.

[0147] Meanwhile, in the case in which the touch signal as shown in (c) of FIG. **17** is input right after the touch signal as shown in (b) of FIG. **17**, it corresponds to a case where a distance between the areas in which the touch signals have been input is changed. Accordingly, vibration in which the vibration **1220** shown in (b) of FIG. **17** and the vibration **1230** shown in (c) of FIG. **17** are combined may be output. Further, in the case in which, after the touch signal as shown in (b) of FIG. **17** is input, the touch signal as shown in (c) of FIG. **17** is input, different vibrations may be output according to a speed of the input touch signal.

[0148] As shown in (a) of FIG. **18**, in the case in which an area of the display unit **151** on which an image list indicated by thumbnail is displayed is set as nine multi-touch areas and touch signals are input through an area P1 and an area P9, vibration **1240** in which a vibration signal **1201** with respect to the multi-touch area P1 has been subtracted from a vibration signal **1209** with respect to the multi-touch area P9 is output.

[0149] In the case in which an area of the display unit **151** on which a plurality of menus is displayed is set as nine multi-touch areas and touch signals are input through an area P1 and an area P9, vibration **1250** in which a vibration signal **1209** with respect to the multi-touch area P9 and a vibration signal **1201** with respect to the multi-touch area P1 have been added is output, as shown in (b) of FIG. **18**.

[0150] In the case in which an area of the display unit **151** on which at least thirty date menus are displayed is set as nine multi-touch areas and touch signals are input through an area P2 and an area P8, vibration **1260** in which a vibration signal **1202** with respect to the multi-touch area P2 and a vibration

signal **1208** with respect to the multi-touch area P8 have been added is output, as shown in (c) of FIG. **18**.

[0151] That is, in the case in which a plurality of menu icons is displayed in a specific area of the display unit **151**, a multi-touch area may be set in the specific area of the display unit **151**, and the number of the multi-touch areas may be decided independently from the number of a plurality of menu icons. Accordingly, even though different menu icons are multi-touched, the same vibration signal may be output.

[0152] FIGS. **19** to **22** are diagrams to which reference is made to illustrate a method of distinguishing input signals received by the mobile terminal **100**, in accordance with one or more embodiments.

[0153] As shown in (a) of FIG. **19**, in the case in which a user's hands, ear or face becomes gradually close to or distant from a screen **1400** of the display unit **151** at a different speed, the proximity sensor **141** detects a proximity signal and the controller **180** analyzes the detected proximity signal. As a result of the analysis, an input signal includes a proximity signal input at a proximity speed V1 and a proximity signal input at a proximity speed V9.

[0154] As shown in (b) of FIG. **19**, a vibration signal **1405** with respect to the proximity speed V1 and a vibration signal **1410** with respect to the proximity speed V9 are set. Accordingly, in the case in which the proximity speed of the proximity signal is changed from the proximity speed V9 to the proximity speed V1, vibration **1415** in which the vibration signal **1405** with respect to the proximity speed V1 has been subtracted from the vibration signal **1410** with respect to the proximity speed V9 is output, as shown in (c) of FIG. **19**.

[0155] Another embodiment in which proximity signals with different speeds are detected is described below with reference to FIG. **20**. In the case in which a proximity speed of a proximity signal with respect to a menu button for multi-tasking is changed from a proximity speed V9 to a proximity speed V1, vibration **1510** in which a vibration signal **1501** with respect to the proximity speed V1 has been subtracted from a vibration signal **1509** with respect to the proximity speed V9 is output, as shown in (a) of FIG. **20**.

[0156] In the case in which a proximity speed of a proximity signal with respect to a menu button for multi-tasking for image enlargement is changed from a proximity speed V1 to a proximity speed V9, vibration **1520** in which the vibration signal **1509** with respect to the proximity speed V9 and the vibration signal **1501** with respect to the proximity speed V1 have been added is output, as shown in (b) of FIG. **20**. In the case in which a proximity speed of a proximity signal with respect to a menu button for setting environments of the display unit **151** is changed from a proximity speed V2 to a proximity speed V8, vibration **1530** in which a vibration signal **1508** with respect to the proximity speed V8 and a vibration signal **1502** with respect to the proximity speed V2 have been added is output, as shown in (c) of FIG. **20**.

[0157] Meanwhile, in the case in which a signal for selection is input in a screen **1600** on which menu buttons are displayed as shown in (a) of FIG. **21**, the controller **180** analyzes an input signal. As a result of the analysis, the input signal includes a proximity signal input through a proximity area M9 and a proximity signal input through a proximity area M1.

[0158] As shown in (b) of FIG. **21**, a vibration signal **1610** with respect to the proximity area M9 and a vibration signal **1605** with respect to the proximity area M1 are set. In the case in which a proximity area of an input proximity signal is changed from the proximity area M9 to the proximity area M1, vibration **1615** in which the vibration signal **1605** with respect to the proximity area M1 has been subtracted from the vibration signal **1610** with respect to the proximity area M9 is output, as shown in (c) of FIG. **21**.

[0159] As still another embodiment in which proximity signals with different proximity areas are detected is described below with reference to FIG. **22**. As shown in (a) of FIG. **22**, in the case in which a proximity area of a proximity signal is changed from a proximity area M9 to a proximity area M1 in a menu button for playing motion images, vibration **1710** in which a vibration signal **1701** with respect to the proximity area M1 has been subtracted from a vibration signal **1709** with respect to the proximity area M9 is output.

[0160] In the case in which a proximity area of a proximity signal is changed from a proximity area M1 to a proximity area M9 in a menu button for enlarging images, vibration **1720** in which a vibration signal **1709** with respect to the proximity area M9 and a vibration signal **1701** with respect to the proximity area M1 have been added is output, as shown in (b) of FIG. **22**.

[0161] In the case in which a proximity area of a proximity signal with respect to a menu button for the worldwide time is changed from M2 to M8, vibration **1730** in which a vibration signal **1702** with respect to the proximity area M2 and a vibration signal **1708** with respect to the proximity area M8 have been added is output, as shown in (c) of FIG. **22**.

[0162] In an alternative embodiment, the invention may be implemented as computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any instruction execution system. For the purposes of this description, a computer-usable or computer-readable medium may be any apparatus that can contain, store, communicate, propagate or transport the program for use by or in connection with the instruction execution system, apparatus or device.

[0163] The computer-readable medium may be an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. Examples of a computer-readable medium include a semiconductor or solid-state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk and an optical disk. Current examples of optical disks include compact disk read only memory (CD-ROM), compact disk read/write (CD-R/W) and digital video disk (DVD).

[0164] It should also be understood that the logic code, programs, modules, processes, methods and the order in which the respective steps of each method are performed are purely exemplary. Depending on implementation, the steps can be performed in any order or in parallel, unless indicated otherwise in the present disclosure. Further, the logic code is not related, or limited to any particular programming language, and may comprise of one or more modules that execute on one or more processors in a distributed, non-distributed or multiprocessing environment.

[0165] The present invention has been described above with reference to one or more features or embodiments. Those skilled in the art will recognize, however, that changes and modifications may be made to these embodiments without departing from the scope of the present invention. These and various other adaptations and combinations of the embodiments disclosed are within the scope of the invention and are further defined by the claims and their full scope of equivalents.

What is claimed is:

1. A method of distinguishing input signals detected by a mobile terminal, the method comprising:

detecting a proximity signal and a touch signal inputted to the mobile terminal, wherein a first vibration signal is associated with the proximity signal and a second vibration is associated with the touch signal;

determining a first location through which the proximity signal is inputted and a second location through which the touch signal is inputted; and

outputting a combined vibration signal that is a mix of the first and the second vibration signals, in response to determining that the first and second locations are the same.

2. The method of claim 1, further comprising outputting the first vibration signal, in response to determining that the first and second locations are different.

3. The method of claim 1, further comprising outputting the second vibration signal, in response to determining that the first and second locations are different.

4. The method of claim 1, further comprising displaying an execution screen corresponding to the first location, in response to determining that the first and second locations are the same.

5. The method of claim 1, wherein the combined vibration signal is an addition or subtraction of the first and second vibration signals.

6. The method of claim 1, wherein the first or second vibration signal is generated by a user.

7. A method of distinguishing proximity signals detected by a proximity sensor of a mobile terminal, the method comprising:

detecting a first proximity signal at a first proximity distance from the proximity sensor and a second proximity signal at a second proximity distance from the proximity sensor, wherein a first vibration signal is associated with the first proximity signal and a second vibration signal is associated with the second proximity signal; and

outputting a combined vibration signal corresponding to the first and second proximity signals.

8. The method of claim 7, further comprising outputting the first vibration signal.

9. The method of claim 7, wherein the combined vibration signal is an addition or subtraction of the first and second vibration signals.

10. The method of claim 7, wherein the first or second vibration signal is generated by a user.

11. A method of distinguishing touch signals detected by a touch screen of a mobile terminal, the method comprising:

detecting a first touch signal inputted at a first area of the touch screen and a second touch signal inputted at a second area of the touch screen, wherein a first vibration signal is associated with the first touch signal and a second vibration signal is associated with the second touch signal; and

outputting a combined vibration signal corresponding to the first and second touch signals.

12. The method of claim 11, wherein the combined vibration signal is an addition or subtraction of the first and second vibration signals.

13. The method of claim 11, wherein the combined vibration signal is outputted according to a distance between the first area and the second area.

14. The method of claim 11, further comprising detecting a third touch signal inputted at a third area of the touch screen and a fourth touch signal inputted at a fourth area of the touch screen, wherein the combined vibration signal is outputted according to a change in a distance between the first and second areas and a distance between the third and fourth areas.

15. The method of claim 11, further comprising detecting a third touch signal inputted at a third area of the touch screen and a fourth touch signal inputted at a fourth area of the touch screen, wherein the combined vibration signal is outputted according to a speed difference between the first and second touch signals inputted through the first and second areas and the third and fourth touch signals inputted through the third and fourth areas.

16. The method of claim 11, further comprising outputting a first alarm vibration, in response to determining that the first and second touch signals enlarge or maximize an image displayed on the touch screen.

17. The method of claim 11, further comprising outputting a second alarm vibration in response to determining that the first and second touch signals reduce or minimize an image displayed on the touch screen.

18. The method of claim 11, wherein the first or second vibration signal is generated by a user.

19. A method of distinguishing input signals detected by a mobile terminal, the method comprising:

detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and

outputting a combined vibration signal corresponding to at least the first and second input signals.

20. The method of claim 19, wherein the first and second input signals are proximity signals detected by a proximity sensor of the mobile terminal.

21. The method of claim 20, wherein proximity signals are detected at different proximity speeds through the proximity sensor.

22. The method of claim 20, wherein the proximity signals are detected at different proximity areas through the proximity sensor.

23. The method of claim 20, wherein the proximity signals are detected at different locations by the proximity sensor.

24. The method of claim 19, wherein the first and second input signals are touch signals inputted through a touch screen of the mobile terminal.

25. The method of claim 24, wherein the touch signals are inputted through different areas of the touch screen.

26. The method of claim 24, wherein the touch signals are inputted with different pressures through the touch screen.

27. The method of claim 19, wherein the first or second vibration signal is generated by a user.

28. A mobile terminal comprising:

a proximity sensor for detecting a proximity signal and a touch signal inputted to the mobile terminal, wherein a first vibration signal is associated with the proximity signal;

a touch screen for detecting touch signal inputted to the mobile terminal, wherein a second vibration is associated with the touch signal;

a controller for determining a first location through which the proximity signal is inputted and a second location through which the touch signal is inputted; and

a haptic module for outputting a combined vibration signal corresponding to the proximity signal and the touch signal, in response to determining that the first and second locations are the same.

29. The mobile terminal of claim 28, wherein the haptic module is further for outputting the first vibration signal, in response to determining that the first and second locations are different.

30. The mobile terminal of claim 28, wherein the haptic module is further for outputting the second vibration signal, in response to determining that the first and second locations are different.

31. The mobile terminal of claim 28, wherein the controller is further for displaying an execution screen corresponding to the first location, in response to determining that the first and second locations are the same.

32. The mobile terminal of claim 28, wherein the combined vibration signal is an addition or subtraction of the first and second vibration signals.

33. The mobile terminal of claim 28, wherein the first or second vibration signal is generated by a user.

34. A mobile terminal comprising:

a proximity sensor for detecting a first proximity signal at a first proximity distance from the proximity sensor and a second proximity signal at a second proximity distance from the proximity sensor, wherein a first vibration signal is associated with the first proximity signal and a second vibration signal is associated with the second proximity signal; and

a haptic module for outputting a combined vibration signal corresponding to the first and second proximity signals.

35. The mobile terminal of claim 34, wherein the haptic module is further for outputting the first vibration signal.

36. The mobile terminal of claim 34, wherein the combined vibration signal is an addition or subtraction of the first and second vibration signals.

37. The mobile terminal of claim 34, wherein the first or second vibration signal is generated by a user.

38. A mobile terminal comprising:

a touch screen for detecting a first touch signal inputted at a first area of the touch screen and a second touch signal inputted at a second area of the touch screen, wherein a first vibration signal is associated with the first touch signal and a second vibration signal is associated with the second touch signal; and

a haptic module for outputting a combined vibration signal corresponding to the first and second touch signals.

39. The mobile terminal of claim 38, wherein the combined vibration signal is an addition or subtraction of the first and second vibration signals.

40. The mobile terminal of claim 38, wherein the combined vibration signal is outputted according to a distance between the first area and the second area.

41. The mobile terminal of claim 38, the touch screen is further for detecting a third touch signal inputted at a third area of the touch screen and a fourth touch signal inputted at a fourth area of the touch screen, wherein the combined vibration signal is outputted according to a change in a distance between the first and second areas and a distance between the third and fourth areas.

42. The mobile terminal of claim 38, the touch screen is further for detecting a third touch signal inputted at a third area of the touch screen and a fourth touch signal inputted at a fourth area of the touch screen, wherein the combined vibration signal is outputted according to a speed difference between the first and second touch signals inputted through the first and second areas and the third and fourth touch signals inputted through the third and fourth areas.

43. The mobile terminal of claim 38, wherein the haptic module is further for outputting a first alarm vibration, in response to determining that the first and second touch signals enlarge or maximize an image displayed on the touch screen.

44. The mobile terminal of claim 38, wherein the haptic module is further for outputting a second alarm vibration in response to determining that the first and second touch signals reduce or minimize an image displayed on the touch screen.

45. The mobile terminal of claim 38, wherein the first or second vibration signal is generated by a user.

46. A mobile terminal comprising:

a detection unit for detecting at least a first and a second input signal, wherein a first vibration signal is associated with the first input signal and a second vibration signal is associated with the second input signal; and

a haptic module for outputting a combined vibration signal corresponding to at least the first and second input signals.

47. The mobile terminal of claim 46, wherein the first and second input signals are proximity signals detected by a proximity sensor.

48. The mobile terminal of claim 47, wherein proximity signals are detected at different proximity speeds through the proximity sensor.

49. The mobile terminal of claim 47, wherein the proximity signals are detected at different proximity areas through the proximity sensor.

50. The mobile terminal of claim 47, wherein the proximity signals are detected at different locations by the proximity sensor.

51. The mobile terminal of claim 46, wherein the first and second input signals are touch signals inputted through a touch screen.

52. The mobile terminal of claim 51, wherein the touch signals are inputted through different areas of the touch screen.

53. The mobile terminal of claim 51, wherein the touch signals are inputted with different pressures through the touch screen.

54. The mobile terminal of claim 46, wherein the first or second vibration signal is generated by a user.

* * * * *

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HOELLWARTH

(54) HAPTIC FEEDBACK SYSTEM

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(73) Assignee: Apple Inc., Cupertino, CA (US)

(21) Appl. No.: 12/240,947

(22) Filed: Sep. 29, 2008

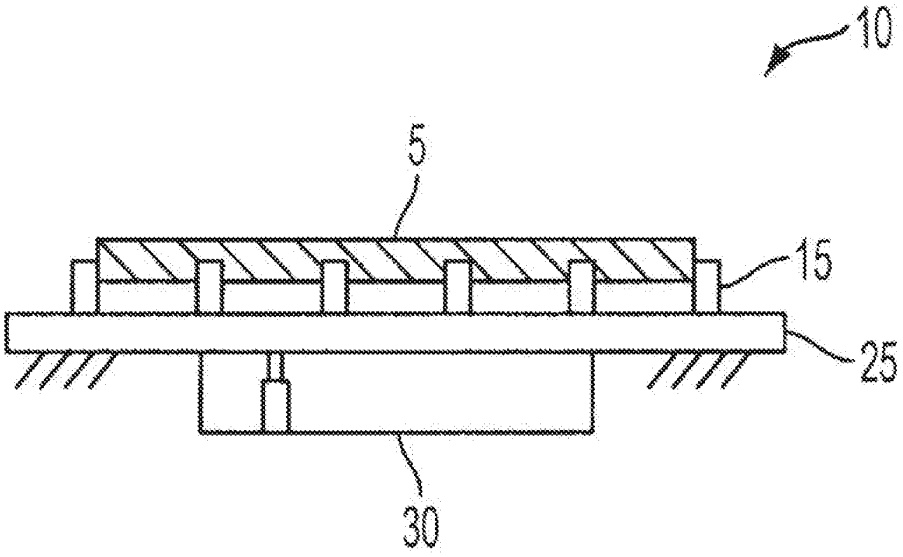
Publication Classification

(51) Int. Cl.
G08B 6/00 (2006.01)

(52) U.S. Cl. 340/407.2

(57) ABSTRACT

Localized haptic feedback at discrete locations or regions of a surface is disclosed. Controllable haptic transmission nodes can be selectively controlled to transmit a haptic feedback signal to a surface. The nodes can be controlled between a first state that transmits the haptic feedback signal to the surface and a second state that dampens or prevents the haptic feedback signal to the surface. The nodes can be located around the perimeter of the surface, where each node can be associated with a particular location or region of the surface and can provide haptic feedback to that particular location or region when the node is selected. A touch surface of a touch sensitive device is an exemplary surface for using localized haptic feedback.



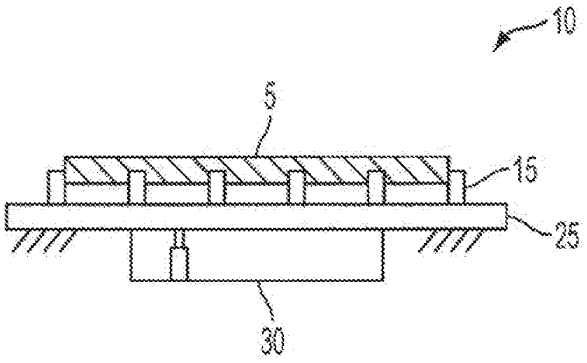


FIG. 1A

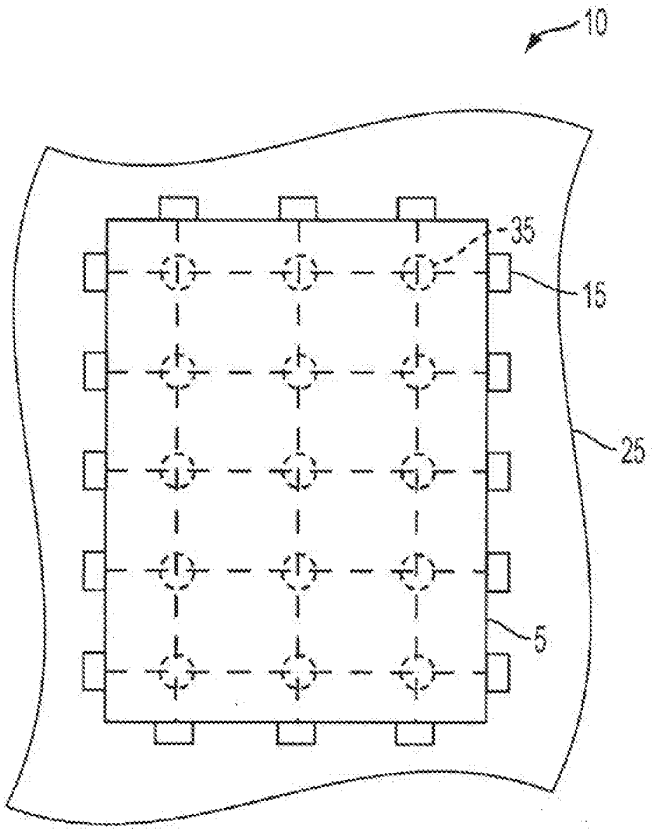


FIG. 1B

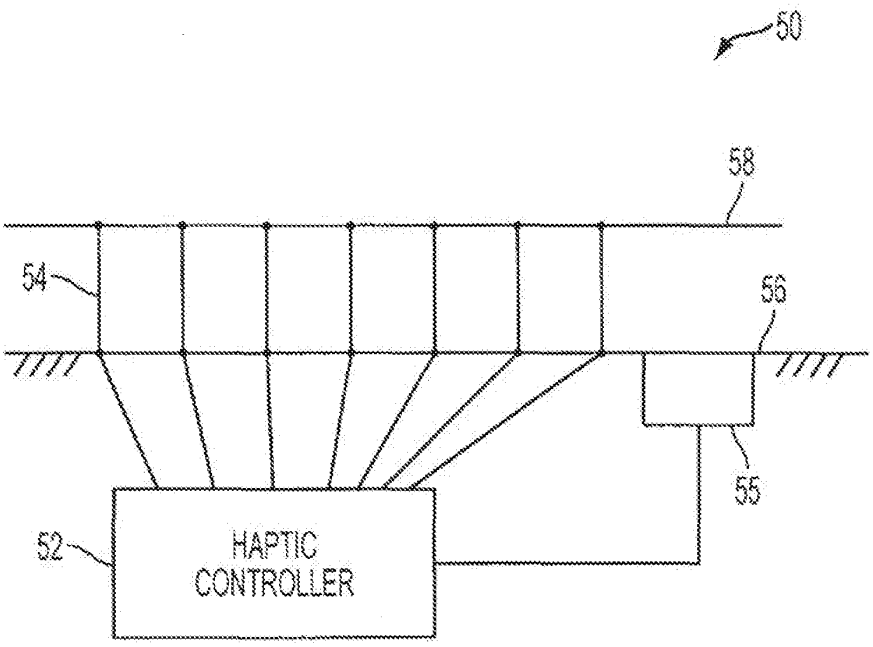


FIG. 2

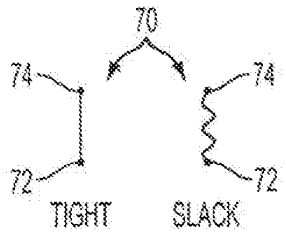


FIG. 3A

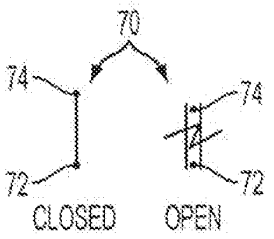


FIG. 3B

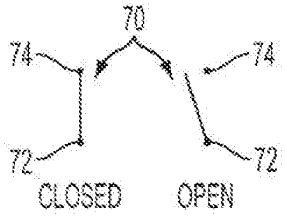


FIG. 3C

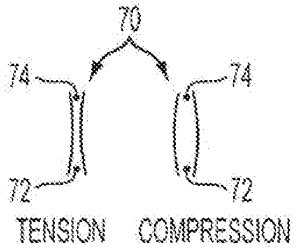


FIG. 3D

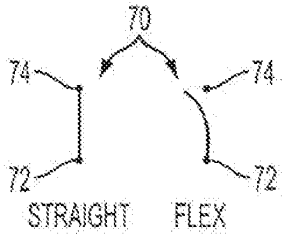


FIG. 3E

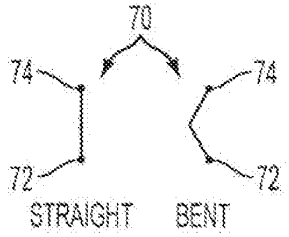


FIG. 3F

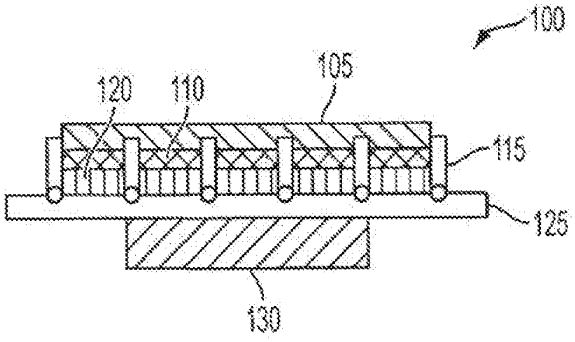


FIG. 4A

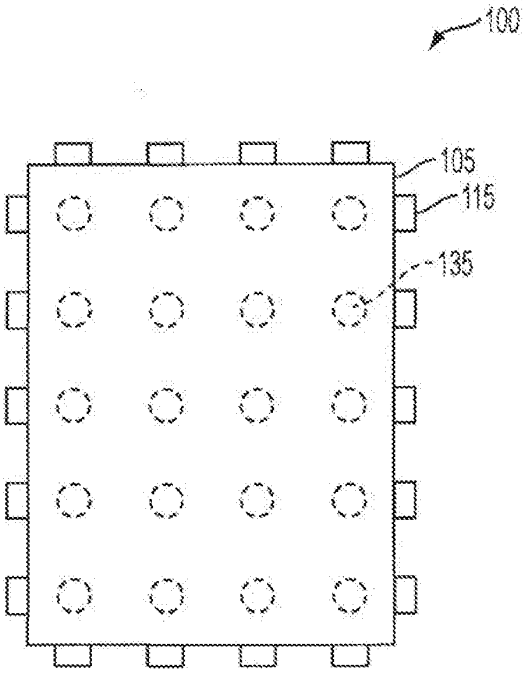


FIG. 4B

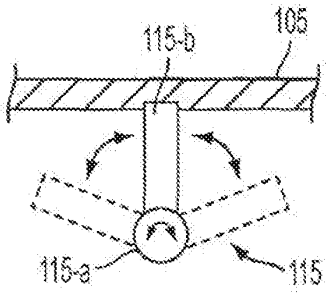


FIG. 5A

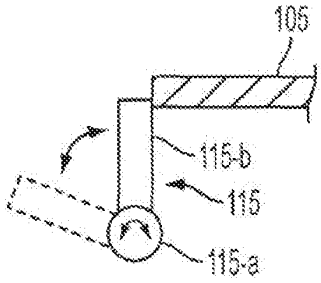


FIG. 5B

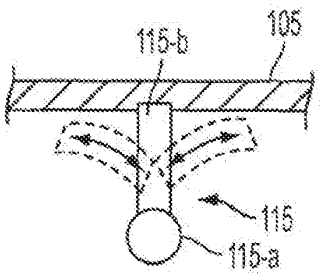


FIG. 5C

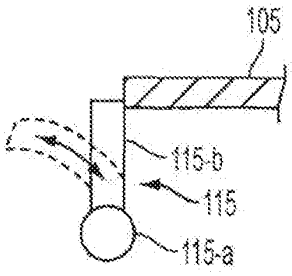


FIG. 5D

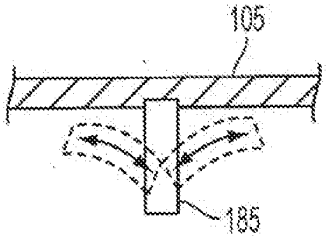


FIG. 5E

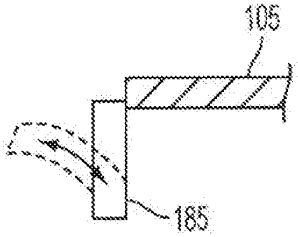


FIG. 5F

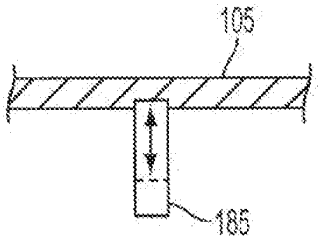


FIG. 5G

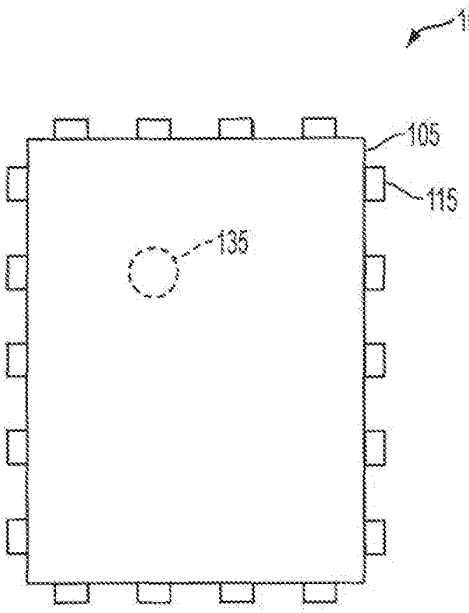


FIG. 6A

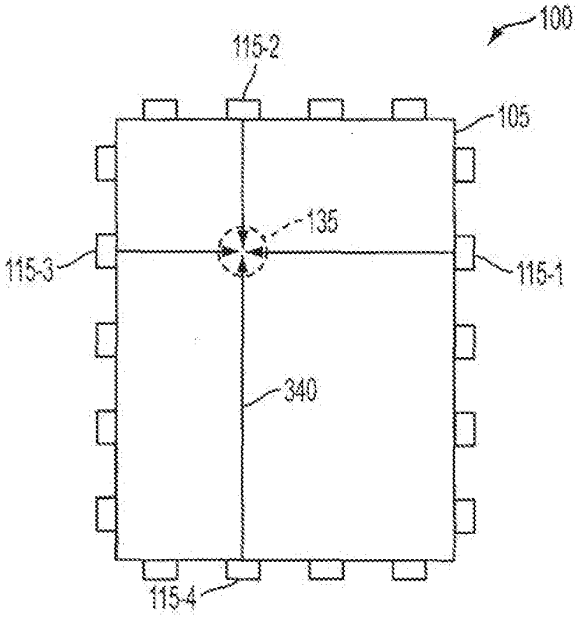


FIG. 6B

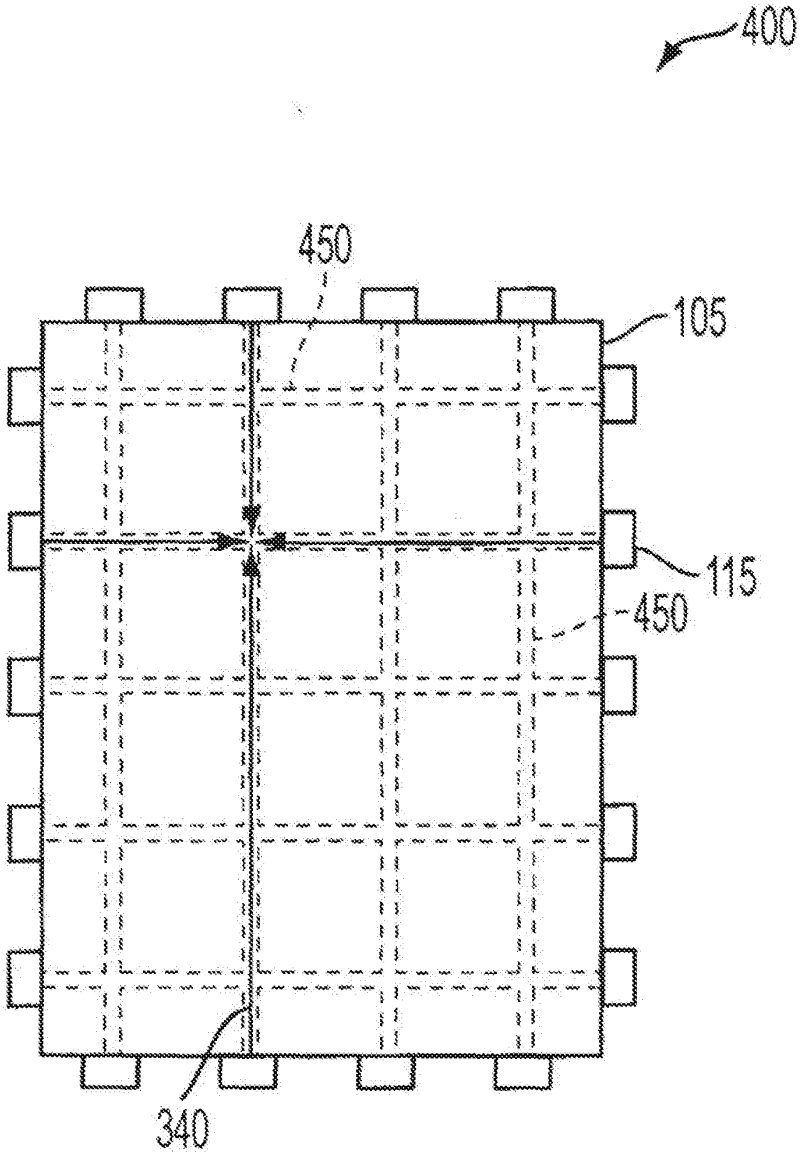


FIG. 7

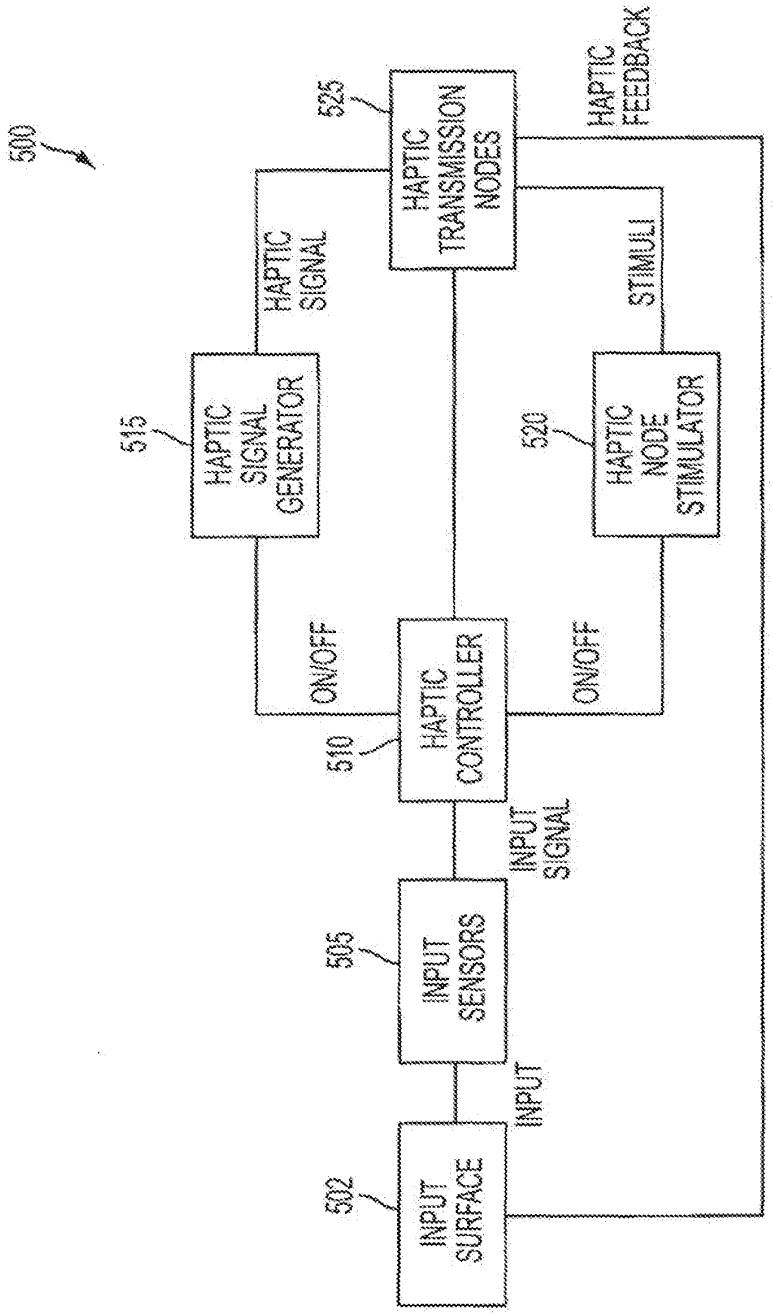


FIG. 8

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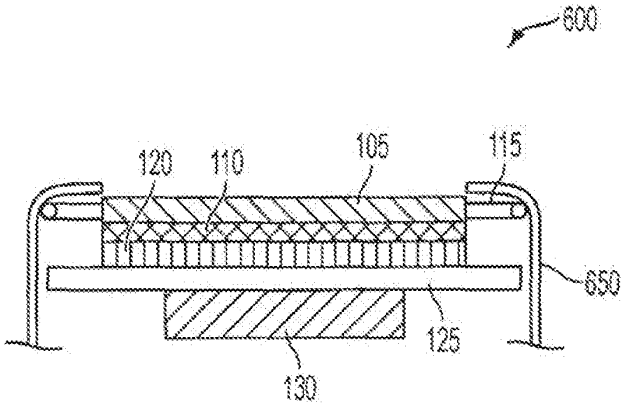


FIG. 9A

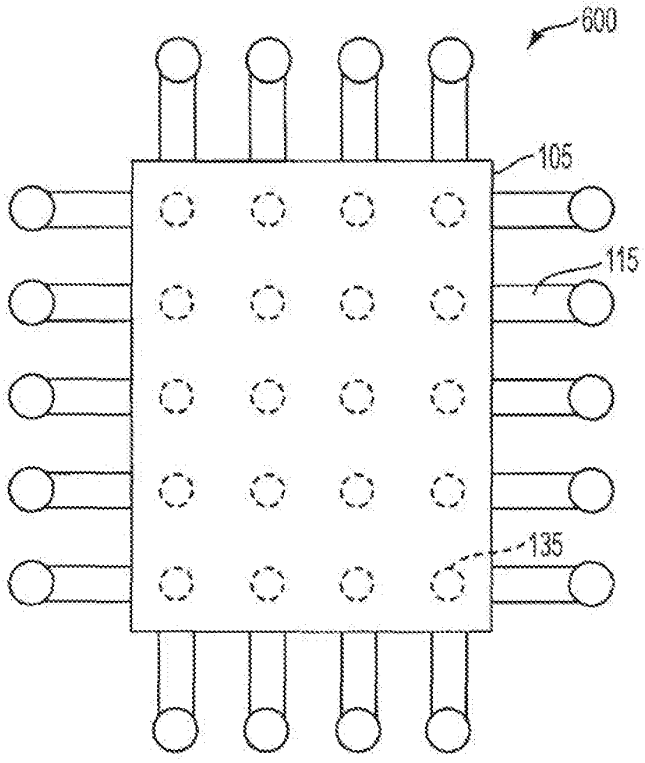


FIG. 9B

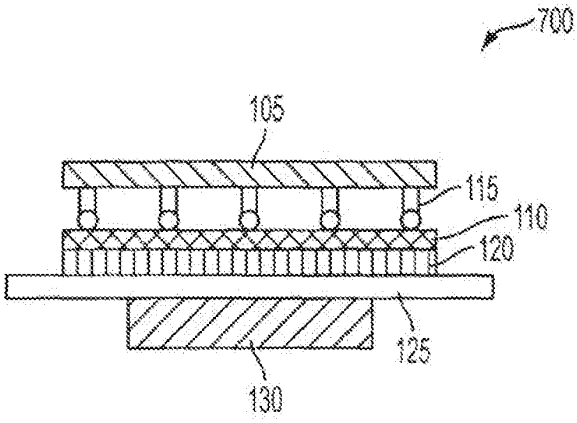


FIG. 10A

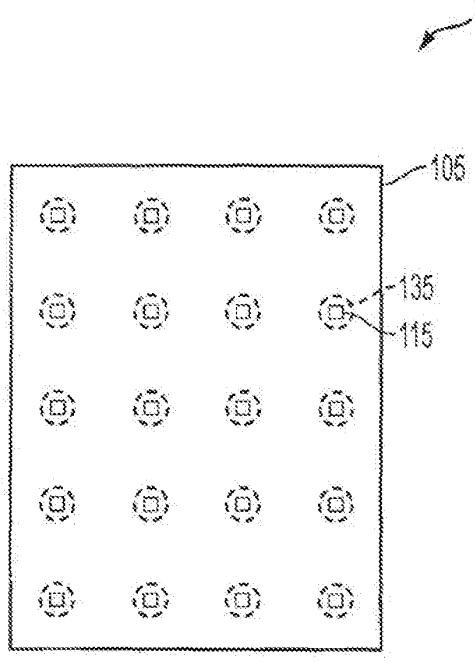


FIG. 10B

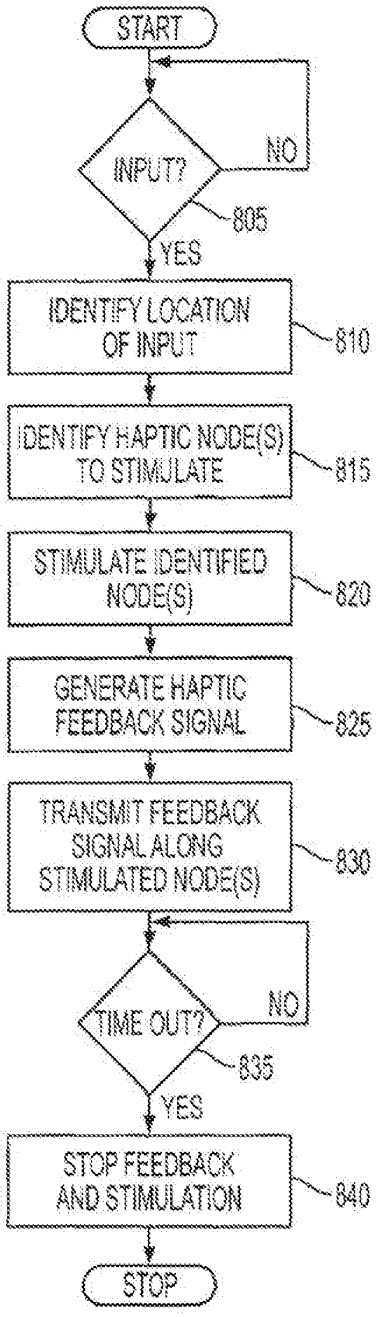

START
INPUT?
NO
805
YES
IDENTIFY LOCATION OF INPUT
810
IDENTIFY HAPTIC NODE(S) TO STIMULATE
815
STIMULATE IDENTIFIED NODE(S)
820
GENERATE HAPTIC FEEDBACK SIGNAL
825
TRANSMIT FEEDBACK SIGNAL ALONG STIMULATED NODE(S)
830
TIME OUT?
NO
835
YES
STOP FEEDBACK AND STIMULATION
840
STOP

FIG. 11

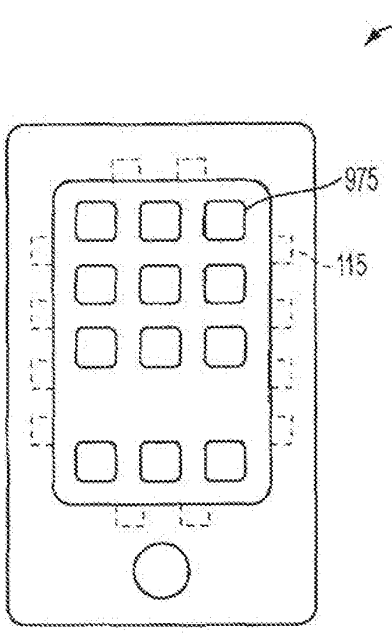


FIG. 12A

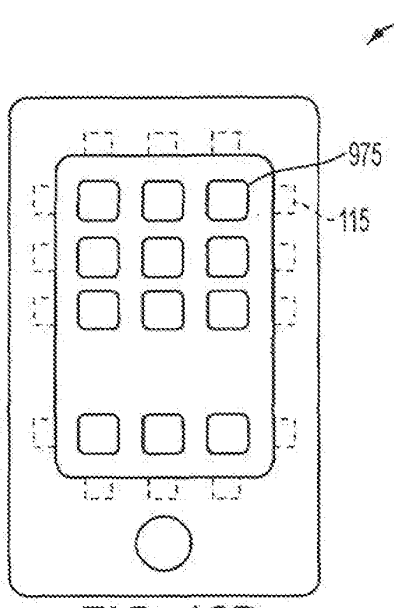


FIG. 12B

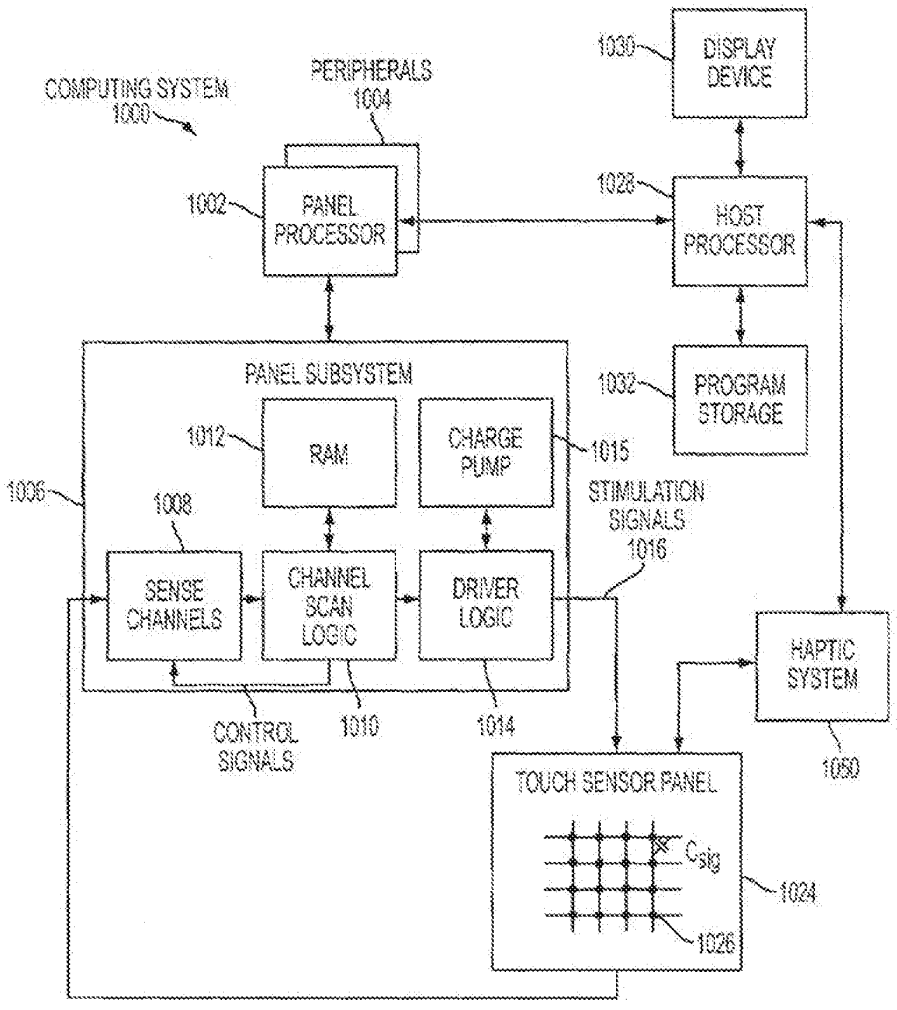

COMPUTING SYSTEM
1000
PERIPHERALS
1004
1030
DISPLAY DEVICE
1002
PANEL PROCESSOR
1028
HOST PROCESSOR
PANEL SUBSYSTEM
1032
PROGRAM STORAGE
1012
RAM
CHARGE PUMP
1015
1006
1008
STIMULATION SIGNALS
1016
SENSE CHANNELS
CHANNEL SCAN LOGIC
DRIVER LOGIC
HAPTIC SYSTEM
CONTROL SIGNALS
1010
1014
1050
TOUCH SENSOR PANEL
C_{sig}
1024
1026

FIG. 13

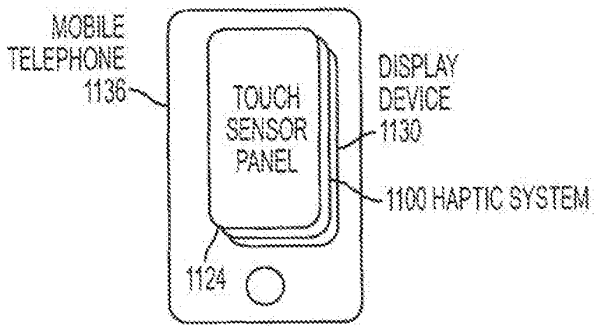


FIG. 14A

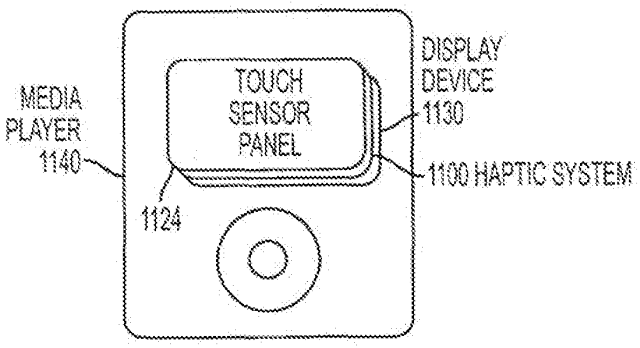


FIG. 14B

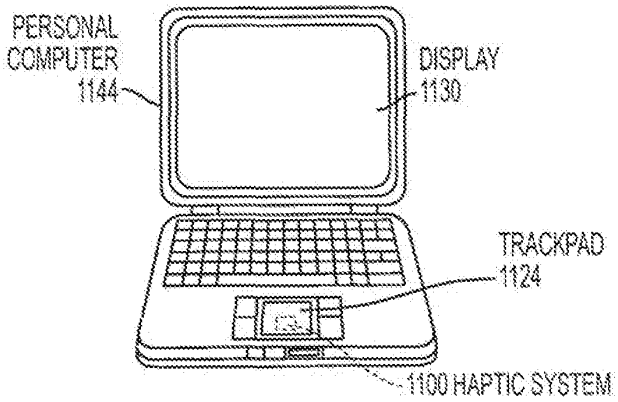


FIG. 14C

HAPTIC FEEDBACK SYSTEM

FIELD OF THE INVENTION

[0001] This relates to devices that provide haptic feedback at a surface and, more particularly, to haptic devices capable of providing haptic sensations at different locations across a surface such as an input/output surface.

BACKGROUND OF THE INVENTION

[0002] Many types of input devices are presently available for performing operations in a computing system, such as buttons or keys, mice, trackballs, touch sensor panels, joysticks, touch screens and the like. Touch screens, in particular, are becoming increasingly popular because of their ease and versatility of operation as well as their declining price. Touch screens can include a touch sensor panel, which can be a clear panel with a touch-sensitive surface, and a display device that can be positioned behind the panel so that the touch-sensitive surface can substantially cover the viewable area of the display device. Touch screens can allow a user to perform various functions by touching the touch sensor panel using one or more fingers, a stylus or other object at a location dictated by a user interface (UI) being displayed by the display device. In general, touch screens can recognize a touch event and the position of the touch event on the touch sensor panel, and the computing system can then interpret the touch event in accordance with the display appearing at the time of the touch event, and thereafter can perform one or more actions based on the touch event.

[0003] The touch screen typically has a smooth touch-sensitive surface. As such, unlike standard keyboards that have physical buttons and keys that the user presses down to select, the UI virtual buttons and keys are selected merely by touching the touch screen at their displayed locations. As such, when a virtual button or key is touched, the user does not get the tactile feedback that pressing on the standard keyboard provides and must therefore watch the UI to ensure that the button or key was in fact touched.

SUMMARY OF THE INVENTION

[0004] The invention relates, in one embodiment, to a haptic feedback device. The haptic feedback device includes a plurality of controllable nodes disposed between a first and a second surface. The controllable nodes are configured to change between transmission states and a non-transmission states so as to provide a localized haptic response in discrete regions of the first surface when the second surface is powered with a haptic signal.

[0005] The invention relates, in one embodiment, to a touch sensitive device. The touch sensitive device includes touch surface having a plurality of touch regions configured to detect a touch. The touch sensitive device also includes a plurality of haptic transmission nodes positioned proximate to the touch surface. Each haptic transmission node is configured to correspond to at least one touch region and is configured to be in a transmission state so as to transmit a haptic feedback signal to the at least one corresponding touch surface region when the at least one corresponding touch surface region receives the touch.

[0006] The invention relates, in one embodiment, to a system having a touch sensitive device and a haptic device. The system includes a surface. The surface may for example be a surface that interfaces with a user. The system also includes a sensor arrangement configured to detect a location of an object in close proximity to the surface. The system additionally includes a haptic signal generator configured to produce a haptic signal when an object is detected. The system further includes a plurality of haptic transmission nodes positioned at different locations relative to the surface. The haptic transmission nodes are configured to receive the haptic signal from the haptic signal generator, and to change states in order control the transmission of the haptic signal to the surface. The haptic transmission nodes associated with the location of the object substantially transmitting the haptic signal to the surface. The haptic transmission nodes not associated with the location of the object substantially not transmitting the haptic signal to the surface.

[0007] The invention relates, in one embodiment, to a method for providing a haptic feedback signal to an input surface. The method includes identifying at least one haptic transmission node corresponding to a location of an input on the input surface. The method also includes placing the identified haptic transmission node into a transmission state. The method additionally includes generating a haptic feedback signal. The method further includes transmitting the generated haptic feedback signal via the at least one identified haptic transmission node to the location of the input on the input surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1***a* illustrates a side view of an exemplary haptic system according to embodiments of the invention.

[0009] FIG. **1***b* illustrates a top view of the exemplary haptic system of FIG. **1***a* according to embodiments of the invention.

[0010] FIG. **2** illustrates a block diagram of an exemplary haptic system according to embodiments of the invention.

[0011] FIGS. **3***a* through **3***f* illustrate various states of exemplary haptic transmission nodes according to embodiments of the invention.

[0012] FIG. **4***a* illustrates a side view of an exemplary touch sensitive device with haptic feedback according to embodiments of the invention.

[0013] FIG. **4***b* illustrates a top view of the exemplary touch sensitive device of FIG. **4***a* according to embodiments of the invention.

[0014] FIGS. **5***a* through **5***g* illustrate various states of exemplary haptic transmission nodes of an exemplary touch sensitive device according to embodiments of the invention.

[0015] FIG. **6***a* illustrates a touch location on an exemplary touch sensitive device according to embodiments of the invention.

[0016] FIG. **6***b* illustrates haptic feedback at a touch location on an exemplary touch sensitive device according to embodiments of the invention.

[0017] FIG. **7** illustrates an exemplary channel waveguide on an exemplary touch sensitive device for transmitting haptic feedback according to embodiments of the invention.

[0018] FIG. **8** illustrates an exemplary haptic feedback circuit for a haptic system according to embodiments of the invention.

[0019] FIG. **9***a* illustrates a side view of another exemplary touch sensitive device with haptic feedback according to embodiments of the invention.

[0020] FIG. **9***b* illustrates a top view of the exemplary touch sensitive device of FIG. **9***a* according to embodiments of the invention.

[0021] FIG. **10***a* illustrates a side view of another exemplary touch sensitive device with haptic feedback according to embodiments of the invention.

[0022] FIG. **10***b* illustrates a top view of the exemplary touch sensitive device of FIG. **10***a* according to embodiments of the invention.

[0023] FIG. **11** illustrates an exemplary method for providing haptic feedback to an input surface according to embodiments of the invention.

[0024] FIGS. **12***a* and **12***b* illustrate an exemplary electronic device with haptic feedback according to embodiments of the invention.

[0025] FIG. **13** illustrates an exemplary computing system with haptic feedback according to embodiments of the invention.

[0026] FIG. **14***a* illustrates an exemplary mobile telephone with haptic feedback according to embodiments of the invention.

[0027] FIG. **14***b* illustrates an exemplary digital media player with haptic feedback according to embodiments of the invention.

[0028] FIG. **14***c* illustrates an exemplary computer with haptic feedback according to embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0029] This relates to providing localized haptic feedback at discrete locations or regions relative to a surface of an input and/or output device, such as a touch sensor panel, a display, or a touch screen. Haptic feedback may be provided by controllable nodes configured to selectively transmit a haptic signal (e.g., vibration) to a particular discrete location or region of the surface. The use of haptic feedback can provide an unobtrusive and effective way for a user to know that an input to a device has been received at various locations across the surface and/or for a user to know where an input can be made at various locations across the surface.

[0030] Haptics often refer to those things that relate to the sense of touch. More specifically, haptics may refer to interfaces that provide force and/or tactile sensations. In the context of electronic devices such as consumer electronic devices, haptic interfaces may provide a way for users to receive feedback from the electronic device. The feedback may for example be in the form of a physical sensation that can be felt by the user when the user interacts with some portion of the electronic device.

[0031] In the following description of preferred embodiments, reference is made to the accompanying drawings in which it is shown by way of illustration specific embodiments in which the invention can be practiced. It is to be understood that other embodiments can be used and structural changes can be made without departing from the scope of the embodiments of this invention.

[0032] FIGS. **1***a* and **1***b* are illustrations of an exemplary haptic system in accordance with embodiments of the present invention. The haptic system **10** may be configured to provide a haptic response. The haptic system **10** may for example cooperate with an input and/or output device such as a touch sensor panel, a display, or a touch screen in order to provide a haptic response to the input and/or output device. The haptic response may for example be associated with a particular input and/or output of the input and/or output device.

[0033] As shown, the haptic system **10** may include a plurality of haptic transmission nodes **15** and a haptic signal generator **30**. The haptic transmission nodes **15** may be disposed between a touchable surface **5** and a fixed structure **25** that may be spatially separated from one another. In some embodiments, the nodes **15** may support the surface **5** relative to the fixed structure **25**. The surface **5** may for example be associated with an input and/or output platform and the fixed structure **25** may for example be associated with a printed circuit board, frame, housing or the like. The shape of the surface **5** may be widely varied. For example, it can be flat (as shown) or curved.

[0034] The haptic signal generator **30** may be configured to produce a haptic signal and may be coupled directly or indirectly to the fixed structure **25** such that the haptic signal may travel via the fixed structure **25**. The haptic transmission nodes **15**, which may be coupled to the fixed structure **25** and the surface **5**, may be configured to transmit the haptic signal to the surface **5** so as to provide a physical sensation at the surface **5**. The sensation may for example be associated with a detected touch or near touch relative to the surface **5**. The sensation may even be associated with an input/output event that occurs at the surface **5**.

[0035] As shown, the haptic transmission nodes **15** may be distributed about the perimeter of the surface **5**. In some embodiments, the haptic transmission nodes **15** may be placed at or near the edge of the surface **5**. The nodes **15** may be configured to direct the haptic signal into the surface **5** as for example in a direction away from the edge of the surface **5**. In some embodiments, the haptic signal may even be directed along imaginary or real meridian lines (shown in broken lines) that traverse the surface **5**. The meridian lines may for example be oriented in horizontal and vertical directions. Although shown as straight lines, the meridian lines may take a variety of forms depending on the needs of the system. In some embodiments, the haptic transmission nodes **15** may be positioned directly across from one another on opposite sides of the surface **5**. The nodes **15** may for example cooperate to form a meridian line or be aligned with a meridian line and thus each other. The number and pitch of the haptic transmission nodes **15** about the perimeter may be widely varied (depends on desired resolution of haptic feedback). As should be appreciated, in some cases (as shown), the haptic transmission nodes **15** may be configured to form a matrix of rows and columns across the surface **5**. It should be appreciated, however, that this is not a limitation and that other configurations may be used.

[0036] In some embodiments, the surface **5** may include a waveguide to help encourage the haptic signal to travel to a desired location within the surface **5**. The waveguide may for example help form the meridian lines. The waveguide may take a variety of forms including mechanisms that are embedded, applied or formed into or on the surface **5**. The mechanisms may for example include channels, passages, protrusions, and/or wires that can be placed within or along the backside of the surface **5** and that may extend between opposing haptic transmission nodes **15**.

[0037] In accordance with one embodiment, the haptic transmission nodes **15** may be configured to change states in order to control the transmission of the haptic signal to the surface **5**. The states may be analog, e.g., having a plurality of states from a full transmission state to a full non-transmission state, or binary, e.g., having only a transmission state and a non-transmission state. For ease of discussion, binary is primarily described herein. In some embodiments, for example, the haptic transmission nodes **15** may be configured to selec-

tively change between a transmission state and non- or near non-transmission state. In the transmission state, the haptic transmission nodes **15** may transmit the haptic signal to the surface **5** such that a physical sensation can be felt at the surface **5**. In the non-transmission state, the haptic transmission nodes **15** may not substantially transmit the haptic signal to the surface **5** such that a physical sensation is not easily felt or not felt at all at the surface **5**. The haptic transmission nodes **15** may be selectively adjusted such that any haptic transmission node **15** may be in any state at any time. By selectively controlling the state of each haptic transmission node **15** while a haptic signal is generated, the haptic system **10** may produce controlled physical sensations at the surface **5**. The location of the physical sensation may be associated with the location of the haptic transmission nodes **15** relative to the surface (e.g., along the meridians).

[0038] In some embodiments, the haptic system **10** may produce localized and discrete physical sensations **35** at different locations across the surface **5**. That is, the haptic system **10** may be able to produce a pixel based haptic response at the surface **5**. This may for example be accomplished by changing the states of the haptic transmission nodes **15** in order to direct the haptic signal along a select group of meridians. For example, it is believed that a localized haptic response may be generated along or at an intersection of meridians by placing those haptic transmission nodes **15** associated with the meridians in the transmission state while holding the rest in the non-transmission state. This will be described in greater detail below.

[0039] The haptic transmission nodes **15**, particularly the ability to change states, may be widely varied. The haptic transmission nodes **15** may dampen the haptic signal, may partially or entirely decouple the connection between the surface **5** and the fixed structure **25** and/or the like. The nodes **15** can for example change between be loose/rigid, coupled/decoupled, free/fixed, stiff/flexible, expand/contract, charged/uncharged, and/or like.

[0040] In one example, the nodes **15** may embody a rigid and loose state while maintaining connection to the surface **5** and the fixed structure **25**. That is, the node **15** may control the rigidity of the connection between the surface **5** and the fixed structure **25**. In the rigid state, the node **15** may rigidly lock/secure the surface **5** to the fixed structure **25**. The rigid state may then provide a path for the haptic signal to the surface **5** from the fixed structure **25** via the haptic signal generator **30**. In the loose state, the node **15** may provide limited play or slack while still maintaining a connection between the surface **5** and the fixed structure **25** (i.e., may float between the surface and the fixed structure). The loose state then may not provide a path for the haptic signal and as a result the haptic signal may not travel to the surface **5**.

[0041] In some embodiments, the nominal state or standard operating condition for this example is the rigid state (so that the surface is more structurally stable). During a haptic response, a control signal may be sent to select nodes **15** to place them in a loose state. At the same time, the haptic signal may be produced. The haptic signal may travel through the nodes **15** in the rigid state to the surface **5** thereby producing a localized physical sensation relative to the location of the rigid nodes **15**. The nodes **15** in the loose state may absorb or otherwise prevent the haptic signal from affecting the surface **5** and thus a physical sensation may not be substantially created in the location of the loose nodes **15**. After the haptic response, the loose nodes **15** may assume the standard state of rigid. See for example FIG. **3***a*.

[0042] In another example, which may operate similarly, the nodes **15** may change their attributes such as shape, temperature, electrical makeup, density, and the like in order to open and close the path and/or alternatively dampen the signal traveling on the path (e.g., reduce the signal). See for example FIG. **3***b*.

[0043] In yet another example, which may operate similarly, the nodes **15** may act as a switch that can couple the node to the surface **5** thereby allowing transmission to take place and decouples the node from the surface thereby preventing transmission from taking place. See for example FIG. **3***c*.

[0044] In yet another example, which may operate similarly, the nodes **15** may expand and contract in order to open and close the path and/or alternatively to dampen the signal traveling on the path (e.g., reduce the signal). See for example FIG. **3***d*.

[0045] In yet another example, which may operate similarly, the nodes **15** may flex in order to open and close the path and/or alternatively dampen the signal traveling on the path (e.g., bend dampens, straight provides a path). See for example FIGS. **3***e* and **3***f*.

[0046] The haptic transmission nodes **15** may include one or more components to effect the change of state. In some embodiments, the haptic transmission nodes **15** may include a bar disposed between the surface **5** and the fixed structure **25**. The bar itself may be configured to change states. The bar may for example be formed from a shape memory material such as nitinol. Alternatively, the haptic transmission nodes **15** may additionally include a driver that may change the state of the bar. The driver may for example be a microelectromechanical (MEM) device or a piezoelectric device. In either case, the node **15** may be provided with a control signal in order to change its state. The control signal may for example be provided by a haptic controller, which may be stand alone or integrated with other controllers, etc.

[0047] Although a single signal generator may provide some benefits (e.g., space requirements, cost, etc.), it should be appreciated that multiple signal generators may be used. Each generator may generate similar or different haptic signals depending on needs of system (e.g., different frequencies or wavelengths). In one example, the system may include an X generator and a Y generator. The X generator may be configured to drive the horizontally configured nodes, while the Y generator may be configured to drive the vertically configured nodes. In some cases, multiple generators may be coupled to the same fixed structure, while in other cases multiple generators may be coupled to different fixed structures so as not to substantially affect one another.

[0048] Furthermore, in some embodiments, the haptic transmission nodes **15** may solely support the surface **5** relative to the fixed structure **25**. That is, the nodes **15** themselves may support and spatially separate the surface **5** from the fixed structure **25**. In cases such as these, there may be a minimum number of nodes **15** that may be required to be in contact with the surface. This may for example be two opposing horizontal nodes **15** and two vertical opposing nodes. The minimum may even be greater than that to prevent an unstable surface **5** especially a surface that may be used for inputting (e.g., receives a force thereon). In an alternate embodiment, the system **10** may further include an additional support system that may cooperate with the nodes **15** to support the

surface **5** or a support system that may provide a majority if not all of the support to the surface. In these examples, the support system may be configured as a dampener such that it may reduce its impact during a haptic response. In one example, the support system may include one or more dampener members. The dampener members may be node based similar to the haptic transmission nodes **15** or they may be layers, which can be disposed below the surface. In one example, the dampener members may be formed from foam.

[0049] As mentioned above, the physical sensation produced by the haptic system **10** may be associated with a detected touch or near touch relative to the surface. For example, the detected touch may drive the haptic system **10** to produce a haptic response in conjunction with a touch or near touch event. In fact, the haptic response may be configured to provide the haptic response proximate the touch or touch event. The touch detection system may be widely varied. It may be integrated with the haptic system **10** or it may be separate from the haptic system altogether. Various sensing technologies may be used to detect the touch or near touch. Examples include optical sensing, touch sensing, force sensing, and/or the like. The sensing mechanism may also serve to provide inputs to a host device. It should be appreciated that detecting a touch is not a limitation and that the haptic system may work independent of detecting a touch. For example, the haptic system may be used to define an input layout. It can also define an input layout and further provide a haptic response when an input is selected.

[0050] In accordance with one embodiment, the surface **5** may be associated with an outer platform of an input and/or output device. In some embodiments, for example, the input/output (I/O) device may include a touch sensing mechanism for inputting (e.g., touch pad). In some embodiments, the I/O device may include a display such as a flat panel display for outputting (e.g., LCD). In some embodiments, the I/O device may be a touch screen that can integrate a touch sensing mechanism and a display into a single device. In all of these cases, the platform may form the outer surface for interfacing with a user. Several examples of touch sensing devices will be described below (e.g., FIGS. **4***a* and **4***b*).

[0051] In one example, the haptic system **10** may receive a signal that may indicate that an object is close or is touching the surface as well as the location of the object relative to the surface. In response to the signal, the haptic system **10** may activate the appropriate haptic transmission nodes **15** associated with the location and may generate a haptic signal. The nodes **15** that may be active may transmit the haptic signal to the surface **5** at the location.

[0052] Additionally or alternatively, the haptic system **10** may receive a signal that an input has been received from an input device. In response to the signal, the haptic system **10** may activate the appropriate haptic transmission nodes **15** associated with the location of the input and generates a haptic signal. The nodes **15** that may be active may transmit the haptic signal to the surface **5** at the location of the input. The user doing the inputting therefore may be provided with feedback about the input.

[0053] Additionally or alternatively, the haptic system **10** may receive a signal that may define various regions of the surface **5**. The haptic system **10** may activate the appropriate haptic transmission nodes **15** associated with the regions and may generate a haptic signal. The nodes **15** that may be active may transmit the haptic signal to the region. Alternatively, the appropriate haptic transmission nodes **15** may not be associated with the regions but instead an area about the regions of interest. The regions may for example correspond to input locations relative to an input device. In this example, the nodes may be active prior to a detected touch or input.

[0054] In accordance with one embodiment, the nodes **15** may additionally be configured to carry signals for the I/O device. For example, the fixed structure **25** may be a circuit board and the nodes **15** may carry a signal path (e.g., traces) between components mounted on the board such as chips and other circuitry to the surface **5** which may include display components and/or sensing components.

[0055] FIG. **2** illustrates a block diagram of an exemplary haptic system according to embodiments of the invention. The haptic system **50** may generally correspond to the haptic system **10** shown in FIGS. **1***a* and **1***b*. The haptic system **50** may include a haptic controller **52** that may be operatively coupled to a plurality of haptic transmission nodes **54** and one or more haptic signal generators **55** (e.g., vibration motor). The one or more haptic signal generators **55** may be configured to produce a haptic signal (e.g., vibration). The haptic transmission nodes **54** and one or more haptic signal generators **55** may be haptically connected to a surface **56** such that a generated haptic signal may be distributed to the haptic transmission nodes **54** (e.g., vibration may travel through the surface from the generator to the nodes). In one embodiment, the haptic transmission nodes **54** may be configured to substantially transmit the haptic signal to a second surface **58** when deactivated and to not substantially transmit a haptic signal to the second surface when activated (or vice versa). This may generally be accomplished under the supervision of the haptic controller **52**. During operation, the haptic controller **52** may receive a control signal indicating a desired haptic response. This may for example be based on a detected signal such as a touch signal from a touch sensor(s). After receiving the control signal, the haptic controller **52** may direct the appropriate nodes **54** to activate/deactivate and may direct the haptic signal generator **55** to power up and generate a haptic signal. The haptic controller **52** may control the attributes of the haptic signal (e.g., frequency, wavelength, time, etc.). The nodes **54** that may be active may allow that haptic signal to pass through the node **54** to the second surface **58**. The nodes **54** may be controlled in a manner that may provide the desired haptic response. In some embodiments, through selective control of the nodes **54**, a haptic response may be tied to a particular location, i.e., a location associated with the active nodes.

[0056] FIGS. **3***a* through **3***f* illustrate various states of exemplary haptic transmission nodes according to embodiments of the invention. Haptic transmission nodes **70** may generally correspond to any of those haptic transmission nodes described herein, including for example the nodes described in FIGS. **1***a*, **1***b*, and **2**. As mentioned previously, the haptic transmission nodes **70** may be configured to change states in order to control the transmission of the haptic signal to a surface. The nodes **70** may be configured to selectively change between a transmission state and non- or near non-transmission state. In the transmission state, the haptic transmission nodes **70** may transmit the haptic signal to the surface such that a physical sensation can be felt at the surface. In the non-transmission state, the haptic transmission nodes may not substantially transmit the haptic signal to the surface such that a physical sensation is not easily felt or not felt at all at the surface. As shown in all of these embodiments, one end of the node **70** may be connected to a fixed structure **72** while the

opposite end may or may not be connected to a surface **74**, depending on the embodiment.

[0057] As shown in the example of FIG. **3***a*, the node **70** may be configured to change between a rigid (tight) and loose (slack) state. The rigid state may be configured to allow transmissions to the surface **74** while the loose state may be configured to prevent or reduce transmissions (e.g., dampen) to the surface **74**.

[0058] As shown in the example of FIG. **3***b*, the node **70** may be configured change its physical structure or attributes in order to open and close the path and/or alternatively dampen the signal traveling on the path (e.g., reduce the signal). The closed path (shown with one line) may be configured to allow transmissions to the surface **74** while the open state (shown with two lines) may be configured to prevent or reduce transmissions (e.g., dampen) to the surface **74**.

[0059] As shown in the example of FIG. **3***c*, the node **70** may be configured move between an open and close position. The closed position may be configured to allow transmissions to the surface **74** while the open position may be configured to prevent or reduce transmissions (e.g., dampen) to the surface **74**.

[0060] As shown in the example of FIG. **3***d*, the node **70** may be configured to change between a tension state and a compression state in order to affect the transmissions between the fixed structure **72** and the surface **74**.

[0061] As shown in the example of FIG. **3***e*, the node **70** may be configured to flex between a closed and an open position similar to the example shown in FIG. **3***c*.

[0062] As shown in the example of FIG. **3***f*, the node **70** may be configured to bend in order to affect the transmissions between the fixed structure **72** and the surface **74**. For example, the node **70** may contract between a straight and a bent configuration. In the straight configuration, the node **70** may be configured to allow transmissions to the surface **74**, while in the bent state, the node **70** may be configured to prevent or reduce transmissions (e.g., dampen) to the surface **74**.

[0063] It should be appreciated that these examples are not a limitation and that the node may have a variety of configurations that are not shown.

[0064] FIG. **4***a* illustrates a side view of an exemplary touch sensitive device with haptic feedback according to embodiments of the invention. The touch sensitive device may for example utilize the haptic system described in FIGS. **1***a* and **1***b*. In the example of FIG. **4***a*, touch sensitive device **100** may include touch surface **105**, touch module **110**, haptic transmission nodes **115**, display module **120**, circuit board **125**, and haptic signal generator **130**. The touch surface **105** may have a front side to receive a touch and a back side opposite the front side. The touch module **110** may be disposed adjacent to the back side of the touch surface **105** and include touch pixels for detecting a touch received on the front side of the touch surface. The display module **120** may be disposed adjacent to the back side of the touch module **110** and comprise a liquid crystal display to display a user interface, e.g., virtual buttons the user touches to select various functions to be performed by the touch sensitive device **100**. In other embodiments, the touch module **110** may be partially or completely integrated within the layers of the display module **120**. The circuit board **125** may be disposed adjacent to the back side of the display module **120** and include circuitry for performing the selected functions and other operations of the touch sensitive device **100**. In some embodiments, the touch sensitive device may include a cover glass member that can overlay the touch surface.

[0065] The haptic transmission nodes **115** may be disposed adjacent to the circuit board **125** at one end and to the touch surface **105** at the other end to provide haptic feedback to the touch surface. The haptic transmission nodes **115** may transmit a haptic feedback signal to the touch surface **105** at the location where the user touches the touch surface so as to provide some tactile feedback to the user.

[0066] In some embodiments, the haptic transmission nodes **115** may include at least two components—an electromechanical device and a movable bar. The electromechanical device (symbolically illustrated by the circles in FIG. **4***a*) may be disposed adjacent to the circuit board **125** and in electrical communication therewith. Examples of the electromechanical device may include microelectromechanical (MEM) devices, piezoelectronics, and other suitable such miniature devices. The movable bar (symbolically illustrated by the vertical bars attached to the circles in FIG. **4***a*) may be attached to the electromechanical device at one end and free at the other end to be proximate to the touch surface **105**. Examples of the movable bar may include a metal, a polymer, or any other material suitable to be made rigid to transmit haptic feedback. The haptic transmission nodes **115** may have a plurality of dynamic loose and rigid states. The nodes **115** may have two states—a rigid state and a loose state. Alternatively, the nodes **115** may have multiple states ranging from a fully loose state to a fully rigid state. The nodes **115** may be configured to selectively change states in order to control the haptic feedback signal propagating through the nodes. The nodes **115** may function as controllable dampeners, for example, where the nodes in a rigid state can transmit the haptic feedback signal and the nodes in a loose state substantially can not transmit the haptic feedback signal.

[0067] The haptic signal generator **130** may be disposed adjacent to the circuit board **125** and in electrical communication therewith to generate a haptic signal. The haptic signal generator **130** may send a haptic signal to particular haptic transmission nodes **115** when the touch sensitive device **100** receives a touch, e.g., to those nodes corresponding to the touch locations on the touch sensitive device **100**. This will be described more below. In some embodiments, the haptic signal may be a vibration wave. Hence, the haptic signal generator **130** may be a vibration motor. In some embodiments, the haptic signal may be an electrical or mechanical pulse. Hence, the haptic signal generator **130** may be a pulse generator. Other suitable haptic signals and corresponding haptic signal generators may be used according to embodiments of the invention.

[0068] It is to be understood that the touch sensitive device is not limited to the structure shown in FIG. **4***a*, but may include other components suitable for providing haptic feedback according to embodiments of the invention. In addition, the haptic transmission nodes and haptic signal generator are not limited to use with a touch sensitive device, but may be used with other devices suitable for providing haptic feedback according to embodiments of the invention.

[0069] FIG. **4***b* illustrates a top view of the exemplary touch sensitive device of FIG. **4***a* according to embodiments of the invention. In the example of FIG. **4***b*, haptic transmission nodes **115** may be disposed around a perimeter of touch surface **105** where each node may be across the perimeter from another node. By being disposed around the perimeter

of the touch surface **105**, the haptic transmission nodes **115** can advantageously avoid taking up space on the touch sensitive device for other components, avoid making direct contact with components that may not be adversely affected by the haptic feedback signal, and have direct contact with the touch surface. The underlying touch module (element **110** in FIG. **4***a*) may include touch pixels **135** to detect a touch received on the touch surface **105**. Here, the touch pixels **135** may form an array of rows and columns. The haptic transmission nodes **115** may be aligned with the rows and columns of the array. Those nodes **115** aligned with a column may transmit a haptic feedback signal to a location on the touch surface **105** along that column. Similarly, those nodes **115** aligned with a row may transmit a haptic feedback signal to a location on the touch surface **105** along that row. Therefore, when a touch is detected at a particular touch pixel **135**, the location of the detected touch involves the nodes **115** at both ends of the touch pixel's row and the nodes **115** at both ends of the touch pixel's column, thereby transmitting a haptic feedback signal from four nodes to that location to provide localized haptic feedback at that discrete location. In some embodiments, the haptic transmission nodes **115** may be aligned with all the rows and columns of the touch pixel array as illustrated in FIG. **4***b*. In some embodiments, the haptic transmission nodes **115** may be spaced several rows and columns apart to align with some of the rows and columns of the touch pixel array, where each haptic transmission node **115** can correspond to several touch pixels. In some embodiments, the haptic transmission nodes **115** may be aligned with the spaces between the rows and columns of the touch pixels, where each haptic transmission node **115** can correspond to adjacent touch pixels. Other configurations, e.g., resolutions and pitches, of the haptic transmission nodes **115** may also be possible.

[0070] It should be appreciated that although the example of FIGS. **4***a* and **4***b* is described as above, it may include some or all of the features described in FIGS. **1***a* through **3***f*.

[0071] FIGS. **5***a* through **5***g* illustrate various states of exemplary haptic transmission nodes for an exemplary touch sensitive device according to embodiments of the invention. The exemplary haptic transmission nodes may generally correspond to any of those haptic transmission nodes described herein including for example the nodes described in FIGS. **1***a* through **4**. The haptic transmission nodes **115** may be configured to change states in order to control the transmission of the haptic signal to the touch surface **105**. The nodes **115** may be configured to selectively change between a transmission state and non- or near non-transmission state. In the transmission state, the haptic transmission nodes **115** may transmit the haptic signal to the surface **105** such that a physical tactile sensation can be felt at the surface. In the non-transmission state, the haptic transmission nodes **115** may not substantially transmit the haptic signal to the surface **105** such that a physical tactile sensation is not easily felt or not felt at all at the surface.

[0072] In some embodiments, the node **115** may include a driver that moves a bar between a transmission state and a non-transmission state. The driver may for example be an electromechanical device and the movable bar may be rigid material. The driver may be attached or otherwise connected to a fixed structure that includes a haptic signal generator. In one example, the driver may rotate the bar so as to dynamically provide various coupled and decoupled states, as illustrated in FIGS. **5***a* and **5***b*.

[0073] In the example of FIG. **5***a*, the driver **115**-*a* (symbolically illustrated by the circle in FIG. *a*) may rotate or tilt or otherwise move the movable bar **115**-*b* (symbolically illustrated by the bar in FIG. **5***a*) between a coupled position (shown by solid lines in FIG. **5***a*) and a decoupled position (shown by dashed lines in FIG. **5***b*). In the coupled position, the bar **115**-*b* may be placed in an upright position in direct contact with the touch surface **105** (thereby allowing a haptic signal to be transmitted). In some cases, the bar **115**-*b* may even be secured to the surface **105**. For example, a mechanism may lock the bar **115**-*b* to the surface **105** when in contact (e.g., snaps, latches, locks, friction couplings, detents, catches, magnets, etc.). When in direct contact and/or locked, the movable bar **115**-*b* may be better able to transmit a haptic feedback signal to the surface **105**. In the decoupled position, the bar **115**-*b* may be positioned away from and not in contact with the surface **105** (thereby preventing a haptic signal from being transmitted).

[0074] Like the example of FIG. **5***a*, in FIG. **5***b*, the driver **115**-*a* may rotate or tilt or otherwise move the movable bar **115**-*b* between a coupled position (shown by solid lines) and a decoupled position (shown by dashed lines). In this particular example, in the decoupled position, the driver **115**-*a* may position the movable bar **115**-*b* in a leaning position at an angle to the edge of the touch surface **105**, and in the coupled position, the driver may rotate the bar in an upright position in direct contact with the surface. In some cases, similarly to above, the bar may even be secured to the surface **105**. For example, a mechanism may lock the bar **115**-*b* to the surface **105** when in contact (e.g., snaps, latches, locks, friction couplings, detents, catches, magnets, etc.). When in direct contact and/or locked, the movable bar **115**-*b* may be better able to transmit a haptic feedback signal to the surface **105**.

[0075] In some embodiments, the bar **115**-*b* may be flexible or have flexible or elastic components that are capable of stretching/squeezing when moved. In this embodiment, as shown in FIGS. **5***c* and **5***d*, the end of the bar **115**-*b* may be fixed to the touch surface **105** such that any rotation by the driver **115**-*a* may cause the bar to stretch/squeeze thereby placing the bar in various states of tension/compression, which can affect the transmission of the haptic signal. Alternatively, the bar **115**-*b* may be free from the surface **105** and instead use the flexible nature of the bar to provide a bias against the surface when the driver **115**-*a* moves the bar against the surface. In addition, this aforementioned embodiment may allow the flexible bar **115**-*b* to be moved away from the surface **105** similar to FIGS. **5***a* and **5***b*.

[0076] In some embodiments, the node **115** may be a dynamic shape-memory material having a plurality of states, as illustrated in FIGS. **5***e*, **5***f*, **5***g*. The material may change its state when a stimulus is applied and return to its original state when the stimulus is reduced or terminated. The material may have two states—a bent state and an upright state. An example material may include nitinol. In the example of FIG. **5***e*, the material **185** (symbolically illustrated by the bar in FIG. **5***e*) may naturally flex or bend (a loose state) parallel to the side face of the touch surface **105** until a stimulus is applied to make the material rigid and straight in an upright position (a rigid state) in direct contact with the touch surface. Example stimuli may include electrical current, heat, or any suitable stimulus capable of changing such a material. In the example of FIG. **5***f*, the material **185** may naturally flex (a loose state) at an angle to the side face of the touch surface **105** until a stimulus is applied to make the material rigid and straight in

an upright position (a rigid state) in direct contact with the touch surface. In the example of FIG. **5***g*, the material **185** may be naturally shrunken (a loose state) and out of contact with the touch surface **105** until a stimulus is applied to make the material rigid and elongated in an upright position (a rigid state) in direct contact with the touch surface. When rigid, straight, and/or elongated to directly contact the touch surface **105**, the material **185** may be better able to transmit a haptic feedback signal to the touch surface.

[0077] FIGS. **6***a* and **6***b* illustrates a touch location on an exemplary touch sensitive device and haptic feedback at the touch location according to embodiments of the invention. This figure may generally correspond any of the embodiments described herein including FIGS. **1**, **2**, and **4** (as well as those mentioned below). In the example of FIG. **6***a*, a touch may be detected by the touch pixel **135** at a location on the touch surface **205**. In the example of FIG. **6***b*, haptic transmission nodes **115-1** through **115-4**, which are aligned with the row and column of the touch pixel **135** that detects the touch, may transmit haptic feedback signals **340** to the touch surface **105** at the touch location while the remaining nodes may be placed in a non transmission state. Here, four haptic feedback signals **340** may be transmitted to the touch location and combined to provide haptic feedback to a user. To combine, the signals **340** may have the same or compatible phases and/or frequencies to be additive and avoid canceling each other out. For example, a vibration wave transmitted by nodes **115-1** through **115-4** may have the same or compatible phases and/or frequencies such that the transmissions may be added at the touch pixel **135** to provide a stronger vibration wave. In some embodiments, the haptic transmission nodes **115** may be spaced sufficiently apart, e.g., at quarter- or half-wavelengths, to ensure that the signals **340** have compatible frequencies at the touch pixel **235**. In some embodiments, the haptic transmission nodes **115** may have phase delays, e.g., 45° or 90°, which may be selectively applied to ensure that the signals **340** have compatible phases at the touch pixel **135**. Other suitable approaches may be used to ensure that the signals are combined at the touch location. Though other locations along the row with nodes **115-1** and **115-3** and along the column with nodes **115-2** and **115-4** may receive the transmitted haptic feedback signals **340**, their signals may be negligible compared to the feedback occurring at the touch location where the four signals **340** intersect and combine.

[0078] In some embodiments where there are more rows and columns of touch pixels than there are corresponding haptic transmission nodes or where the touch pixels are not aligned with the haptic transmission nodes, those haptic transmission nodes which best intersect the touch location or are best associated with the touch location may transmit haptic feedback signals to the touch surface at the touch location.

[0079] FIG. **7** illustrates an exemplary channel waveguide on an exemplary touch sensitive device for transmitting haptic feedback according to embodiments of the invention. In the example of FIG. **7**, channel waveguide **450** (symbolically illustrated by dotted lines in FIG. **7**) with rows and columns of channels may be disposed on the back side of the touch surface **105**, where the channels may be aligned with the haptic transmission nodes **115** and the intersections of the channels' rows and columns may correspond to the locations of the touch pixels **135**. The channel waveguide may transmit haptic feedback signals **340** along the channels, thereby reducing the scattering of the signals to locations adjacent to the touch location. Alternative to channels, the waveguide **450** can have holes, ridges, protrusions, or lines disposed on the back side of the touch surface **105** or embedded in the touch surface to transmit the haptic feedback signals **340**.

[0080] FIG. **8** illustrates an exemplary haptic feedback circuit for a haptic system according to embodiments of the invention. The exemplary haptic feedback circuit may generally correspond to any of the haptic systems described herein. In the example of FIG. **8**, haptic feedback circuit **500** may include input surface **502**, input sensors **505**, haptic controller **510**, haptic signal generator **515**, haptic node stimulator **520**, and haptic transmission nodes **525**. The input surface **502** may receive an input, e.g., a touch. The input surface **502** may be in communication with the input sensors **505** to transmit the input. The input surface **502** may also be in communication with the haptic transmission nodes **525** to receive haptic feedback in response to the input. The input sensors **505**, e.g., touch pixels, may detect the input received by the input surface **502**. The input sensors **505** may be in communication with the haptic controller **510** to transmit information about the detected input to the controller, e.g., the location of the touch on the touch surface.

[0081] The haptic signal generator **515**, e.g., a vibration motor, may generate a haptic signal, e.g., a vibration wave. The haptic signal generator **515** may be in communication with the haptic controller **510** to receive control signals to either start or stop generating haptic signals. The haptic signal generator **515** may also be in communication with the haptic transmission nodes **525** to transmit generated haptic signals to the nodes. The haptic node stimulator **520** may generate a stimulation signal, e.g., electrical current, to stimulate the haptic transmission nodes **525**. The haptic node stimulator **520** may be in communication with the haptic controller **510** to receive control signals to either start or stop generating the stimulation signal. The haptic node stimulator **520** may also be in communication with the haptic transmission nodes **525** to transmit the generated stimulation signals to the nodes.

[0082] The haptic transmission nodes **525** may transmit a haptic signal to an input surface. The haptic transmission nodes **525** may be in communication with the haptic controller **510** to receive control signals regarding which nodes are to be stimulated and/or transmit the haptic signals. The haptic transmission nodes **525** may also be in communication with the haptic signal generator **515** to receive the generated haptic signals and with the haptic node stimulator **520** to receive the node stimulation signals. The haptic transmission nodes **525** may further be in communication with the input surface **502** to transmit the haptic signals as feedback in response to an input on the input surface.

[0083] The haptic controller **510** may control the haptic feedback process. The haptic controller **510** may include a processor to perform the control. The haptic controller **510** may be in communication with the input sensors **505** to receive information about the input. The haptic controller **510** may also be in communication with the haptic signal generator **515** to send control signals to start or stop generating haptic signals and with the haptic node stimulator **520** to send control signals to start or stop generating node stimulation signals. The control signals may include ON/OFF signals. The control signals may also include the identification of the haptic transmission nodes **525** to be stimulated to transmit the haptic signals to the input surface **502**. The haptic controller **510** may further be in communication with the haptic trans-

mission nodes **525** to send control signals regarding the nodes to be stimulated and/or transmit the haptic signals to the input surface **502**.

[0084] In some embodiments, all of the haptic transmission nodes may receive the generated haptic signals from the haptic signal generator. In such embodiments, only those that are stimulated may sufficiently transmit the haptic signals as feedback. The haptic signals received by the unstimulated nodes may be attenuated or otherwise prevented from transmitting to the input surface. In other embodiments, the system works oppositely where only those that are stimulated may be attenuated or otherwise prevented from transmitting to the input surface and the haptic signals received by the unstimulated nodes may sufficiently transmit the haptic signals as feedback.

[0085] In some embodiments, only the stimulated haptic transmission nodes may receive the generated haptic signals from the haptic signal generator. In such embodiments, a selector may receive the generated haptic signals from the haptic signal generator and a control signal from the haptic controller indicating the stimulated nodes. The selector may then only open signal lines to the stimulated nodes to send the generated haptic signals.

[0086] It is to be understood that the haptic feedback circuit is not limited to that shown in FIG. **8**, but may include other components suitable for providing haptic feedback to a surface.

[0087] FIG. **9***a* illustrates a side view of another exemplary touch sensitive device with haptic feedback according to embodiments of the invention. In the example of FIG. **9***a*, touch sensitive device **600** may be the same as touch sensitive device **100** of FIG. **4***a* with the following differences. Here, haptic transmission nodes **115** may be disposed on an interior surface of housing **650** of the touch sensitive device **600** at one end and adjacent to touch surface **105** at the other end. The haptic transmission nodes **115** may be positioned outward around a perimeter of the touch surface **105**. The housing **650** may contain the components of the touch sensitive device **600**. The electromechanical device (symbolically illustrated by the circles in FIG. **9***a*) may be attached to the interior surface of the housing **650**. The movable bar (symbolically illustrated by the horizontal bar attached to the circle in FIG. **9***a*) may be attached to the electromechanical device at one end and free at the other end to be proximate to the touch surface **105**. The haptic transmission nodes **115** may have various exemplary states similar to those illustrated in FIGS. **3***a* through **3***f* and **5***a* through **5***g*.

[0088] FIG. **9***b* illustrates a top view of the exemplary touch sensitive device of FIG. **9***a* according to embodiments of the invention. In the example of FIG. **9***b*, touch sensitive device **600** may be the same as touch sensitive device **100** of FIG. **4***b* with the following differences. Here, haptic transmission nodes **115** may be disposed outward around a perimeter of the touch surface **105** and aligned with the rows and columns of the touch pixels **135**.

[0089] It is to be understood that the alignment of the haptic transmission nodes around the perimeter of the touch surface is not limited to that illustrated in FIG. **9***b*, but may include other alignments suitable for transmitting haptic feedback to various locations on a touch surface. For example, the haptic transmission nodes may be positioned between rows and columns of the touch pixel array or at alternate rows and columns.

[0090] FIG. **10***a* illustrates a side view of another exemplary touch sensitive device with haptic feedback according to embodiments of the invention. In the example of FIG. **10***a*, touch sensitive device **700** may be the same as touch sensitive device **100** of FIG. **4***a* with the following differences. Here, haptic transmission nodes **115** may be disposed between the touch surface **105** and the touch module **110** to form an array of nodes positioned at approximately the same locations as the touch module's touch pixels. The electromechanical device (symbolically illustrated by the circles in FIG. **10***a*) may be adjacent to the touch pixels. The movable bar (symbolically illustrated by the vertical bar attached to the circle in FIG. **10***a*) may be attached to the electromechanical device at one end and free at the other end to be proximate to the back side of the touch surface **105**. The haptic transmission nodes **115** may have a multifunctional role of providing feedback to the touch surface **105** and transmitting touch signals between the touch surface and the touch module **110**. The haptic transmission nodes **115** may have various exemplary states similar to those illustrated in FIGS. **3***a* through **3***f* and **5***a* through **5***g*.

[0091] FIG. **10***b* illustrates a top view of the exemplary touch sensitive device of FIG. **10***a* according to embodiments of the invention. In the example of FIG. **10***b*, touch sensitive device **700** may be the same as touch sensitive device **100** of FIG. **4***b* with the following differences. Here, haptic transmission nodes **115** may be disposed on the back side of the touch surface **105** at approximately the same locations as the touch pixels **135**. The haptic transmission nodes **115** may be formed in an array of rows and columns at approximately the same locations as the touch pixels **135** form in an array of rows and columns. The nodes **115** may transmit a haptic feedback signal to a location on the touch surface **105** corresponding to the touch pixels **135** that detect a touch. Each node **115** may correspond to a touch pixel **135**. Therefore, when a touch is detected at a particular touch pixel **135**, the node **115** at that touch pixel's location may transmit a haptic feedback signal to the touch location on the touch surface **105**.

[0092] It is to be understood that the alignment of the haptic transmission nodes with the touch pixels is not limited to that illustrated in FIG. **10***b*, but may include other alignments suitable for transmitting haptic feedback to various locations on a touch surface. For example, the haptic transmission nodes may be positioned between the touch pixel locations or at alternate pixel locations.

[0093] FIG. **11** illustrates an exemplary method for providing haptic feedback to an input surface according to embodiments of the invention. In the example of FIG. **11**, a determination can be made about whether an input has been received on an input surface (**805**). If an input has been received, the location of the input on the input surface may be identified (**810**). The haptic transmission nodes corresponding to the location of the input may be identified (**815**). For example, the haptic transmission nodes on the perimeter of the input surface that are aligned with the row and column of the input location may be identified. Alternatively, the haptic transmission nodes located on a back side of the input surface at the input location may be identified. In some embodiments, the haptic transmission nodes may be identified without there having been an input on the input surface. For example, the haptic transmission nodes may be identified prior to the input so that the haptic feedback signal will already be present when the input is received.

[0094] The identified haptic transmission nodes can be stimulated (**820**) in order to place in transmission or non transmission state. For example, electromechanical devices may be powered up to apply an electrical current to movable bars to bring the bars into rigid contact with the input surface. Alternatively, electromechanical devices may be actuated to rotate the movable bars to bring the bars into rigid contact with the input surface. Alternatively, dynamic shape-memory material may become rigid and made to contact the input surface. If there are currently stimulated nodes that have not been identified, i.e., that do not correspond with the input location, these nodes may be unstimulated. For example, their electromechanical devices may be powered down to terminate or reduce an electrical current to movable bars to make the bars loose and out of contact with the input surface. Alternatively, their electromechanical devices may be actuated to rotate the movable bars out of contact with the input surface. Alternatively, their dynamic shape-memory material may be made loose and move away from the input surface.

[0095] A haptic feedback signal may be generated (**825**). For example, a vibration wave may be generated by a vibration motor. Alternatively, a pulse signal may be generated by a pulse generator. In some embodiments, multiple haptic feedback signals may be generated using multiple generators and applied to different sets of haptic transmission nodes. For example, a first vibration wave may be generated by a first vibration motor for one set of haptic transmission nodes, e.g., the nodes aligned with rows of touch pixels. A second vibration wave may be generated by a second vibration motor for another set of haptic transmission nodes, e.g., the nodes aligned with columns of touch pixels. The different vibrations could be combined to provide suitable haptic feedback. To combine, the first and second vibration waves may have the same or compatible phases and/or frequencies to be additive and avoid canceling each other out. In some embodiments, the haptic transmission nodes may be spaced sufficiently apart, e.g., at quarter- or half-wavelengths, to ensure that the signals have compatible frequencies at the input location. In some embodiments, the haptic transmission nodes may have phase delays, e.g., 45° or 90°, which may be selectively applied to ensure that the signals have compatible phases at the input location. Other suitable approaches may be used to ensure that the signals are combined at the input location.

[0096] The generated haptic feedback signal can be transmitted by the stimulated haptic transmission nodes to the identified input location on the input surface, thereby providing haptic feedback (**830**). The generated haptic feedback signal may be received by all the nodes and only transmitted by the stimulated nodes. The unstimulated nodes may attenuate or otherwise prevent transmission. Alternatively, the generated haptic feedback signal may only be received by the stimulated nodes and then transmitted therefrom.

[0097] The generated haptic feedback signal may be transmitted to the input surface for a predetermined time period. A determination can be made whether the predetermined time period has timed out (**835**). If so, the transmission may stop and the stimulated nodes may be unstimulated as described above (**840**).

[0098] When there is no received input on the input surface, the haptic transmission nodes may go to a default state. Some nodes may be made rigid in order to stabilize the input surface, while others may be loose. Alternatively, all the nodes may be made rigid.

[0099] FIGS. **12***a* and **12***b* illustrate an exemplary electronic device with haptic feedback according to embodiments of the invention. In the example of FIG. **12***a*, electronic device **900** can display graphical user interface (GUI) buttons **975** that a user can select by touching the display surface at the displayed buttons' locations. In some embodiments, the electronic device **900** can have controllable haptic transmission nodes **115** proximate to the display surface and aligned with the spaces between the buttons **975**. The nodes **115** can be controlled to together transmit a haptic feedback signal to the display surface, resulting in haptic feedback on all four sides of the buttons **975** to provide a tactile boundary for each button. As such, a user can know the location of the buttons **975**. In the example of FIG. **12***b*, the electronic device **900** can have controllable haptic transmission nodes **115** proximate to the display surface and aligned with the buttons **975** themselves. The nodes **115** aligned with a particular button **975** can be controlled to transmit a haptic feedback signal to the display surface when the button is pressed. As such, a user can know that the button **975** has been pressed. A combination of the embodiments shown in FIGS. **12***a* and **12***b* may also be used.

[0100] The exemplary electronic device may be widely varied. In some embodiments, the electronic device is a handheld electronic device such as a phone, media player, PDA, miniature computer, internet/email device and/or the like. In one example, the electronic device includes a front face for providing inputs/outputs. In one example, the front face includes an upper display and a lower input device such as touch pad or navigation pad. In this example, the lower input device may include a haptic system. In another example, the front face may include a touch screen that combines a display and a touch sensing mechanism into a single unit. The touch screen may for example substantially fill the front face. Examples of handheld electronic device may be iPod and iPhone products produced by Apple, Inc of Cupertino, Calif.

[0101] FIG. **13** illustrates an exemplary computing system that can include one or more of the embodiments of the invention described herein. In the example of FIG. **13**, computing system **1000** can include one or more panel processors **1002** and peripherals **1004**, and panel subsystem **1006**. Peripherals **1004** can include, but are not limited to, random access memory (RAM) or other types of memory or storage, watchdog timers and the like. Panel subsystem **1006** can include, but is not limited to, one or more sense channels **1008**, channel scan logic (analog or digital) **1010** and driver logic (analog or digital) **1014**. Channel scan logic **1010** can access RAM **1012**, autonomously read data from sense channels **1008** and provide control for the sense channels. In addition, channel scan logic **1010** can control driver logic **1014** to generate stimulation signals **1016** at various phases that can be simultaneously applied to drive lines of touch sensor panel **1024** according to embodiments of the invention. Panel subsystem **1006** can operate at a low digital logic voltage level (e.g. 1.7 to 3.3V). Driver logic **1014** can generate a supply voltage greater than the digital logic level supply voltages by cascading two charge storage devices, e.g., capacitors, together to form charge pump **1015**. Charge pump **1015** can be used to generate stimulation signals **1016** that can have amplitudes of about twice the digital logic level supply voltages (e.g. 3.4 to 6.6V). Although FIG. **13** shows charge pump **1015** separate from driver logic **1014**, the charge pump can be part of the driver logic. In some embodiments, panel

subsystem **1006**, panel processor **1002** and peripherals **1004** can be integrated into a single application specific integrated circuit (ASIC).

[0102] Touch sensor panel **1024** can include a capacitive sensing medium having a plurality of drive lines and a plurality of sense lines, although other sensing media can also be used. The drive and sense lines can be formed from a transparent conductive medium such as Indium Tin Oxide (ITO) or Antimony Tin Oxide (ATO), although other transparent and non-transparent materials such as copper can also be used. The drive and sense lines can be formed on a single side of a substantially transparent substrate, on opposite sides of the substrate, or on two separate substrates separated by the dielectric material. Each intersection of drive and sense lines can represent a capacitive sensing node and can be viewed as picture element (pixel) **1026**, which can be particularly useful when touch sensor panel **1024** is viewed as capturing an "image" of touch. (In other words, after panel subsystem **1006** has determined whether a touch event has been detected at each touch sensor in the touch sensor panel, the pattern of touch sensors in the multi-touch panel at which a touch event occurred can be viewed as an "image" of touch (e.g. a pattern of fingers touching the panel).) Haptic feedback can be transmitted to the location of the "image" of touch according to embodiments of the invention. The capacitance between the drive and sense lines and local system ground appears as a stray capacitance Cstray and the capacitance at the intersections of the drive and sense lines, i.e., the pixels, as a mutual signal capacitance Csig when the given drive line is stimulated with an alternating current (AC) signal. The presence of a finger or other object near or on the touch sensor panel can be detected by measuring changes to a signal charge present at the pixels being touched, which is a function of Csig. Each sense line of touch sensor panel **1024** can drive sense channel **1008** in panel subsystem **1006**.

[0103] Haptic system **1050** can include controllable nodes and associated haptic feedback circuitry as described previously to provide haptic feed back to a surface of touch sensor panel **1024** according to embodiments of the invention.

[0104] Computing system **1000** can also include host processor **1028** for receiving outputs from panel processor **1002** and performing actions based on the outputs that can include, but are not limited to, moving one or more objects such as a cursor or pointer, scrolling or panning, adjusting control settings, opening a file or document, viewing a menu, making a selection, executing instructions, operating a peripheral device coupled to the host device, answering a telephone call, placing a telephone call, terminating a telephone call, changing the volume or audio settings, storing information related to telephone communications such as addresses, frequently dialed numbers, received calls, missed calls, logging onto a computer or a computer network, permitting authorized individuals access to restricted areas of the computer or computer network, loading a user profile associated with a user's preferred arrangement of the computer desktop, permitting access to web content, launching a particular program, encrypting or decoding a message, and/or the like. Host processor **1028** can also perform additional functions that may not be related to panel processing, and can be coupled to program storage **1032**, haptic system **1050**, and display device **1030** such as an LCD display for providing a UI to a user of the device. Display device **1030** together with touch sensor panel **1024**, when located partially or entirely under the touch sensor panel, can form a touch screen. Haptic system **1050** together with touch sensor panel **1024**, when proximate to the touch sensor panel, can provide haptic feedback to the surface of the touch sensor panel.

[0105] Note that one or more of the functions described above can be performed by firmware stored in memory (e.g. one of the peripherals **1004** in FIG. **13**) and executed by panel processor **1002**, or stored in program storage **1032** and executed by host processor **1028**. The firmware can also be stored and/or transported within any computer-readable medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "computer-readable medium" can be any medium that can contain or store the program for use by or in connection with the instruction execution system, apparatus, or device. The computer readable medium can include, but is not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus or device, a portable computer diskette (magnetic), a random access memory (RAM) (magnetic), a read-only memory (ROM) (magnetic), an erasable programmable read-only memory (EPROM) (magnetic), a portable optical disc such a CD, CD-R, CD-RW, DVD, DVD-R, or DVD-RW, or flash memory such as compact flash cards, secured digital cards, USB memory devices, memory sticks, and the like.

[0106] The firmware can also be propagated within any transport medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "transport medium" can be any medium that can communicate, propagate or transport the program for use by or in connection with the instruction execution system, apparatus, or device. The transport readable medium can include, but is not limited to, an electronic, magnetic, optical, electromagnetic or infrared wired or wireless propagation medium.

[0107] It is to be understood that the sensor panel is not limited to a touch sensor panel, as described in FIG. **13**, but may be a proximity sensor panel or any other sensor panel capable of sensing a touch or hover event and providing haptic feedback thereto according to embodiments of the invention. Furthermore, although the touch sensors in the touch sensor panel may be described herein in terms of an orthogonal array of touch sensors having rows and columns, it should be understood that embodiments of this invention are not limited to orthogonal arrays, but can be generally applicable to touch sensors arranged in any number of dimensions and orientations, including diagonal, concentric circle, and three-dimensional and random orientations. In addition, the touch sensor panel described herein can be either a single-touch or a multi-touch sensor panel.

[0108] Although some embodiments of this invention may be described herein in terms of touch sensitive devices with haptic feedback, it should be understood that embodiments of this invention are not so limited, but are generally applicable to input devices utilizing some type of sensing technology with haptic feedback. For example, an alternate input device may be a navigation device utilizing a moving action with haptic feedback.

[0109] FIG. **14***a* illustrates an exemplary mobile telephone **1136** that can include touch sensor panel **1124**, haptic system **1100**, display device **1130**, and other computing system blocks that can be utilized for providing haptic feedback.

[0110] FIG. **14***b* illustrates an exemplary digital media player **1140** that can include touch sensor panel **1124**, haptic system **1100**, display device **1130**, and other computing system blocks that can be utilized for providing haptic feedback.

[0111] FIG. **14***c* illustrates an exemplary personal computer **1144** that can include touch sensor panel (trackpad) **1124**, haptic system **1100**, display **1130**, and other computing system blocks that can be utilized for providing haptic feedback.

[0112] The mobile telephone, media player, and personal computer of FIGS. **14***a*, **14***b* and **14***c* can improve the user experience by providing haptic feedback according to embodiments of the invention.

[0113] Although embodiments of this invention have been fully described with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of embodiments of this invention as defined by the appended claims.

What is claimed is:

1. A haptic feedback device comprising:

a plurality of controllable nodes disposed between a first and a second surface, the controllable nodes being configured to change between transmission states and a non-transmission states so as to provide a localized haptic response in discrete regions of the first surface when the second surface is powered with a haptic signal.

2. The haptic feedback device of claim **1**, further comprising a haptic signal generator configured to produce the haptic signal, the haptic signal generator being operatively coupled to the plurality of controllable nodes through the second surface.

3. The haptic feedback device of claim **1**, wherein the controllable nodes are placed proximate and edge of the first surface.

4. The haptic feedback device of claim **1**, wherein the controllable nodes are disposed around the perimeter of the first surface.

5. The haptic feedback device of claim **4**, wherein some of the controllable nodes are disposed on a first side of the first surface and some of the controllable nodes are placed on a second side of the first surface, and wherein the controllable nodes on opposing sides are aligned with one another, each of the opposing controllable nodes forming a haptic path for the haptic signal at the first surface.

6. The haptic feedback device of claim **5**, wherein a first set of nodes are aligned in a first direction, and a second set of controllable nodes are aligned in a second direction, the first and second directions being transverse to one another such that they intersect, the intersection of the haptic paths creating a haptic output region where the haptic signal can be felt by a user.

7. The haptic feedback device of claim **1**, wherein the controllable nodes are configured to dampen the haptic signal to the first surface thereby creating the transmission and non transmission states.

8. The haptic feedback device of claim **1**, wherein the controllable nodes are configured to decouple the haptic signal to the first surface thereby creating the transmission and non transmission states.

9. The haptic feedback device further comprising a haptic controller that receives a signal indicating a location of an object near or at the first surface, and that selectively controls the controllable nodes to produce the localized haptic response at the location of the object relative to the first surface.

10. The haptic feedback device of claim **1** wherein the first surface is configured as a touch sensor panel.

11. The haptic feedback device of claim **1**, wherein each node comprises:

a movable bar, and

an electromechanical device attached to one end of the movable bar and configured to rotate the movable bar, the electromechanical device having a plurality of states, wherein the transmission state is a rigid state at which the other end of the movable bar is in direct contact with the surface and the non-transmission state is a loose state at which the other end of the movable bar is away from the surface.

12. The haptic feedback device of claim **1**, wherein each node comprises:

a flexible bar having a plurality of states, the transmission state being rigid in which the flexible bar is in contact with the surface and the non-transmission state being loose in which the flexible bar is away from the surface; and

an electromechanical device attached to the flexible bar and configured to trigger a particular state in the flexible bar.

13. The haptic feedback device of claim **1**, wherein each node comprises:

a dynamic material having a plurality of states, wherein, in the transmission state, the material is rigid and, in the non-transmission state, the material is loose.

14. The haptic feedback device of claim **1**, further comprising a waveguide configured to transmit the haptic signal from the nodes in the transmission state to specific regions of the first surface.

15. A touch sensitive device with a haptic system, comprising:

a surface;

a sensor arrangement configured to detect a location of an object in close proximity to the surface;

a haptic signal generator configured to produce a haptic signal when an object is detected; and

a plurality of haptic transmission nodes positioned at different locations relative to the surface, the haptic transmission nodes being configured to receive the haptic signal from the haptic signal generator, and to change states in order control the transmission of the haptic signal to the surface, the haptic transmission nodes associated with the location of the object substantially transmitting the haptic signal to the surface, the haptic transmission nodes not associated with the location of the object substantially not transmitting the haptic signal to the surface.

16. The device of claim **15**, wherein the haptic transmission nodes are positioned at different locations around a perimeter of the surface.

17. The device of claim 16, wherein haptic transmission nodes disposed on opposite sides of the surface are aligned with one another.

18. The device of claim 15, wherein the sensor arrangement is a touch sensor arrangement having a plurality of touch pixels disposed across the surface.

19. The device of claim 18 further comprising a controller in communication with the touch pixels and the haptic transmission nodes, wherein the controller is configured to identify one or more of the nodes corresponding to the at least one touch pixel that detects the touch and to cause the identified one or more haptic transmission nodes to transmit the haptic signal to the location of the detected touch on the device.

20. The device of claim 15, wherein the haptic signal includes first and second vibration waves, the device further comprising a first vibration motor configured to generate the first vibration wave to transmit to some of the nodes and a second vibration motor configured to generate the second vibration wave to transmit to the rest of the nodes.

21. The device of claim 15, wherein the touch sensitive device with haptic system is incorporated in an electronic device selected from a mobile telephone, a digital media player or a computer.

22. A method for providing a haptic feedback signal to an input surface, comprising:

identifying at least one haptic transmission node corresponding to a location of an input on the input surface;

placing the identified haptic transmission node into a transmission state;

generating a haptic feedback signal; and

transmitting the generated haptic feedback signal via the at least one identified haptic transmission node to the location of the input on the input surface.

23. The method of claim 22, further comprising determining whether the generated haptic feedback signal has been transmitted for a predetermined time.

24. The method of claim 23, further comprising, if the generated haptic feedback signal has been transmitted for the predetermined time, stopping transmission of the generated haptic feedback signal, and reducing the transmission of the at least one haptic transmission node.

25. The method of claim 24, further comprising:

identifying a plurality of haptic transmission nodes corresponding to a location of an input on the input surface; and

selectively transmitting the haptic feedback signal via the plurality of haptic transmission nodes to the input surface.

26. The method of claim 24, wherein selectively transmitting includes placing a first set of the haptic transmission nodes in a non transmission state while placing a second set of the haptic transmission nodes in a transmission state, the haptic transmission nodes in the transmission state corresponding the input location.

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(54) **HAPTIC EFFECTS WITH PROXIMITY SENSING**

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(60) Provisional application No. 60/828,195, filed on Oct. 4, 2006.

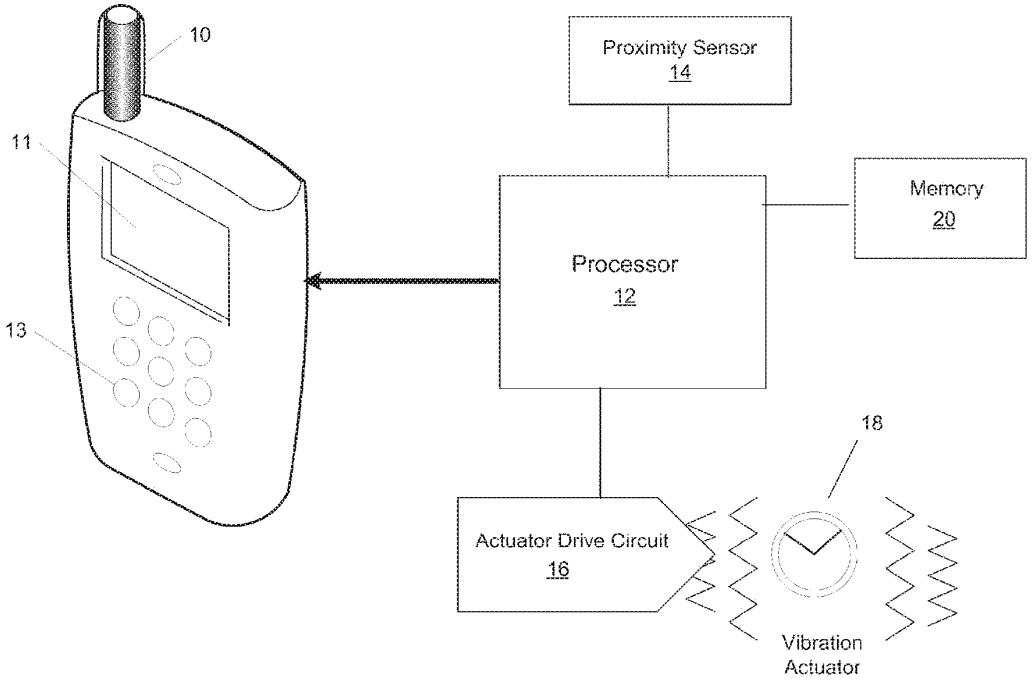
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(57) **ABSTRACT**

A method of generating haptic effects on a device includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.



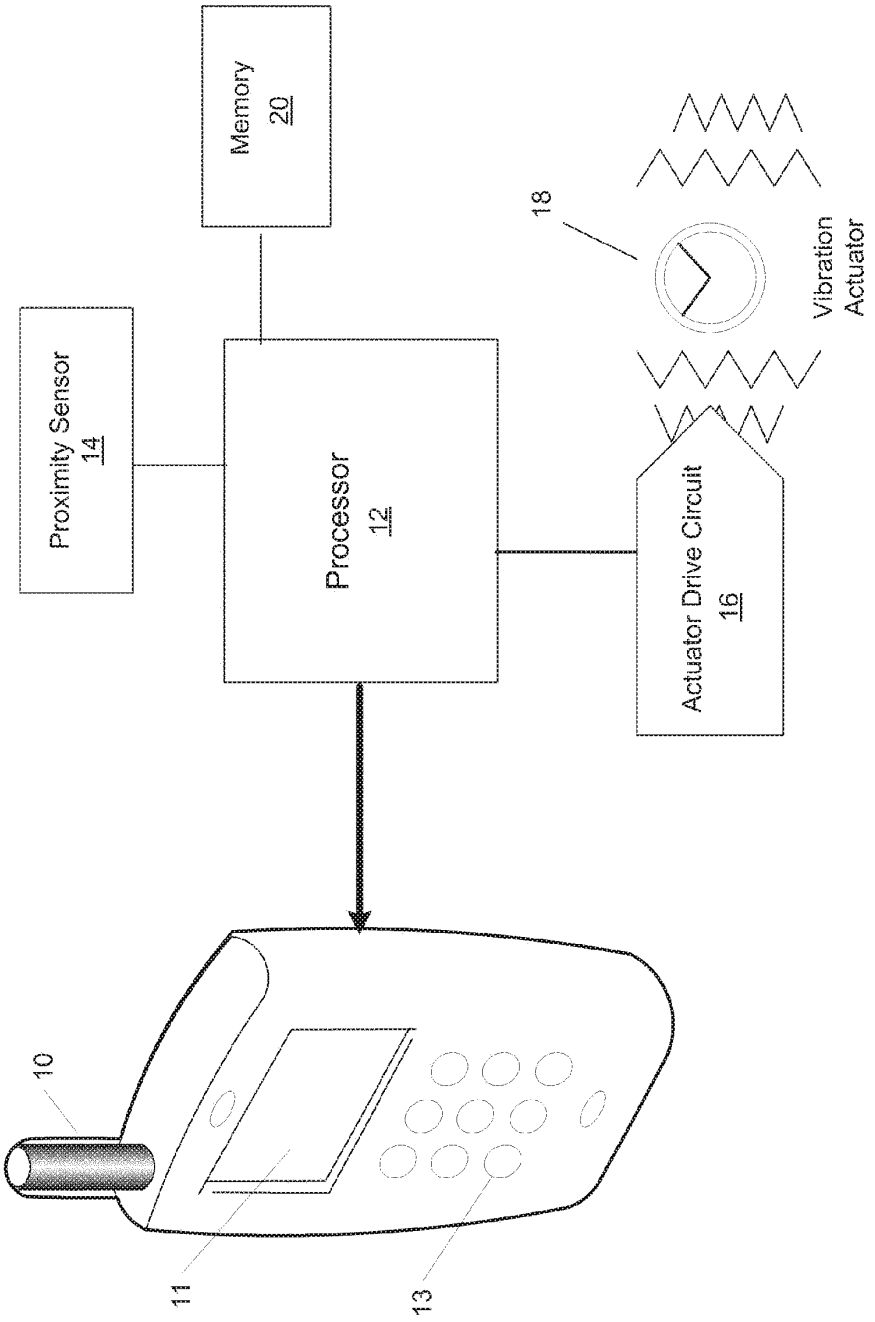

Memory
20
18
Vibration
Actuator
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
10
11
13

Fig. 1

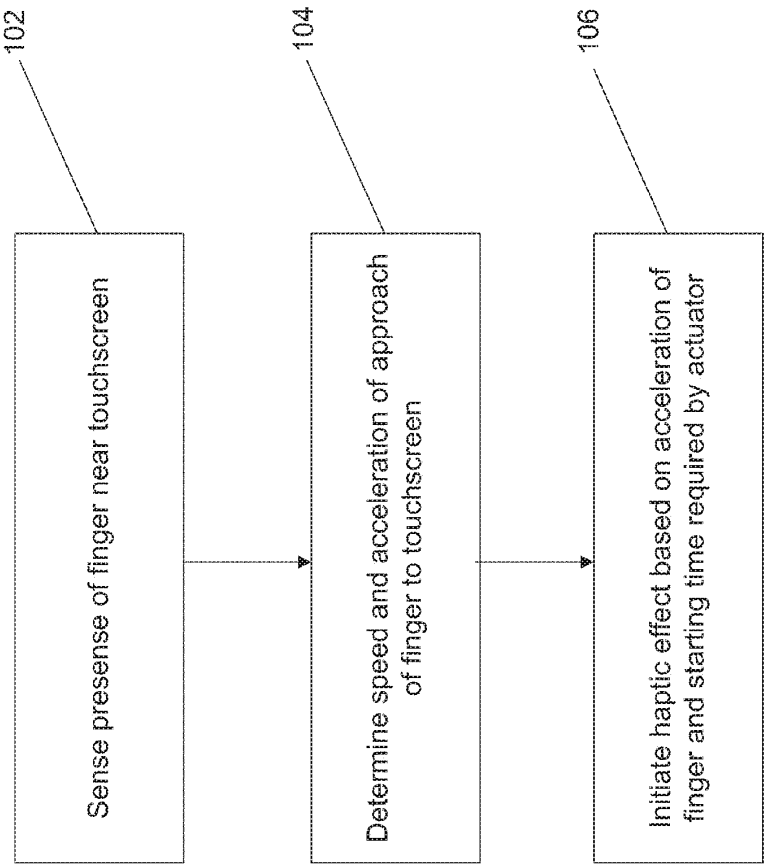

102
Sense presense of finger near touchscreen
104
Determine speed and acceleration of approach of finger to touchscreen
106
Initiate haptic effect based on acceleration of finger and starting time required by actuator

Fig. 2

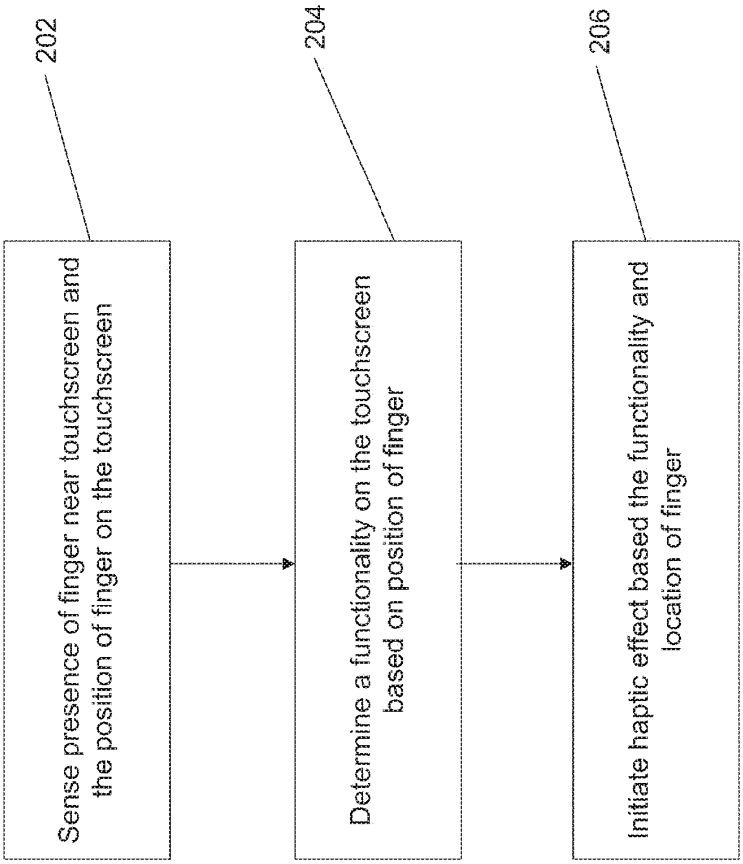

202
Sense presence of finger near touchscreen and the position of finger on the touchscreen
204
Determine a functionality on the touchscreen based on position of finger
206
Initiate haptic effect based the functionality and location of finger

Fig. 3

HAPTIC EFFECTS WITH PROXIMITY SENSING

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 11/744,636, filed on May 4, 2007, the specification of which is hereby incorporated by reference, which claims the benefit of U.S. Provisional Patent Application No. 60/828,195, filed Oct. 4, 2006.

FIELD OF THE INVENTION

[0002] One embodiment of the present invention is directed to a haptic feedback system. More particularly, one embodiment of the present invention is directed to a haptic feedback system that utilizes proximity sensing.

BACKGROUND INFORMATION

[0003] Electronic device manufacturers strive to produce a rich interface for users. Conventional devices use visual and auditory cues to provide feedback to a user. In some interface devices, kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, texture, and heat) is also provided to the user, more generally known collectively as "haptic feedback." Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, vibration effects, or vibrotactile haptic effects, may be useful in providing cues to users of electronic devices to alert the user to specific events, or provide realistic feedback to create greater sensory immersion within a simulated or virtual environment.

[0004] Haptic feedback has also been increasingly incorporated in portable electronic devices, such as cellular telephones, personal digital assistants (PDAs), portable gaming devices, and a variety of other portable electronic devices. For example, some portable gaming applications are capable of vibrating in a manner similar to control devices (e.g., joysticks, etc.) used with larger-scale gaming systems that are configured to provide haptic feedback. Additionally, devices such as cellular telephones and PDAs are capable of providing various alerts to users by way of vibrations. For example, a cellular telephone can alert a user to an incoming telephone call by vibrating. Similarly, a PDA can alert a user to a scheduled calendar item or provide a user with a reminder for a "to do" list item or calendar appointment.

[0005] Increasingly, portable devices are moving away from physical buttons in favor of touchscreen-only interfaces. This shift allows increased flexibility, reduced parts count, and reduced dependence on failure-prone mechanical buttons and is in line with emerging trends in product design. When using the touchscreen input device, a mechanical confirmation on button press or other user interface action can be simulated with haptics.

[0006] For portable devices, cost is an important driving factor. Therefore, to generate haptic effects a single low cost actuator is generally used, for example an eccentric rotating mass ("ERM") motor or an electromagnetic motor. These actuators are able to produce strong magnitude haptic outputs. However, they also require a certain amount of time to achieve their peak haptic output (e.g., approximately 50 ms). These actuators are also used to provide feedback to the user when operating a touch sensitive input of a touchscreen device. For example when the user presses a button on a touchscreen a haptic effect is output to give the sensation of pressing a mechanical button. It is desired to output the haptic effect at the same time the user has selected the button in the interface. However, due to the time it takes to have actuator reach a desired magnitude, the haptic effect lags behind the button press event. If this lag becomes too long the user will not perceive the button press and the haptic effect as a single event.

[0007] Based on the foregoing, there is a need for an improved system and method for generating haptic effects for a touchscreen.

SUMMARY OF THE INVENTION

[0008] One embodiment is a method of generating haptic effects on a device. The method includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a block diagram of a cellular telephone in accordance with one embodiment.

[0010] FIG. **2** is a flow diagram of the functionality performed by a telephone when generating haptic effects in response to the proximity of a user to a touchscreen in accordance with one embodiment.

[0011] FIG. **3** is a flow diagram of the functionality performed by the telephone when generating haptic effects in response to the proximity of a user to the touchscreen in accordance with one embodiment.

DETAILED DESCRIPTION

[0012] One embodiment is a portable device that includes a haptic feedback system with proximity sensing. The haptic system initiates the haptic feedback before a user actually touches a touchscreen or other input area based on the proximity information.

[0013] FIG. **1** is a block diagram of a cellular telephone **10** in accordance with one embodiment. Telephone **10** includes a screen **11** and an input area, touchscreen **13**, that includes "keys" and can include other types of user interfaces, including menus, etc. In another embodiment, the keys of telephone **10** can be mechanical type keys. Internal to telephone **10** is a haptic feedback system that generates vibrations on telephone **10**. In one embodiment, the vibrations are generated on the entire telephone **10**. In other embodiments, specific portions of telephone **10** can be haptically enabled by the haptic feedback system, including the entire touchscreen **13** or individual keys of touchscreen **13**.

[0014] The haptic feedback system includes a processor **12**. Coupled to processor **12** is a memory **20** and an actuator drive circuit **16**, which is coupled to a vibration actuator **18**. Although the embodiment of FIG. **1** is a cellular telephone, embodiments can be implemented with any type of handset or mobile/portable device, or any device that uses an actuator to generate vibrations. For example, other embodiments may not include touchscreens but are haptic devices with other types of input areas. Other input areas besides touchscreens may be a mini-joystick, scroll wheel, d-Pad, keyboard, touch sensitive surface, etc. As with a cellular telephone, for these devices there is a desire for a haptic effect to be generated on the input area and/or the entire device.

[0015] Processor **12** may be any type of general purpose processor, or could be a processor specifically designed to

provide haptic effects, such as an application-specific integrated circuit ("ASIC"). Processor **12** may be the same processor that operates the entire telephone **10**, or may be a separate processor. Processor **12** can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters. In general, the high level parameters that define a particular haptic effect include magnitude, frequency and duration. Low level parameters such as streaming motor commands could also be used to determine a particular haptic effect.

[0016] Processor **12** outputs the control signals to drive circuit **16** which includes electronic components and circuitry used to supply actuator **18** with the required electrical current and voltage to cause the desired haptic effects. Actuator **18** is a haptic device that generates a vibration on telephone **10**. Actuator **18** can include one or more force applying mechanisms which are capable of applying a vibrotactile force to a user of telephone **10** (e.g., via the housing of telephone **10**). Memory device **20** can be any type of storage device, such as random access memory ("RAM") or read-only memory ("ROM"). Memory **20** stores instructions executed by processor **12**. Memory **20** may also be located internal to processor **12**, or any combination of internal and external memory.

[0017] A proximity sensor **14** is coupled to processor **12**. Proximity sensor **14** detects when a finger (or stylus) is in close proximity to but not in contact with touchscreen **13**. Proximity sensor **14** may also detect location (e.g., x, y, z), direction, speed and acceleration, orientation (e.g., roll, pitch, yaw), etc. of the finger relative to touchscreen **13**. Proximity sensor **14** provides its information as an input to processor **12** when a finger is placed above touchscreen **13**. This input can be used by processor **12** when generating haptic feedback for telephone **10**.

[0018] Proximity sensor **14** may use any technology that allows the proximity of a finger or other object to touchscreen **13** to be sensed. For example, it may be based on sensing technologies including capacitive, electric field, inductive, hall effect, reed, eddy current, magneto resistive, optical shadow, optical visual light, optical IR, optical color recognition, ultrasonic, acoustic emission, radar, heat, sonar, conductive or resistive and the like.

[0019] In one embodiment, proximity sensor **14** includes one or more proximity sensors that each generate a sensing field above touchscreen **13** and that produce signals when an object disturbs or intercepts the sensing field(s). Each sensing field typically generates its own signals when disturbed. In one embodiment, a single sensing field is used to cover the entire touchscreen **13** surface. In another embodiment, a single sensing field only covers a portion of the touchscreen **13** surface. In another embodiment, multiple sensing fields are used to cover the entire touchscreen **13** surface. Any number of sensing fields may be used. In some cases, in order to perform tracking, the sensing fields may even be distributed as a pixelated array of nodes.

[0020] FIG. **2** is a flow diagram of the functionality performed by telephone **10** when generating haptic effects in response to the proximity of a user to touchscreen **13** in accordance with one embodiment. In one embodiment, the functionality of FIG. **2** is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0021] At **102**, proximity sensor **14** senses the presence of a finger, stylus, or other object above or in some other manner near touchscreen **13** or other input area of telephone **10**.

[0022] At **104**, proximity sensor **14** determines the position, speed and/or acceleration of the finger relative to the surface of touchscreen **13**. This enables processor **12** to determine whether the user's finger will actually contact touchscreen **13**. For example, if the proximity signal is increasing at a certain rate, it is highly likely that the user will contact touchscreen **13** and press a button.

[0023] At **106**, based on the determination at **104**, processor **12** can calculate when the finger is expected to contact touchscreen **13**. In anticipation of this contact, processor **12** initiates the haptic effect before the actual contact, thus avoiding the lag time caused by actuator **18**. Processor **12** may use the acceleration of the finger and the starting time required by actuator **18** to determine how far in advance to initiate the haptic effect and energize actuator **18**. Therefore, the haptic effect will be implemented at approximately the exact time that the finger actually contacts touchscreen **13** and result in better synchrony of the haptic effect with the button press event. In another embodiment, processor **12** may initiate the haptic effect upon sensing the mere presence of the finger at **102**.

[0024] In typical use of cell phones or PDA's, the user generally holds the device in one hand and uses the other hand to interact with the user interface such as touchscreen **13**. For handheld haptic devices with proximity sensing this means that the user can sense the haptic feedback with the hand holding the device even though the finger has not yet touched the surface. Therefore, useful haptic effects can be created as a function of the proximity even when a finger never touches touchscreen **13**.

[0025] In one embodiment, if a user is hovering a finger over the touchscreen and moving over a grid of displayed buttons, a first haptic effect can be played when the user is moving from over one button to over the next button. The first haptic effect can be a short soft haptic effect in order to simulate the feel of moving over the edge of one button to the next. This first haptic effect will give the user an indication of the button locations without the user activating the buttons. A second haptic effect can be played when the user actually touches the screen and acts to select the button. The second haptic effect can be a strong haptic effect simulating a sharp button click.

[0026] FIG. **3** is a flow diagram of the functionality performed by telephone **10** when generating haptic effects in response to the proximity of a user to touchscreen **13** in accordance with one embodiment. In one embodiment, the functionality of FIG. **3** is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0027] At **202**, proximity sensor **14** senses the presence and position of a finger, stylus, or other object above or in some other manner near touchscreen **13**. The sensed position may include the x and y coordinates of the finger relative to touchscreen **13**.

[0028] At **204**, the functionality on the touchscreen is determined based on position of the finger. For example, if a

multiple button graphical user interface on touchscreen **13** is displayed, the closest button that the finger is above and the functionality of that button is determined.

[0029] At **206**, processor **12** initiates a haptic effect based the functionality and location of finger. Depending on the functionality on the touchscreen, a different haptic effect may be generated by processor **12**. Because the finger does not actually touch touchscreen **13** in this embodiment, the haptic effect is felt by the other hand that is holding telephone **10**.

[0030] In one embodiment, haptic effects can be applied to various menu navigation steps. For a user holding a hand held haptic enabled device, the haptics can be directed to the housing such that the user's hand holding the device will experience the haptic effect. For example, when using a touchscreen, if the user hovers over a top level menu choice and a sub-menu exists for that choice, then a light haptic effect simulating a soft button click (first haptic effect) can be played as the graphics display the preview sub-menu items. If there is no sub-menu attached to that particular menu item (or no valid choices exist) then a second haptic effect can be generated, for example a buzz created by series of pulses. If the user then selects the top level menu item, a strong haptic effect simulating a sharp button click (third haptic effect) can be played. If the user decides to move to another top-level menu a fourth haptic effect can be played when entering the new menu. The fourth haptic effect can be the same as the first haptic effect if it is a similar menu item. These haptic effects, resulting while a user finger is still hovering over a surface, i.e., before contract has been made, would be directed to the other hand that is holding the haptic device.

[0031] In one embodiment, different haptic effects can be applied depending on the intended use of the touchscreen area. For example, when a user's finger is hovering over a touch screen integrated into a cell phone or PDA, different haptic effects can be produced in the cell phone when in a map/GPS navigation mode than when managing climate control or when entering hand written notes.

[0032] In one embodiment, during typical operation of a cell phone, the user can have many different proximity relationships to the device. For example the cell phone could be in the user's hand, in the user's pocket, or right next to the user's face. These different operating conditions required different levels of haptic feedback to the user. A proximity sensor could be used to detect these different operating conditions. It is also possible to detect these user conditions through the use of acceleration and/or orientation measurements. Once the current operating condition of the device is known, for example holding the phone next to an ear, a global haptic volume adjustment could be made for the different operating states. In one example, the user could have a specific vibration pattern set for a reminder event. If the user has the phone attached to a belt clip the vibration pattern could contain strong haptic effects in order to signal the reminder event. If the user is actually using the phone and has the phone pressed up next to the user's face where the user will be more sensitive to the haptic effects, when the reminder event is triggered, it would be useful to have the haptic magnitude reduced for that event.

[0033] In one embodiment, gestures can be recognized such as a virtual jog dial. A jog dial recognizes rotation and when performed above a proximity active surface can be recognized without the surface being touched. A movement in the x, y and/or z direction can also be recognized. As an example, haptic effects can be attached to the use of the virtual jog wheel. A first haptic effect can be played at regular intervals of the jog wheel to give the user an indication and confirmation of progress in moving the wheel. A second haptic effect can be output when the user reaches the end of a list that the jog wheel is controlling. These jog and/or x, y, z motions can be recognized even when performed with proximity sensing, over a mechanical alpha/numeric keypad such as which exists on most cell phones today.

[0034] Several embodiments disclosed are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

1. A method of generating haptic effects on a device, said method comprising:

detecting the presence of an object near an input area of the device; and

generating a haptic effect on the device in response to the presence detection.

2. The method of claim **1**, further comprising:

determining the approximate time when the object will touch the input area; and

generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

3. The method of claim **2**, wherein said generating comprises energizing an actuator before the object touches the input area.

4. The method of claim **1**, wherein said haptic effect comprises generating a vibration on the input area.

5. The method of claim **1**, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

6. The method of claim **1**, wherein said device is a cellular telephone.

7. The method of claim **1**, wherein said input area is a touch sensitive surface.

8. The method of claim **1**, further comprising:

determining a position of the object relative to the input area; and

determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

9. The method of claim **8**, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

10. A haptically enabled device comprising:

an input area;

a proximity sensor coupled to said input area; and

a haptic feedback system coupled to said input area.

11. The device of claim **10**, wherein said proximity sensor is adapted to detect the presence of an object near the input area and said haptic feedback system is adapted to generate a haptic effect on the device in response to the presence detection.

12. The device of claim **11**, wherein said haptic feedback system is adapted to determine the approximate time when the object will touch the input area; and

generate the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

13. The device of claim **12**, wherein said haptic feedback system comprises an actuator, and said system energizes said actuator before the object touches the input area.

14. The device of claim **10**, wherein said input area comprises a touch sensitive surface.

15. The device of claim **14**, wherein said touch sensitive surface is a touchscreen.

16. A computer readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate haptic effects on a device, said processor:

detecting the presence of an object near an input area of the device; and

generating a haptic effect on the device in response to the presence detection.

17. The computer readable medium of claim **16**, said processor further:

determining the approximate time when the object will touch the input area; and

generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

18. The computer readable medium of claim **17**, wherein said generating comprises energizing an actuator before the object touches the input area.

19. The computer readable medium of claim **16**, wherein said haptic effect comprises generating a vibration on the input area.

20. The computer readable medium of claim **16**, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

* * * * *

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(54) **DISPLAY INPUT DEVICE**

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(57) **ABSTRACT**

A display input device is comprised of a touch panel **1** for carrying out a display of information and an input of information, a proximity sensor **12** for detecting a movement of an object to be detected which is positioned opposite to the touch panel **1** in a noncontact manner, and a control unit **3** for, when the proximity sensor **12** detects an approach of the object to be detected to within a predetermined distance from the touch panel **1**, moving a specific display object displayed on the touch panel **1** close to a stop position of the object to be detected to display the specific display object.

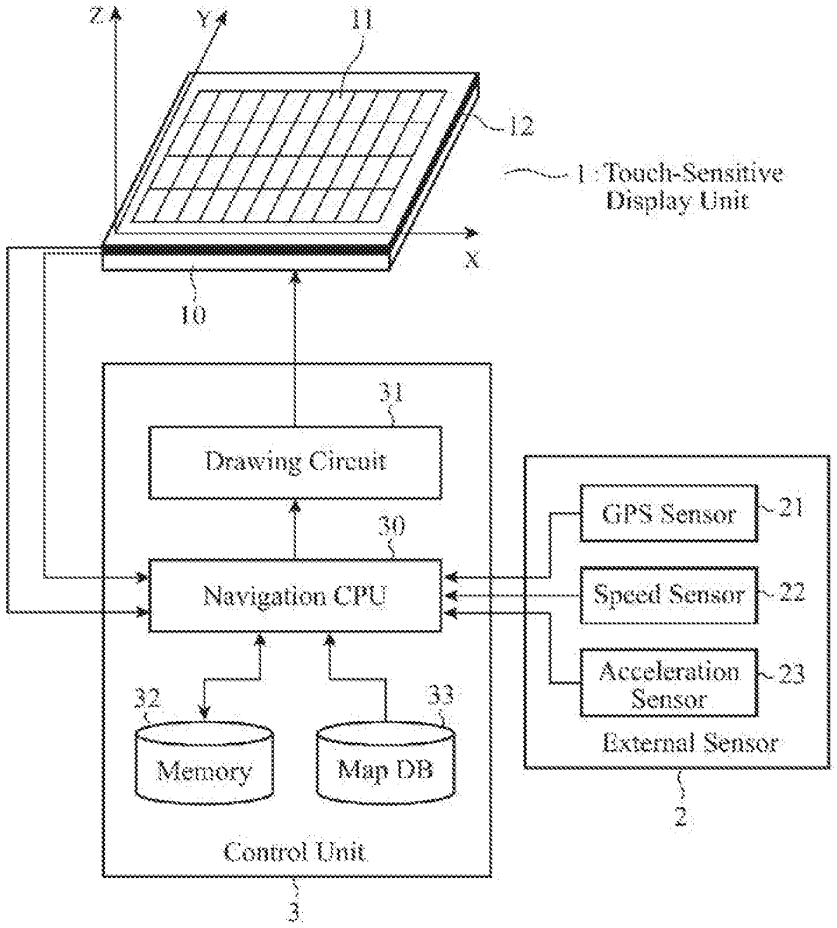


FIG.1

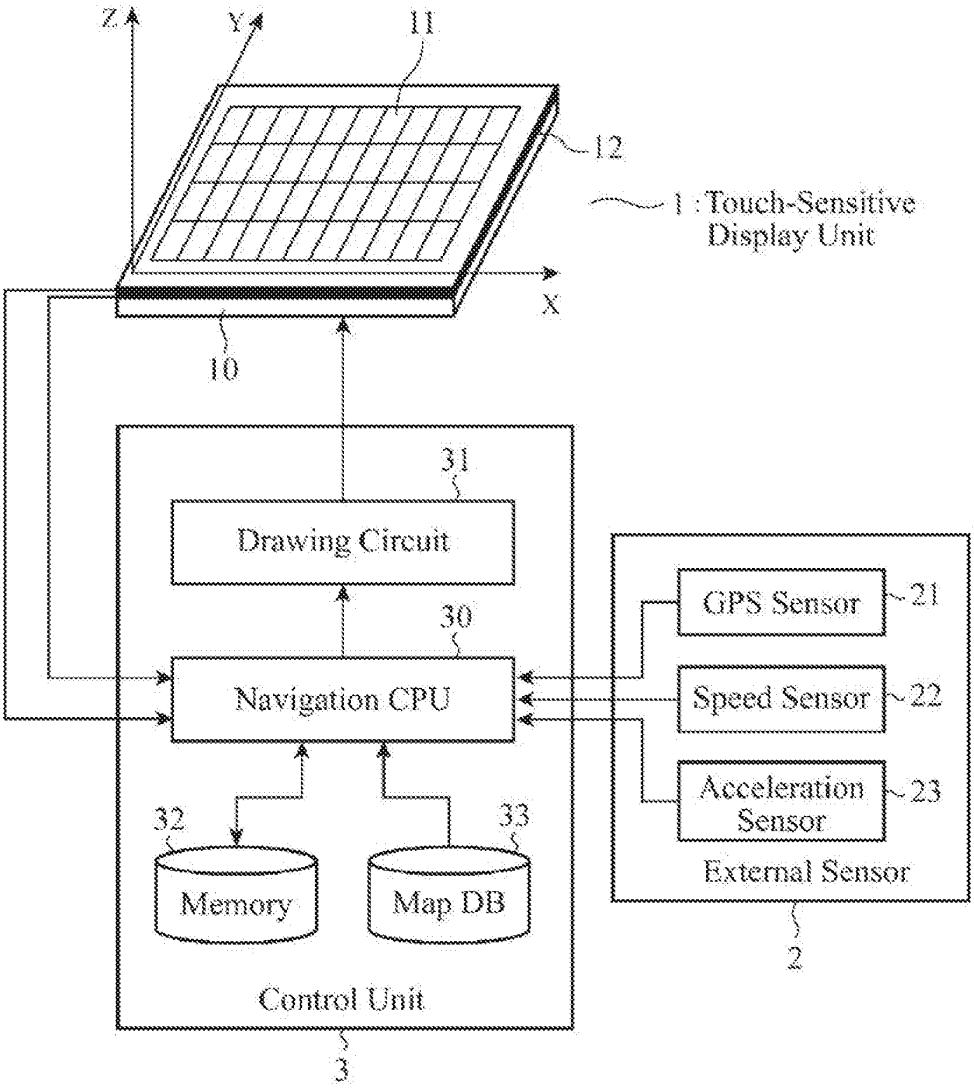
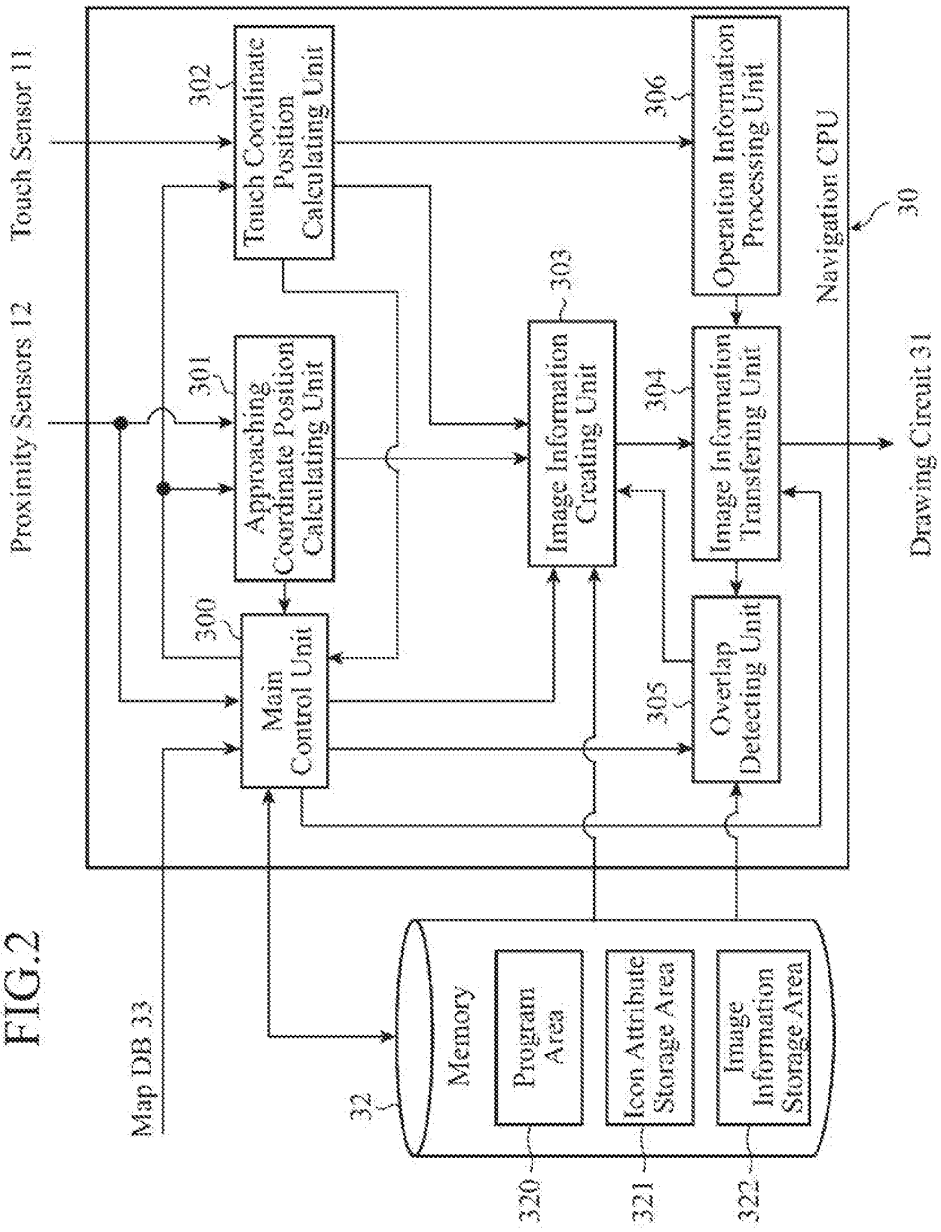

Z
Y
11
12
1 : Touch-Sensitive Display Unit
X
10
31
Drawing Circuit
30
Navigation CPU
32
33
Memory
Map DB
Control Unit
3
GPS Sensor
21
Speed Sensor
22
Acceleration Sensor
23
External Sensor
2

FIG.2



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FIG.3

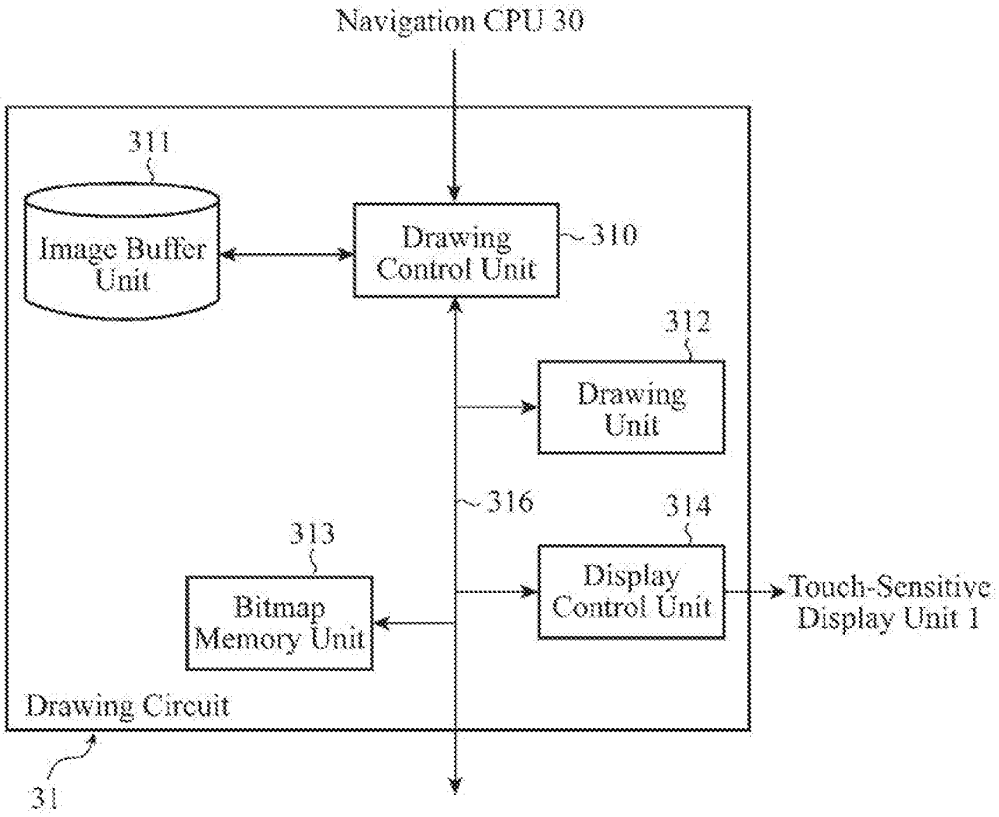

Navigation CPU 30
311
Image Buffer Unit
Drawing Control Unit
310
312
Drawing Unit
316
314
313
Display Control Unit
Touch-Sensitive Display Unit 1
Bitmap Memory Unit
Drawing Circuit
31

FIG.4

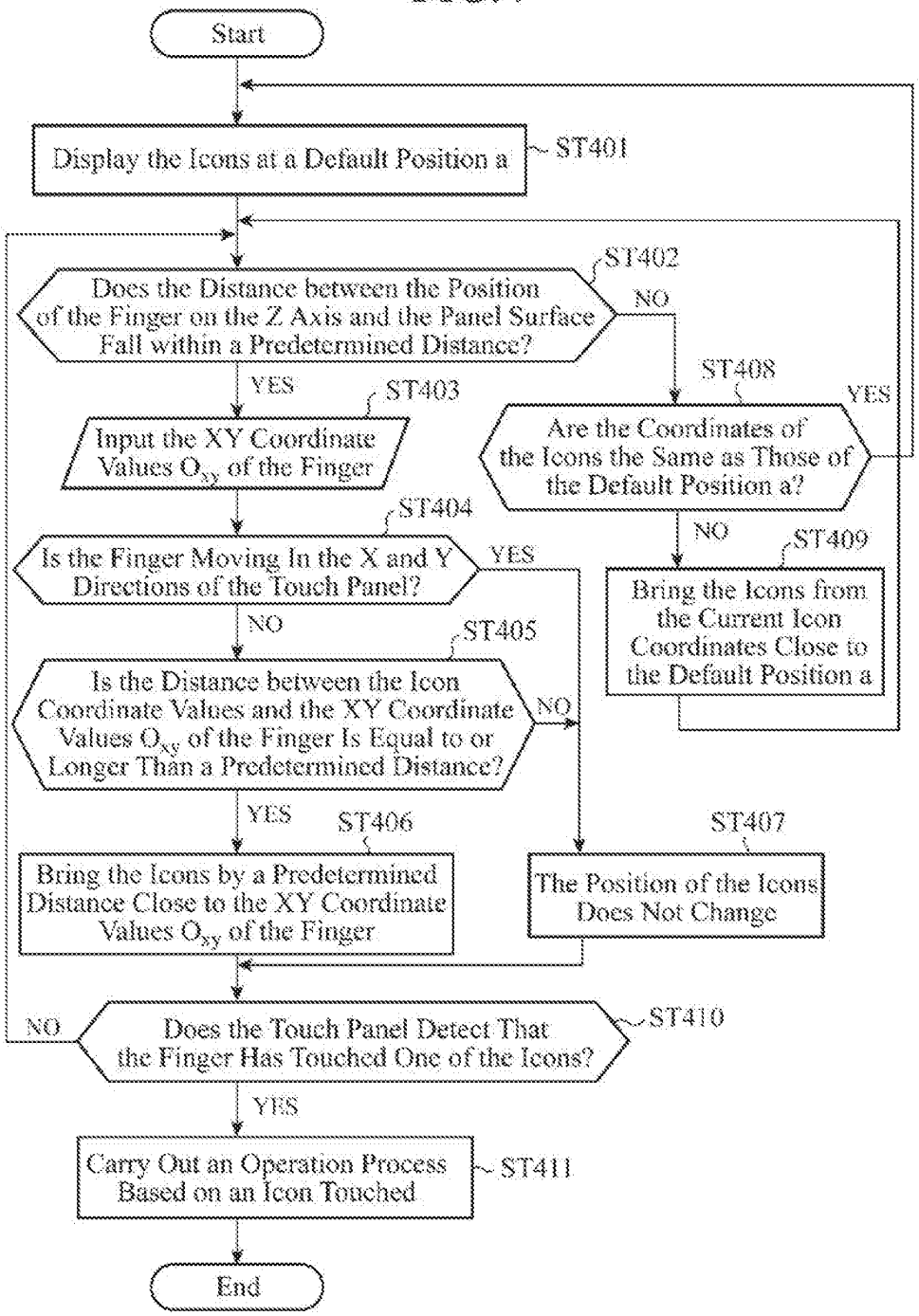

Start
Display the Icons at a Default Position a
ST401
ST402
Does the Distance between the Position of the Finger on the Z Axis and the Panel Surface Fall within a Predetermined Distance?
NO
YES
ST403
Input the XY Coordinate Values O_{xy} of the Finger
ST404
Is the Finger Moving In the X and Y Directions of the Touch Panel?
YES
NO
ST405
Is the Distance between the Icon Coordinate Values and the XY Coordinate Values O_{xy} of the Finger Is Equal to or Longer Than a Predetermined Distance?
NO
YES
ST406
Bring the Icons by a Predetermined Distance Close to the XY Coordinate Values O_{xy} of the Finger
ST407
The Position of the Icons Does Not Change
ST408
Are the Coordinates of the Icons the Same as Those of the Default Position a?
YES
NO
ST409
Bring the Icons from the Current Icon Coordinates Close to the Default Position a
ST410
Does the Touch Panel Detect That the Finger Has Touched One of the Icons?
NO
YES
ST411
Carry Out an Operation Process Based on an Icon Touched
End

FIG.5

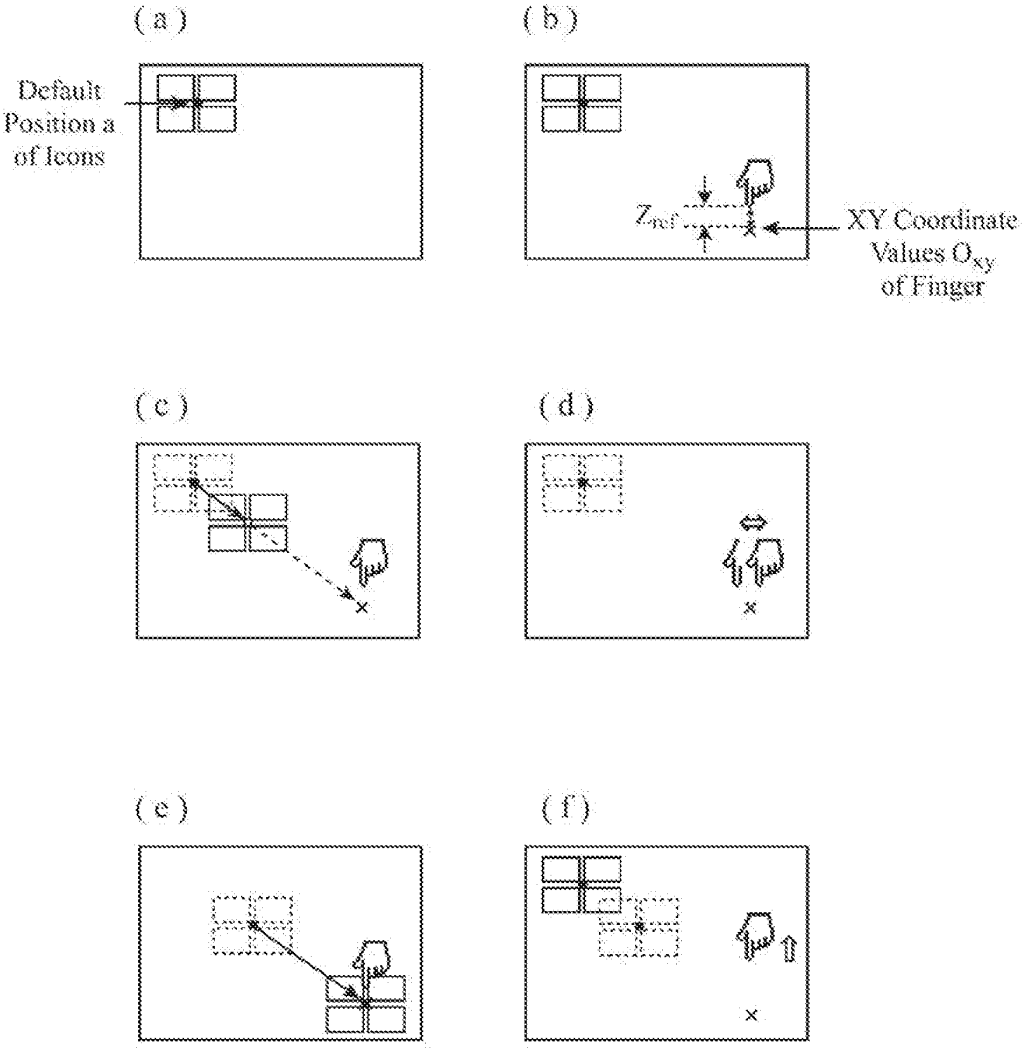

(a)
Default Position a of Icons
(b)
Z_{ref}
XY Coordinate Values O_{xy} of Finger
(c)
(d)
(e)
(f)

FIG.6

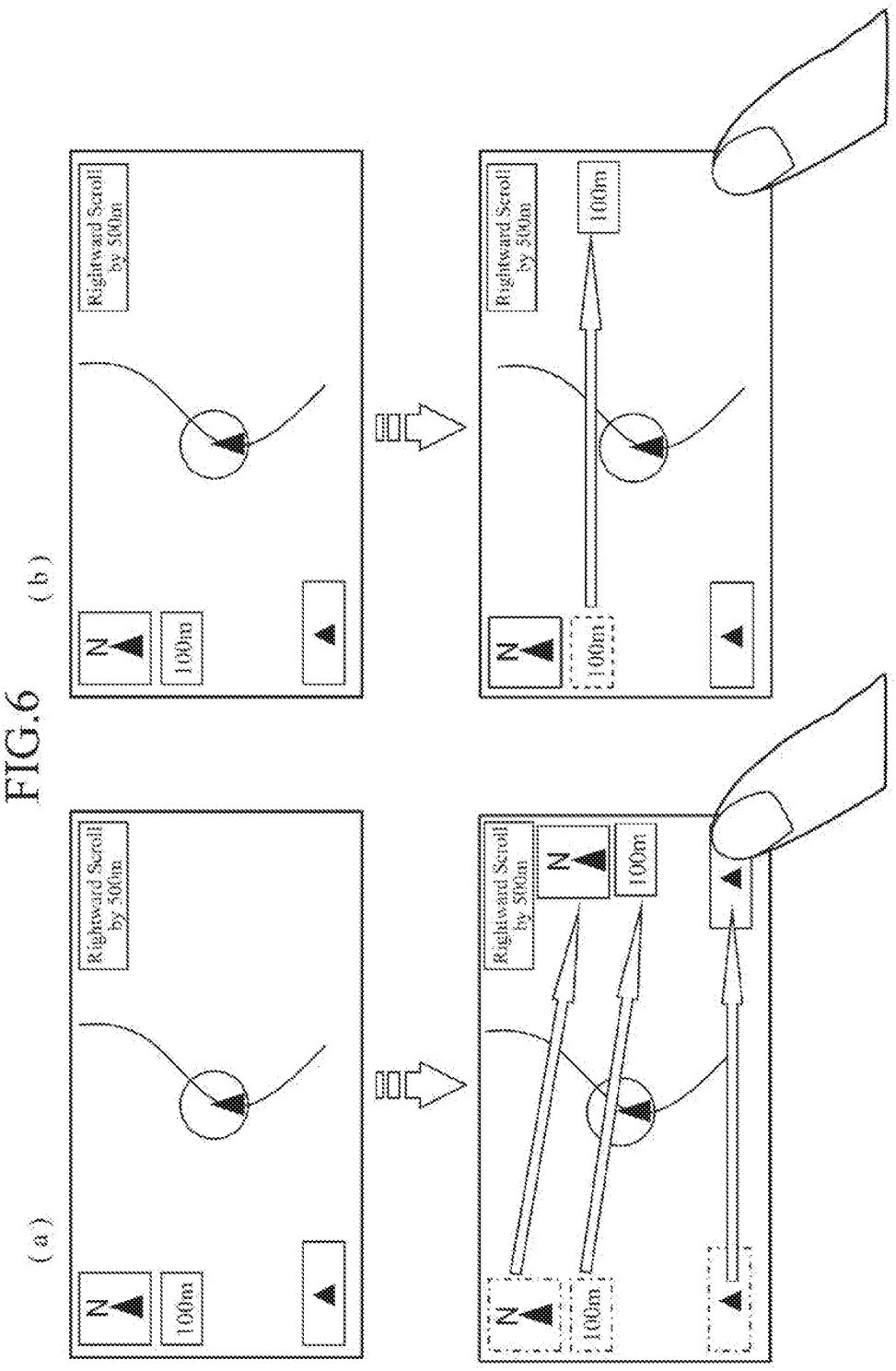

(a)
Rightward Scroll by 500m
N
100m
(b)
Rightward Scroll by 500m
N
100m

FIG.7

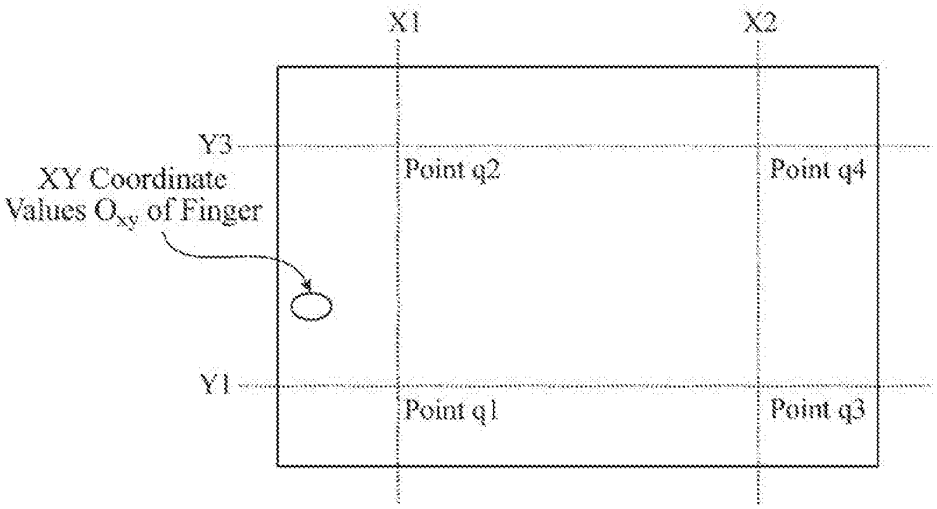

X1
X2
Y3
Point q2
Point q4
XY Coordinate Values O_{xy} of Finger
Y1
Point q1
Point q3

FIG.8

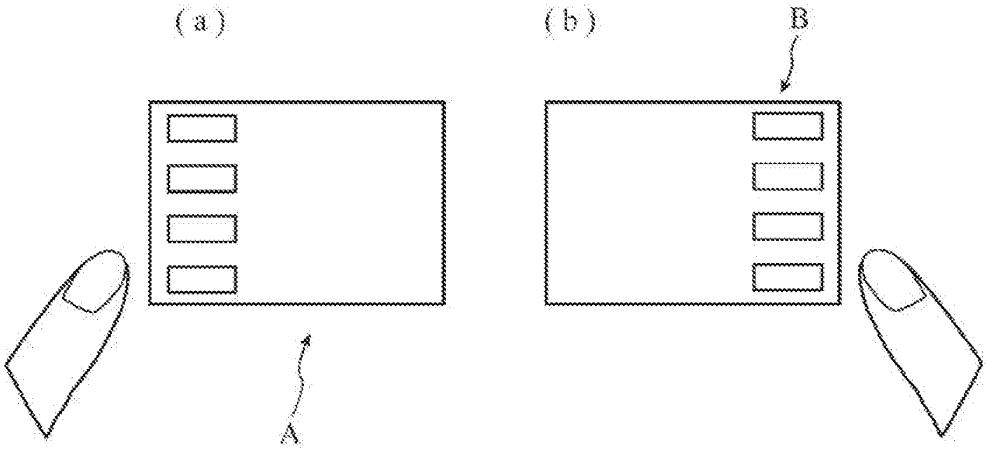
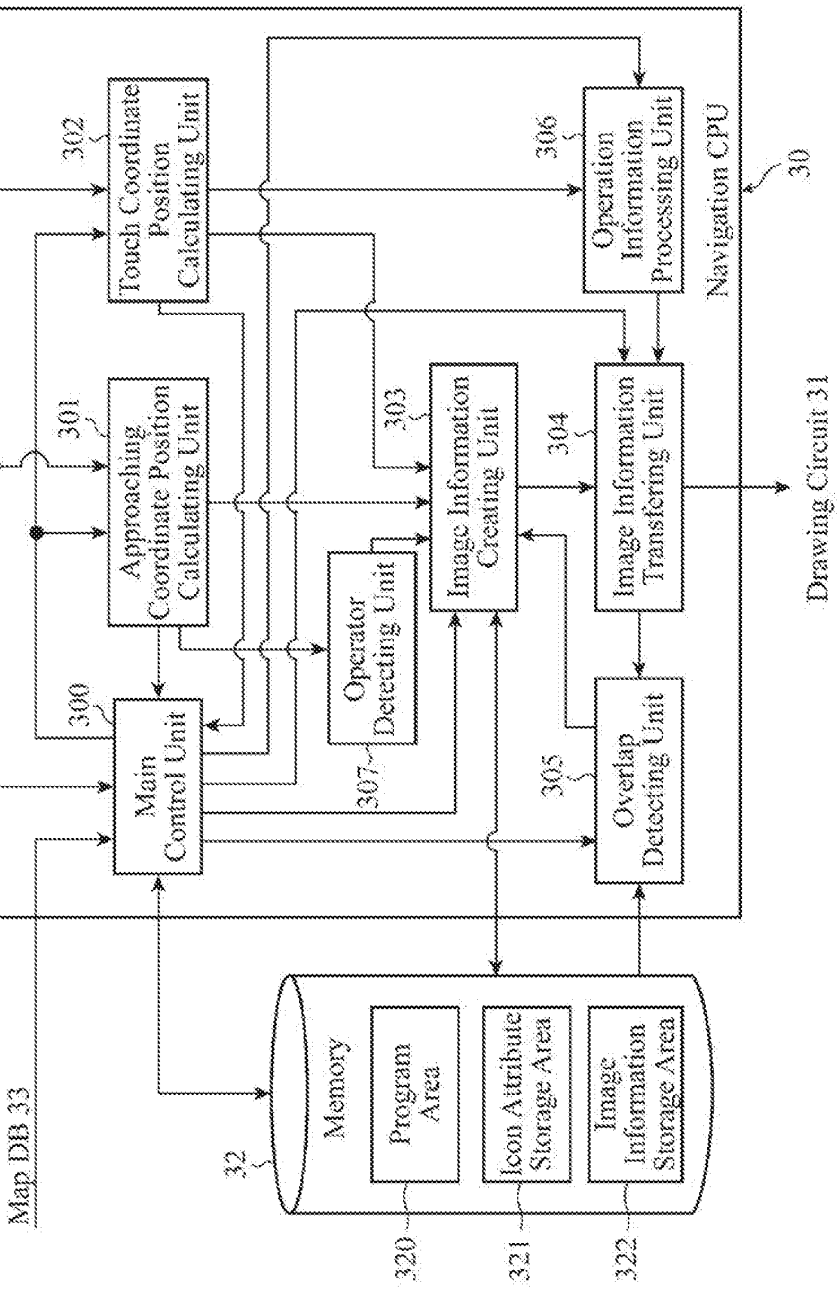

(a)
(b)
B
A

FIG.9



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FIG.10

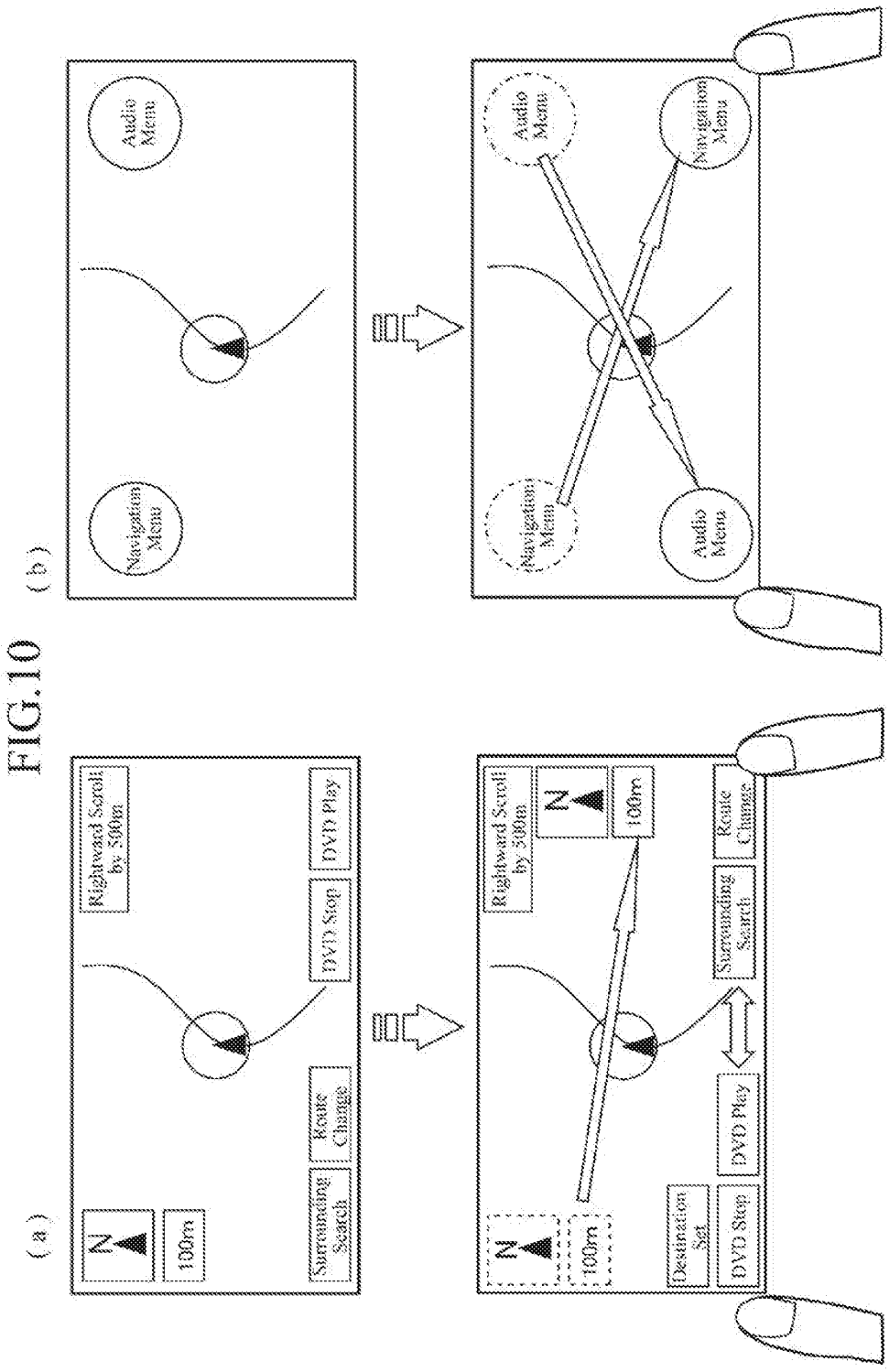
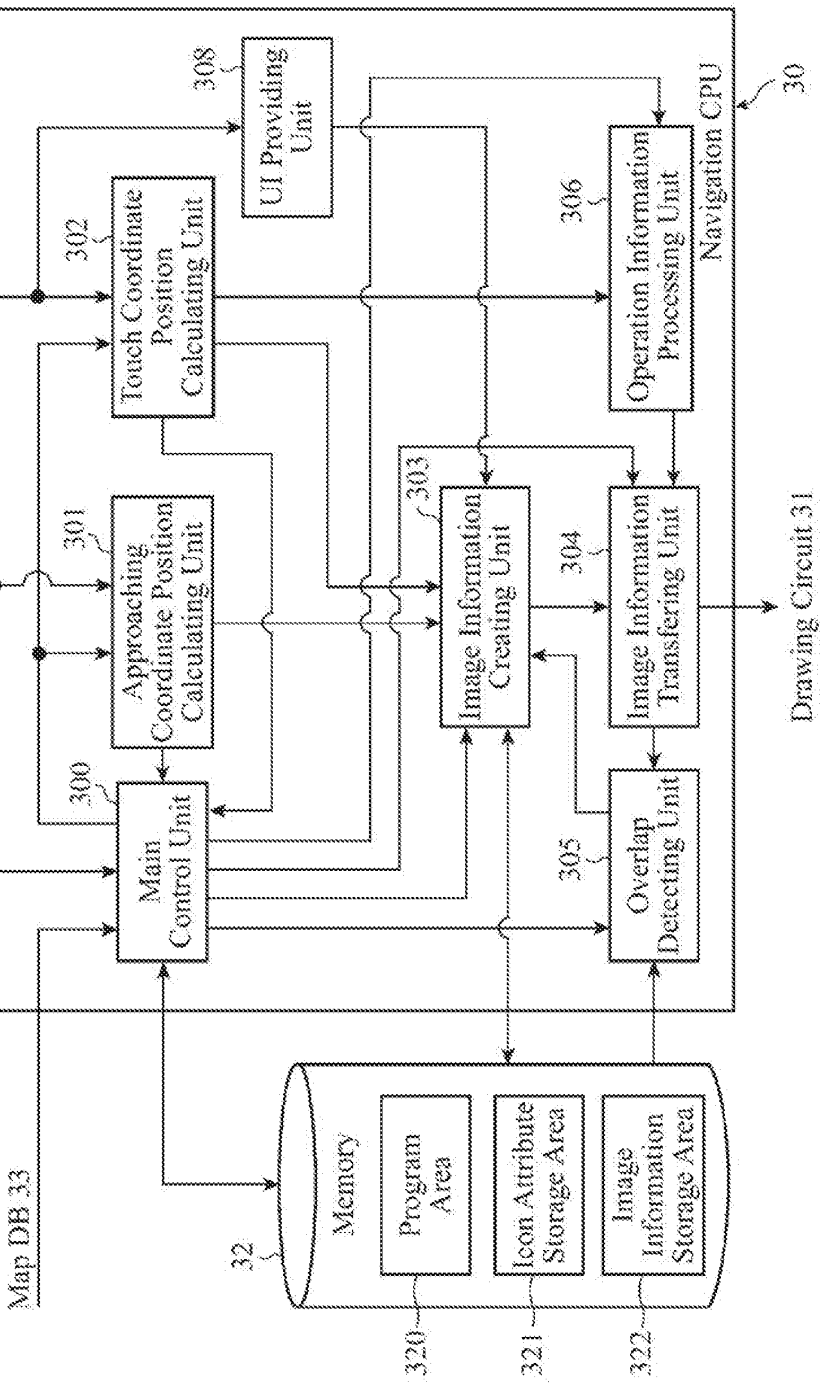

(a)
N
100m
Surrounding Search
Route Change
DVD Stop
DVD Play
Rightward Scroll by 500m
Destination Set
(b)
Audio Menu
Navigation Menu

FIG. 11



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FIG.12

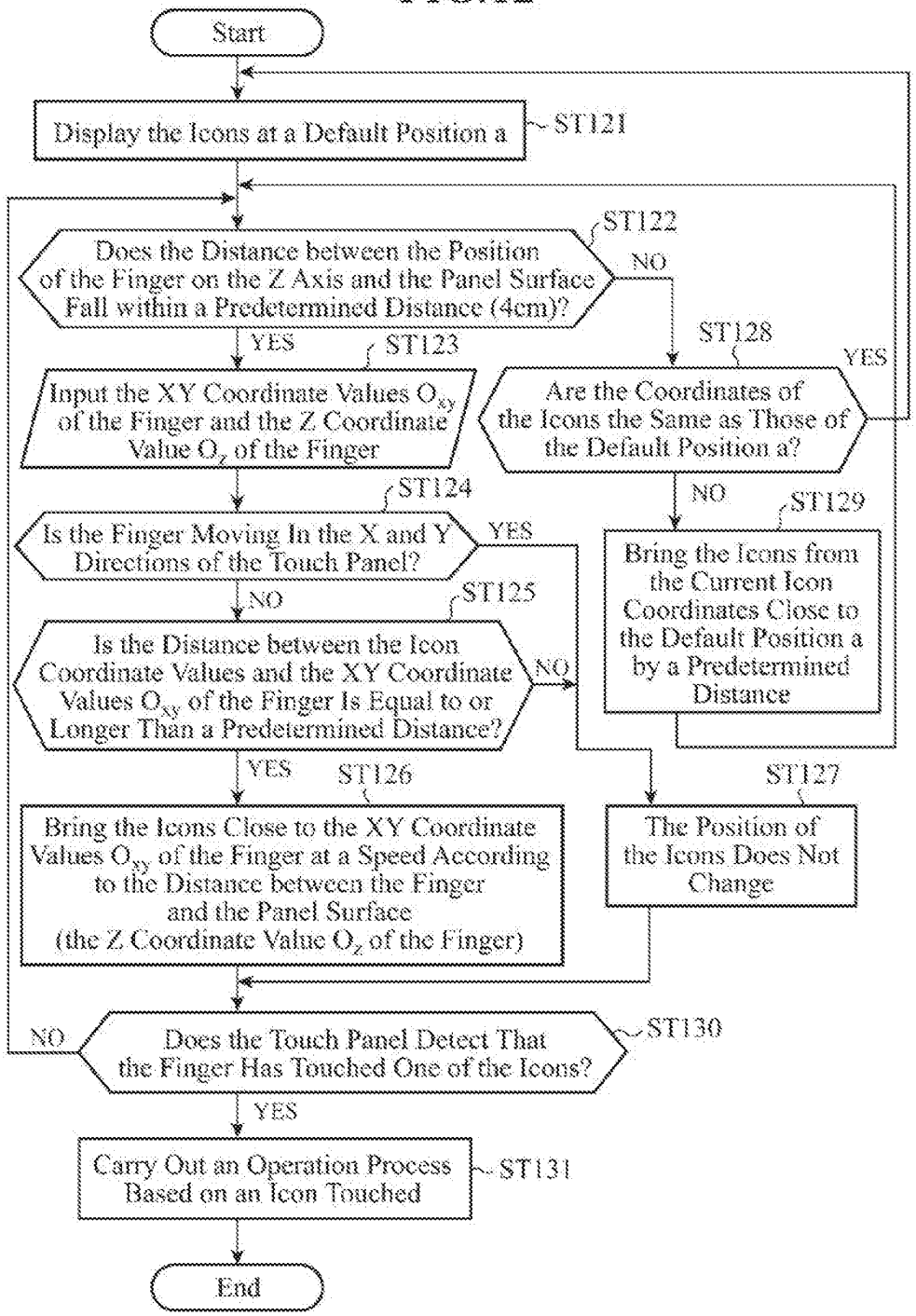

Start
Display the Icons at a Default Position a
ST121
Does the Distance between the Position of the Finger on the Z Axis and the Panel Surface Fall within a Predetermined Distance (4cm)?
ST122
NO
YES
Input the XY Coordinate Values O_{xy} of the Finger and the Z Coordinate Value O_z of the Finger
ST123
Are the Coordinates of the Icons the Same as Those of the Default Position a?
ST128
YES
NO
Is the Finger Moving In the X and Y Directions of the Touch Panel?
ST124
YES
NO
Bring the Icons from the Current Icon Coordinates Close to the Default Position a by a Predetermined Distance
ST129
Is the Distance between the Icon Coordinate Values and the XY Coordinate Values O_{xy} of the Finger Is Equal to or Longer Than a Predetermined Distance?
ST125
NO
YES
Bring the Icons Close to the XY Coordinate Values O_{xy} of the Finger at a Speed According to the Distance between the Finger and the Panel Surface (the Z Coordinate Value O_z of the Finger)
ST126
The Position of the Icons Does Not Change
ST127
NO
Does the Touch Panel Detect That the Finger Has Touched One of the Icons?
ST130
YES
Carry Out an Operation Process Based on an Icon Touched
ST131
End

FIG.13

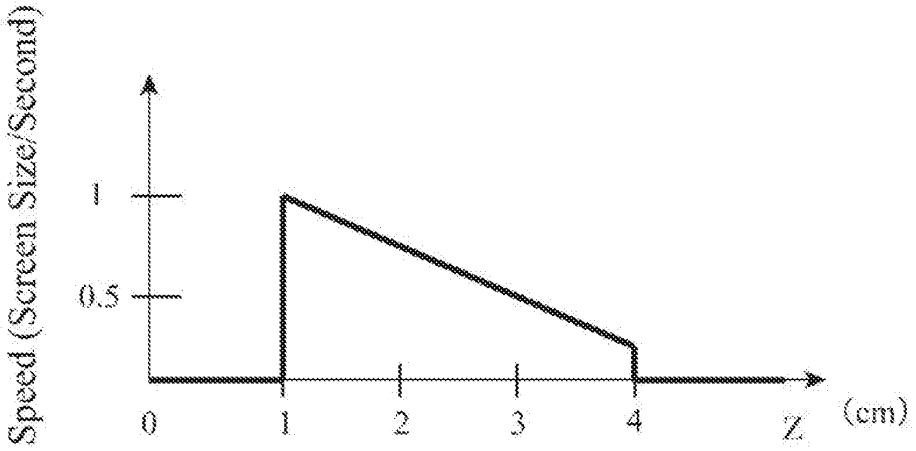
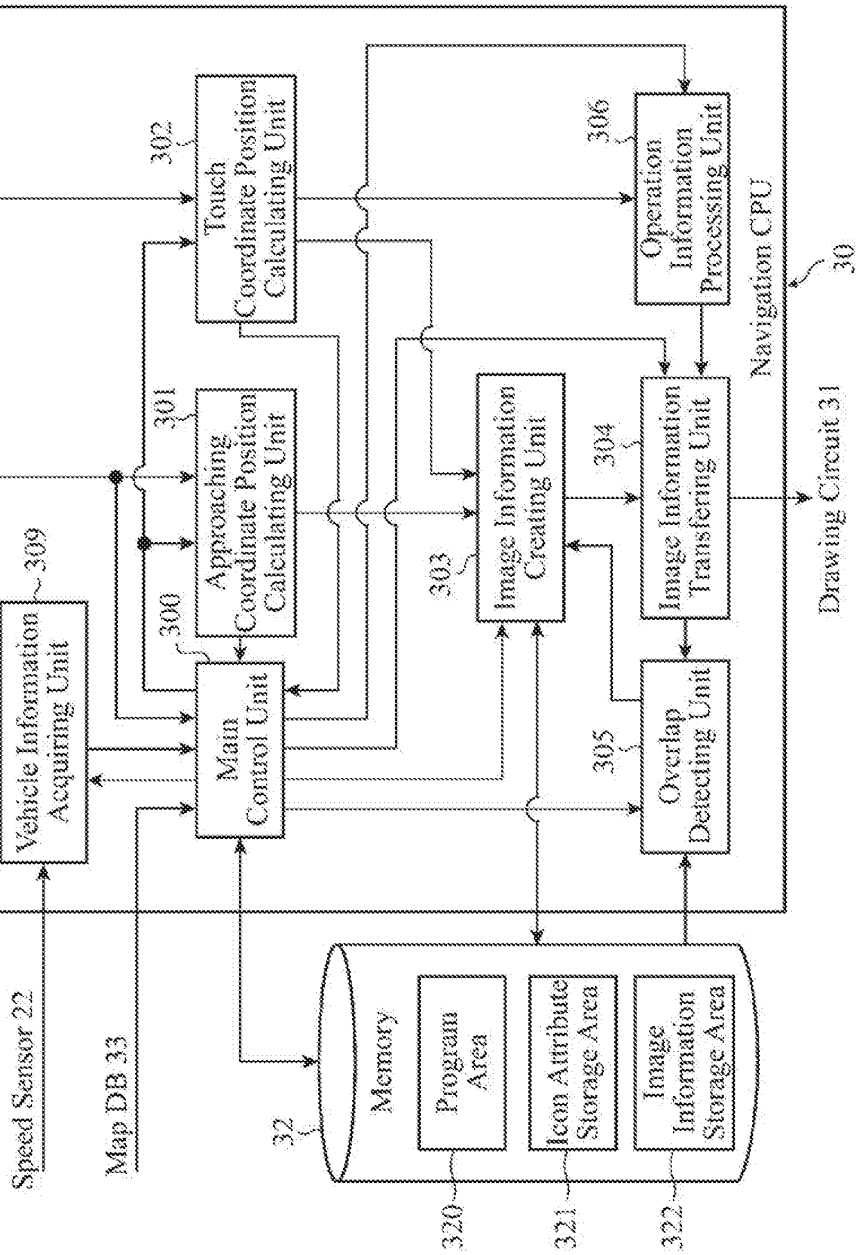
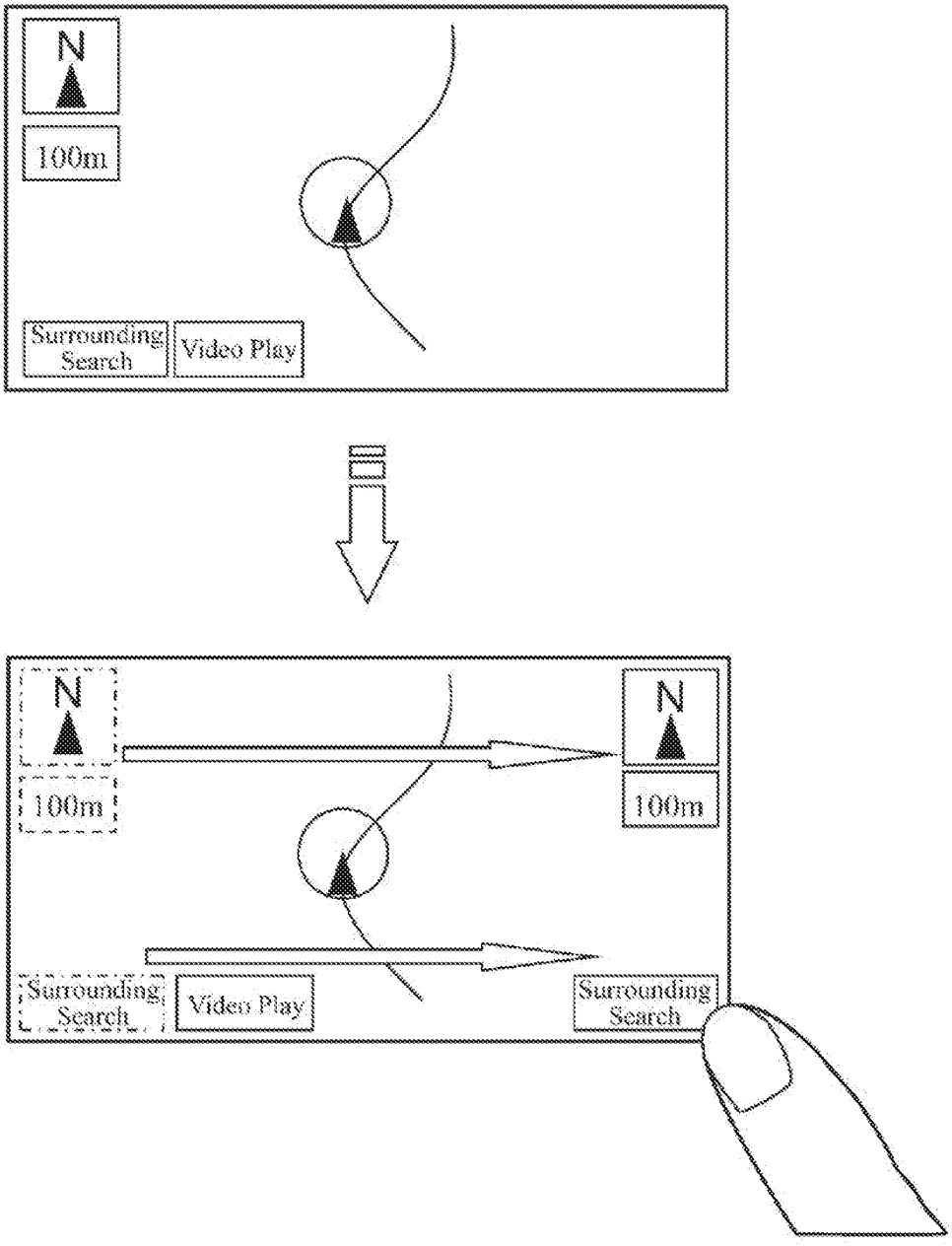


FIG. 14



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FIG.15


N
100m
Surrounding Search
Video Play
N
100m
N
100m
Surrounding Search
Video Play
Surrounding Search

DISPLAY INPUT DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates to a display input device which is particularly suitable for use in vehicle-mounted information equipment such as a navigation system.

BACKGROUND OF THE INVENTION

[0002] A touch panel is an electronic part which is constructed of a matrix-shaped touch sensor laminated on an LCD (liquid crystal display) panel, for example, and is a display input device that can allow a user to touch an input button display area, such as an icon displayed on the LCD panel, by using an object to be detected, such as a finger or a pen, and detect information about the coordinate position of a part on the screen which has been touched by the user to enable the user to operate target equipment. Therefore, in many cases, a touch panel is used while being incorporated into equipment, such a vehicle-mounted navigation system or a bank ATM (Automatic Teller Machine), which has to meet the need for the user to handle the equipment by following a self-explanatory procedure.

[0003] Many proposals for improving the operability and user-friendliness of a touch panel as mentioned above have been applied for patent.

[0004] For example, a display input device which, when a user brings his or her finger close to the device, enlarges and displays a key switch which is positioned in the vicinity of the finger so as to facilitate the user's selection operation (for example, refer to patent reference 1), a CRT device which detects a vertical distance of a finger and displays information with a scale of enlargement according to the distance (for example, refer to patent reference 2), an input unit equipped with a touch panel which detects whether or not a user's hand is in contact with an arm switch and changes an arrangement of icons when detecting that the user's hand is in contact with the arm switch (for example, refer to patent reference 3), and so on have been known.

RELATED ART DOCUMENT

Patent Reference

[0005] Patent reference 1: JP,2006-31499,A
Patent reference 2: JP,04-128877,A
Patent reference 3: JP,2008-129689,A

SUMMARY OF THE INVENTION

[0006] According to the technology disclosed by above-mentioned patent reference 1, because when a user brings his or her finger close to the touch panel, an enlarged display of an icon positioned in the vicinity of the position where the user's finger is close to the touch panel is produced, operation mistakes can be prevented and the user is enabled to easily perform an operation of selecting the icon. However, because the icon positioned in the vicinity of the position where the user's finger is close to the touch panel is simply enlarged and displayed on the screen, the user needs to move his or her finger in many directions to perform an operation on vehicle-mounted information equipment in which icons are distributedly arranged on the screen, and such a movement is not preferable for safe driving. Furthermore, a new user interface using the three-dimensional touch panel disclosed by patent reference 2 has not been provided yet.

[0007] Furthermore, according to the technology disclosed by patent reference 3, because an icon is brought closer to a predetermined position and is displayed at the position as compared with a case in which the user's hand is not detected, the input operation is facilitated and the operability of the equipment is improved. However, in this case, because the display position at which the icon is displayed is dependent upon the mounting position of the arm switch, and a touch of the user's hand on the arm switch is needed to change the arrangement of icons displayed on the screen, the operability of the equipment may be impaired conversely.

[0008] The present invention is made in order to solve the above-mentioned problems, and it is therefore an object of the present invention to provide a display input device that obtains a great improvement in its operability.

[0009] In order to solve the above-mentioned problems, in accordance with the present invention, there is provided a display input device including: a touch panel for carrying out a display of information and an input of information; a proximity sensor for detecting a movement of an object to be detected which is positioned opposite to the above-mentioned touch panel in a noncontact manner; and a control unit for, when the above-mentioned proximity sensor detects an approach of the above-mentioned object to be detected to within a predetermined distance from the above-mentioned touch panel, moving a specific display object displayed on the above-mentioned touch panel close to a stop position of the above-mentioned object to be detected to display the above-mentioned specific display object.

[0010] In accordance with the present invention, the display input device can achieve a further improvement in operability.

BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. **1** is a block diagram showing the internal structure of a display input device in accordance with Embodiment 1 of the present invention;

[0012] FIG. **2** is a block diagram showing a functional development of the program structure of a navigation CPU which the display input device in accordance with Embodiment 1 of the present invention has;

[0013] FIG. **3** is a block diagram showing the internal structure of a drawing circuit which the display input device in accordance with Embodiment 1 of the present invention has;

[0014] FIG. **4** is a flow chart showing the operation of the display input device in accordance with Embodiment 1 of the present invention;

[0015] FIG. **5** is a screen transition figure schematically showing the operation of the display input device in accordance with Embodiment 1 of the present invention on a touch panel;

[0016] FIG. **6** is an operation conceptual diagram schematically showing the operation of the display input device in accordance with Embodiment 1 of the present invention on the touch panel;

[0017] FIG. **7** is an operation conceptual diagram schematically showing the operation of a display input device in accordance with Embodiment 2 of the present invention on a touch panel;

[0018] FIG. **8** is an operation conceptual diagram schematically showing the operation of a display input device in accordance with Embodiment 3 of the present invention on a touch panel;

[0019] FIG. **9** is a block diagram showing a functional development of the program structure of a navigation CPU which a display input device in accordance with Embodiment 4 of the present invention has;

[0020] FIG. **10** is an operation conceptual diagram schematically showing the operation of a display input device in accordance with Embodiment 4 of the present invention on a touch panel;

[0021] FIG. **11** is a block diagram showing a functional development of the program structure of a navigation CPU which a display input device in accordance with Embodiment 5 of the present invention has;

[0022] FIG. **12** is a flow chart showing the operation of the display input device in accordance with Embodiment 5 of the present invention;

[0023] FIG. **13** is a figure showing the operation of the display input device in accordance with Embodiment 5 of the present invention in the form of a graph;

[0024] FIG. **14** is a block diagram showing a functional development of the program structure of a navigation CPU which a display input device in accordance with Embodiment 6 of the present invention has; and

[0025] FIG. **15** is an operation conceptual diagram schematically showing the operation of the display input device in accordance with Embodiment 6 of the present invention on a touch panel.

EMBODIMENTS OF THE INVENTION

[0026] Hereafter, in order to explain this invention in greater detail, the preferred embodiments of the present invention will be described with reference to the accompanying drawings.

Embodiment 1

[0027] FIG. **1** is a block diagram showing the structure of a display input device in accordance with Embodiment 1 of the present invention. As shown in FIG. **1**, the display input device in accordance with Embodiment 1 of the present invention is comprised of a touch-sensitive display unit (abbreviated as a touch panel from here on) **1**, external sensors **2**, and a control unit **3**.

[0028] The touch panel **1** carries out a display of information and an input of the information. For example, the touch panel **1** is constructed in such a way that a touch sensor **11** for inputting information is laminated on an LCD panel **10** for displaying information. In this embodiment, the touch panel **1** and a plurality of proximity sensors **12** each of which carries out non-contact detection in two dimensions of a movement of an object to be detected, such as a finger or a pen, which is positioned opposite to the touch panel **1** are mounted on a peripheral portion outside the touch sensor **11**.

[0029] In a case in which each of the proximity sensors **12** uses an infrared ray as a detection medium, infrared ray emission LEDs (Light Emitted Diodes) and light receiving transistors are arranged opposite to each other on the peripheral portion outside the touch sensor **11** in the form of an array. Each of the proximity sensors **12** detects a block of light emitted therefrom or reflected light which is caused by an approach of an object to be detected to detect the approach and also detects the coordinate position of the object.

[0030] The proximity sensors **12** are not limited to the above-mentioned sensors which employ infrared rays as their detection media. For example, sensors of capacity type each of which detects an approach of an object to be detected from a change of its capacitance which occurs between the object to be detected and two plates arranged in parallel like a capacitor can be alternatively used. In this case, one of the two plates serves as a ground plane oriented toward the object to be detected, and the other plate serves as a sensor detection plane, and each of the sensors of capacity type can detect an approach of the object to be detected from a change of its capacitance formed between the two plates and can also detect the coordinate position of the object.

[0031] On the other hand, the external sensors **2** can be mounted at any positions in a vehicle, and include at least a GPS (Global Positioning System) sensor **21**, a speed sensor **22**, and an acceleration sensor **23**.

[0032] The GPS sensor **21** receives radio waves from GPS satellites, creates a signal for enabling the control unit **3** to measure the latitude and longitude of the vehicle, and outputs the signal to the control unit **3**. The speed sensor **22** measures vehicle speed pulses for determining whether or not the vehicle is running and outputs the vehicle speed pulses to the control unit **3**, for example. The acceleration sensor **23** measures a displacement of a weight attached to a spring to estimate an acceleration applied to the weight, for example. In a case in which the acceleration sensor **23** is a three-axis one, the acceleration sensor follows an acceleration variation ranging from 0 Hz (only the gravitational acceleration) to several 100 Hz, for example, and measures the direction (attitude) of the weight with respect to the ground surface from the sum total of acceleration vectors in X and Y directions and informs the direction to the control unit **3**.

[0033] The control unit **3** has a function of, when the proximity sensors **12** detect an approach of an object to be detected to within a predetermined distance from the touch panel **1**, moving a display object displayed on the touch panel **1**, such as an icon or specific image information, by using a method, such as a smoothly scrolling method, close to a stop position of the object to be detected, to display the display object in the vicinity of the position. To this end, the control unit **3** is comprised of a CPU (referred to as a navigation CPU **30**) mainly aimed at providing navigation, a drawing circuit **31**, a memory **32**, and a map DB (Data Base) **33**.

[0034] The navigation CPU **30** carries out a navigation process of, when a navigation menu, such as a destination guidance menu, which is displayed on the touch panel **1** is selected by a user, providing navigation following the menu. When carrying out the navigation process, the navigation CPU **30** refers to map information stored in the map DB **33**, and carries out a route search, the above-mentioned destination guidance or the like according to various sensor signals acquired from the external sensors **2**.

[0035] Furthermore, when the proximity sensors **12** detect an approach of an object to be detected to within the predetermined distance from the touch panel **1**, in order to implement the function, as the control unit **3**, of moving at least one of pieces of information in one or more display areas each having a fixed range which are displayed on the touch panel **1** close to the stop position of the object to be detected to display the one or more pieces of information in the vicinity of the position, the navigation CPU **30** creates image information according to a program stored in the memory **32** to control the drawing circuit **31**. The structure of the program which the navigation CPU **30** executes in that case is shown in FIG. **2**, and the details of the structure will be mentioned below.

[0036] The drawing circuit **31** expands the image information created by the navigation CPU **30** on a bit map memory built therein or mounted outside the drawing circuit at a fixed speed, reads image information which is expanded on the bit map memory by a display control unit similarly built therein in synchronization with the display timing of the touch panel **1** (the LCD panel **10**), and displays the image information on the touch panel **1**. The above-mentioned bit map memory and the above-mentioned display control unit are shown in FIG. **3**, and the details of these components will be mentioned below.

[0037] An icon attribute storage area, an image information storage area, and so on are assigned to a work area of the memory **32**, which is provided in addition to a program area in which the above-mentioned program is stored, and icon attributes and image information are stored in the memory **32**.

[0038] In this case, an "icon attribute" is information which is defined for each icon, and which includes a default display position and a flag showing whether or not the above-mentioned movement and display is possible. In addition, when the display input device is applied as vehicle-mounted man-machine equipment, information showing whether each icon is used by either a passenger on the driver's seat or a passenger on the front seat can also be added as an attribute. The details of icon attributes will be mentioned below. Furthermore, maps, facility information and so on required for navigation including a route search and guidance are stored in the map DB **33**.

[0039] FIG. **2** is a block diagram showing a functional development of the structure of the program which the navigation CPU **30** of FIG. **1**, which the display input device (the control unit **3**) in accordance with Embodiment 1 of the present invention has, executes.

[0040] As shown in FIG. **2**, the navigation CPU **30** includes a main control unit **300**, an approaching coordinate position calculating unit **301**, a touch coordinate position calculating unit **302**, an image information creating unit **303**, an image information transferring unit **304**, an overlap detecting unit **305**, and an operation information processing unit **306**.

[0041] The approaching coordinate position calculating unit **301** has a function of, when the proximity sensors **12** detect an approach of an object to be detected, calculating the XY coordinate position of the object and delivering the XY coordinate position to the main control unit **300**.

[0042] The touch coordinate position calculating unit **302** has a function of, when the touch sensor **11** detects a touch of an object to be detected on the touch panel **1**, calculating the XY coordinate position of the touch and delivering the XY coordinate position to the main control unit **300**.

[0043] The image information creating unit **303** has a function of creating image information including an icon to be displayed on the touch panel **1** under the control of the main control unit **300**, and outputting the image information to the image information transferring unit **304**.

[0044] In this case, when moving information about one or more display areas each having a fixed range, such as an icon displayed on the touch panel **1**, close to the stop position of the object to be detected, such as a finger or a pen, to display the information in the vicinity of the position, the navigation CPU **30** uses a method of "screen switching" or "smoothly scrolling". The "screen switching" means that the image information creating unit **303** instantaneously updates the image information to be displayed within a non-display period of the touch panel **1** (the LCD panel **10**) to write the image information updated thereby in the image information storage area **322** of the memory **32**, and the image information transferring unit **304** transfers the image information updated instantaneously to the drawing circuit **31** during the next display period to carry out the movement and display in an instant. The "smoothly scrolling" means that the image information creating unit **303** repeats an update of the image information on a bit-by-bit basis during each non-display period of the touch panel **1** (the LCD panel **10**), and the image information transferring unit **304** transfers the image information updated during each non-display period to the drawing circuit **31** during each display period to carry out the movement and display smoothly. Either of "screen switching" and "smoothly scrolling" can have various methods each of which is implemented via H/W or S/W, and both of them are not limited to the above-mentioned methods.

[0045] Furthermore, under the control of the main control unit **300**, the image information creating unit **303** can also carryout a process of enlarging the information about the one or more display areas each having a fixed range, such as an icon, which are to be moved close to the stop position of the object to be detected, such as a finger or a pen, and displayed in the vicinity of the position, according to the distance between the object to be detected which has got close to the touch panel **1**, and the touch panel **1**.

[0046] In this case, the "enlarging process" means that the image information creating unit **303** reads an already-created bitmap image, such as a bitmapped image of an icon, at a fixed rate, and interpolates intermediate pixels to draw an image into a new bitmap. For example, the image information creating unit **303** can implement the enlarging process by copying the value of each pixel of the original bitmap image to each of the four values of an array of two rows and two columns when enlarging the original bitmap image to twice of its original size. In contrast with this, when reducing the original bitmap image, the image information creating unit can implement this reducing process by thinning out the pixels of the original bitmap image at a fixed ratio. Although the method of enlarging or reducing the original bitmap image is explained as an example, in a case of processing a vector image instead of a bit image, the vector image can be enlarged or reduced to a more beautiful image through a predetermined enlarging and reducing computation.

[0047] The image information transferring unit **304** has a function of transferring the image information created by the image information creating unit **303** to the drawing circuit **31** under the timing control of the main control unit **300**.

[0048] The overlap detecting unit **305** has a function of, when moving a plurality of icons close to the stop position of the object to be detected, such as a finger or a pen, to display the plurality of icons in the vicinity of the position, detecting an overlap which can occur among the icon display positions where the plurality of icons are displayed. In this case, when the overlap detecting unit detects an overlap among the icon display positions, the image information creating unit **303** creates image information including the icons which are rearranged in such a way that no overlap occurs among their icon display positions, and transfers the image information to the image information storage area **322** of the memory **32**. In this case, the detection of an overlap among the icon display positions and the rearrangement of the icons can be implemented by calculating and comparing the display address of each of the icons after the movement and display has been carried out on the basis of a default display position defined

by an icon attribute of each of the icons which is assigned to and stored in a predetermined area of the memory **32**.

[0049] The operation information processing unit **306** has a function of creating operation information defined for an icon which is based on the coordinate position of the touch calculated by the touch coordinate position calculating unit **302**, outputting the operation information to the image information transferring unit **304**, and then displaying the operation information on the touch panel **1** (the LCD monitor **10**) under the control of the main control unit **300**. For example, when the touched icon is a key of a soft keyboard, the operation information processing unit **306** creates image information based on the touched key, outputs the image information to the image information transferring unit **304**, and then displays the image information on the touch panel **1**. When the touched icon is an icon button, the operation information processing unit **306** carries out a navigation process defined for the icon button, such as a destination search, creates image information, outputs the image information to the image information transferring unit **304**, and then displays the image information on the touch panel **1**.

[0050] The work area having a predetermined amount of storage, in addition to the program area **320** in which the above-mentioned program is stored is assigned to the memory **32**. In this work area, the icon attribute storage area **321** in which the above-mentioned icon attributes are defined and stored, and the image information storage area **322** in which the image information created by the image information creating unit **303** is stored temporarily are included.

[0051] FIG. **3** is a block diagram showing the internal structure of the drawing circuit **31** shown in FIG. **1**. As shown in FIG. **3**, the drawing circuit **31** is comprised of a drawing control unit **310**, an image buffer unit **311**, a drawing unit **312**, the bitmap memory unit **313**, and the display control unit **314**. They are commonly connected to one another via a local bus **316** which consists of a plurality of lines used for address, data and control.

[0052] In the above-mentioned construction, the image information transferred from the navigation CPU **30** shown in FIG. **2** (the image information transferring unit **304**) is held by the image buffer unit **311** under the control of the drawing control unit **310**, and the drawing control unit **310** decodes a command such as a straight line drawing command or a rectangle drawing command, or carries out preprocessing about the slope of a line or the like prior to a drawing process. The drawing unit **312**, which is started by the drawing control unit **310**, then carries out high-speed drawing of the image information decoded by the drawing control unit **310** into the bitmap memory unit **313**, and the display control unit **314** reads and displays the image information held by the bitmap memory unit **313** in synchronization with the display timing of the LCD panel **10** of the touch panel **1**.

[0053] FIG. **4** is a flow chart showing the operation of the display input device in accordance with Embodiment 1 of the present invention. Furthermore, FIG. **5** is a screen transition figure schematically showing movements of an icon group, which is information about one or more display areas each having a fixed range, and a finger which is an object to be detected at that time on the touch panel **1**.

[0054] Hereafter, the operation of the display input device in accordance with Embodiment 1 of the present invention shown in FIGS. **1** to **3** will be explained in detail with reference to FIGS. **4** and **5**.

[0055] As shown in FIG. **5**(*a*), it is assumed that the icon group is displayed at a default position a on the touch panel **1** (the LCD panel **10**) at first (step ST**401** of FIG. **4**).

[0056] When the user brings his or her finger close to the touch panel **1** to operate the touch panel **1**, the proximity sensors **12** detect this approach and transmit an approaching signal to the navigation CPU **30**. At this time, the main control unit **300** of the navigation CPU **30** determines whether the distance between the position of the finger on the Z axis and the panel surface of the touch panel **1** falls within a predetermined distance (step ST**402**). In this case, the predetermined value is defined as Zref shown in FIG. **5**(*b*).

[0057] At that time, when it is detected that the distance between the finger and the panel surface is equal to or shorter than the predetermined distance (if "YES" in step ST**402**), the approaching coordinate position calculating unit **301** calculates the XY coordinate values O_{xy} of the finger, and inputs the XY coordinate values O_{xy} of the finger to the main control unit **300** every 0.01 second only during 0.1 seconds, for example (step ST**403**).

[0058] The main control unit **300** can determine whether the finger is moving or at rest by receiving the inputted XY coordinate values O_{xy} of the finger continuously during 0.1 seconds. More specifically, when there is no change in the XY coordinate values O_{xy} of the finger during 0.1 seconds, that is, when determining that the finger is not moving in the X and Y directions of the touch panel **1** (if "NO" in step ST**404**), the main control unit **300** determines whether or not the distance between the icon display position and the XY coordinate values O_{xy} of the finger is equal to or longer than a predetermined distance (step ST**405**), and, when the distance is equal to or longer than the predetermined distance (if "YES" in step ST**405**), the main control unit **300** starts a process of creating image information (a scroll image) by using the image information creating unit **303**. For the convenience of this explanation, although it is described that the main control unit **300** determines whether or not the finger is moving during 0.1 seconds, the main control unit **300** can keep a history of some continuously-performed determinations of whether or not the finger is moving during 0.1 seconds and determine whether or not the finger is moving from the several pieces of information each about the determination during a time period of 0.1 seconds. In this case, when the finger is trembling slightly, the main control unit can determine that there is no change in the above-mentioned XY coordinate values O_{xy}, and the accuracy of the determination can be improved.

[0059] More specifically, the image information creating unit **303** creates image information in such a way that the icon display position is placed close to the XY coordinate values O_{xy} of the finger. The image information created at this time is written in the image information storage area **322** of the memory **32**, and is updated as occasion demands according to the scroll rate and is also outputted to the image information transferring unit **304**.

[0060] The image information transferring unit **304** receives the image information created by the image information creating unit **303** and transfers this image information to the drawing circuit **31**. The drawing control unit **310** of the drawing circuit **31** expands the image information transferred to the drawing circuit, and the drawing unit **312** draws the expanded image information into the bitmap memory unit **313** at a high speed. The display control unit **314** then performs a desired scroll display process on the touch panel **1**. More specifically, the display control unit **314** carries out a

smoothly scrolling display process of gradually moving the icons toward the XY coordinate values O_{xy} of the finger on the touch panel **1** to bring them close to the XY coordinate values (step ST**406**). An example of the screen transition at this time is shown in FIG. **5**(*c*).

[0061] When it is determined in the process in step ST**404** of determining whether or not the finger is moving in the X and Y directions that the finger is moving (if "YES" in step ST**404**), or when it is determined in the process in step ST**405** of determining whether the distance between the icon display position and the XY coordinate values O_{xy} of the finger is equal to or longer than the predetermined distance that the distance is neither equal to nor longer than the predetermined distance (if "NO" in step ST**405**), the display control unit can understand that there is no change in the display position of the icons (step ST**407**). An example of the screen transition at this time is shown in FIG. **5**(*d*).

[0062] When it is determined in step ST**402** that the distance between the finger and the touch panel face falls within the predetermined range (if "YES" in step ST**402**), the main control unit **300** repeatedly carries out the above-mentioned processes of steps ST**402** to ST**407** until the touch panel **1** detects that the finger has touched one of the icons (if "YES" in step ST**410**).

[0063] As a result, as shown in an example of the screen transition of FIG. **5**(*e*), a scroll display is produced in such a way that the icon display position gets closer and closer to the XY coordinate values O_{xy} of the finger of the touch panel **1**.

[0064] When the touch panel **1** (the touch sensor **11**) detects that the finger has touched one of the icons (if "YES" in step ST**410**), the touch coordinate position calculating unit **302** calculates the coordinate position of the touch and starts the operation information processing unit **306**. The operation information processing unit **306** then carries out an operation process based on the key corresponding to the coordinates of the touch calculated by the touch coordinate position calculating unit **302** (step ST**411**). In this case, the operation process based on the key corresponding to the coordinates of the touch means that, in the case in which the touched icon is a key of the soft keyboard, the operation information processing unit creates image information based on the touched key, outputs the image information to the image information transferring unit **304**, and displays the image information on the touch panel **1** (the LCD monitor **10**). In the case in which the touched icon is an icon button, the operation information processing unit carries out a navigation process defined for the icon button, such as a destination search, creates image information, outputs the image information to the image information transferring unit **304**, and then displays the image information on the touch panel **1** (the LCD monitor **10**).

[0065] In contrast, when it is detected in step ST**402** that the distance between the finger and the panel surface is equal to or longer than the predetermined distance (if "NO" in step ST**402**), the main control unit **300** performs a comparison between the display position of the icons currently being displayed and the default coordinate position a of the icons (step ST**408**). At this time, when determining that the display position of the icons currently being displayed differs from the default coordinate position a (if "NO" in step ST**408**), that is, when the icons have moved from the default position on the screen of the touch panel **1**, the main control unit **300** controls the image information creating unit **303** to cause the image information creating unit **303** to create image information in such a way as to bring the icons close to the default display position a. The image information created is stored in the image information storage area **322** of the memory **32** and is outputted to the image information transferring unit **304** as occasion demands.

[0066] The image information transferring unit **304** receives the image information and transfers this image information to the drawing circuit **31**, and the drawing control unit **310** of the drawing circuit **31** expands the image information transferred thereto, and the drawing unit **312** draws the expanded image information into the bitmap memory unit **313** at a high speed.

[0067] The display control unit **314** then produces a desired display on the touch panel **1** (the LCD panel **10**). More specifically, the display control unit **314** carries out a smoothly scrolling display process of bringing the icons from the current display position at which they are positioned near the stop position of the finger close to the default display position a (step ST**409**). An example of the screen transition at this time is shown in FIG. **5**(*f*).

[0068] When it is determined in step ST**402** that the distance between the position on the Z axis of the finger and the touch panel face is equal to or longer than the predetermined distance (if "NO" in step ST**402**), the main control unit **300** repeatedly carries out the icon coordinate determining process in step ST**408** and the smoothly scrolling display process in ST**409** of moving the icons to the default position a until the icons are returned to the default position a.

[0069] In the above-mentioned display input device in accordance with Embodiment 1 of the present invention, when a finger's approach to within a predetermined distance from the touch panel **1** is detected by the proximity sensors **12**, the control unit **3** (the navigation CPU **30**) moves at least one of the icons displayed on the touch panel **1** close to the stop position of the finger and display at least the icon in the vicinity of the position, thereby being able to provide a new user interface. Particularly, when the display input device in accordance with Embodiment 1 of the present invention is used for vehicle-mounted information equipment that carries out navigation etc., the user-friendliness of the vehicle-mounted information equipment can be improved and a further improvement can be provided in the operability of the vehicle-mounted information equipment.

[0070] In the display input device in accordance with Embodiment 1 of the present invention, the smoothly scrolling method of moving one or more icons close to the coordinate position of the finger at a constant speed in order to implement the movement and display is explained above. Instead of using the smoothly scrolling method, the movement and display can be implemented by using a method of moving the one or more icons in an instant.

[0071] In this case, the navigation CPU **30** (the image information creating unit **303**) needs to create an image to which the image displayed on the touch panel **1** (the LCD panel **10**) is to be switched and in which the one or more icons have been moved in order to change the currently-displayed image in an instant, and update the currently-displayed image into the created image. As a result, the load on the navigation CPU **30** can be reduced.

[0072] Furthermore, in the display input device in accordance with Embodiment 1 of the present invention, a plurality of icons are gathered at the stop position of the finger and displayed, as previously explained as an example. As an alternative, any icon which is not affected by the finger's approach can be excluded from the target of the movement and display

process, or some icons which are not affected by the finger's approach can be set in such a way to go away from the stop position of the finger as the finger approaches the touch panel. This variant can be implemented by rewriting the icon attributes of such icons which are defined in the icon attribute storage area **321** of the memory **32**.

[0073] An operation conceptual diagram schematically showing the operation of the display input device in accordance with Embodiment 1 of the present invention on the touch panel is shown in FIG. **6**. In an example shown in FIG. **6**(*a*), icons (icons showing the "compass bearing", the "scale", and the "heading" respectively) are gathered close to the finger position through the smoothly scrolling process as the finger approaches the touch panel are shown. In contrast, in an example shown in FIG. **6**(*b*), the icon (the "scale" icon) is gathered close to the finger position through the smoothly scrolling process as the finger approaches the touch panel, whereas the icons (the "compass bearing" icon, etc.) are not gathered close to the finger position.

[0074] Furthermore, when an overlap occurs among the icon display positions of a plurality of icons through the process of moving and displaying the plurality of icons, the image information creating unit **303** needs to create an icon image in which the plurality of icons are rearranged in such a way that no overlap occurs among the plurality of icons under the control of the main control unit **300**. At this time, the navigation CPU **30** (the overlap detecting unit **305**) needs to detect an overlap occurring among the plurality of icons with reference to their icon attributes stored in the memory **32** to control the process of creating an image in which the plurality of icons are rearranged which is carried out by the image information creating unit **303**. As a result, the visibility of the icons can be improved and hence operation mistakes can be prevented.

[0075] In addition, the navigation CPU **30** can carry out a process of enlarging the icons to display them according to the distance between the finger approaching the touch panel **1** and the touch panel **1**. In this case, when the display of the icons is enlarged as the distance between the finger approaching the touch panel **1** and the touch panel **1** becomes short, operation mistakes resulting from unsteadiness, such as a vibration of the vehicle, can be prevented, and a further improvement can be provided in the operability, for example. In this embodiment, the display input device brings the icons close to the default position a immediately after making a transition from the process of step ST**408** to that of step ST**409**. As an alternative, after a state in which the finger is far from the touch panel for a fixed period of time (e.g., about 0.5 seconds) continues, the display input device can move the icons to the default position. In this case, the operation feeling which the user has when accidentally moving his or her finger away from the touch panel becomes good.

Embodiment 2

[0076] FIG. **7** is an operation conceptual diagram showing the operation of a display input device in accordance with Embodiment 2 of the present invention on the screen of a touch panel.

[0077] The display input device in accordance with Embodiment 2 of the present invention uses the same structure as that of the display input device shown in FIG. **1**, and also uses the same program structure as that of the navigation CPU **30** shown in FIG. **2**, like that of above-mentioned Embodiment 1.

[0078] The display input device in accordance with Embodiment 1 which operates according to the flow chart shown in FIG. **4** moves icons displayed on the touch panel **1** to the position shown by the XY coordinate values O_{xy} of a finger approaching the touch panel to display the icons at the position shown by the XY coordinate values. In contrast, the display input device in accordance with Embodiment 2, which will be explained hereafter, brings icons displayed on the touch panel **1** close to not the position shown by the XY coordinate values O_{xy} of the finger, but a predetermined coordinate position on the touch panel **1**.

[0079] More specifically, as shown in the operation conceptual diagram of FIG. **7**, representative points $q1(_{X1Y1})$ to $q4(_{X2Y2})$ which are lattice points on the touch panel **1** are defined, and the display input device performs a control operation in such a way that the icons get close to the representative point $q1(_{X1Y1})$ which is the closest to the XY coordinate values O_{xy} of the finger. The display input device can implement this control operation by, when a navigation CPU **30** (an image information creating unit **303**) creates image information including the icons, computing the difference between each of the plurality of pre-defined representative points and the XY coordinate values O_{xy} of the finger, and writing the created image information including the icons placed at the representative point having the smallest difference in an image information storage area **322** of a memory **32**.

[0080] In the display input device in accordance with above-mentioned Embodiment 2, when a finger's approach to within a predetermined distance from the touch panel is detected by proximity sensors **12**, a control unit **3** (the navigation CPU**30**) moves at least one of the icons displayed on the touch panel **1** to a pre-defined position which is the closest to the stop position of the finger to display at least the icon at the pre-defined position. Therefore, in addition to the advantages provided by above-mentioned Embodiment 1, this Embodiment 2 offers an advantage of making it easy to create the software because the coordinates of the touch panel **1** to which the one or more icons are moved and displayed are fixed.

[0081] Furthermore, because a limited number of patterns in which the one or more icons are moved and gathered have only to be prepared according to the number of representative lattice points, a process of preventing an overlap among the one or more icons and so on can be eliminated.

Embodiment 3

[0082] FIG. **8** is an operation conceptual diagram showing the operation of a display input device in accordance with Embodiment 3 of the present invention on the screen of a touch panel.

[0083] The display input device in accordance with Embodiment 3 of the present invention uses the same structure as that of the display input device shown in FIG. **1**, and also uses the same program structure as that of the navigation CPU **30** shown in FIG. **2**, like that of above-mentioned Embodiment 1.

[0084] In the display input device in accordance with Embodiment 3, which will be explained hereafter, when the proximity sensors **12** detect that a finger is positioned in a left half of the touch panel **1** (when viewed from above), as shown in FIG. **8**(*a*), a navigation CPU **30** moves an icon group close to the stop position of the finger according to a first pattern (A)

in which the one or more icons according to their icon attributes are arranged to display the icon group in the vicinity of the position.

[0085] In contrast, when proximity sensors **12** detect that a finger is positioned in a right half of the touch panel **1** (when viewed from above), as shown in FIG. **8**(*b*), the navigation CPU **30** moves the icon group close to the stop position of the finger according to a second pattern (B) in which the one or more icons according to their icon attributes are arranged to display the icon group in the vicinity of the position. Because the principles on which the movement and display is based are the same as those of Embodiment 1, the explanation of the principles will be omitted hereafter to avoid any duplicate explanation.

[0086] The display input device in accordance with above-mentioned Embodiment 3 of the present invention changes the arrangement of icons according to a pattern when a finger approaches the touch panel **1**. For example, because a passenger on the front seat easily operates the display input device from a left side of the display input device when using the display input device mounted in a vehicle intended for Japan, when the user brings a finger close to the touch panel **1** from a left side of the touch panel, the display input device gathers the icon group in a left side area of the touch panel **1** to display the icon group, while when a passenger on the driver's seat brings a finger close to the touch panel **1** from a right side of the touch panel, the display input device gathers the icon group in a right side area of the touch panel **1** to display the icon group.

[0087] Therefore, the display input device can provide an icon arrangement suitable for an operation done by either a passenger on the front seat or a passenger on the driver's seat, thereby being able to provide an improvement in the user-friendliness for each passenger. In this case, the icon group gathered and arranged in the left or right side area of the touch panel can be implemented by storing a definition of each icon in advance in an icon attribute storage area **321** of a memory **32**. For example, a "DVD play" icon is defined as an icon for a passenger on the front seat and a "route search" icon is defined as an icon for a passenger on the driver's seat.

Embodiment 4

[0088] FIG. **9** is a block diagram showing a functional development of the structure of a program which a navigation CPU **30** of a display input device in accordance with Embodiment 4 of the present invention has.

[0089] As shown in FIG. **9**, in the display input device in accordance with Embodiment **4** of the present invention, the navigation CPU **30** further includes an operator detecting unit **307** in addition to the structure of that in accordance with Embodiment 1 shown in FIG. **2**. The operator detecting unit **307** has a function of detecting whether a finger which is positioned opposite to a touch panel **1** has approached the touch panel from either a direction of the driver's seat of a vehicle or a direction of the front seat of the vehicle. Concretely, the operator detecting unit **307** detects whether a finger has approached the touch panel from either the direction of the driver's seat of the vehicle or the direction of the front seat of the vehicle by calculating the coordinate position of the approaching object on the basis of a signal outputted by proximity sensors or by processing an image captured by a not-shown vehicle-mounted camera to control a process of creating a scroll image which is carried out by an image information creating unit **303**.

[0090] For example, when the operator detecting unit determines that a finger has approached the touch panel from the direction of the driver's seat of the vehicle from the signal of the proximity sensors **12**, a control unit **3** (the navigation CPU **30**) moves a first pattern in which one or more icons suitable for operations done by a passenger on the driver's seat are arranged at a predetermined speed to display the first pattern moved. In contrast, when the operator detecting unit determines that a finger has approached the touch panel from the direction of the front seat of the vehicle from the signal of the proximity sensors **12**, the control unit **3** moves a second pattern in which one or more icons suitable for operations done by a passenger on the front seat are arranged at a predetermined speed to display the second pattern moved. Because the principles on which the movement and display is based are the same as those of Embodiment 1, the explanation of the principles will be omitted hereafter to avoid any duplicate explanation.

[0091] FIG. **10** is an operation conceptual diagram showing the operation of the display input device in accordance with Embodiment 4 of the present invention on the touch panel.

[0092] FIG. **10**(*a*) shows an icon group of icons which are arranged when a passenger on the driver's seat brings a finger close to the touch panel **1**, and an icon group of icons which are arranged when a passenger on the front seat brings a finger close to the touch panel **1**. The icon group corresponding to the above-mentioned first pattern is shown on a left side of the upper figure, and the icon group corresponding to the second pattern is shown on a right side of the upper figure. In this example, button icons of "DVD stop" and "DVD play" are displayed on a left side of the lower figure for operations to be done by a passenger on the front seat while button icons of "surrounding search" and "route change" are displayed on a right side of the lower figure for operations to be done by a passenger on the driver's seat, with a boundary between the left and right sides being an approximately center of the screen. As an alternatively, as shown in FIG. **10**(*b*), icons which are to be moved and displayed are selectively displayed according to whether a finger has approached the touch panel from either the direction of the driver's seat of the vehicle or the direction of the front seat of the vehicle. In this case, in either of the case in which the operator detecting unit determines that a finger has approached the touch panel from the direction of the driver's seat from the signal of the proximity sensors **12** and the case in which the operator detecting unit determines that a finger has approached the touch panel from the direction of the front seat from the signal of the proximity sensor **12**, the control unit **3** (the navigation CPU **30**) selectively displays the icons which are to be moved close to the stop position of the finger by using the attributes shown by an icon attribute storage area **321** of a memory **32**. In this embodiment, an example in which a passenger on the driver's seat selects a navigation menu to move this navigation menu close to the finger position to display the navigation menu in the vicinity of the position, and an example in which a passenger on the front seat selects an audio menu to move this audio menu close to the finger position to display the audio menu in the vicinity of the position are shown.

[0093] Therefore, in addition to the advantages provided by Embodiment 1, the above-mentioned display input device in accordance with Embodiment 4 of the present invention offers an advantage of, when applied to vehicle-mounted information equipment that carries out navigation and so on, making it possible to provide an icon arrangement suitable for

operations to be done by a passenger on the front seat and an icon arrangement suitable for operations to be done by a passenger on the driver's seat, and another advantage of being able to provide a user interface excellent in flexibility and extendibility by enabling the user to select icons displayed in each of the icon arrangements, thereby being able to provide a further improvement in the operability and an improvement in the user-friendliness.

Embodiment 5

[0094] A display input device in accordance with Embodiment 5 which will be explained hereafter is applied to a three-dimensional touch panel which can also measure the distance in the Z direction between its panel surface and a finger. More specifically, the touch panel **1** shown in FIG. **1** that can detect the position of an object in the X and Y directions is replaced by the three-dimensional touch panel that can also measure a distance in the Z direction. Because a technology of measuring a three-dimensional position is disclosed by patent reference 2, an explanation will be made assuming that this technology is simply applied to this embodiment. The display input device in accordance with Embodiment 5, which will be explained hereafter, varies and controls the moving display speed of icons according to the distance of an approaching finger.

[0095] FIG. **11** is a block diagram showing a functional development of the structure of a program which a navigation CPU **30** of the display input device in accordance with Embodiment 5 of the present invention has.

[0096] As shown in FIG. **11**, the navigation CPU **30** for use in the display input device in accordance with Embodiment 5 of the present invention includes an approaching coordinate position calculating unit **301** which is upgraded, from that of the navigation CPU **30** of the display input device in accordance with Embodiment 1 shown in FIG. **2**, in such a way as to be able to carryout three-dimensional coordinate position calculations, and further includes a UI (User Interface) providing unit **308**. The UI providing unit **308** has a function of providing a user interface which makes it possible for the user to make the display movement speed of icons, which is determined according to the distance in the Z direction between the touch panel **1** and the user's finger, variable according a setting inputted by the user via the three-dimensional touch panel. More specifically, the UI providing unit makes it possible for the user to make the display movement speed (scrolling speed) of icons variable by using a setting screen.

[0097] The above-mentioned display movement speed is not necessarily made variable according to the user setting. As an alternative, the icons can be moved close to the stop position of the finger at a speed determined according to the distance between the touch panel **1** and the finger which is detected by proximity sensors **12**, so that the icons are displayed in the vicinity of the stop position. Furthermore, the display movement speed can be made variable according to the attributes of the icons defined in an icon attribute storage area **321** of a memory **32**.

[0098] FIG. **12** is a flow chart showing the operation of the display input device in accordance with Embodiment 5 of the present invention, and FIG. **13** is a figure which is a graphical representation of a relationship between the distance between the touch panel **1** and a finger, and the movement speed of the icons.

[0099] An explanation will be made assuming that, as shown in the graph of FIG. **13**, when a finger approaches to within a distance of 4 cm from the touch panel **1**, the display input device smoothly scrolls the icons in such a way that they are gathered close to the position of the finger and displayed in the vicinity of the position of the finger, and the scrolling speed reaches its maximum when the distance between the finger and the touch panel is 1 cm and the icons do not move when the distance becomes shorter than 1 cm. Hereafter, the operation of the display input device in accordance with Embodiment 5 of the present invention will be explained in detail with reference to FIGS. **12** and **13**.

[0100] It is assumed that an icon group is displayed at a default position a on the screen of the three-dimensional touch panel at first (step ST**121**).

[0101] When a user brings his or her finger close to the three-dimensional touch panel to operate the three-dimensional touch panel, the proximity sensors **12** detect this approach and transmits a signal to the navigation CPU **30**, and a main control unit **300** of the navigation CPU **30** determines whether the distance between the position of the finger on the Z axis and the panel surface of the three-dimensional touch panel falls within a predetermined distance of 4 cm (step ST**122**).

[0102] When the main control unit detects that the distance between the position of the finger on the Z axis and the panel surface of the three-dimensional touch panel falls within the predetermined distance of 4 cm (if "YES" in step ST**122**), an approaching coordinate position calculating unit **301** calculates both the XY coordinate values O_{xy} of the finger and the Z coordinate value O_z of the finger, and outputs the XYZ coordinates O_{xyz} of the finger to the main control unit **300** every 0.01 second only during 0.1 seconds, for example (step ST**123**).

[0103] The main control unit **300** can determine whether or not the finger is moving by receiving these coordinates continuously. More specifically, when there is no change in the XY coordinate values O_{xy} of the finger during 0.1 seconds, the main control unit **300** determines that the finger is not moving in the X and Y directions of the touch panel **1** (if "NO" in step ST**124**), and further determines whether or not the distance between the icon display position and the XY coordinate values O_{xy} of the finger is equal to or longer than a predetermined distance (step ST**125**). In this case, when the distance between the icon display position and the XY coordinate values O_{xy} of the finger is equal to or longer than the predetermined distance (if "YES" in step ST**125**), the main control unit **300** starts a process of creating a scroll image which is carried out by an image information creating unit **303**.

[0104] More specifically, the image information creating unit **303** creates image information (a scroll image) in such a way that the icon display position is placed close to the XY coordinate values O_{xy} of the finger. This created image information is outputted to an image information transferring unit **304** while it is stored in an image information storage area **322** of a memory **32**.

[0105] The image information transferring unit **304** receives the image information and transfers this image information to a drawing circuit **31**, and a drawing control unit **310** of the drawing circuit **31** expands the image information transferred thereto, and a drawing unit **312** draws the expanded image information into a bitmap memory unit **313** at a high speed. A display control unit **314** then produces a desired display on the touch panel **1** (an LCD panel **10**) according to the distance (the Z coordinate value O_z of the finger) between the finger and the panel surface. More spe-

cifically, the display control unit **314** carries out a smoothly scrolling display process of bringing the icons close to the XY coordinate values O_{xy} of the finger on the touch panel **1** (step ST**126**).

[0106] When it is determined in the process in step ST**124** of determining whether or not the finger is moving in the X and Y directions that the finger is moving (if "YES" in step ST**124**), or when it is determined in the process in step ST**125** of determining whether the distance between the icon display position and the XY coordinate values O_{xy} of the finger is equal to or longer than the predetermined distance that the distance is neither equal to nor longer than the predetermined distance (if "NO" in step ST**125**), the display control unit determines that there is no change in the display position of the icons (step ST**127**).

[0107] When it is determined in step ST**122** that the distance between the finger and the touch panel face falls within the predetermined range (if "YES" in step ST**122**), the main control unit **300** repeatedly carries out the above-mentioned processes of steps ST**122** to ST**127** until the touch panel **1** detects that the finger has touched one of the icons (if "YES" in step ST**130**). As a result, the icon group gets closer and closer to the XY coordinate values O_{xy} of the finger on the three-dimensional touch panel at the movement speed according to the distance (the Z coordinate value O_z of the finger) between the finger and the panel surface, so that the icon group is displayed in the vicinity of the XY coordinate values O_{xy} of the finger.

[0108] When the three-dimensional touch panel detects that the finger has touched one of the icons (if "YES" in step ST**130**), a touch coordinate position calculating unit **302** calculates the coordinate position of the touch and hands over the control operation to an operation information processing unit **306**. The operation information processing unit **306** then carries out an operation process based on an icon corresponding to the coordinates of the touch calculated by the touch coordinate position calculating unit (step ST**131**).

[0109] In contrast, when it is detected that the distance between the position on the Z axis of the finger and the panel surface is equal to or longer than 4 cm (if "NO" in step ST**122**), the main control unit **300** performs a comparison between the display position of the icons currently being displayed and the default coordinate position a (step ST**128**).

[0110] When determining that the display position of the icons currently being displayed differs from the default coordinate position a (if "NO" instep ST**128**), that it, when the icons have moved from the default position on the panel, the main control unit **300** controls the image information creating unit **303**, and the image information creating unit **303** creates image information in such a way that the icons are brought close to the original display position a. This created image information created is then stored in the image information storage area **322** of the memory **32**, and is further outputted to the image information transferring unit **304**.

[0111] The image information transferring unit **304** receives the image information and transfers this image information to the drawing circuit **31**, and the drawing control unit **310** of the drawing circuit **31** expands the image information transferred thereto, and the drawing unit **312** draws the expanded image information into the bitmap memory unit **313** at a high speed. The display control unit **314** produces a desired screen display on the three-dimensional touch panel. More specifically, the display control unit **314** produces a smoothly scrolling screen display on the three-dimensional touch panel at the movement speed according to the distance (the Z coordinate value O_z of the finger) between the finger and the panel surface in such a way that the icons are brought close to the default position a from the current display position (step ST**129**).

[0112] When it is determined in step ST**122** that the distance between the position on the Z axis of the finger and the panel surface is equal to or longer than 4 cm (if "NO" in step ST**122**), the main control unit **300** repeatedly carries out the processes of step ST**128** and ST**129** until the icons are returned to the default position a.

[0113] In the above-mentioned display input device in accordance with Embodiment 5 of the present invention, the control unit **3** (the navigation CPU **30**) moves the icons close to the stop position of the finger at a speed according to the distance in the Z direction between the finger and the panel surface which is detected by the proximity sensors **12**, and then displays the icons in the vicinity of the stop position of the finger. For example, when the distance in the Z axis reaches 4 cm, the icons start to be gradually (smoothly) gathered close to the stop position of the finger. After that, the control unit carries out the control operation to gradually increase the speed (the scrolling display speed) at which the icons are gathered as the distance in the Z axis varies from 4 cm to 1 cm, maximize the speed when the distance reaches 1 cm, and place the icons in a state in which they are at rest when the distance becomes shorter than 1 cm. As a result, the user-friendliness of the display input device is further improved.

[0114] The relationship between the distance in the Z direction and the movement speed (the scroll display speed) of the icons is limited to a linear numerical value as shown in a graph of FIG. **13**. As an alternative, the relationship can be a curved line. Furthermore, the display movement speed can be made variable according to the icon attributes stored in the icon attribute storage area **321** of the memory **32**, or can be made variable according to a setting made by a user. Because whether the display movement speed is made variable according to either the icon attributes or a setting made by a user can be selected arbitrarily, a flexible user interface can be provided.

Embodiment 6

[0115] FIG. **14** is a block diagram showing a functional development of the structure of a program which a navigation CPU **30** of a display input device in accordance with Embodiment 6 of the present invention has.

[0116] As shown in FIG. **14**, the navigation CPU **30** which the display input device in accordance with Embodiment 6 of the present invention has includes a vehicle information acquiring unit **309** in addition to the program structure which the navigation CPU in accordance with Embodiment 1 shown in FIG. **2** has. The vehicle information acquiring unit **309** has a function of measuring vehicle speed pulses outputted from a speed sensor **22** for detecting the running state of a vehicle, and informing the vehicle speed to a control unit **3** (the navigation CPU **30**). At this time, when it is detected that the vehicle is running, the navigation CPU **30** moves an icon preset with a flag close to the stop position of a finger at a predetermined speed to display the icon in the vicinity of the stop position. Furthermore, when determining that the finger has approached from a front seat side of the vehicle by using proximity sensors **12**, the navigation CPU **30** can move a

preselected icon close to the stop position of the finger to display the preselected icon in the vicinity of the stop position.

[0117] FIG. **15** is an operation conceptual diagram showing the operation of the display input device in accordance with Embodiment 6 of the present invention on a touch panel **1**.

[0118] As shown in FIG. **15**, when a passenger on the driver's seat moves his or her finger close to the panel surface, a "compass bearing" icon, a "scale" icon, and a "surrounding search" button icon are moved and displayed in the vicinity of the stop position of the finger. At this time, a "video play" button icon is kept being displayed at a default position. By simply defining information showing that it is not preferable to move and display for the icon attribute of any icon which should not be moved and displayed (should not be brought close to the position of the finger) while the vehicle is running, and storing the information in an icon attribute storage area **321** of a memory **32**, such an icon can be prevented from moving close to the position of the finger while the vehicle is running. When a passenger on the front seat operates the touch panel, the display input device can bring all icons close to the position of the finger to display them in the vicinity of the position of the finger. The icon attribute of any icon which should not be moved and displayed can be set arbitrarily.

[0119] In the above-mentioned display input device in accordance with Embodiment 6, when the speed sensor **22** detects that the vehicle is running, the control unit **3** moves a preselected icon close to the stop position of a finger at a predetermined speed to display the icon in the vicinity of the stop position. Therefore, in a case in which the display input device is used for vehicle-mounted equipment, the user-friendliness of the vehicle-mounted equipment can be improved. Furthermore, when the proximity sensors **12** determine that the finger has approached from a front seat side of the vehicle, the control unit **3** moves a preselected icon close to the stop position of the finger to display the icon in the vicinity of the stop position. As a result, because the display input device can restrict icons which a passenger on the driver's seat can use, the display input device can contribute to safe driving. Furthermore, because the display input device can arbitrarily form an arrangement of icons which are to be gathered when a passenger on the front seat brings his or her finger close to the touch panel, the user-friendliness can be further improved.

[0120] As previously explained, the display input device in accordance with any one of Embodiments 1 to 6 can respond to only an approach thereto of an object to be detected, such as a finger or a pen, to provide a new user interface in which a specific display object displayed on the screen, such as a icon, is moved close to the object to be detected according to a predetermined rule, and is displayed in the vicinity of the position of the object to be detected. Therefore, the operability can be further improved.

[0121] In the display input device in accordance with any one of Embodiments 1 to 6, although only icons are mentioned as the target for the movement and display, as previously explained, the target for the movement and display is not limited to icons. For example, specific information displayed in an arbitrary display area of the touch panel **1** can be the target for the movement and display. Furthermore, although only a finger is mentioned as an object to be detected, any object to be detected, such as a pen, other than a finger can also be detected by the display input device. In this case, the same advantages are provided.

[0122] The functions of the control unit **3** (the navigation CPU **30**) shown in FIG. **2**, **9**, **11**, or **14** can be all implemented via hardware, or at least a part of the functions can be implemented via software.

[0123] For example, the data process of, when the proximity sensors **12** detect an approach of an object to be detected to within a predetermined distance from the touch panel **1**, moving at least one of pieces of information in one or more display areas each having a fixed range which are displayed on the touch panel **1** close to the stop position of the object to be detected to display the one or more pieces of information in the vicinity of the stop position can be implemented via one or more programs on a computer, at least a part of the data process can be implemented via hardware. In the above-mentioned embodiments, although the touch panel display that detects an approach of a finger and a touch of the finger on the touch panel is used, a touch panel display that detects a touch of a finger on the touch panel and a pushdown by the finger can be alternatively used, and the display input device can be constructed in such a way that, when the touch panel display is touched, bring an icon close to the touch position, and, when the touch panel display is pushed down, carry out a predetermined operation according to an icon at the pushdowned position. In this case, by using an operation method, such as a method of stopping the movement of the icon, when the finger is in contact with the touch panel at two points, the display input device can further improve the operation feeling. In this case, when the touch panel display is touched, the display input device can move the icon after a short lapse of time (e.g., after waiting for about 0.5 seconds).

INDUSTRIAL APPLICABILITY

[0124] Because the display input device in accordance with the present invention can achieve a further improvement in operability, the display input device in accordance with the present invention is suitable for use in vehicle-mounted information equipment of a navigation system, and so on.

1. A display input device comprising:

a touch panel for carrying out a display of information and an input of information;

a proximity sensor for detecting a movement of an object to be detected which is positioned opposite to said touch panel; and

a control unit for, when said proximity sensor detects an approach of said object to be detected to within a predetermined distance from said touch panel, moving a specific display object displayed on said touch panel close to a stop position of said object to be detected to display said specific display object.

2. The display input device according to claim **1**, wherein said display object has attribution information showing that said movement is possible, and said control unit moves the specific display object displayed on said touch panel close to the stop position of said object to be detected to display said specific display object with reference to said attribution information.

3. The display input device according to claim **1**, wherein when moving said display object close to the stop position of said object to be detected at a predetermined speed to display said display object, said control unit rearranges and displays said display object in such a way that said display object does not overlap any other display object.

4. The display input device according to claim **1**, wherein said control unit carries out a process of enlarging said display

object to display said display object according to a distance between said object to be detected and said touch panel.

5. The display input device according to claim 1, wherein when said proximity sensor detects an approach of said object to be detected to within the predetermined distance from said touch panel, said control unit moves said display object displayed on said touch panel to a predetermined position close to the stop position of said object to be detected to display said display object.

6. The display input device according to claim 1, wherein said display object has attribution information showing that said movement is possible and said attribution information includes information specifying a display pattern of said display object, and when said proximity sensor detects that said object to be detected is positioned in a left half of said touch panel, said control unit moves said display object close to the stop position of said object to be detected to display said display object according to said attribution information and on a basis of a first pattern, whereas when said proximity sensor detects that said object to be detected is positioned in a right half of said touch panel, said control unit moves said display object close to the stop position of said object to be detected to display said display object according to said attribution information and on a basis of a second pattern.

7. The display input device according to claim 1, wherein said display object has attribution information showing that said movement is possible, said display input device has an operator detecting means for detecting whether either a driver or a passenger on a front seat operates said display input device, and said attribution information includes information specifying a display pattern of said display object, and wherein when said operator detecting means determines that said driver operates said display input device, said control unit displays said display object according to a display pattern suitable for operations by said passenger on a driver's seat, whereas when said operator detecting means determines that said passenger on the front seat operates said display input device, said control unit displays said display object according to a display pattern suitable for operations by said passenger on the front seat.

8. The display input device according to claim 7, wherein when said operator detecting means determines that said driver operates said display input device and when said operator detecting means determines that said passenger on the front seat operates said display input device, said control unit selects said display object which is to be moved close to the stop position of said object to be detected according to the attribute shown by said attribution information.

9. The display input device according to claim 1, wherein said control unit moves said display object close to the stop position of said object to be detected according to a speed dependent upon a distance between said touch panel and said object to be detected which is detected by said proximity sensor to display said display object.

10. The display input device according to claim 9, wherein said control unit changes the speed at which said control unit moves said display object to display said display object according to the attribution information about said display object.

11. The display input device according to claim 9, wherein said control unit changes the speed at which said control unit moves said display object to display said display object, the speed being determined according to the distance between said touch panel and said object to be detected, according to a user setting inputted via said touch panel.

12. The display input device according to claim 1, wherein said display input device has a speed sensor for detecting a running state of a vehicle, and when said speed sensor detects that said vehicle is running, said control unit moves said display object which is preselected close to the stop position of said object to be detected at a predetermined speed to display said display object.

13. The display input device according to claim 12, wherein said proximity sensor detects whether said object to be detected approaches said touch panel from either a direction of a driver's seat of the vehicle or a direction of a front seat of the vehicle, and when said proximity sensor determines that said object to be detected approaches said touch panel from the direction of said front seat of the vehicle, said control unit moves said display object which is preselected close to the stop position of said object to be detected to display said display object.

* * * * *

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(54) **SYSTEMS AND METHODS FOR PRE-TOUCH AND TRUE TOUCH**

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(73) Assignee: **Immersion Corporation**, San Jose, CA (US)

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(22) Filed: **Mar. 11, 2011**

Related U.S. Application Data

(60) Provisional application No. 61/314,337, filed on Mar. 16, 2010.

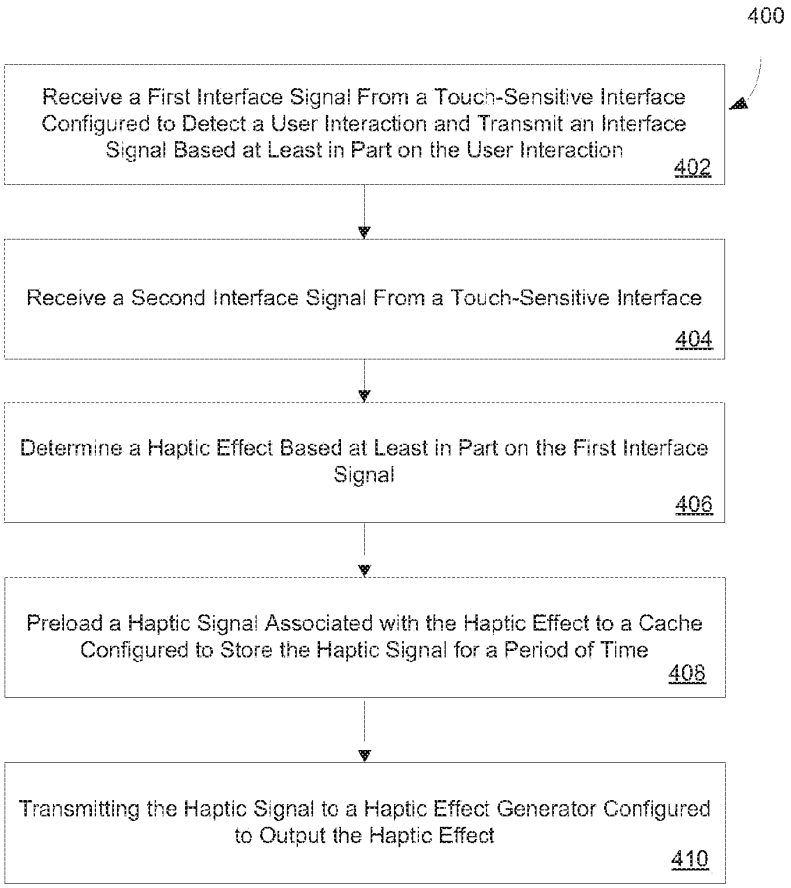
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G06F 3/041 (2006.01)

(52) **U.S. Cl.** **345/173**

(57) **ABSTRACT**

Systems and methods for pre-touch and true touch are disclosed. For example, in one described system for pre-touch and true touch includes a touch-sensitive interface configured to detect a user interaction and transmit a first interface signal based at least in part on the user interaction. The system also includes a processor in communication with the touch-sensitive interface and configured to receive the first interface signal and determine a haptic effect based at least in part on the first interface signal. The processor is further configured to preload a haptic signal associated with the haptic effect. The system also includes a cache in communication with the processor and configured to store the preloaded haptic signal for a time period and then transmit the haptic signal and a haptic effect generator in communication with the cache and configured to receive the haptic signal from the cache and, in response, output a haptic effect based at least in part on the haptic signal.



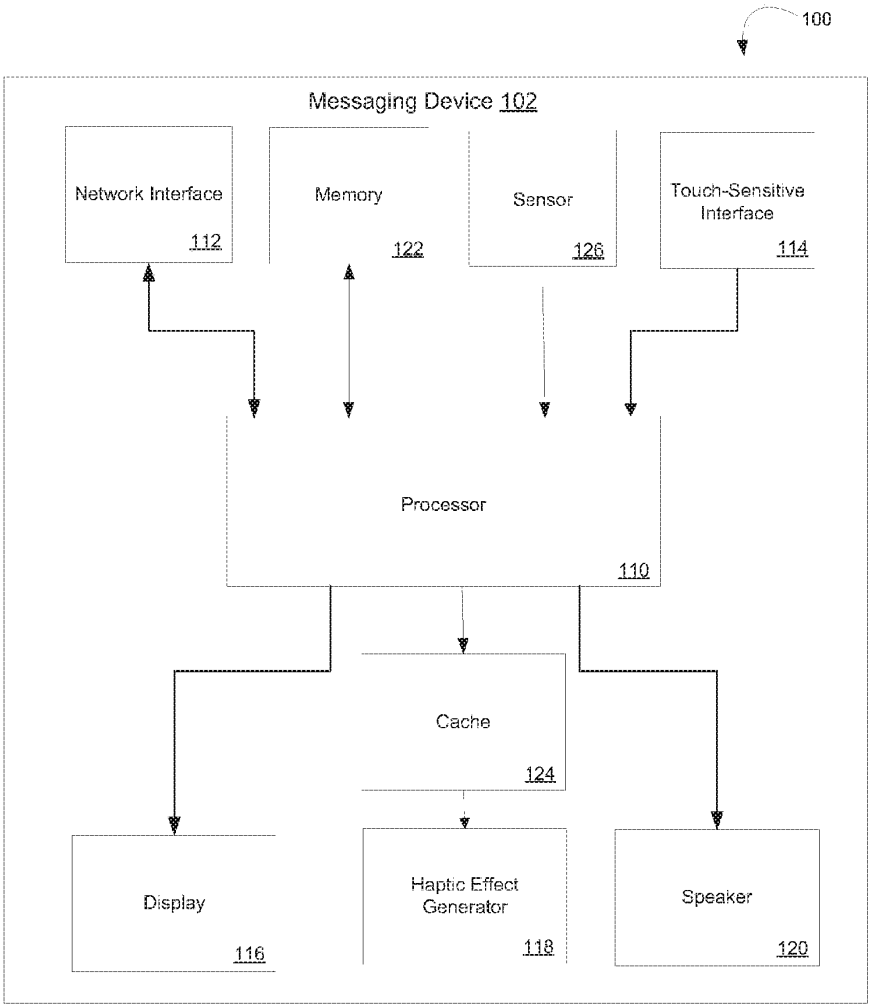

100
Messaging Device 102
Network Interface
112
Memory
122
Sensor
126
Touch-Sensitive Interface
114
Processor
110
Cache
124
Display
116
Haptic Effect Generator
118
Speaker
120

Figure 1

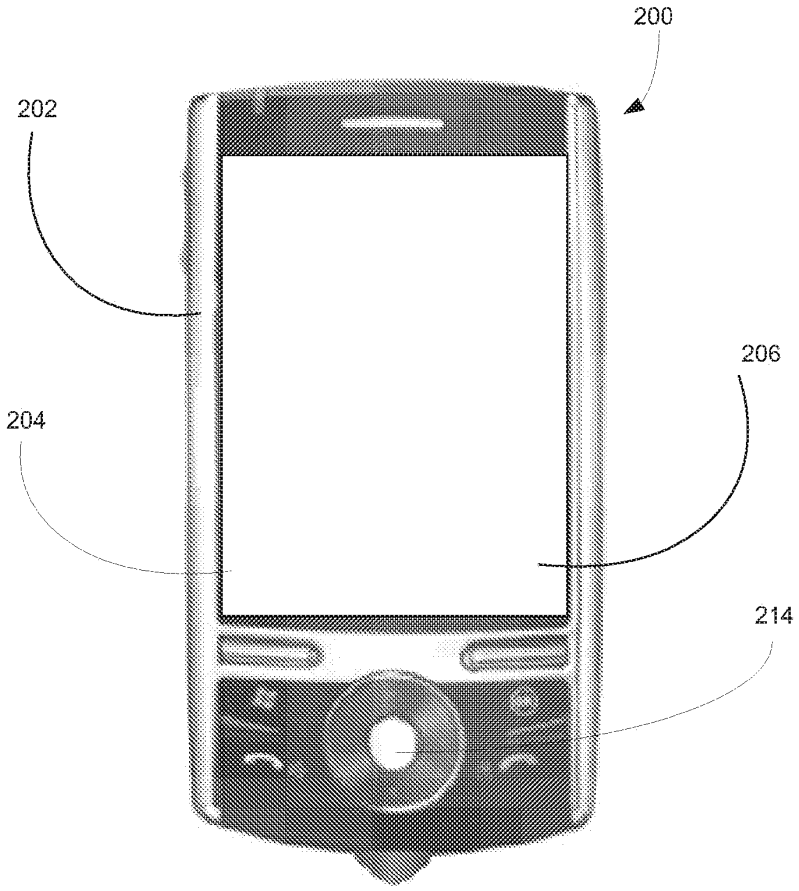


Figure 2

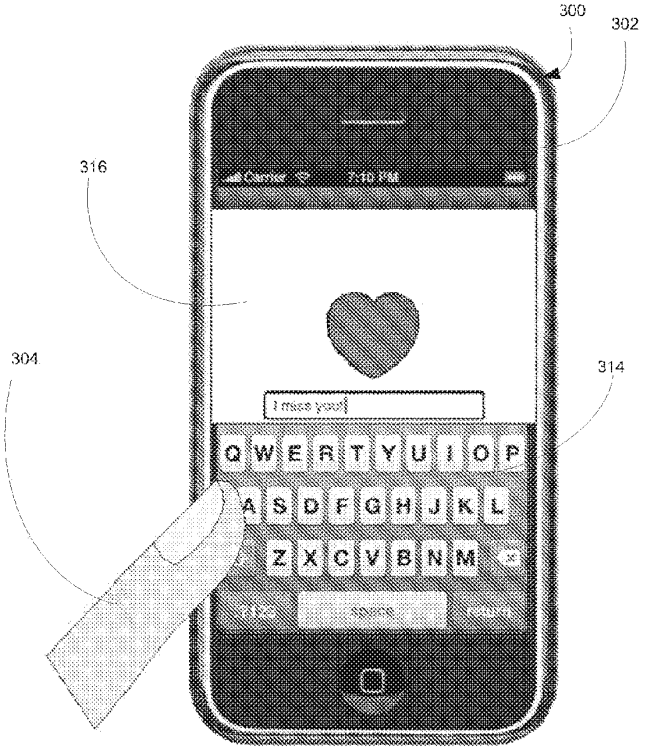


Figure 3A

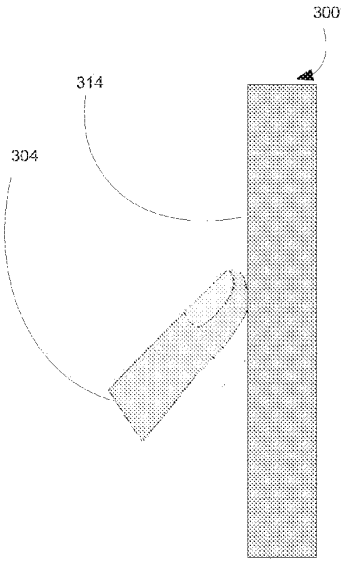


Figure 3B

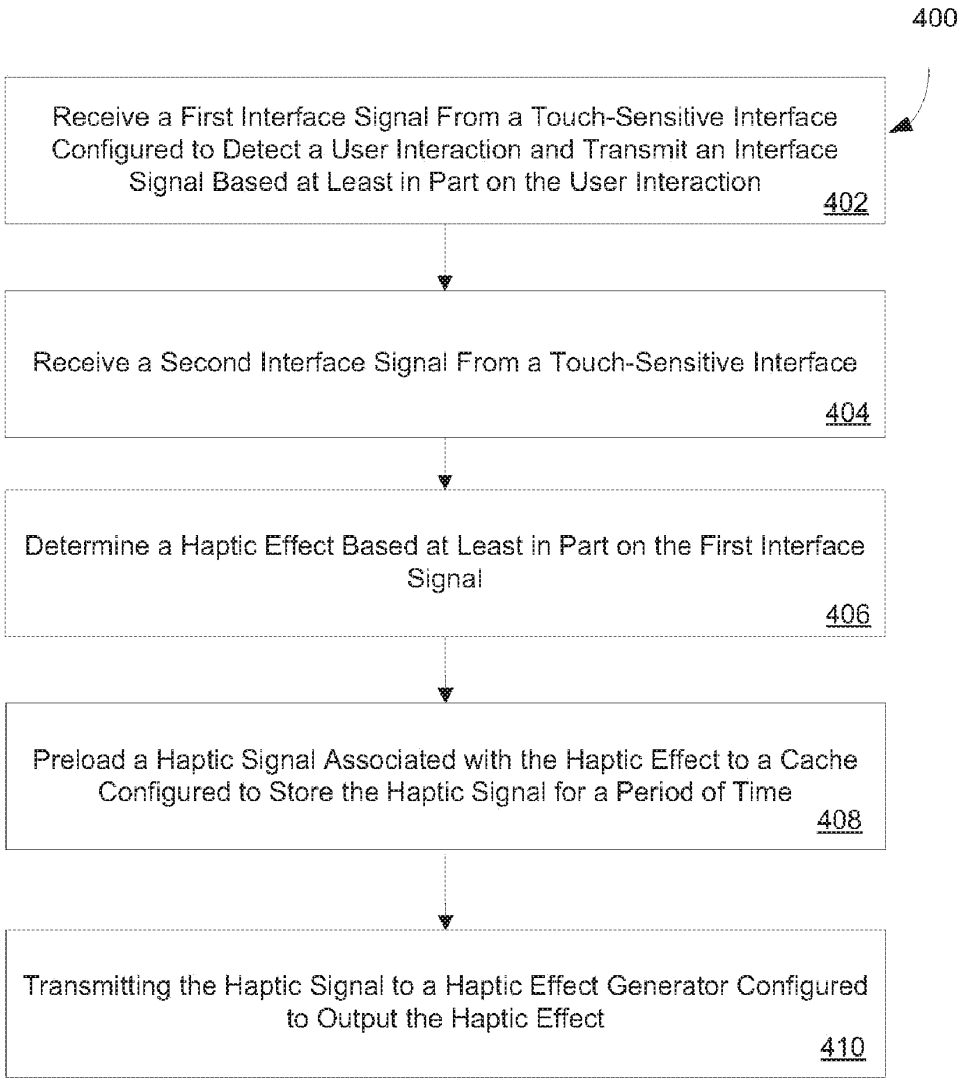

400
Receive a First Interface Signal From a Touch-Sensitive Interface Configured to Detect a User Interaction and Transmit an Interface Signal Based at Least in Part on the User Interaction
402
Receive a Second Interface Signal From a Touch-Sensitive Interface
404
Determine a Haptic Effect Based at Least in Part on the First Interface Signal
406
Preload a Haptic Signal Associated with the Haptic Effect to a Cache Configured to Store the Haptic Signal for a Period of Time
408
Transmitting the Haptic Signal to a Haptic Effect Generator Configured to Output the Haptic Effect
410

Figure 4

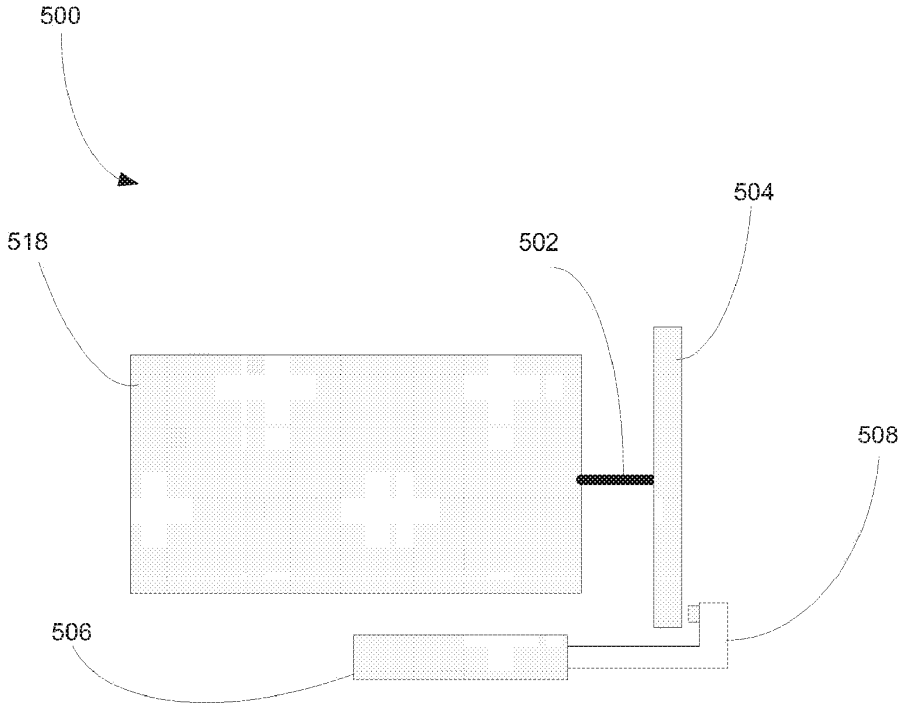


Figure 5

SYSTEMS AND METHODS FOR PRE-TOUCH AND TRUE TOUCH

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent application claims priority to U.S. Provisional Patent Application No. 61/314,337, entitled "Systems and Methods for Pre-Touch and True Touch," filed Mar. 16, 2010, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present invention generally relates to haptic feedback and more particularly to systems and methods for pre-touch and true touch.

BACKGROUND

[0003] In recent years, the use of handheld devices of all types has grown exponentially. These devices are used as portable organizers, telephones, music players, and gaming systems. Many modern handheld devices now incorporate some type of haptic feedback. In some handheld devices haptic feedback is not output as quickly as is preferable. Thus there is a need for systems and methods of pre-touch and true touch.

SUMMARY

[0004] Embodiments of the present invention provide systems and methods for pre-touch and true touch. For example, in one embodiment, a system for pre-touch and true touch comprises: a touch-sensitive interface configured to detect a user interaction and transmit a first interface signal based at least in part on the user interaction; a processor in communication with the touch-sensitive interface and configured to receive the first interface signal and determine a haptic effect based at least in part on the first interface signal, the processor further configured to preload a haptic signal associated with the haptic effect; a cache in communication with the processor and configured to store the preloaded haptic signal for a time period, then transmit the haptic signal; and a haptic effect generator in communication with the cache and configured to receive the haptic signal from the cache and output a haptic effect based at least in part on the haptic signal.

[0005] This illustrative system is mentioned not to limit or define the invention, but rather to provide an example to aid understanding thereof. Illustrative systems and methods are discussed in the Detailed Description, which provides further description of the invention. Advantages offered by various embodiments of this invention may be further understood by examining this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] These and other features, aspects, and advantages of the present invention are better understood when the following Detailed Description is read with reference to the accompanying drawings, wherein:

[0007] FIG. **1** is a block diagram of a system for pre-touch and true touch according to one embodiment of the present invention;

[0008] FIG. **2** is an illustrative device utilizing a system for pre-touch and true touch according to one embodiment of the present invention;

[0009] FIG. **3**A is an illustration of a system for pre-touch and true touch according to one embodiment of the present invention;

[0010] FIG. **3**B is an illustration of a system for pre-touch and true touch according to one embodiment of the present invention;

[0011] FIG. **4** is a flow chart of a method for pre-touch and true touch according to one embodiment of the present invention;

[0012] FIG. **5** is an illustration of a system for pre-touch and true touch according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0013] Embodiments of the present invention provide systems and methods for pre-touch and true touch.

Illustrative Embodiment of Pre-Touch and True Touch

[0014] One illustrative embodiment of the present invention comprises a handheld device, such as a mobile phone. The illustrative handheld device comprises the Samsung Haptic Phone (SCH-W420) equipped with Immersion Corporation's TouchSense® 3000, TouchSense® 4000, or TouchSense® 5000 vibrotactile feedback systems, formerly known as Immersion Corporation's VibeTonz® vibrotactile feedback system. In other embodiments, different handheld devices and haptic feedback systems may be utilized.

[0015] The illustrative handheld device comprises a display, a speaker, a network interface, a memory, a cache, and a processor in communication with each of these elements. The illustrative handheld device also comprises a touch-sensitive interface and an haptic effect generator, both of which are in communication with the processor. The touch-sensitive interface is configured to sense a user's interaction with the handheld device and the haptic effect generator is configured to output a haptic effect. The illustrative handheld device may further comprise a manipulandum, such as a scroll wheel, keyboard, or buttons, configured to detect a user interaction and transmit an interface signal associated with the user interaction to the processor.

[0016] In the illustrative handheld device, the display is configured to display a graphical user interface to the user. The graphical user interface may comprise virtual objects, for example icons, buttons, or a virtual keyboard. The illustrative handheld device further comprises a touch-sensitive interface, such as a touch-screen, mounted overtop of the display. The touch-sensitive interface, allows the user to interact with the virtual objects displayed in the graphical user interface. For example, the graphical user interface may comprise a virtual keyboard. In such an embodiment, the touch-sensitive interface allows the user to touch a key on the virtual keyboard to press that key. This functionality may be used to type messages, or otherwise interact with objects in the graphical user interface.

[0017] The illustrative handheld device further comprises an haptic effect generator configured to receive a haptic signal and output a haptic effect. The haptic effect may comprise one of several haptic effects known in the art, for example, vibrating, knocking, buzzing, jolting, or torquing the handheld device. In the illustrative handheld device, the haptic effect may act as a confirmation that the processor has received a signal associated with user interaction from the touch-sensi-

tive interface. For example, the graphical user interface may comprise a button, and the touch-sensitive interface may detect user interaction associated with pressing the button and transmit an interface signal to the processor. In response, the processor may determine a haptic effect to confirm that it received the interface signal. The processor will then preload the haptic signal associated with the haptic effect to a cache. The cache will store the haptic signal for a period of time and then transmit the haptic signal to the haptic effect generator, which outputs the haptic effect.

[0018] In the illustrative handheld device, the touch-sensitive interface or an associated sensor is capable of detecting the user interaction before the user touches the surface of the touch-sensitive interface. User interaction that does not make physical contact with the touch-screen may be referred to herein as a pre-touch. Based on the pre-touch, the touch-screen transmits a first interface signal to the processor. In the illustrative handheld device, the touch-screen is also configured to detect when the user makes physical contact with the touch-screen. User interaction that makes physical contact with the touch-screen may be referred to herein as a true touch. Based on the true touch, the touch-screen transmits a second interface signal to the processor.

[0019] In the illustrative handheld device, when the processor receives the first interface signal, associated with the pre-touch, the processor is configured to determine a haptic effect. Then the processor transmits a haptic signal associated with the haptic effect to a cache configured to store the haptic signal. Then when the processor receives the second interface signal, associated with the true touch, the processor transmits a signal to the cache, which causes the cache to transmit the haptic effect to the haptic effect generator. Using a cache to preload a haptic effect based on a pre-touch, and then output the haptic effect based on the true touch, allows the illustrative handheld device to output a haptic effect very close to the time the user makes physical contact with the touch-screen. This functionality reduces the risk that the illustrative handheld device will output a "late effect" after the user is no longer touching the touch-screen. This allows the illustrative handheld device to output more compelling haptic effects than other devices known in the art.

[0020] This illustrative example is given to introduce the reader to the general subject matter discussed herein. The invention is not limited to this example. The following sections describe various additional non-limiting embodiments and examples of systems and methods for pre-touch and true touch.

Illustrated System for Pre-Touch and True Touch

[0021] Referring now to the drawings in which like numerals indicate like elements throughout the several figures, FIG. **1** is a block diagram of a system for pre-touch and true touch according to one embodiment of the present invention. As shown in FIG. **1**, the system **100** comprises a handheld device **102**, such as a mobile phone, portable digital assistant (PDA), portable media player, portable computer, messaging device, or portable gaming device. In some embodiment, handheld device **102** comprises a larger device, for example a laptop or desktop computer, a television, or monitor. The handheld device **102** comprises a processor **110** in communication with a network interface **112**, a touch-sensitive interface **114**, a display **116**, a haptic effect generator **118**, a speaker **120**, a memory **122**, a cache **124**, and a sensor **126**. The processor **110** is configured to generate a graphical user interface, which is shown on display **116**.

[0022] The processor **110** is configured to execute computer-executable program instructions stored in memory **122**. For example, processor **110** may execute one or more computer programs for messaging or for generating haptic feedback. Processor **110** may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), one or more field programmable gate arrays (FPGAs), or state machines. Processor **110** may further comprise a programmable electronic device, such as a programmable logic controller (PLC), a programmable interrupt controller (PIC), a programmable logic device (PLD), a programmable read-only memory (PROM), an electronically programmable read-only memory (EPROM or EEPROM), or other similar devices.

[0023] Memory **122** comprises a computer-readable medium that stores instructions, which when executed by processor **110**, cause processor **110** to perform various steps such as those described herein. Embodiments of computer-readable media may comprise, but are not limited to, an electronic, optical, magnetic, or other storage or transmission devices capable of storing and providing processor **110** with computer-executable instructions. Other examples of media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. In addition, various other devices may include computer-readable media such as a router, private or public network, or other transmission devices. The processor **110** and the processing described may be in one or more structures and may be dispersed throughout one or more structures.

[0024] The processor **110** is in communication with a network interface **112**. Network interface **112** may comprise one or more methods of mobile communication, such as infrared, radio, Wi-Fi, or cellular network communication. In other variations, the network interface **112** comprises a wired network interface, such as Ethernet. The handheld device **102** can be configured to exchange messages or virtual message objects with other devices (not shown) over networks, such as a cellular network and/or the Internet. Embodiments of messages exchanged between devices may comprise voice messages, text messages, data messages, or other forms of digital messages.

[0025] The processor **110** is also in communication with one or more touch-sensitive interfaces **114**. The touch-sensitive interface **114** may comprise a touch-sensitive input device (e.g. touch-screen, touch-pad) or some other type of physical device interface known in the art. In some embodiments, the processor is in communication with a single touch-sensitive interface **114**. In other embodiments, the processor is in communication with a plurality of touch-sensitive interfaces, for example, a touch-screen and a touch-pad. Touch-sensitive interface **114** is configured to detect user interaction and, based on the user interaction, transmit interface signals to processor **110**.

[0026] In the embodiment shown in FIG. **1**, the processor **110** is also in communication with a display **116**. The processor **110** can be configured to generate a graphical representation of a user interface to be shown on display **116**, and then transmit a display signal to display **116**. In other embodi-

ments, display **116** is configured to receive a display signal from another device. For example, in some embodiments, display **116** may comprise an external display such as a computer monitor. Display **116** is configured to receive a display signal and output an image associated with that display signal. In some embodiments, the display signal may comprise a vga, hdmi, svga, video, s-video, or other type of display signal known in the art. In some embodiments, display **116** comprises a flat screen display, such as a Liquid Crystal Display (LCD) or Plasma Screen Display. In other embodiments display **116** comprises a Cathode Ray Tube (CRT) or other type of display known in the art. In some embodiments, the display **116** may comprise touch-sensitive interface **114**. In such an embodiment, the touch-sensitive interface **114** may comprise a touch-screen mounted overtop of display **116**. In some embodiments, touch-sensitive interface **114** and display **116** may comprise a single integrated component, such as a touch-screen LCD.

[0027] In some embodiments, the signals received from touch-sensitive interface **114** may be associated with an interaction with the graphical user interface shown on display **116**. For example, in one embodiment, touch-sensitive interface **114** may comprise a touch-screen, and the graphical user interface may comprise a virtual keyboard. In such an embodiment, when the user interacts with a section of the touch-screen that overlays one of the keys of the keyboard, the touch-screen sends a signal to processor **110** corresponding to the user interaction. Based on this signal, processor **110** will determine that the user has pressed one of the keys on the virtual keyboard. In some embodiments, this functionality may be used to type messages, such as text messages and emails. Such an embodiment may further allow the user to interact with other icons and virtual objects on the display. For example, in some embodiments the user may flick a touch-screen to move a virtual ball, or turn a virtual knob on a touch-screen. In some embodiments, not shown in FIG. **1**, the handheld device may comprise an additional manipulandum, such as a scroll wheel, roller ball, or button that facilitates similar interactions between the user and the graphical user interface.

[0028] Touch-sensitive interface **114** is configured to detect two types of user interaction. First touch-sensitive interface **114** is configured to detect a pre-touch. A pre-touch may comprise user interaction prior to the user making physical contact with touch-sensitive interface **114**. In some embodiments, touch-sensitive interface **114** may detect a pre-touch when the user is within a few centimeters off its surface, for example any interaction within 3 cm. In other embodiments, touch-sensitive interface **114** may detect a pre-touch when the user is closer to user interface, for example within ½ cm. In other embodiments, touch-sensitive interface **114** may detect a pre-touch when the user first makes contact with the touch-sensitive interface, but has not applied pressure to touch-sensitive interface **114**. In other embodiments, touch-sensitive interface **114** may detect a pre-touch when the user has made contact with touch-sensitive interface **114**, but less than a threshold surface area of skin is contacting touch-sensitive interface **114**. For example, touch-sensitive interface **114** may detect a pre-touch when the user has contacted touch-sensitive interface **114**, but less than 0.2 cm^2 of skin is in contact with touch-sensitive interface **114**. In still other embodiments, touch-sensitive interface **114** may detect a pre-touch when the user has made contact with touch-sensitive interface **114**, but the contact has not lasted for a threshold length of time. For example, when the user has contacted the touch-sensitive interface, but has not yet stayed in contact with touch-sensitive interface **114** for 0.02 seconds. In some embodiments, touch-sensitive interface **114** may detect the pre-touch by detecting a change in capacitance. For example, in such an embodiment touch sensitive interface **114** may comprise a capacitive touch-screen. In another embodiment, touch-sensitive interface **114** may detect the pre-touch by detect a change in the resistance. For example, in such an embodiment touch-sensitive interface **114** may comprise a resistive touch-screen. When touch-sensitive interface **114** detects a pre-touch, it transmits a first interface signal to processor **110**.

[0029] In some embodiments, processor **110** is also in communication with one or more sensors **126**. Sensor **126** comprises a sensor configured to detect user interaction over the surface of touch-sensitive interface **114** or display **116**, such as user interaction comprising a pre-touch. Based on this user interaction, sensor **126** will send a corresponding sensor signal to processor **110**. Sensor **126** may comprise, for example, an optic, infrared, motion sensor, or some other sensor known in the art.

[0030] Touch-sensitive interface **114** is also configured to detect a true touch. The true touch may comprise user interaction that makes physical contact with the touch-sensitive interface. For example, in one embodiment, a true touch occurs when the user puts his or her finger on the surface of touch-sensitive interface **114**. In such an embodiment, touch-sensitive interface **114** may detect a true touch when a threshold of skin surface area in contact with touch-sensitive interface **114** is crossed, for example, when more than 0.2 cm^2 of skin is in contact with touch-sensitive interface **114**. In other embodiments, touch-sensitive interface **114** may detect a pre-touch when the user first contacts touch-sensitive interface **114**. In such an embodiment, touch-sensitive interface **114** may detect a true touch when the user applies a certain amount of force to touch-sensitive interface **114**, for example, 0.2N. In such an embodiment, touch-sensitive interface **114** may further comprise a force sensor, such as a mechanical or pneumatic pressure sensor. For example, in such an embodiment, touch-sensitive interface **114** may comprise a capacitive touch-screen configured to detect a pre-touch, and further comprise a pressure sensor configured to detect a true touch. In other embodiments, touch-sensitive interface **114** may comprise a plurality of manipulanda, for example a button or switch and a touch-screen. In such an embodiment, the button may be configured to detect a pre-touch, and the touch-screen may be configured to detect a true touch. In other embodiments, the touch-screen may be configured to detect a pre-touch, and the button may be configured to detect a true touch. When touch sensitive interface **114** detects a true touch, it transmits a second interface signal to processor **110**.

[0031] As shown in FIG. **1**, processor **110** is also in communication with a cache **124**. Cache **124** is configured to receive the haptic signal from processor **110** and store or preload the haptic signal for a period of time. In some embodiments, the period of time is fixed, for example a time of 10 ms. In other embodiments, the period of time is defined by the length of time between the pre-touch and the true touch. For example, in such an embodiment, processor **110** transmits the haptic signal to cache **124** after the touch-sensitive interface detects the pre-touch. Then, cache **124** stores the haptic signal until processor **110** receives an interface signal associated with the true touch from touch-sensitive interface **114**. In

some embodiments, the cache may comprise memory, such as RAM, Flash, ROM, or some other memory known in the art. In other embodiments, cache **124** may comprise a means for storing mechanical energy, for example, a flywheel or a spring. In such an embodiment, storing the haptic effect comprises rotating the flywheel and outputting the haptic effect comprises applying a brake to the flywheel. In still other embodiments, the cache and the haptic effect generator may comprise a single component. In such an embodiment, preloading the haptic signal may comprise powering the haptic effect generator to a level just below the point where the haptic effect generator outputs a perceptible haptic effect. For example, in such an embodiment, preloading the haptic signal may comprise powering an eccentric rotating mass actuator to the point just below the level necessary to break the actuator motor's coefficient of static friction. Further, in such an embodiment, transmitting the haptic signal may comprise applying additional power to the actuator, thereby causing the actuator to output the haptic effect. In such an embodiment, the additional power may comprise substantially the full power of the haptic signal. In some embodiments, cache **124** may comprise a capacitor. In such an embodiment, preloading the haptic signal may comprise charging the capacitor with power that can be used to jumpstart a haptic effect generator. In other embodiments, the capacitor could be used to provide an energy boost or "overdrive" to a haptic effect generator that is already in operation.

[0032] As shown in FIG. **1**, handheld device **102** comprises one or more haptic effect generator s **118**. Processor **110** is configured to determine a haptic effect and preload, or transmit a haptic signal corresponding to the haptic effect to cache **124**. Cache **124** is configured to store the haptic signal for a period of time then transmit the haptic signal to haptic effect generator **118**. Haptic effect generator **118** is configured to receive the haptic signal and output the haptic effect. In some embodiments, haptic effect generator **118** is further configured to output the haptic effect after discharging cache **124**. For example, in some embodiments, haptic effect generator **118** may discharge the cache, and then continue outputting the haptic effect until it receives a signal from processor **110** to stop outputting the haptic effect. Haptic effect generator **118** may be an actuator, for example, a piezoelectric actuator, an electric motor, an electro-magnetic actuator, a voice coil, a linear resonant actuator, a shape memory alloy, an electro-active polymer, a solenoid, an eccentric rotating mass motor (ERM), or a linear resonant actuator (LRA). In another embodiment, haptic effect generator **118** may comprise an electrostatic generator or electrostatic display configured to generate a haptic effect. For example, in such an embodiment, the haptic effect generator **118** may use one or more films of a capacitive sheet to output a periodic electrostatic charge, which generates a force that attracts the user's finger to a surface of the haptic effect generator. For example, by generating a charge differential between the user's finger and the surface of a display or a surface of touch-sensitive interface **114**. In some embodiments, this electrostatic force may be configured to control friction between the user's finger and the haptic effect generator. This friction may simulate a texture on the surface of the display, or some other haptic effect.

[0033] In some embodiments, after detecting the pre-touch, touch-sensitive interface **114** may never detect a true touch. In such an embodiment, processor **110** may be configured to wait a predetermined time period, and then send an instruction to the cache **124** to discharge the haptic effect slowly so that no effect is perceptible to the user of the device **100**. For example, processor **110** may be configured to slowly discharge the contents of a capacitor, allow the speed of the flywheel to decrease, or delete the haptic signal stored in a memory. In such an embodiment, the cache **124** is discharged without outputting the haptic effect.

[0034] As shown in FIG. **1**, processor **110** is also in communication with speaker **120**. Speaker **120** is configured to receive audio signals from processor **110** and output them to the user. In some embodiments, the audio signals may be associated with the haptic effect output by haptic effect generator **118**, or the image output by display **116**. In other embodiments, the audio signal may not correspond to the haptic effect or the image.

[0035] FIG. **2** is an illustrative handheld device utilizing a system for pre-touch and true touch according to one embodiment of the present invention. FIG. **2** comprises a handheld device **200**, such as a mobile phone, PDA, portable media player, global positioning system, or portable gaming device. The handheld device **200** is configured to send and receive signals, such as voicemail, text messages, and other data messages, over a network such as a cellular network or the Internet. The handheld device **200** may comprise a wireless network interface and/or a wired network interface (not shown in FIG. **2**). Although the device **200** is illustrated as a handheld device in FIG. **2**, other embodiments may comprise different devices, such as video game systems and/or personal computers.

[0036] As shown in FIG. **2**, the handheld device **200** comprises a housing **202** and a display **206**. In some embodiments, display **206** may comprise an LCD display. In other embodiments, display **206** may comprise a plasma display, or other type of display known in the art. In the embodiment shown in FIG. **2**, display **206** is blank. But display **206** is configured to receive display signals from the processor and output them to the user. For example, in some embodiments these signals may comprise a graphical user interface. In such an embodiment, display **206** is configured to receive a display signal comprising the graphical user interface, and output an image comprising the graphical user interface.

[0037] Referring still to FIG. **2**, the handheld device **200** further comprises a manipulandum **214**. In the embodiment shown in FIG. **2**, the manipulandum **214** comprises a roller ball and buttons. The handheld device **200** also comprises a touch-sensitive interface **204**. In the embodiment shown in FIG. **2**, the touch-sensitive interface comprises a touch-screen positioned overtop of display **206**. In some embodiments, display **206** and the touch-screen may comprise a single integrated component, such as a touch-screen display.

[0038] Manipulandum **214** and touch-sensitive interface **204** are configured to detect user interaction and transmit interface signals corresponding to the user interaction to the processor. In some embodiments, the user interaction is associated with a graphical user interface shown on display **206**. In such an embodiment, the processor receives the interface signal and, based at least in part on the interface signal, manipulates the graphical user interface. For example, the user may use manipulandum **214** or touch-sensitive interface **204** to depress a virtual button displayed on the graphical user interface. In another embodiment, the user may use manipulandum **214** or touch-sensitive interface **204** to navigate a set of menus in the graphical user interface.

[0039] Touch-sensitive interface **204** is configured to detect two types of user interaction. First touch-sensitive interface

204 is configured to detect a pre-touch. A pre-touch may comprise user interaction prior to the user making physical contact with the surface of touch-sensitive interface **204**, user interaction that does not result in a certain threshold area of skin in contact with touch-sensitive interface **204**, or user interaction that has not yet lasted for a threshold length of time. For example, the touch-sensitive interface **204** may detect user interaction a few millimeters or up to several centimeters above its surface, or detect a pre-touch when the user has made contact with touch-sensitive interface **204**, but less than 0.2 cm^2 of skin is in contact with touch-sensitive interface **204**. When touch-sensitive interface **204** detects a pre-touch, it transmits a first interface signal to a processor. Touch-sensitive interface **204** is also configured to detect a true touch. A true touch may comprise user interaction that makes physical contact with the surface of the touch-sensitive interface. In other embodiments, touch-sensitive interface **204** may detect a true touch when a certain threshold area of skin is in contact with touch-sensitive interface **204**. For example, when the user puts their finger on the surface of a touch-screen, or when the touch-screen detects contact with more than 0.2 cm^2 of skin. When touch sensitive interface **204** detects a true touch, it transmits a second interface signal to the processor.

[0040] In some embodiments, a pre-touch and a true touch can be interpreted as two thresholds detected by touch-sensitive interface **204**. For example, in one embodiment, touch-sensitive interface **204** comprises a capacitive touch-screen. In such an embodiment, touch-sensitive interface **204** may detect a pre-touch when it detects a first capacitance. Further, in such an embodiment, touch-sensitive interface **204** may detect a true touch when it detects a second capacitance that is greater or less than the first capacitance. In another embodiment, touch-sensitive interface **204** may comprise a resistive touch-screen. In such an embodiment, touch-sensitive interface **204** may detect a pre-touch when it detects a first resistance. Further, in such an embodiment, touch-sensitive interface **204** may detect a true touch when it detects a second resistance that is greater or less than the first capacitance. In other embodiments, the thresholds may be of a different type, for example voltage, current, magnetic, temperature, or data based thresholds.

[0041] When the processor receives the first interface signal, associated with the pre-touch, processor **110** determines a haptic effect. Then, the processor transmits the haptic signal to a cache (not shown in FIG. **2**) configured to preload the haptic effect. Then, when the processor receives the second interface signal, associated with the true touch, it transmits a signal to the cache. Upon receiving this signal, the cache transmits the haptic signal to an haptic effect generator (not shown in FIG. **2**) configured to output the haptic effect. In other embodiments, touch-sensitive interface **204** is in direct communication with the cache. In such an embodiment, touch-sensitive interface **204** is configured to transmit the signal associated with the true touch directly to the cache.

[0042] In some embodiments, after detecting the pre-touch, touch-sensitive interface **204** may never detect a true touch. In such an embodiment, the processor may be configured to wait a predetermined time period, and then send an instruction to the cache to discharge the haptic effect slowly. For example, slowly discharging the contents of a capacitor, slowly decreasing the speed of the flywheel, or deleting the haptic signal stored in a memory. In such an embodiment, the cache is discharged without outputting the haptic effect.

[0043] FIG. **3**A is an illustration of a system for pre-touch and true touch according to one embodiment of the present invention. FIG. **3**A comprises a handheld device **300**, such as a mobile phone, PDA, portable media player, or portable gaming device. The handheld device **300** is configured to send and receive signals, such as voicemail, text messages, and other data messages, over a network such as a cellular network or the Internet. The handheld device **300** comprises a wireless network interface and/or a wired network interface (not shown in FIG. **3**A). Although the device **300** is illustrated as a handheld device in FIG. **3**A, other embodiments may comprise different devices, such as video game systems and/or personal computers.

[0044] As shown in FIG. **3**A, the handheld device **300** comprises a housing **302** and a display **316**. In some embodiments, display **316** may comprise an LCD display. In other embodiments, display **316** may comprise a plasma display, or other type of display known in the art. Display **316** is configured to receive display signals from the processor and output them to the user. In the embodiment shown in FIG. **3**A, display **316** comprises a graphical user interface comprising a virtual QWERTY keyboard, a heart, and a text box.

[0045] Referring still to FIG. **3**A, the handheld device **300** further comprises a touch-sensitive interface **314**. In the embodiment shown in FIG. **2**, touch-sensitive interface **314** comprise a touch-screen positioned overtop of display **316**. Touch-sensitive interface **314** is configured to detect two types of user interaction and transmit interface signals corresponding to the user interaction to processor **110**. First touch-sensitive interface **314** is configured to detect a pre-touch. A pre-touch may comprise user interaction prior to the user making physical contact with the surface of touch-sensitive interface **314**. For example, as shown in FIG. **3**A, user's finger **304** is moving towards touch-sensitive interface **314**. In the embodiment shown in FIG. **3**A, touch-sensitive interface **314** may detect the user interaction prior to the user's finger **304** making physical contact with touch-sensitive interface **314**. For example, in some embodiments, touch-sensitive interface **314** may detect the user's finger **304** when it is just a few millimeters over the surface of touch-sensitive interface **314**, e.g. within 5 mm. In other embodiments, touch-sensitive interface **314** will detect the user's finger **304** when it is a few centimeters over the surface touch-sensitive interface **314**, for example within 5 cm. In other embodiments, touch-sensitive interface **314** may detect a pre-touch when the user has made contact with touch-sensitive interface **314**, but when less than a threshold area of skin is in contact with touch-sensitive interface **314**. In other embodiments, touch-sensitive interface may detect a pre-touch when it detects a user interaction for less than a threshold period of time, for example, less than 0.02 seconds. When touch-sensitive interface **314** detects a pre-touch, it transmits a first interface signal to processor **110**.

[0046] When processor **110** receives the first interface signal associated with the pre-touch, processor **110** determines a haptic effect. Then processor **110** transmits a haptic signal to a cache (not shown in FIG. **3**A) configured to preload the haptic signal. In some embodiments, the cache may comprise a memory, such as a RAM, ROM, EEPROM, or other type of memory known in the art. In such an embodiment, preloading the haptic signal may comprise storing the haptic signal in memory. In other embodiments, the cache may comprise a battery, capacitor, inductor, or some other energy storage means. In such an embodiment, preloading the haptic signal may comprise storing the energy necessary to generate the

haptic effect. In still other embodiments, the cache may comprise a means for storing mechanical energy, for example, flywheel or a spring. In such an embodiment, preloading the haptic signal may comprise rotating the flywheel or preloading the spring. In still other embodiments, the cache may comprise the haptic effect generator itself. In such an embodiment, preloading the haptic signal comprises powering a haptic effect generator to a point below the point where the user can feel a haptic effect. For example, preloading the haptic signal may comprise powering the haptic effect generator to a point just below the power that breaks the coefficient of static friction within the haptic effect generator. In such an embodiment, transmitting the haptic signal may comprise applying additional power to the haptic effect generator, thereby causing the haptic effect generator to output the haptic effect. In such an embodiment, the additional power may comprise substantially the full power of the haptic signal.

[0047] FIG. **3**B is an illustration of a system for pre-touch and true touch according to one embodiment of the present invention. FIG. **3**B comprises a side view of the handheld device **300**, also shown in FIG. **3**A. In the embodiment shown in FIG. **3**B, the user's finger **304** has made physical contact with touch-sensitive interface **314**. When user's finger **304** makes physical contact with touch-sensitive interface **314**, it detects a true touch. In other embodiments, touch-sensitive interface **314** may not detect a true touch until a certain threshold area of skin is in contact with touch-sensitive interface **314**. For example, when more than 0.2 cm^2 is in contact with touch-sensitive interface **314**. In other embodiments, touch-sensitive interface **314** may detect a true touch when the user has been in contact with touch-sensitive interface **314** for more than a threshold period of time, for example, more than 0.02 seconds. When touch-sensitive interface detects a true touch, it transmits a second interface signal to processor **110**.

[0048] When processor **110** receives the second interface signal, processor **110** transmits a signal to the cache configured to cause the cache to transmit the haptic signal to the haptic effect generator, which then outputs the haptic effect. In an embodiment wherein the cache comprises a memory, transmitting the haptic signal comprises transmitting the haptic signal to the haptic effect generator. In an embodiment wherein the cache comprises an energy storage device such as a battery, inductor, or capacitor, transmitting the haptic signal comprises outputting the energy to the haptic effect generator. In an embodiment wherein the cache comprises a flywheel, transmitting the haptic signal comprises transmitting a signal to a brake configured to slow the speed of the haptic effect generator, outputting a torque on the handheld device. In an embodiment wherein the cache comprises the haptic effect generator, transmitting the haptic signal to the haptic effect generator comprises activating the haptic effect generator at the power necessary to generate the haptic effect.

[0049] In some embodiments, after detecting the pre-touch, touch-sensitive interface **314** may never detect a true touch. In such an embodiment, processor **110** may be configured to wait a predetermined time period, and then send an instruction to the cache to discharge the haptic effect slowly. For example, slowly discharging the contents of a capacitor, slowly slowing the speed of the flywheel, or deleting the haptic signal stored in a memory. In such an embodiment, the cache is discharged without outputting the haptic effect.

Illustrative Methods for Pre-Touch and True Touch

[0050] FIG. **4** is a flow chart for a method of pre-touch and true touch according to one embodiment of the present invention. The method **400** shown in FIG. **4** is described with reference to the system shown in FIG. **1**. The method **400** begins when processor **110** receives an interface signal from touch-sensitive interface **114**, which is configured to detect a user interaction and transmit an interface signal based at least in part on the user interaction **402**. In some embodiments, touch-sensitive interface **114** comprises a touch-pad or a touch-screen. In some embodiments, the touch-sensitive interface is mounted overtop of a display. The touch-sensitive interface **114** is configured to detect two types of user interaction, a pre-touch and a true touch. The pre-touch may comprise user interaction above the surface of touch-sensitive interface **114** that does not make contact with the surface of touch-sensitive interface **114**. For example, in one embodiment, the user may use the touch-sensitive interface to interact with a virtual keyboard. In such an embodiment, touch-sensitive interface **114** may detect a pre-touch when the user's finger is a few millimeters over the surface of the touch-screen, for example 5 millimeters or less. In other embodiments touch-sensitive interface **114** may detect the user interaction further from its surface, for example when the user interaction is within 3 centimeter or more. In still other embodiments, touch-sensitive interface **114** may detect a pre-touch when it detects user contact that has not yet lasted for over a threshold period of time, for example less than 0.02 seconds. In yet another embodiment, touch-sensitive interface **114** may detect a pre-touch when it detects user contact, but less than a threshold area of skin is in contact with touch-sensitive interface **114**, for example, less than 0.2 cm^2 of skin.

[0051] Next, touch-sensitive interface **114** transmits a second interface signal and processor **110** receives the second interface signal **404**. Touch-sensitive interface **114** is configured to transmit the second interface signal to processor **110**, based at least in part on a true touch. A true touch may comprise user interaction that results in physical contact between the user and the touch-sensitive interface, for example, when the user places a finger on the surface of the touch-sensitive interface. In other embodiments, touch-sensitive interface **114** may not detect a true touch until a certain threshold area of skin is in contact with touch-sensitive interface **114**. For example, when more than 0.2 cm^2 is in contact with touch-sensitive interface **114**. In other embodiments, touch-sensitive interface **114** may detect a true touch when the user has been in contact with touch-sensitive interface **114** for more than a threshold period of time, for example, more than 0.02 seconds.

[0052] Then, processor **110** determines a haptic effect based at least in part on the first interface signal **406**. For example, in one embodiment, processor **110** may perform a series of algorithms to determine the appropriate haptic effect. In another embodiment, processor **110** may use a lookup table to determine the haptic effect. The haptic effect may comprise one of any haptic effect known in the art, for example, a vibration, a torque, a knocking, a clicking, or a haptic effect configured to generate a texture or a friction.

[0053] Next, processor **110** preloads a haptic signal associated with the haptic effect to cache **124**, which is configured to store haptic signal for a period of time **408**. In some embodiments, the period of time is fixed, for example a time of 10 ms. In other embodiments, the period of time may be a fixed period of time that is longer or shorter than 10 ms. In still other embodiments, the period of time is defined by the length of time between the pre-touch and the true touch. For example, in some embodiments processor **110** transmits the

haptic signal to cache **124** after the touch-sensitive interface detects the pre-touch. Then, cache **124** stores the haptic signal until processor **110** receives an interface signal associated with the true touch from touch-sensitive interface **114**. In some embodiments, the cache may comprise memory, such as RAM, Flash, ROM, configured processor or some other memory known in the art. In other embodiments, cache **124** may comprise a means for storing mechanical energy, for example, a spring or a flywheel. In such an embodiment, storing the haptic effect comprises rotating the flywheel and outputting the haptic effect comprises applying a brake to the flywheel. In still other embodiments, the cache and the haptic effect generator may comprise a single component. In such an embodiment, preloading the haptic signal may comprise powering the haptic effect generator to a level just below the point where the haptic effect generator outputs a perceptible haptic effect. For example, in such an embodiment, preloading the haptic signal may comprise powering the haptic effect generator to the point just below the level necessary to break the haptic effect generator's coefficient of static friction.

[0054] Finally, cache **124** transmits the haptic signal to an haptic effect generator **118** configured to output the haptic effect **410**. In some embodiments, cache **124** transmits the haptic signal to haptic effect generator **118** after receiving the second interface signal from touch-sensitive interface **114**. For example, after touch-sensitive interface **114** detects a true touch. In some embodiments, Haptic effect generator **118** may be, a piezoelectric actuator, an electric motor, an electromagnetic actuator, a voice coil, a linear resonant actuator, a shape memory alloy, an electro-active polymer, a solenoid, an eccentric rotating mass motor (ERM), or a linear resonant actuator (LRA). In some embodiments, the cache may receive a signal from processor **110**, and based on that signal transmit the haptic signal to the haptic effect generator. In other embodiments, the cache may be in communication with touch-sensitive interface **114**. In such an embodiment, the touch-sensitive interface may transmit the second interface signal, associated with the true touch, to the cache. In such an embodiment, the cache will transmit the haptic signal to the haptic effect generator when it receives the second interface signal.

[0055] In embodiments wherein the cache comprises different components, transmitting the haptic signal may comprise different operations. For example, in an embodiment wherein the cache comprises a memory, transmitting the haptic signal comprises transmitting the haptic signal to the haptic effect generator. In an embodiment, wherein the cache comprises an energy storage device such as a battery, inductor, or capacitor, transmitting the haptic signal comprises outputting the energy to the haptic effect generator. In an embodiment wherein the cache comprises a flywheel, transmitting the haptic signal comprises transmitting a signal to a brake configured to slow the speed of the haptic effect generator, outputting a torque on the handheld device. In an embodiment wherein the cache comprises the haptic effect generator, transmitting the haptic signal to the haptic effect generator comprises activating the haptic effect generator at the power necessary to generate the haptic effect.

Illustrated Embodiments of Systems for Pre-Touch and True Touch

[0056] FIG. **5** is an illustration of a system for pre-touch and true touch according to one embodiment of the present invention. FIG. **5** comprises system **500**, which is configured to be mounted inside the housing of a handheld device according to one embodiment of the present invention. The system **500** is configured to receive a haptic signal from processor **110** and in response output a haptic effect. System **500** comprises an actuator **518**, which is connected to axle **502**, and flywheel **504**. System **500** further comprises a braking mechanism **506** and brake **508** configured to stop the flywheel.

[0057] According to one embodiment of the present invention, when processor **110** receives a first interface signal associated with a pre-touch, processor **110** will determine a haptic effect. Then processor **110** will preload the haptic signal to a cache configured to store the haptic signal. In the embodiment shown in FIG. **5**, the cache comprises flywheel **504**, and preloading the cache comprises spinning flywheel **504**. Accordingly, when processor **110** transmits, or preloads, the haptic signal to the cache, actuator **518** rotates axle **502**, which then rotates flywheel **504**. In order to prevent the handheld device from receiving a torque, actuator **518** may be configured to slowly accelerate flywheel **504** up to speed, thereby preventing a noticeable torque on the handheld device.

[0058] When processor **110** receives the second interface signal, associated with a true touch, from the touch-sensitive interface, processor **110** transmits a second signal to braking mechanism **506**. In response, braking mechanism **506** pulls brake **508** against flywheel **504**, thus slowing flywheel **504**. When flywheel **504** is slowed, it outputs a torque on the housing that actuator **518** is mounted to. The strength of the torque is associated with how rapidly flywheel **504** is slowed. Thus, braking mechanism **506** may be configured to apply varying pressures on flywheel **508** in order to provide varying levels of torque. For example, processor **110** may determine a weak haptic effect. In such an embodiment braking mechanism may slow flywheel **504** only slightly, thereby outputting a minimal torque. In other embodiments, processor **110** may determine a strong haptic effect. In such an embodiment, braking mechanism may slow flywheel to a complete stop in less than a rotation and thereby output a very strong torque.

Advantages of Systems for Pre-Touch and True Touch

[0059] Systems and methods of pre-touch and true touch provide many advantages. For example, systems and methods of pre-touch and true touch allow devices to output more compelling haptic effects because they allow the handheld device to output the haptic effect more quickly. This reduces the risk that the user will have already removed their fingers from the device when the effect is output. Further, systems and methods of pre-touch and true touch provide greater flexibility in component selection in haptic devices. For example, a slower processor may be used because there is less risk that a system utilizing systems and methods of pre-touch and true touch will output a haptic effect after the user has stopped touching the system. Similarly, a less powerful haptic effect generator may be required because systems and methods of pre-touch and true touch require less acceleration from the haptic effect generator to generate the haptic effect on time. All of these benefits may lead to greater satisfaction and faster adoption of devices that incorporate systems and methods for pre-touch and true touch.

General Considerations

[0060] The use of "adapted to" or "configured to" herein is meant as open and inclusive language that does not foreclose

devices adapted to or configured to perform additional tasks or steps. Additionally, the use of "based on" is meant to be open and inclusive, in that a process, step, calculation, or other action "based on" one or more recited conditions or values may, in practice, be based on additional conditions or values beyond those recited. Headings, lists, and numbering included herein are for ease of explanation only and are not meant to be limiting.

[0061] Embodiments in accordance with aspects of the present subject matter can be implemented in digital electronic circuitry, in computer hardware, firmware, software, or in combinations of the preceding. In one embodiment, a computer may comprise a processor or processors. The processor comprises or has access to a computer-readable medium, such as a random access memory (RAM) coupled to the processor. The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs including a sensor sampling routine, a haptic effect selection routine, and suitable programming to produce signals to generate the selected haptic effects as noted above.

[0062] Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

[0063] Such processors may comprise, or may be in communication with, media, for example tangible computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, all electronic, optical, magnetic, or other storage devices capable of providing a processor, such as the processor in a web server, with computer-readable instructions. Other examples of media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other devices may include computer-readable media, such as a router, private or public network, or other transmission device. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein.

[0064] While the present subject matter has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, it should be understood that the present disclosure has been presented for purposes of example rather than limitation, and does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art.

That which is claimed is:

1. A system comprising:

a touch-sensitive interface configured to detect a user interaction and transmit a first interface signal based at least in part on the user interaction;

a processor in communication with the touch-sensitive interface and configured to receive the first interface signal and determine a haptic effect based at least in part on the first interface signal, the processor further configured to preload a haptic signal associated with the haptic effect;

a cache in communication with the processor and configured to store the preloaded haptic signal for a time period, then transmit the haptic signal; and

a haptic effect generator in communication with the cache and configured to receive the haptic signal from the cache and output a haptic effect based at least in part on the haptic signal.

2. The system of claim **1**, wherein the touch-sensitive interface comprises a touch-screen.

3. The system of claim **1**, wherein the touch-sensitive interface is configured:

to detect the user interaction before a physical contact; and

to detect the physical contact.

4. The system of claim **3**, wherein the touch-sensitive interface is configured to transmit the first interface signal based at least in part on the user interaction before the physical contact, and wherein the touch-sensitive interface is configured to transmit a second interface signal based at least in part on the physical contact.

5. The system of claim **4**, wherein:

the processor is configured to determine the haptic effect based at least in part on the first interface signal, and

the cache is configured to output the haptic signal based at least in part on the second interface signal.

6. The system of claim **3**, wherein the period of time is the time between detecting user interaction and detecting the physical contact.

7. The system of claim **3**, wherein the cache transmits the haptic signal to the haptic effect generator after detecting the physical contact.

8. The system of claim **1**, wherein the time period is predefined.

9. The system of claim **1**, wherein the cache comprises a memory.

10. The system of claim **1**, wherein the cache comprises one of: a capacitor, an inductor, or a battery.

11. The system of claim **1**, wherein:

the cache comprises a flywheel, and

storing the haptic signal comprises rotating the flywheel.

12. The system of claim **11**, further comprising a flywheel brake and wherein outputting the haptic effect comprises slowing the flywheel.

13. The system of claim **1**, further comprising a sensor configured to detect a user interaction above the surface of the touch-sensitive interface and transmit a sensor signal to the processor corresponding to the user interaction.

14. The system of claim **13**, wherein the sensor comprises one of: an optical sensor, an infrared sensor, or a motion sensor.

15. The system of claim **1**, further comprising a housing configured to contain the processor, the cache, and the haptic effect generator.

16. The system of claim 15, wherein the housing comprises a handheld device housing.

17. The system of claim 15, wherein the haptic effect generator is configured to output the haptic effect onto the housing.

18. A method for generating a haptic effect comprising:

receiving a first interface signal from a touch-sensitive interface configured to detect a user interaction and transmit an interface signal based at least in part on the user interaction;

determining a haptic effect based at least in part on the first interface signal;

preloading a haptic signal associated with the haptic effect to a cache configured to store the haptic signal for a period of time; and

transmitting the haptic signal to a haptic effect generator configured to output the haptic effect.

19. The method of claim 18, wherein the touch-sensitive interface is configured to detect the user interaction before a physical contact and to detect the physical contact.

20. The method of claim 19, wherein the period of time is the period between detecting the user interaction and detecting physical contact.

21. The method of claim 19, further comprising receiving a second interface signal from the touch-sensitive interface, and wherein the touch-sensitive interface is configured to transmit the first interface signal based at least in part on the user interaction before the physical contact and transmit the second interface signal based at least in part on the physical contact.

22. The method of claim 21, wherein the haptic signal is transmitted to the haptic effect generator after receiving the second interface signal.

23. A computer readable medium encoded with processor executable program code, the computer readable medium comprising:

program code to receive an interface signal from a touch-sensitive interface configured to detect a user interaction, the touch-sensitive interface further configured to transmit an interface signal based at least in part on the user interaction;

program code to determine a haptic effect based at least in part on the interface signal;

program code to preload a haptic signal associated with the haptic effect to a cache configured to store the haptic signal for a time period; and

program code to transmit the stored haptic signal to a haptic effect generator configured to output the haptic effect.

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最終頁に続く

(54)【発明の名称】　集塊の検知及び／又は定量法

【特許請求の範囲】

【請求項１】ｉ）受体基質をブロッティング媒体に固定化し；

ii）該ブロッティング媒体を、該受体基質に対するコロイド状金属粒子で標識された特異的結合剤と接触させ；そして

iii）該受体基質と該特異的結合剤との間の反応部位でコロイド状金属粒子により生ずるブロッティング媒体の表面における着色信号を検知する、工程からなることを特徴とするブロット・オーバレイ分析による受体基質の検知及び／又は定量法。

【請求項２】随時電気泳動分離法を適用し、電気泳動媒体からブロッティング媒体への転移又はブロッティングを適用し、続いて結合部位に特異的な残存する試剤を技術的に公知の方法で消去した後、直接的吸着及び／又は共有結合によって固定化工程を行なう特許請求の範囲第１項記載の方法。

【請求項３】ブロッティング媒体を、受体基質を含有する水溶液と接触させることによって、該ブロッティング媒体に固定化せしめられた特異的結合蛋白により、受体基質を結合せしめることで固定化工程を行なう特許請求の範囲第１項記載の方法。

【請求項４】コロイド状金属粒子が粒子径３～１００ｎｍの金、銀、白金又はこれらの金属の化合物或いは鉄又は銅化合物からなる特許請求の範囲第１～３項のいずれかに記載の方法。

【請求項５】コロイド状金属粒子が粒子径３～１００ｎｍの金及び／又は銀からなる特許請求の範囲第１～４項のいずれかに記載の方法。

【請求項６】コロイド状金属粒子の最終的検知を、物理

的現像剤の適用後に行なう特許請求の範囲第１～５項のいずれかに記載の方法。
【請求項７】物理的現像剤が銀含有化合物である特許請求の範囲第６項記載の方法。
【請求項８】ｉ）受体基質をブロッティング媒体に固定化し；
ii）該ブロッティング媒体を、該受体媒質に対する標識されていない特異的結合剤と、そして続いて該標識されていない特異的結合剤に対して特異的なコロイド状金属で標識された蛋白と接触させ；そして
iii）該受体基質と該特異的結合剤との間の反応部位でコロイド状金属粒子により生ずるブロッティング媒体の表面における着色信号を検知する、工程からなることを特徴とするブロット・オーバレイ分析による受体基質の検知及び／又は定量法。
【請求項９】随時電気泳動分離法を適用し、電気泳動媒体からブロッティング媒体への転移又はブロッティングを適用し、続いて結合部位に特異的な残存する試剤を技術的に公知の方法で消去した後、直接的吸着及び／又は共有結合によって固定化工程を行なう特許請求の範囲第８項記載の方法。
【請求項１０】ブロッティング媒体を、受体基質を含有する水溶液と接触させることによって、該ブロッティング媒体に固定化せしめられた特異的結合蛋白により、受体基質を結合せしめることで固定化工程を行なう特許請求の範囲第８項記載の方法。
【請求項１１】コロイド状金属粒子が粒子径３～１００ｎｍの金、銀、白金又はこれらの金属の化合物或いは鉄又は銅化合物からなる特許請求の範囲第８～１０項のいずれかに記載の方法。
【請求項１２】コロイド状金属粒子が粒子径３～１００ｎｍの金及び／又は銀からなる特許請求の範囲第８～１１項のいずれかに記載の方法。
【請求項１３】コロイド状金属粒子の最終的検知を、物理的現像剤の適用後に行なう特許請求の範囲第８～１２項のいずれかに記載の方法。
【請求項１４】物理的現像剤が銀含有化合物である特許請求の範囲第１３項記載の方法。
【発明の詳細な説明】
本発明は、結合剤及び対応する受体基質によって生成した凝集物の、ブロット・オーバレイ分析（blot overlay assays）による検知及び／又は定量法に関する。受体基質は普通水性試験試料中に含まれ、分析の後の段階において固定化マトリックスに吸着され及び／又は共有的に結合せしめられる。固定化マトリックスの例は、ニトロセルロース（ＮＣ）フィルム（公知の孔性の硝酸エステル化セルロースの薄い層）、ジアゾベンジルオキシメチル（ＤＢＭ）－及びジアゾフェニルチオエーテル（ＤＰＴ）改変のセルロース紙、シアノーゲンブロマイドで活性化された紙又は酢酸セルロース、及びナイロンに基づく膜例えばGene Screen及びZetabindである。この後者は、製造中に多くの３級アミノ基を導入することによって改変したナイロンマトリックス（ナイロン６６として言及されるポリヘキサメチレンアジペート）である。該固定化マトリックスは通常ブロッティング媒体（blotting media）として言及される。〔例えば、ジエイ・エム・ゲルシヨニ及びジー・イー・パレード（Ｊ．Ｍ．Gershoni及びＧ．Ｅ．Pallade）、アナリテイカル・バイオケミストリイ(Analytical Biochemistry)、１３１、１～１５（１９８３）参照〕。
ブロット・オーバレイ分析は一般に２つの異なる技術に分類できる：
Ａ．サンドウィッチ式オーバレイ分析では、Ｂ（下記参照）による固定化マトリックスに、精製した又は富んだ特異的結合剤を好ましくは小さいスポットとして付け、受体基質をこれに結合させてマトリックスに固定化し、続いてこれを検知する。これは特異的結合剤の特異性のために受体基質を複雑な試験試料例えば尿、血漿、血清、他の体液、細胞を含まない翻訳系、細胞及び組織溶解物などから分離することに、またこの手法を半定量及び／又は定性（診断）分析、即ち所謂サンドウィッチ式ブロット・オーバレイ分析（ＳＢＯＡ）に使用することを可能にする。現在まで、比較的複雑な検知法だけが今日使用されているから、ＳＢＯＡの実際的な価値は無視されてきた。しかし本発明の具体例によれば、その検知法は非常に単純化され、ＳＢＯＡの診断に対する興味は増大する可能性がある。
Ｂ．直接的なブロット・オーバレイ分析においては、「転移（transfer）」又は「ブロッティング（blotting）」として公知の方法により受体基質をブロッティング媒体に直接付ける。これを行なう文献から良く知られた他の方法も存在する。例えば１μｌ程度（他の量でもよい）の公知の又は未知の量の受体基質（精製したもの又はしないもの）を含有する小滴を、ブロッティング媒体上に点として適用して、受体基質をブロッティング媒体に付着させる。そのような点状のブロット（blot）は種々の体液中の固定化された受体基質に対する特異的結合剤の存在の診断上の検知に潜在的に用いることができる。受体基質が複雑な混合物の一部である場合には、受体基質の同定を容易にするために、後者を種々のクロマトグラフィー法例えば薄層クロマトグラフィー法又は電気泳動法例えばポリアクリルアミドゲル中での方法、例えばドデシル硫酸ナトリウム（ＳＤＳ）電気泳動法、等電フォーカス法（isoelectric focusing）、２－Ｄゲル電気泳動法、グラジエント・ゲル及び酸－尿素ゲル電気泳動法、及び無変性ゲル電気泳動法で分離することができる。核酸に対するようないくつかの場合には、寒天ゲルも使用できる。次いで電気泳動法で分割した成分（例えば蛋白質、ペプチド及び核酸）をキャピラリー、真空又は電気的転移（或いはブロッティング）によって固定

化マトリックスに転移させる。続いて元の電気泳動パターンを殆んど保持させながら、成分をブロッティング媒体上に固定化させる。この完全なパターンは公知の染色法例えばアミド・ブラック及びクーマシー（coomassie）青を用いて肉眼で見えようにでき、問題としている成分（受体基質）を検知する（更に見る）ことができる。この時その位置は全電気泳動パターンと関係づけられる。

今まで使用された特異的結合剤のほとんどは、受体基質の十分はっきりした領域へ結合する蛋白質であった。糖蛋白を検知するにはレクチンが使用される。ポリクローナル及びモノクローナル抗体は、その対応する抗原又はハプテンを検知するために使用される（例えばビオチン又はビオチニル化（biotynylated）ＤＮＡは、抗ＤＮＰを有するジニトロフエニル化蛋白上において抗ビオチン、ＤＮＰで検査される）。ブロット・オーバレイ分析は、抗体の特異性を試験するために及びモノクローナル抗体の選別においてすでに広く使用されている。これら広く使用されている系のほかに、成分の１つが固定化されている場合多くの他の蛋白－蛋白（例えばカルモジュリン（calmodulin）又はアクチン（actin）結合蛋白）、或いは蛋白－配位体（例えばアビジン（avidin）－ビオチン）相互作用も分析することができる。これらはＤＮＡ－蛋白及びＲＮＡ－蛋白相互作用、受体－配位体相互作用、及び一般にいずれか他の、十分に特異的な及び親和性の巨大分子－巨大分子相互作用を含む。

ブロット・オーバレイ分析の本質的な部分は、固定化された受体基質を見えるようにするために使用される方法である。直接的及び間接的方法が存在する。検知の本質はマーカー、即ち放射性同位元素（３Ｈ、１４Ｃ、３２Ｐ、３５Ｓ又は１２５Ｉ）を利用し、続いて自動放射線写真現像剤；不溶性の着色生成物又は螢光色素を形成することのできる酵素を用いるものである。直接的な方法においては、マーカーが特異的結合剤に結合する。間接的な方法では、それは第１の特異的結合剤に対して特異的に結合することのできる巨大分子に結合する。後者が抗体である場合、巨大分子は蛋白質Ａ又は２次抗体を有していてよい。アビジン・ビオチニル化西洋ワサビペルオキシダーゼの複合体（ＡＢＣ）及び標識されてないペルオキシダーゼの抗ペルオキシダーゼ（ＰＡＰ）を用いる方法のような工程の多い技術も抗体に対して使用できる。

本発明の本質的な観点は、金属又は金属化合物或いは金属又は金属化合物でコーティングした核の分散液を、ブロット・オーバレイ法における視覚化及び／又は検知手段として利用する。本明細書で用いる如き「コロイド状金属粒子」とは、粒子の分散液、随時金属、金属化合物或いは金属又は金属化合物でコーティングした核からなるゾルを包含する。

コロイド状金属粒子は、次の技術的に公知の方法、例えばコロイド状の金、銀又は鉄酸化物などの製造法に従って製造することができる。コロイド状金属粒子は、技術的に公知の方法に従い、特異的に結合する蛋白又は受体基質に或いは第１の特異的に結合する試剤に対して特異的に結合する巨大分子例えば蛋白質Ａ、２次抗体（１次抗体の場合）、又はストレプタビジン（streptavidin）及びアビジン（成分の１つをビオチニル化する場合）に、元の結合活性のほとんどを保持したままで直接又は間接的に付着させることができる。ここにこの付着（attaching）とは、化学的又は物理的結合、例えば共有結合、水素橋、極性引力及び吸着による結合として理解される。

今回、受体基質が間接的に（Ａ参照）又は直接に（Ｂ参照）付着せしめられたブロッティング媒体を、コロイド状金属粒子で標識された特異的結合剤の適当な濃度と共に（直接的検知法）或いは最初に標識されてない特異的結合剤と、次いで第１の特異的結合剤に特異的に結合することのできるコロイド状金属粒子で標識された巨大分子と共に（間接的検知法）保温する場合、コロイド状金属粒子が特異的結合部位に蓄積し、驚くことに用いたコロイド状金属粒子に特徴的な色として見えるようになることが発見された。例えば金のような金属を用いると桃色ないし暗赤色が、銀を用いると黄色ないし褐／黒色が得られる。この色は裸眼で定性的に読むことのできる或いは随時技術的に公知の分光学的方法例えば濃度計を用いて測定することのできる信号を生成する。

コロイド状金属粒子の粒径は、好ましくは３～１００ｎｍ、更に好ましくは５～５０ｎｍである。

特異的結合剤に付着せしめうるコロイド状金属粒子の例としては、金属、白金、金、銀及び銅、及び金属化合物、ヨウ化銀、臭化銀、水和酸化銅、酸化鉄、水酸化鉄又は水和酸化鉄、水酸化アルミニウム又は水和酸化アルミニウム、水酸化クロム又は水和酸化クロム、酸化バナジウム、硫化砒素、水酸化マンガン、硫化鉛、硫化水銀、硫酸バリウム、及び二酸化チタンが記述されている。上述の金属又は金属化合物で被覆された核からなるコロイドが使用できることも公知である。これらの粒子は金属又は金属化合物コロイドとして類似の性質を有するが、寸法、密度及び金属含量は随時組合せることができる。一般に、特異的結合剤にその結合活性を破壊することなしに結合することができ且つ裸眼で見るのに十分なブロット・オーバレイ分析での色強度を与えるすべてのコロイド状金属又は金属化合物は使用しうる。好ましくはこれらの感度は金または銀で得られるものに等しいか、それよりも優れているものがよい。

今や特異的結合剤例えば抗体、レクチン、蛋白Ａ、アビジン、及びその他、或いは更に受体蛋白例えば抗原で表面が被覆されるコロイド状金属粒子、特に金ゾルのそれを用いることは、透過型及び掃引型電子顕微鏡による多くの細胞化学的着色技術において良く確立されている。

金属で被覆された重合体からなるコロイド状金属粒子を用いる例は、抗体に付着した時に透過型電子顕微鏡に対して非常に有用なマーカーを与える鉄で被覆されたデキストランである。しかしながらこれらの使用は、このマーカーの典型的な電子不透明性（透過型電子顕微鏡）或いは２次電子又は後方散乱１次電子を放射するその能力（掃査型電子顕微鏡）を利用する。

コロイド状金属粒子、特に金及び銀からなるものは、試料を見るために光学顕微鏡を用いる場合に、そのようなコロイド状金属粒子の、組織スライドにおける結合部位又は細胞表面における蓄積が見られるということが示されて以来、光学顕微鏡による細胞化学的着色技術に対するマーカーとしても使用されてきた。

コロイド状金属粒子は、免疫学的成分、例えば水性媒体中ハプテン、抗原及び抗体のある試験管内での定量及び定性試験にも使用される。これらの技術は、ゾル粒子免疫分析及び受動的金接合法（passive gold agglutination）（Geoghegan）と呼ばれている。

受動的金接合技術は、金で標識された抗原（金粒子１８～２０nmの、標識されてない抗体への接合に基づき、そして接合してない金が赤色の流れをなして壁面を流下するという標準的なミクロン力価セットを用いることを含む。この技術は、古典的な受動的接合に同様であり、同じく敏感であり、金で標識された抗体である逆接合（reverse agglutinamtion）に対して能力を有すると言われた。

ゾル粒子免疫分析は２つの範ちゅうに分類される。この第１は均一ゾル粒子分析と呼ばれ、抗体で標識されたコロイド状粒子の、免疫化学的２価又は多価抗原による或いは担体蛋白に結合したハプテンによる接合に基づく。この接合は空試験として緩衝剤を用いる比色法によって測定される如く色を減少させる。コロイド状金属粒子の接合は試料からの遊離のハプテン分子によって禁止されてよい。そのような方法はヨーロッパ特許第０００７６５４号に記述されている。

第２の種類のゾル粒子免疫分析は、放射線免疫分析及び酵素免疫分析に類似の結合した／遊離のコロイド状金属粒子共役体分離法に基づく。そのような方法はヨーロッパ特許第０００７６５４号に記述されている。１つのそのような方法は、サンドウィッチ式ゾル粒子免疫分析（Sandwich Sol Particle Immunoassay（ＳＳＰＬＡ）と呼ばれ、サンドウィッチ式ＥＬＩＳＡ又は固相サンドウィッチ式放射線免疫分析に同様である。ＳＳＰＬＡにおいて、典型的には決定すべき抗原に対する抗体をミクロ滴定板（例えばポリスチレン製）の表面上に吸着させる。適当な緩衝系に溶解した試料（抗原標準物又は空試料）を抗体で被覆された井戸にピペットで入れ、適当に保温する。金で標識された抗体を添加し、反応混合物を更に保温する。井戸を吸引し、洗浄して結合してない共役体を除去する。最後に、結合した免疫錯体を、均一にしたコロイド状金属粒子と一緒に離脱させる。得られる分散液の色の強度を視覚的に検査し或いは金属濃度を比色計によって測定する。視覚による検査法（例えば分散された金の色）はより高い抗原濃度においてだけ使用することができる。

ゾル粒子分析は、非免疫学的分析に対して、一般に「反応成分の相互に対する公知の結合親和性を適用することにより、水性試験試料中の特異的結合蛋白及び対応する結合しうる基質間の反応の１つ又はそれ以上の成分を検知及び／又は定量する、すなわち該反応の所望の成分を、粒子径が少なくとも５ｎｍの金属、金属化合物或いは金属又は金属化合物で被覆された重合体核の水性分散液の粒子に直接又は間接的に結合させることによって得られる１つ又はそれ以上の標識された成分を用い、これによって反応中に又は適当な反応時間後、随時結合した及び遊離の標識された成分の分離後に、技術的に公知の方法に従って金属及び／又は生成した金属含有の集塊の物理的性質及び／又は性質を試験試料又は誘導された画分の１つにおいて決定し、検知及び／又は定量すべき成分を定性及び／又は定量する」分析に対して有用であると記述されていることも特記すべきである。

本発明は、ブロット・オーバレイ分析法におけるマーカーとしてコロイド状金属粒子を用いることに関する。この使用は全く新規であり、驚くことに使用可能であることがわかった。

コロイド状金属粒子とは、金属、金属化合物、或いは金属又は金属化合物で被覆された核の分散液を含む。

コロイド状金属粒子の、マーカーとしての使用は、ブロット・オーバレイ分析のすべての形態に当てはまり、ブロッティング媒体の表面において結合部位に蓄積するコロイド金属粒子が、少くとも現存する技術の非常に高感度のもの、例えば酵素に基づくブロット・オーバレイ分析と対比しうる感度を有して裸眼で直接見えるようになるという利点をもたらす。本発明は、上述の点が含まれないならば実際上の価値がないということが強調される。分析値が２次的酵素反応の必要なしに、螢光染料に対する自動放射線計法又は視覚系で、或いはサンドウィッチ式ゾル粒子免疫分析における如く結合したコロイド状金属粒子の離脱、続く裸眼（低感度）、比色計又はＣＲＡＡＳ（高感度）での測定で読みとることができるということは重要な利点である。また本発明の最大の利点は、反応中に色が発現するから簡単であるということである。これは所望の信号が生じた時に反応を停止する。或いは予じめ決められた結果を固定された時間限界内で得るために系を補正することを可能にする。

金で標識された抗体の使用は、非常に感度のよいと言われる免疫ペルオキシダーゼ法よりも非常に簡単であり、それと同程度の感度を与える。本発明のこの簡単な分析法は、ブロッティング媒体に結合した受体基質に対する特異的結合剤、及び第１の特異的結合剤に対するコロイ

ド状金属粒子で標識された特異的結合剤の存在を間接的に検知するための試験キットに使用できる。特異的結合剤が抗体である場合、これはコロイド状金属粒子で標識された２次抗体又は蛋白Ａであってよい。これは非常に簡単な浸漬棒（dip stick）試験として、例えば血清のような水性試験試料中の選んだ抗原に対する抗体の存在を迅速に選別するためのスポット・ブロット・オーバレイ免疫分析として使用できた。

本方法は、

ｉ．受体基質の、ブロッティング媒体として公知の固定化マトリックスへの次の方法のいずれかによる固定化、

i.i.随時電気泳動分離法を適用し且つ電気泳動媒体からブロッティング媒体への転移又はブロッティング法を適用し、そして続いてＢＳＡ、ゼラチン、ＰＥＧ又はTween２０の使用のような技術的に公知の方法に従い、残存する蛋白結合部位を消去させた後、一般にブロッティングを呼ばれる直接的な結合及び／又は共有結合をさせること、或いは

i.ii.ブロッティング媒体を受体基質を含む水溶液と接触させることによりブロッティング媒体に固定化されるようになった特異的結合剤によって受体基質を結合せしめること。

ii.i)のブロッティング媒体を、洗浄及び空気乾燥後にある期間次のいずれかと接触させること、

i.i.適当な濃度のコロイド状金属粒子で標識された特異的結合剤、或いは

ii.ii.先ず適当な濃度の標識されてない特異的結合剤、次いで標識されてない特異的結合剤に特異的なコロイド状金属で標識された蛋白。

iii.ブロッティング表面において結合したコロイド状金属粒子によって生ずる着色信号及び特性を裸眼で或いは濃度計のような技術的に公知の分光学的技術を用いて読むこと、

の連続的工程を含んでなる。

また本発明は、反応の成分又はこの反応を間接的に検知するために使用できる成分を、上述の如きコロイド状金属粒子に結合させることによって得られたコロイド状金属粒子で標識された成分及び他の試剤を含有するブロット・オーバレイ分析において、特異的結合剤及び対応する受体基質間の反応の１つで直接的に又は間接的に決定するのに用いるための試験キットに関する。反応が免疫学的反応の場合には、サンドウィッチ式ブロット・オーバレイ分析（参照、実施例III）に対して、また選んだ抗原に対する血清中の抗体の存在の決定（参照、実施例Ｉ）に対して試験キットが使用できる。

本発明の随意の特徴は、ブロット・オーバレイ分析の特徴として、ブロッティング媒体の表面に結合したコロイド状金属粒子の検知が、対応する金属に還元できる物理的現像剤を適用することによって間接的に見る及び／又は高めることができるという事実を利用する。適当な物理的現像剤は例えば乳酸銀、硝酸銀などである。例えば銀を物理的現像剤として用いる場合、反応は最初に還元を接触する金属粒子の表面で起こり、続いてこれを種にして自動触媒となる。この結果金属銀の蓄積によって黒い、非常にコントラストのきいた信号が生成する。これは感度のかなりの増加をもたらす。光に鈍感な銀沈殿物を得るためには、顕微鏡写真のプリントに対して使用される安定化液でブロットを定着しなければならないということも発見された。

物理的現像剤は、組織中の水に不溶な金属、特に硫化金属を見るために多年に亘って使用されてきた〔ダンシヤー(Danscher)、ヒストケミストリイ(Histochemistry)71、１～１６、１９８１参照〕。硫化金属及び金属銀は金属イオンの還元に触媒効果を示す。組織中のコロイド状金金属も物理的現像剤で現像でき、またこれは元来の免疫金着色法よりも非常に優れた感度をもたらす免疫金／銀着色法の導入に対するホルゲートら(Holgate et al.)〔ジャーナル・オブ・ヒストケミカル・シトケミストリイ（J.Histochem.Cytochem.）３１、９３８～９４４（１９８３）参照〕によつて開発されたものである。

本発明の随意の特徴の主たる利点は、ブロット・オーバレイ分析に対して存在するいずれか他の検知法よりも優れた多大の感度を示すということにある。これは、使用者が用いる試薬量を経済的にしたい時或いは受体基質及び／又は特異的結合剤が非常に低量でしか存在しない場合に使用することができる。

本発明の更なる随意の特徴は、バックグランドを減じ及び物理的現像剤の反応生成物の安定性を改良する写真の定着剤を使用することである。

次の実施例は本発明を例示するが、その範囲を限定するものではない。

実施例

実施例Ｉ

犬の脳のツブリン（tubulin）及びカルモジュン（calmodulin）に対する抗体を、免疫にしたウサギの血清中の金で標識された２次抗体で間接的に示すための簡単なスポット・ブロット・オーバレイ免疫分析。

I.1.抗血清の製造

1.1.抗血清の増殖

緩衝剤（０．１Ｍ Pipes, pH６．９）

１．０ml中の犬の脳のツブリン（ＳＤＳ－ポリアクリルアミドゲルから抽出）１mg或いは電気泳動的に純粋な犬の脳のカルモジュリン１mg（H_2O中）を、完全なフロインド佐剤（ＤＩＦＣＯ）１．０mlと混合した。均一にした後、白ウサギの背骨に沿って５ケ所に抗原を皮下注射した。４週間毎にブースター注射をした。不完全なフロインド佐剤を用いる以外同一の方法で抗原を調製した。各ブースターから１週間後に、ウサギから採血し（±６０mlの血液を採取）、血清を準備し、使用まで－

２０℃下に一部ずつ貯蔵した。

1.2.コロイド状金属で標識された２次抗体

これはジヤンセン・ライフ・サイエンス・プロダクツ（Janssen Life Science Products）〔２３４０　ベンゼ，ベルギー（２３４０Beerse，Belgium）〕から購入した。

コード番号：＝ＧＡＲ　Ｇ２０。これは２０㎚のコロイド状金粒子で標識されたウサギのＩｇＧに対する親和性精製したヤギの抗体である。

抗原を含むスポットを有するニトロセルロース紙ストリップの調製

０．１Ｍ　Pipes，１ｍＭ　ＥＧＴＡ、１ｍＭ　ＭｇＣｌ$_2$（pH６．７５）中の純粋なツブリン或いはH_2O中の純粋なカルモジュリンの４倍の血清希釈物（初め２５０ng／μｌ）の１０個の１μｌ小滴を、乾いたニトロセルロース・ストリップ（６㎝×０．６㎝）上に１列にスポットした。このスポットが乾燥した時（約５分間）、ストリップ上の残存する蛋白結合部位を、２０ｍＭ　Tris緩衝食塩水（pH８．２）中の５％の牛の血清アルブミン（ＢＳＡ）の溶液と共に３０℃で３０分間保温することによって消去した。

1.3.ツブリン及びカルモジュリン抗体の検知のための試験法。金で標識された抗体を用いることの、ＡＢＣ－ペルオキシダーゼ検知法との比較

工程で用いる緩衝剤は断らない限り０．１％ＢＳＡ、Tris（２０ｍＭ　Tris-ＨＣｌ，０．９％ＮａＣｌ　pH８．２，２０ｍＭ　NaN_3中０．１％ＢＳＡ）であった。

ａ．１次抗血清を用いる培養

－２つのストリップを、栓つきの５㎖のプラスチック管内において、０．１％ＢＳＡ－Tris中で１：１０００に希釈したウサギの抗ツブリン血清１㎖と共に室温で２時間保温した。

－２つのストリップを、抗原の特異性に対する対照として役立つSepharose－４Ｂに共有結合させたツブリンに吸着された同一の抗血清と共に、上述の如く保温した。

－２つのストリップを、０．１％ＢＳＡ－Tris中で１：１０００で希釈したウサギの抗カルモジュリン血清１㎖と共に、室温で２時間保温した。

－２つのストリップを、セファロース－４Ｂ（Sepharose－４Ｂ）に共有結合させたカルモジュリンに吸着された同一のものと共に上述の如く保温した。吸着された及び吸着されてない１次抗血清との保温後、ストリップを０．１％ＢＳＡ－Tris中で３×１０分間洗浄した。各対の１つのストリップを、ＧＡＲ　Ｇ２０（参照1.3.ｂ）を用いて更に保温した。他のものを、ベクター・ラボラトリーズ（Vector Laboratories）から購入し且つ製造業者の指示に従って使用される非常に敏感なベクタスタイン（Vectastain）ＡＢＣ免疫ペルオキシダーゼ・キットと共に保温した（参照、1.3.ｃ）。

ｂ．金で標識された２次抗体：ＧＡＲ　Ｇ２０を用いる培養

Ｏ．Ｄ▲．1^{cm}_{520nm}▼＝０．１％ＳＡ－Tris＋０．４％ゼラチン中０．２に希釈したＧＡＲ　Ｇ２０を用い、洗浄したストリップ（参照1.3.ａ）を２時間保温した。この保温後、ストリップを０．１％ＢＳＡ－Trisで２×１０分間洗浄し、空気乾燥した。

ｃ．ベクタスタイン（Vectastain）キットを用いる培養

洗浄したストリップ（参照、1.3.ａ）を、２次ビオチニル化抗体溶液（０．１％ＢＳＡ－Tris中１：２００）と共に１時間保温した。このストリップを過剰量の０．１％ＢＳＡ－Tris中において３×１０分間洗浄し、次いでアジビン－ピオチニル・ペルオキシダーゼ複合体中で１時間保温した。この複合体は、製造業者の指示に従って準備した：試薬Ａ（アビジンＨ）１００μｌＰＢＳ〔プルベコ（Pulbecco）液，Mg^{2+}及びCa^{2+}なし〕１０㎖に添加した。試薬Ｂ（ビオチニル化西洋ワサビのペルオキシダーゼ）１００μｌを連続的に撹拌しながら添加した。５分後に複合体を用いた。ストリップを０．１％ＢＳＡ－Tris（２×１０分間）中で、続いてTris-Ｈ　Ｃｌ緩衝液（pH７．６）中で洗浄した。次いで固定化したペルオキシダーゼを、基質としての４－クロル－１－ナフトールで見えるようにした：４－クロル－１－ナフトール２０㎎を、エタノール１㎖に溶解し、更に１００ｍＭ　Tris-ＨＣｌ緩衝液（pH７．６）２０㎖で希釈し、約５０℃まで暖めた。１％$H_2O_2$２００μｌを添加し、基質溶液を注射器に取りつけたミクロフィルター（０．２μ、ミリポア）を通してストリップにつけた。反応を５分間進行させ、次いでストリップをH_2Oで洗浄することによって反応を停止させ、空気乾燥した。

1.4.評　価

ＡＢＣ法において、正（positivity）は青色として検知される。コロイド状金を用いる場合、用いる金の寸法に対して正は桃赤色である（大きい、例えば４０㎚の金の粒子は紫色がかった色を示す）。両方法に対する感度は全く対比でき、用いる条件下にツブリンに対して５ng／μｌ及びカルモジュリンに対して３０ng／μｌの程度である。特異性は、抗血清をそのそれぞれの抗原と共に吸着させた時、負の反応によって示される。

実施例Ⅱ

金で標識したヤギの抗体をマウスのIgGに対して用いることによる、生育ヒブリドマ（hybridomas）の培養上澄液中の微小管と関連した蛋白に対するマウスのモノクローナル抗体の存在の選別。

2.1.マウスの免疫化

ラットの脳の微小管蛋白（１００μｇ／マウス）（温度依存性の重合－解重合のサイクル２回で調製）及び完全なフロインド佐薬の均一な混合物（参照、実施例1.1.）をマウス（Balb／Ｃ）に注射した。この注射は背中に５点、皮下的に行なった。不完全なフロインド佐薬を用い

て調製した抗原（１００μｇ）のブースター注射を隔週に３回行なった脾臓細胞の骨髄腫細胞腺との融合（fusion）の３日前に、マウスにＰＢＳ－緩衝液１００μｌ中５０μｌ抗原／マウスを静脈内ブースター注射した。

2.2.脾蔵細胞の、ＮＳ－１骨髄腫細胞との融合

技術的に公知の方法に従ってＮＳ－１細胞を２匹の免疫にしたマウスの脾臓細胞と融合させ、得られたヒブリドマ（hybridomas）を、７％のCO_2を含む水蒸気飽和雰囲気中、３７℃下に、５つの９６井戸のプレート（Nunc）中で培養した。約２週間の生長後、生長するヒブリドマを含む井戸の培養上澄液１００μｌをとり、分泌されたモノクローナル抗体の存在に対して試験した（参照、2.4.）。

2.3.ＳＤＳ－ポリアクリルアミドゲルからある種類の蛋白を電気的にブロッティングしたニトロセルロース紙ストリップの調製

抗原（２回重合させた微小管蛋白）のＳＤＳ－ポリアクリルアミドゲルの電気泳動を、Laemmliに従い、７．５％ゲルについて行なった。試料緩衝液に溶解し且つ沸とうさせた抗原を、連続層として積層のゲルの上に３００μｇ／ゲルの量でつけた。染料の先端が分離するゲル中に3cm移動した時、電気泳動を止めた。ゲルの小さい垂直のストリップをクーマシー（coomassie）青での染色のために切り取り、残りをニトロセルロース紙上に電気的にブロッティングするために使用した。ゲルを転移緩衝液（２５mM　Tris-１９２mMグリシン／２０％（容量／容量）メタノール、pH８．３）中において室温で３０分間平衡させた。このゲルをニトロセルロースのシート（予じめ緩衝液中に浸漬）上に置き、いずれか捕捉される空気泡を避け或いは除去するように注意した。これを２つの予じめ浸漬した紙及び２つのナイロン・スクリーンクッション間にサンドウィッチにした。この結果ＥＣ－電気ブロッティング装置の密閉される電極グリッドにぴったりはまった。次いで室温４００mAにおいて電極ブロッティングを夜通し行なった。電気泳動転移後、ニトロセルロース紙シート上に残る蛋白結合部位を、２０mM　Trisで緩衝された食塩水中５％ＢＳＡ（pH８．２）に３７℃で３０分間浸すことにより消滅させた。続いてニトロセルロースシートを、電気泳動の方向に対して平行に巾3mmのストリップに切断した。これらのストリップを用いてヒブリドマ細胞の上澄液を選別した。

2.4.モノクローナル抗体の検知

各ヒブリドマ培養上澄液１００μｌを、長３．５cmの０．５mlのエッペンドルフ（Eppendorf）チップに移し、０．１％ＢＳＡ－Trisの０．４mlで１：５に希釈した。このチップ及びストリップをコートnr.とした。各チップには１つのストリップを与え、これらを２時間保温した。各ストップを過剰量の０．１％ＢＳＡ－Tris中においてバッチ式で洗浄し、またジヤンセン・ライフ・サイエンス・プロダクツ(Janssen Life Science Products)〔２３４０ベンゼ，ベルギー（２３４０Beerse，Belgium）〕から購入したＧＡＭ　Ｇ２０（２０nmのコロイド状金粒子で標識されたヤギの抗マウスＩIgG）と共にバッチ式で培養した。ＧＡＭ　Ｇ２０を０．１％ＢＳＡ－Tris＋０．４％ゼラチンで０．Ｄ▲．$^{1cm}_{520nm}$▼＝０．１まで希釈し、夜通し反応させた。次いでストリップを０．１％ＢＳＡ－Tris及びH_2Oで洗浄し、空気乾燥した。

与えられた分子物質を含む蛋白バンドに相当して、正は桃色ないし赤色がかったバンドとしてはっきり見ることができた（参照、他の実施例）。この非常に簡単な選別法は、抗体を分泌するヒブリドマを同定するばかりでなく、開連する抗体の特異性に関する直接的な情報を与え、それ故に興味ある抗体分泌のヒブリドマの選別の多大な助けとなる。

実施例III

水性試験試料における抗原の検知のためのサンドウィッチ式免疫ブロット・オーバレイ分析：水性試験試料中のIgGの検知。

3.1.分　析　法

決定すべき抗原に対してモノ特異的な精製された又は富んだ抗体の小滴（±１μｌ）を、ニトロセルロース紙（又はいずれか簡便なブロッティング媒体）のストリップ上にブロッティングし、乾燥し、遊離の蛋白結合部位を消滅させた（参照、実施例1.3.）。随時これらの抗体を含む消滅させたストリップを水中で洗浄し、空気乾燥し、貯蔵した。次いでこのストリップを一定の期間に亘り、抗原を含む試験溶液のある容量と共に保温した。結合してない基質を洗い落した後、更にブロッティング媒体上へ吸着されたものと同様に、ストリップを適当に希釈されたコロイド状金属粒子（例えば金又は銀のゾル）で標識された抗体と共に保温した。随時、それぞれが異なる抗原エピトープ（epitope）を認識する２つのモノクローナル抗体を使用することができた。この時１つをブロッティング媒体に付着させ、他をコロイド状金属粒子に付着させた。一定の条件下に、予じめ決められた最小濃度の抗原を検知でき、また与えられた試験溶液中に最小の必要な濃度を検出しうる場合には定性的な診断試験として使用することができた。

3.2.分析例：公知の濃度のウサギのIgGを含む緩衝された溶液におけるウサギのIgGの検知

本発明の新規なサンドウィッチ式分析法の実用性を試験するために次の実験を行なった：

－６×０．６cmのニトロセルロース紙の６つのストリップに、実施例1.2.に記述したようにウサギのIgG（ＧＡＲ　IgG）に対する親和性精製したヤギの抗体を漸減量（１２５ng／μｌから始めて１／２希釈の一連の希釈物）で含有する小滴（１μｌ）を付けた。

－残存する蛋白結合部位を実施例1.2.に記述したように

消滅させた。１つのストリップ（第６番）を２０ｍＭ Tris−緩衝の食塩水中で洗浄し、紙上に乾式ブロッティング処理し、空気乾燥し、室温で乾燥下に夜通し貯蔵した後使用した。
−残りの５つのストリップを、次のように室温下に３０分間、栓つきのプラスチック管中で保温した：
第１番：ＲIgG、１ml、１μｇ／ml
第２番：ＲIgG、１ml、０．２５μｇ／ml
第３番：ＲIgG、１ml、０．０６３μｇ／ml
第４番：ＲIgG、１ml、０．０１５μｇ／ml
第５番：ＲIgG、１ml、０μｇ／ml
ウサギのIgGを０．１％ＢＳＡ−Tris中で希釈した。第６番のストリップをＲIgG　０．２５μｇ／mlと共に保温した。
−ストリップを０．１％ＢＳＡ−Tris中で２×１０分間洗浄した。
−すべてのストリップを、ジヤンセン・ライフ・サイエンセス・プロダクツ(Janssen Life Sciences Products)〔Ｂ−２３４０ベンゼル，ベルギー（Ｂ−２３４０Beerse,Belgium〕から購入したガル（ＧＡＲ）Ｇ２０（直径２０nmのコロイド状金粒子で標識されたウサギのIgGに対するヤギの抗体）中で室温下に正確に１時間培養した。ＧＡＲ　Ｇ２０を０．１％ＢＳＡ−Tris＋０．４％ゼラチンでＯ．Ｄ▲．$^{1cm}_{520nm}$▼＝０．２まで希釈した。
−ストリップを０．１％ＢＳＡ−Trisで、次いで水で洗浄し、空気乾燥した。

3.3.　評　価

１５ng程度の少量のＧＡＲ　IgGを吸着させたスポットは、ＲIgG　１５ng／mlを含有する溶液１ml中で３０分間だけ培養し、続いてＧＡＲＧ２０（０．０５２０nm＝０．２）１mlと共に１時間培養した後桃色の点として見えるようになった。少くともこの量のＲIgGを含有する溶液は正と判定されるであろう。第６番のストリップの結果は、第２番のストリップのそれと同一であり、ストリップは消滅工程に乾燥しても抗体活性を保持しうるということを示す。

実施例Ⅳ

コロイド状銀で標識された１次抗体を有するＮＣ紙に付着させた抗原の直接的検知：コロイド状銀で標識した、マウスのIgGに対するヤギの抗体を用いるマウスのIgGのスポットの検知。
−ＮＣ紙のストリップ（６cm×０．６cm）に、実施例1.2.に記述した如く、２５０〜０．４ng／μｌの一連の２倍希釈のマウスIgGのスポット（１μｌ）をつけた。
−残存する蛋白結合部位を実施例1.2.における如く消滅させた。
−ストリップを、０．１％ＢＳＡ−Trisで１：１００に希釈したマウスのIgG（Ｅ．Ｙ．Laboratoriesから購入、ＳＰ−００１１）に対するコロイド状銀で標識したヤギの抗体と共に培養した。
−ストリップを０．１％ＢＳＡ−TrisH_2Oで２×１０分間洗浄し、空気乾燥した。
−正のスポットは黄色であった。これらの条件下に１μｌ＝±３０ngのスポットが検知できた。

実施例Ⅴ

ブロット・オーバレイ免疫分析及び金で標識された２次抗体、続く銀増感を用いることによる、ヒヨコの未成熟の肺の上皮細胞の２次培養における全細胞溶解物中に産するアクチンのための、親和性精製したウサギの抗体のヒヨコの砂袋アクチンに対する特異性の試験。

5.1.抗アクチン抗血清の調製

電気泳動的に純粋なヒヨコの砂袋アクチンを均一にし、実施例1.1においてツブリン及びカルモジュリンに対して記述したようにウサギに注射した。次いで血清を実施例1.1.に記述したように調製し、貯蔵した。

5.2.アクチンに対する抗体の親和性精製

製造業者の指示に従ってアクチンをセファロース(Sepharose)−４Ｂ−ＣＮＢｒ〔ファルマシア(Pharmacia)〕に結合させた。抗体を血清から直接精製した。後者を抗原を含むゲルと一緒に培養した。１０mgの結合した抗原に対して血清２０mlを用いた。培養２時間後に、ゲルをカラム中に注ぎ、２８０nmにおけるＯ．Ｄ．が殆んど０になるまで１０ｍＭ　Trisで緩衝させた食塩水（ＴＢＳ）で洗浄した。非特異的吸着物質を、１Ｍ　ＮａＣｌを含むＴＢＳで流出させ、次いでＴＢＳで洗浄した。特異的抗体をpH２．８の０．１Ｍグリシン−ＨＣｌ緩衝液で流出させた。１mlずつの画分を、１Ｍ　Tris-HCl緩衝液（pH８．５）で直ぐに中和した。抗体の濃度を、$E_{1\%}$＝１４．３を用いて２８０nmで測定した。流出した抗体の画分を更に処理しないで−２０℃下に貯蔵した。

5.3.未成熟なヒヨコの肺の上皮細胞の培養

未成熟なヒヨコの肺の上皮細胞を日令１４日のヒヨコの未成熟な肺から分離した。この組織を手で裂き、Ca^{2+}及びMg^{2+}を含まないHanksの平衡化塩溶液中０．２５％トリプシンを用いて、３７℃で３０分間トリプシン化した。この反応を媒体及び１０％ＦＣＳで停止させた。遠心分離及び再懸濁後、細胞を７５cm²のＴ−フラスコに移し、１２〜２４時間に亘って付着させ、次いで媒体を変えた。培養３〜５日後、細胞を短期間（２〜３分間）、（０．２５％トリプシン溶液中で）トリプシン化し、９cmφのペトリ皿の上に置き、細胞が接合する培養３〜５日後に使用された。細胞は、非必須アミノ酸及び１０％胎牛血清の補充されたEagleの最小必須培地において、有湿の５％CO_2／空気の雰囲気中で３７℃下に生長させた。

5.4.未成熟なヒヨコの肺の上皮細胞の全細胞ＳＤＳ溶解物の調製

９cmφのペトリ皿で生長させた細胞をCa^{2+}、Mg^{2+}を含ま

ないＰＢＳ（Dulbecco）中で洗浄し、ゴム製ポリスマンで集め、Eppendorfチップ（１．５ml）中の無水アセトン中に－２０℃で浸した。このアセトンを蒸発させ、乾燥した細胞残渣を、１mM　TAME（プロテアーゼ禁止剤）を含む沸とうＳＤＳ－試料緩衝液中に溶解した。遠心分離後、不溶性の残渣を捨てた。試料緩衝液で連続的に希釈し且つクーマシー青で着色したこの溶解物のＳＤＳＳゲル（Laemmliによる）を用いて試料の最も適当な希釈度を見積った。続く遺伝子選別膜（ＮＥＮから購入）への電気泳動的転移に対して１：１６の希釈を使用した。１つの転移単位は、１列のそのような希釈した溶解物及び１列の精製した対照蛋白の混合物：１列当りCh.g.フィラミン、＝Ch.g.ミオシン（Ｈ＋Ｌ鎖）、Ch.g.α－アクチニン、ＢＳＡ、ラットの脳のツブリン、豚の胃のトロポミオシン各０．０６μg、からなった。

緩衝液の先端をゲルの底部に達しせしめ、遺伝子選別膜への電気泳動的移動を実施例2.3.と正確に同じにして行なった。プロット単位を切り取り、残存する蛋白結合部位を実施例1.2.及び2.3.に記述したように消滅させた。

アクチンに対する抗体（０．５μg／ml）及びＧＡＲ　Ｇ２０（Ｏ．Ｄ．５２０nm＝０．２）との培養及びＧＡＲ　Ｇ２０の、０．１%ＢＳＡ－Tris＋０．４%ゼラチンでの希釈は、実施例2.4.に記述したものと同一の方法に従い、シートの寸法の±の密閉されたプラスチック製バック中において、それぞれ２時間行なった。

ＧＡＲ　Ｇ２０との２時間の保温後、シートを０．１%ＢＳＡ－Trisで洗浄し、銀での増感にそなえた。この時点において、溶解物におけるアクチンの移動及び蛋白混合物中のアクチンとの対応に基づき、桃赤色のバンドがすでに見られた。

5.5.銀での増感

－シートを１：１０で希釈したクエン酸塩原料緩衝液中において２分間洗浄した。この緩衝液は１００mlに対してクエン酸三ナトリウム２５．５g及びクエン酸２３．５gを含有した（pH４）。

－次いでシートを、次のものを含む物理学的現像剤中において、注意深く光から保護しつつ１５分間培養した：

脱イオン水　６０ml

脱イオン水１５．０ml中ハイドロキノン０．８５g

クエン酸塩緩衝液（pH４）１０ml

脱イオン水15.0ml中乳酸銀０．１１g。

乳酸銀を注意深く光から保護し、使用直前に他の成分に添加した。

－反応時間後、シートを過剰のH_2Oで洗浄し、Agetix（水中１：４）写真定着剤で処理した。

－このシートを再び過剰のH_2O中で洗浄し、空気乾燥した。

5.6.結　果

初めに桃赤色のバンドとして見えていたバンドは今や深い黒色になった。アクチンに対する抗体は、非常に特異的と考えられ、培養細胞中におけるアクチン含有物の免疫細胞化学的な着色に対して満足しうる結果を与えた。

5.7.結　論

上述の銀増感は、検知法のコントラスト及び感度を強く増大させた。例えば実施例IVにおいて、コロイド状銀で標識された抗体で着色したものを更に現像し、そして反応の僅か５分後に検出限界が３０ng／スポットの代りに３ng／スポットとなった。

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(54) Title: HAPTIC EFFECTS WITH PROXIMITY SENSING

(57) Abstract: A method of generating haptic effects on a device includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

HAPTIC EFFECTS WITH PROXIMITY SENSING

FIELD OF THE INVENTION

[0001] One embodiment of the present invention is directed to a haptic feedback system. More particularly, one embodiment of the present invention is directed to a haptic feedback system that utilizes proximity sensing.

BACKGROUND INFORMATION

[0002] Electronic device manufacturers strive to produce a rich interface for users. Conventional devices use visual and auditory cues to provide feedback to a user. In some interface devices, kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, texture, and heat) is also provided to the user, more generally known collectively as "haptic feedback." Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, vibration effects, or vibrotactile haptic effects, may be useful in providing cues to users of electronic devices to alert the user to specific events, or provide realistic feedback to create greater sensory immersion within a simulated or virtual environment.

[0004] Haptic feedback has also been increasingly incorporated in portable electronic devices, such as cellular telephones, personal digital assistants (PDAs), portable gaming devices, and a variety of other portable electronic devices. For example, some portable gaming applications are capable of vibrating in a manner similar to control devices (e.g., joysticks, etc.) used with larger-scale gaming systems that are configured to provide haptic feedback. Additionally, devices such as cellular telephones and PDAs are capable of providing various alerts to users by way of vibrations. For example, a cellular telephone can alert a user to an incoming telephone call by vibrating. Similarly, a PDA can alert a user to a scheduled calendar item or provide a user with a reminder for a "to do" list item or calendar appointment.

[0005] Increasingly, portable devices are moving away from physical buttons in favor of touchscreen-only interfaces. This shift allows increased flexibility, reduced parts count, and reduced dependence on failure-prone mechanical buttons and is in line with emerging trends in product design. When using the touchscreen input device, a mechanical confirmation on button press or other user interface action can be simulated with haptics.

[0006] For portable devices, cost is an important driving factor. Therefore, to generate haptic effects a single low cost actuator is generally used, for example an eccentric rotating mass ("ERM") motor or an electromagnetic motor. These actuators are able to produce strong magnitude haptic outputs. However, they also require a certain amount of time to achieve their peak haptic output (e.g., approximately 50 ms). These actuators are also used to provide feedback to the user when operating a touch sensitive input of a touchscreen device. For example when the user presses a button on a touchscreen a haptic effect is output to give the sensation of pressing a

mechanical button. It is desired to output the haptic effect at the same time the user has selected the button in the interface. However, due to the time it takes to have actuator reach a desired magnitude, the haptic effect lags behind the button press event. If this lag becomes too long the user will not perceive the button press and the haptic effect as a single event.

[0007] Based on the foregoing, there is a need for an improved system and method for generating haptic effects for a touchscreen.

SUMMARY OF THE INVENTION

[0008] One embodiment is a method of generating haptic effects on a device. The method includes detecting the presence of an object near an input area of the device and generating a haptic effect on the device in response to the presence detection.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1 is a block diagram of a cellular telephone in accordance with one embodiment.

[0010] Fig. 2 is a flow diagram of the functionality performed by a telephone when generating haptic effects in response to the proximity of a user to a touchscreen in accordance with one embodiment.

[0011] Fig. 3 is a flow diagram of the functionality performed by the telephone when generating haptic effects in response to the proximity of a user to the touchscreen in accordance with one embodiment.

DETAILED DESCRIPTION

[0012] One embodiment is a portable device that includes a haptic feedback system with proximity sensing. The haptic system initiates the haptic feedback before a user actually touches a touchscreen or other input area based on the proximity information.

[0013] Fig. 1 is a block diagram of a cellular telephone 10 in accordance with one embodiment. Telephone 10 includes a screen 11 and an input area, touchscreen 13, that includes "keys" and can include other types of user interfaces, including menus, etc. In another embodiment, the keys of telephone 10 can be mechanical type keys. Internal to telephone 10 is a haptic feedback system that generates vibrations on telephone 10. In one embodiment, the vibrations are generated on the entire telephone 10. In other embodiments, specific portions of telephone 10 can be haptically enabled by the haptic feedback system, including the entire touchscreen 13 or individual keys of touchscreen 13.

[0014] The haptic feedback system includes a processor 12. Coupled to processor 12 is a memory 20 and an actuator drive circuit 16, which is coupled to a vibration actuator 18. Although the embodiment of Fig. 1 is a cellular telephone, embodiments can be implemented with any type of handset or mobile/portable device, or any device that uses an actuator to generate vibrations. For example, other embodiments may not include touchscreens but are haptic devices with other types of input areas. Other input areas besides touchscreens may be a mini-joystick, scroll wheel, d-Pad, keyboard, touch sensitive surface, etc. As with a cellular telephone, for these devices there is a desire for a haptic effect to be generated on the input area and/or the entire device.

[0015] Processor 12 may be any type of general purpose processor, or could be a processor specifically designed to provide haptic effects, such as an application-specific integrated circuit ("ASIC"). Processor 12 may be the same processor that operates the entire telephone 10, or may be a separate processor. Processor 12 can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters. In general, the high level parameters that define a particular haptic effect include magnitude, frequency and duration. Low level parameters such as streaming motor commands could also be used to determine a particular haptic effect.

[0016] Processor 12 outputs the control signals to drive circuit 16 which includes electronic components and circuitry used to supply actuator 18 with the required electrical current and voltage to cause the desired haptic effects. Actuator 18 is a haptic device that generates a vibration on telephone 10. Actuator 18 can include one or more force applying mechanisms which are capable of applying a vibrotactile force to a user of telephone 10 (e.g., via the housing of telephone 10). Memory device 20 can be any type of storage device, such as random access memory ("RAM") or read-only memory ("ROM"). Memory 20 stores instructions executed by processor 12. Memory 20 may also be located internal to processor 12, or any combination of internal and external memory.

[0017] A proximity sensor 14 is coupled to processor 12. Proximity sensor 14 detects when a finger (or stylus) is in close proximity to but not in contact with touchscreen 13. Proximity sensor 14 may also detect location (e.g., x, y, z), direction, speed and acceleration, orientation (e.g., roll, pitch, yaw), etc. of the finger relative to touchscreen 13. Proximity sensor 14 provides its information as an input to processor

12 when a finger is placed above touchscreen 13. This input can be used by processor 12 when generating haptic feedback for telephone 10.

[0018] Proximity sensor 14 may use any technology that allows the proximity of a finger or other object to touchscreen 13 to be sensed. For example, it may be based on sensing technologies including capacitive, electric field, inductive, hall effect, reed, eddy current, magneto resistive, optical shadow, optical visual light, optical IR, optical color recognition, ultrasonic, acoustic emission, radar, heat, sonar, conductive or resistive and the like.

[0019] In one embodiment, proximity sensor 14 includes one or more proximity sensors that each generate a sensing field above touchscreen 13 and that produce signals when an object disturbs or intercepts the sensing field(s). Each sensing field typically generates its own signals when disturbed. In one embodiment, a single sensing field is used to cover the entire touchscreen 13 surface. In another embodiment, a single sensing field only covers a portion of the touchscreen 13 surface. In another embodiment, multiple sensing fields are used to cover the entire touchscreen 13 surface. Any number of sensing fields may be used. In some cases, in order to perform tracking, the sensing fields may even be distributed as a pixelated array of nodes.

[0020] Fig. 2 is a flow diagram of the functionality performed by telephone 10 when generating haptic effects in response to the proximity of a user to touchscreen 13 in accordance with one embodiment. In one embodiment, the functionality of Fig. 2 is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0021] At 102, proximity sensor 14 senses the presence of a finger, stylus, or other object above or in some other manner near touchscreen 13 or other input area of telephone 10.

[0022] At 104, proximity sensor 14 determines the position, speed and/or acceleration of the finger relative to the surface of touchscreen 13. This enables processor 12 to determine whether the user's finger will actually contact touchscreen 13. For example, if the proximity signal is increasing at a certain rate, it is highly likely that the user will contact touchscreen 13 and press a button.

[0023] At 106, based on the determination at 104, processor 12 can calculate when the finger is expected to contact touchscreen 13. In anticipation of this contact, processor 12 initiates the haptic effect before the actual contact, thus avoiding the lag time caused by actuator 18. Processor 12 may use the acceleration of the finger and the starting time required by actuator 18 to determine how far in advance to initiate the haptic effect and energize actuator 18. Therefore, the haptic effect will be implemented at approximately the exact time that the finger actually contacts touchscreen 13 and result in better synchrony of the haptic effect with the button press event. In another embodiment, processor 12 may initiate the haptic effect upon sensing the mere presence of the finger at 102.

[0024] In typical use of cell phones or PDA's, the user generally holds the device in one hand and uses the other hand to interact with the user interface such as touchscreen 13. For handheld haptic devices with proximity sensing this means that the user can sense the haptic feedback with the hand holding the device even though the finger has not yet touched the surface. Therefore, useful haptic effects can be created as a function of the proximity even when a finger never touches touchscreen

13.

[0025] In one embodiment, if a user is hovering a finger over the touchscreen and moving over a grid of displayed buttons, a first haptic effect can be played when the user is moving from over one button to over the next button. The first haptic effect can be a short soft haptic effect in order to simulate the feel of moving over the edge of one button to the next. This first haptic effect will give the user an indication of the button locations without the user activating the buttons. A second haptic effect can be played when the user actually touches the screen and acts to select the button. The second haptic effect can be a strong haptic effect simulating a sharp button click.

[0026] Fig. 3 is a flow diagram of the functionality performed by telephone 10 when generating haptic effects in response to the proximity of a user to touchscreen 13 in accordance with one embodiment. In one embodiment, the functionality of Fig. 3 is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0027] At 202, proximity sensor 14 senses the presence and position of a finger, stylus, or other object above or in some other manner near touchscreen 13. The sensed position may include the x and y coordinates of the finger relative to touchscreen 13.

[0028] At 204, the functionality on the touchscreen is determined based on position of the finger. For example, if a multiple button graphical user interface on touchscreen 13 is displayed, the closest button that the finger is above and the functionality of that button is determined.

[0029] At 206, processor 12 initiates a haptic effect based the functionality and location of finger. Depending on the functionality on the touchscreen, a different haptic effect may be generated by processor 12. Because the finger does not actually touch touchscreen 13 in this embodiment, the haptic effect is felt by the other hand that is holding telephone 10.

[0030] In one embodiment, haptic effects can be applied to various menu navigation steps. For a user holding a hand held haptic enabled device, the haptics can be directed to the housing such that the user's hand holding the device will experience the haptic effect. For example, when using a touchscreen, if the user hovers over a top level menu choice and a sub-menu exists for that choice, then a light haptic effect simulating a soft button click (first haptic effect) can be played as the graphics display the preview sub-menu items. If there is no sub-menu attached to that particular menu item (or no valid choices exist) then a second haptic effect can be generated, for example a buzz created by series of pulses. If the user then selects the top level menu item, a strong haptic effect simulating a sharp button click (third haptic effect) can be played. If the user decides to move to another top-level menu a fourth haptic effect can be played when entering the new menu. The fourth haptic effect can be the same as the first haptic effect if it is a similar menu item. These haptic effects, resulting while a user finger is still hovering over a surface, i.e., before contract has been made, would be directed to the other hand that is holding the haptic device.

[0031] In one embodiment, different haptic effects can be applied depending on the intended use of the touchscreen area. For example, when a user's finger is hovering over a touch screen integrated into a cell phone or PDA, different haptic

effects can be produced in the cell phone when in a map/GPS navigation mode than when managing climate control or when entering hand written notes.

[0032] In one embodiment, during typical operation of a cell phone, the user can have many different proximity relationships to the device. For example the cell phone could be in the user's hand, in the user's pocket, or right next to the user's face. These different operating conditions required different levels of haptic feedback to the user. A proximity sensor could be used to detect these different operating conditions. It is also possible to detect these user conditions through the use of acceleration and/or orientation measurements. Once the current operating condition of the device is known, for example holding the phone next to an ear, a global haptic volume adjustment could be made for the different operating states. In one example, the user could have a specific vibration pattern set for a reminder event. If the user has the phone attached to a belt clip the vibration pattern could contain strong haptic effects in order to signal the reminder event. If the user is actually using the phone and has the phone pressed up next to the user's face where the user will be more sensitive to the haptic effects, when the reminder event is triggered, it would be useful to have the haptic magnitude reduced for that event.

[0033] In one embodiment, gestures can be recognized such as a virtual jog dial. A jog dial recognizes rotation and when performed above a proximity active surface can be recognized without the surface being touched. A movement in the x, y and/or z direction can also be recognized. As an example, haptic effects can be attached to the use of the virtual jog wheel. A first haptic effect can be played at regular intervals of the jog wheel to give the user an indication and confirmation of progress in moving the wheel. A second haptic effect can be output when the user

reaches the end of a list that the jog wheel is controlling. These jog and/or x, y, z motions can be recognized even when performed with proximity sensing, over a mechanical alpha/numeric keypad such as which exists on most cell phones today.

[0034] Several embodiments disclosed are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

WHAT IS CLAIMED IS:

1. A method of generating haptic effects on a device, said method comprising:

detecting the presence of an object near an input area of the device; and

generating a haptic effect on the device in response to the presence detection.

2. The method of claim 1, further comprising:

determining the approximate time when the object will touch the input area; and

generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

3. The method of claim 2, wherein said generating comprises energizing an actuator before the object touches the input area.

4. The method of claim 1, wherein said haptic effect comprises generating a vibration on the input area.

5. The method of claim 1, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

6. The method of claim 1, wherein said device is a cellular telephone.

7. The method of claim 1, wherein said input area is a touch sensitive surface.

8. The method of claim 1, further comprising:

determining a position of the object relative to the input area; and

determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

9. The method of claim 8, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

10. A haptically enabled device comprising:

an input area;

a proximity sensor coupled to said input area; and

a haptic feedback system coupled to said input area.

11. The device of claim 10, wherein said proximity sensor is adapted to detect the presence of an object near the input area and said haptic feedback system is adapted to generate a haptic effect on the device in response to the presence detection.

12. The device of claim 11, wherein said haptic feedback system is adapted to determine the approximate time when the object will touch the input area; and

generate the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

13. The device of claim 12, wherein said haptic feedback system comprises an actuator, and said system energizes said actuator before the object touches the input area.

14. The device of claim 10, wherein said input area comprises a touch sensitive surface.

15. The device of claim 14, wherein said touch sensitive surface is a touchscreen.

16. A computer readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate haptic effects on a device, said processor:

detecting the presence of an object near an input area of the device; and

generating a haptic effect on the device in response to the presence detection.

17. The computer readable medium of claim 16, said processor further:

determining the approximate time when the object will touch the input area; and

generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

18. The computer readable medium of claim 17, wherein said generating comprises energizing an actuator before the object touches the input area.

19. The computer readable medium of claim 16, wherein said haptic effect comprises generating a vibration on the input area.

20. The computer readable medium of claim 16, wherein said device comprises a housing and said haptic effect comprises generating a vibration on the housing.

21. The computer readable medium of claim 16, wherein said device is a cellular telephone.

22. The computer readable medium of claim 16, wherein said input area is a touch sensitive surface.

23. The computer readable medium of claim 16, said processor further:

determining a position of the object relative to the input area; and

determining a functionality on the input area based on the position;

wherein said generating the haptic effect comprises selecting a first type of the haptic effect based on the functionality.

24. The computer readable medium of claim 23, wherein said generating the haptic effect comprises selecting a second type of the haptic effect based on the functionality, wherein said second type is different than said first type.

25. A haptically enabled device comprising:

means for detecting the presence of an object near an input area of the device; and

means for generating a haptic effect on the device in response to the presence detection.

26. A haptically enabled device of claim 25, further comprising:

means for determining the approximate time when the object will touch the input area; and

means for generating the haptic effect so that it is implemented at approximately the same time as when the object touches the input area.

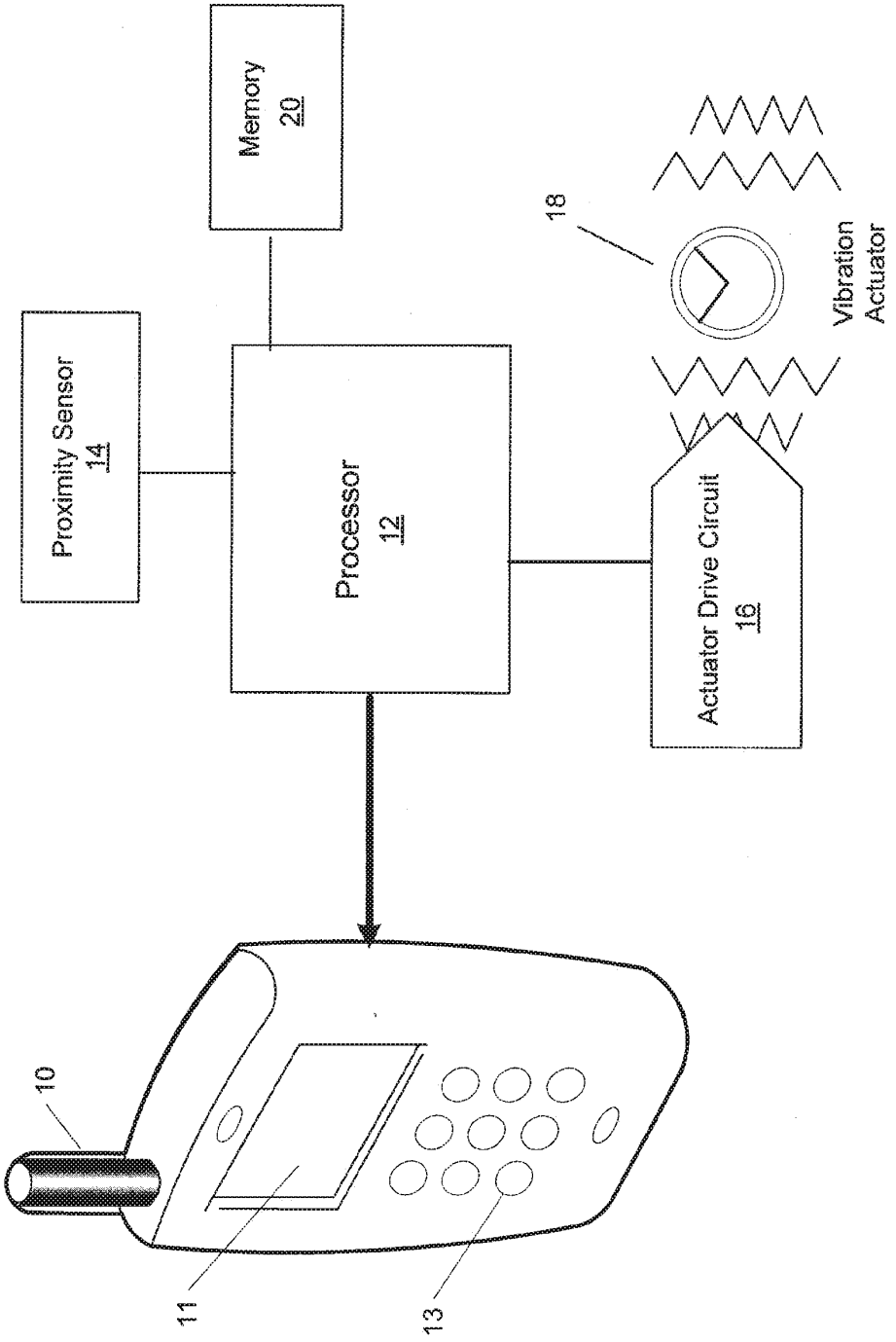

Memory
20
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
18
Vibration
Actuator
10
11
13

Fig. 1

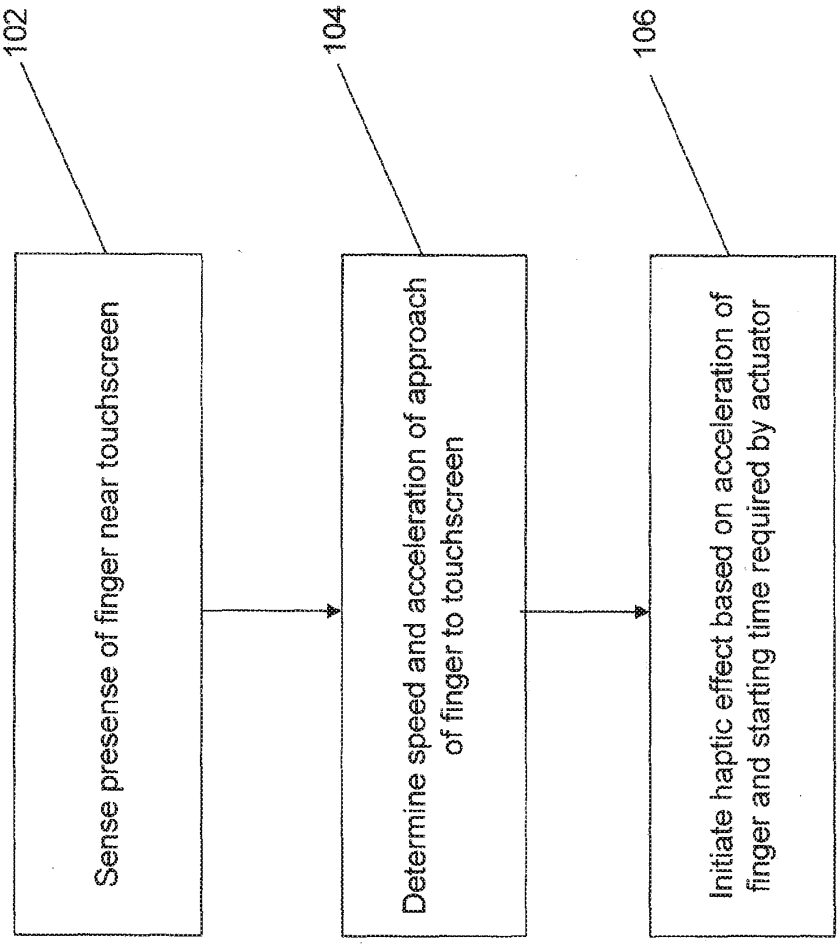

102
Sense presense of finger near touchscreen
104
Determine speed and acceleration of approach of finger to touchscreen
106
Initiate haptic effect based on acceleration of finger and starting time required by actuator

Fig. 2

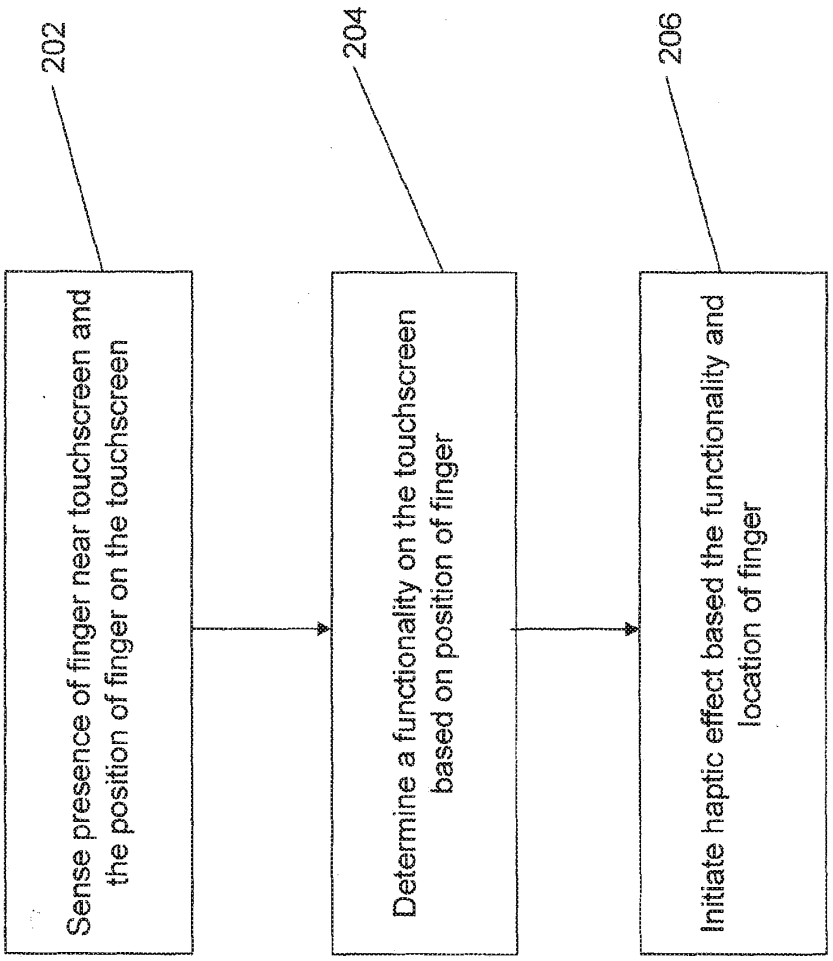

202
Sense presence of finger near touchscreen and the position of finger on the touchscreen
204
Determine a functionality on the touchscreen based on position of finger
206
Initiate haptic effect based the functionality and location of finger

Fig. 3

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G06F 3/01	(2006.01)	G06F 3/01	310A	

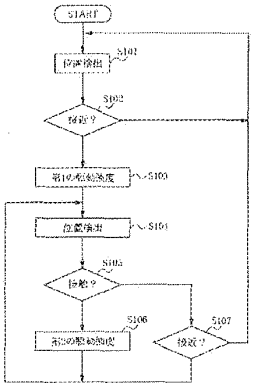
審査請求 未請求　請求項の数 10　OL　（全 15 頁）

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(54)【発明の名称】接触提示装置及び方法

(57)【要約】
【課題】　本発明は、接触を提示したいタイミングに遅れることなくアクチュエータを駆動して、人体へ刺激を提示する触覚提示装置を提供する。
【解決手段】　人体の位置を検出し（Ｓ１０１）、検出した位置により人体が仮想物体に接近したか否かを判断する（Ｓ１０２）。接近した場合は、第１の駆動強度で駆動モータを駆動する（Ｓ１０３）。人体が更に接近して仮想物体に接触したときは（Ｓ１０５）、第２の駆動強度で駆動モータを駆動する（Ｓ１０６）ことにより、タイミングに遅れることなく人体へ刺激を提示する。
【選択図】　図９



【特許請求の範囲】
【請求項１】
人体に刺激を与えるための刺激発生部と、
人体の位置を取得するための位置検出手段と、
前記位置検出手段により得られた人体の位置と、仮想物体との位置関係を判断する位置判定部と、
人体と仮想物体の位置関係に基づいて前記刺激発生部に駆動信号を送る制御部とを備え、
前記制御部が、人体と仮想物体が接触していないときに、第一の強度で前記刺激発生部を駆動し、人体と仮想物体が接触したときに、前記第一の強度よりも強度の強い第二の強度で刺激発生部を駆動することを特徴とする接触提示装置。
【請求項２】
前記制御部は、人体と仮想物体が特定の距離内に接近したときに、前記第一の強度で前記刺激発生部を駆動することを特徴とする請求項１に記載の接触提示装置。
【請求項３】
前記特定の距離は、人体の移動速度に基づいて変更されることを特徴とする請求項２に記載の接触提示装置。
【請求項４】
前記制御部は、人体と仮想物体が前記特定の距離内に接近したときに、接近の方向が該仮想物体の特定の方向に向いていないときには、前記刺激発生部を駆動しないことを特徴とする請求項２に記載の接触提示装置。
【請求項５】
予め前記刺激発生部で人体に異なる刺激を与えて決定した前記第一の強度と前記第二の強度を用いることを特徴とする請求項１に記載の接触提示装置。
【請求項６】
前記刺激発生部の発生する刺激をセンサによりセンシングし、前記センサの情報に基づいて前記第一の強度と前記第二の強度を決定されることを特徴とする請求項１に記載の接触提示装置。
【請求項７】
前記刺激発生部と人体との装着状態をセンサによりセンシングし、前記センサの情報に基づいて前記第一の強度と前記第二の強度を決定されることを特徴とする請求項１に記載の接触提示装置。
【請求項８】
前記刺激発生部が、振動モータを含むことを特徴とする請求項１に記載の接触提示装置。
【請求項９】
請求項１に記載の接触提示装置と、仮想空間を表示する表示装置とからなるバーチャルリアリティ装置。
【請求項１０】
人体の位置を位置検出手段により取得する位置検出ステップと、
前記位置検出手段により得られた人体の位置と、仮想物体との位置関係を判断する位置判定ステップと、
人体と仮想物体の位置関係に基づいて、人体に刺激を与えるための刺激発生部に、制御部から駆動信号を送る制御ステップとを備え、
前記制御部が、人体と仮想物体が接触していないときに、第一の強度で前記刺激発生部を駆動し、人体と仮想物体が接触したときに、前記第一の強度よりも強度の強い第二の強度で刺激発生部を駆動することを特徴とする接触提示方法。
【発明の詳細な説明】
【技術分野】
【０００１】

本発明は接触提示装置及び方法に関し、特に、バーチャルリアリティの分野において、仮想物体との接触をユーザに知覚させるための接触提示装置及び方法に関する。

【背景技術】

【０００２】

バーチャルリアリティの分野では、仮想物体に触れたり、操作したりするために触覚ディスプレイの検討が行われている。触覚ディスプレイは大きく分類して、人体に物体からの反力を提示する力覚ディスプレイ（フォース・フィードバック・ディスプレイ）と、物体の手触り感を提示するタクタイルディスプレイに分類される。

【０００３】

しかし、従来の力覚ディスプレイは、大型で可搬性に乏しい物が多く、また構成が複雑で高価になりやすい。タクタイルディスプレイについても装置の構成が複雑になりやすく、また現状の技術では十分に手触り感を提示するまでに至っていない。

【０００４】

そこで、仮想物体からの十分な反力や、物体表面の正確な手触り感を提示するのではなく、単純に仮想物体に「接触したかどうか」を提示する接触提示装置が検討されている。この方法では、振動モータを人体に複数装着し、仮想物体と触れた時に適切な位置の振動モータを振動させ、物体との接触をユーザに知覚させる。振動モータの振動により、ユーザは身体のどの部分が物体に触れているかを知覚することができる。また、振動モータは小型、安価、軽量であることから、人体の全体に装着することも比較的容易で、移動自由度の高いバーチャルリアリティシステムでの仮想物体とのインタラクションには特に有効である。

【０００５】

振動モータを用いた従来の接触提示装置には、次のようなものがある。

【０００６】

特許文献１は、指先の位置を取得するためのデータグローブに振動モータを設置し、指先に振動を与えることで、指先と仮想物体の接触をユーザに知覚させるものである。また、非特許文献１は、全身に計１２個の振動モータを装着し、仮想壁との接触時に振動モータを振動させることで、ユーザに壁を認知させる装置を提案している。この提案での振動モータ装着位置は、人体感覚図から判断し、頭、手の甲、肘、胴回り（３個）、膝、足首に装着している。また、非特許文献２では、腕４カ所、脚４カ所に振動モータを装着し、振動モータの振動を変化させて、異なる質感の物体への接触を提示している。また、非特許文献３では、戦場シミュレータ用に、振動モータを人体に装着した装置を開発している。この例では、振動モータ制御を無線で行うことが特徴である。

【０００７】

従来の振動モータを使用した接触提示装置の構成例を、図１０に示す。図１０では、複数の振動モータ１０を人体に装着している。また、ユーザは仮想物体を見るためにヘッドマウントディスプレイ１００を装着している。また、仮想物体との接触を検知するために、人体の位置情報が必要であるため、人体の各部位に位置検出用のマーカ８を複数設置している。マーカは、従来の手法では光学マーカや画像マーカが使われている。これらの構成により、ユーザの位置姿勢を検出し、仮想物体との接触を判定した後に、接触部位に最も近い部位に装着している振動モータ１０を振動させる。ユーザは振動した部分が、仮想物体と接触しているということを知覚する。

【０００８】

ここで、振動モータの一般的な構成を図１１に示す。振動モータ１０は、電磁力により偏心分銅１１を回転させることにより振動を得る。この振動モータ１０に電力を供給し振動を開始するときに、入力した信号（電圧、電流など）に応じた回転数を得るまでに遅れが生じる。すなわち、接触提示装置が、振動モータの駆動を命令してから目的の振動強度を得るまでに遅延が発生する。

【０００９】

この遅延の原因は、モータの時定数にある。モータの時定数は、電気的時定数と機械的

時定数に分けられ、一般に機械的時定数は電気的時定数の１０倍以上であり、遅延時間に大きな影響を与えるのは機械的時定数である。

【００１０】

振動モータの起動遅延が接触提示装置に与える影響を図１２に示す。図１２では、人体（指先）２に振動モータ１０を装着し、仮想物体１に接触する場合の振動モータの動作状況を示している。人体２と仮想物体１が接触する前（ｔ０）では、振動モータは駆動しておらず、振動の強度はゼロである。そして、人体２と仮想物体１が接触したと判定された時点（ｔ１）で振動モータに駆動命令が送られる。しかし、モータの時定数により、目的の振動強度１に達し、人が振動を知覚するまでにはｔ１２の時間を要する。つまり、人体２が仮想物体１に接触したｔ１以後も移動を継続した場合、ユーザは時間ｔ１２の間に移動した距離分、仮想物体表面から内部に入り込んだ位置で、物体に接触したことを知覚することになる。

【特許文献１】特表２０００－５０１０３３

【非特許文献１】矢野　博明，小木　哲朗，廣瀬　通孝：“振動モータを用いた全身触覚提示デバイスの開発”，日本バーチャルリアリティ学会論文誌，Ｖｏｌ．３，Ｎｏ．３，１９９８

【非特許文献２】Ｊｏｎｇｈｙｕｎ　Ｒｙｕ，Ｇｅｒａｒｄ　Ｊｏｕｎｇｈｙｕｎ　Ｋｉｍ：“Ｕｓｉｎｇ　ａ　Ｖｉｂｒｏ－ｔａｃｔｉｌｅ　Ｄｉｓｐｌａｙ　ｆｏｒ　Ｅｎｈａｎｃｅｄ　Ｃｏｌｌｉｓｉｏｎ　Ｐｅｒｃｅｐｔｉｏｎ　ａｎｄ　Ｐｒｅｓｅｎｃｅ”，ＶＲＳＴ‘０４，Ｎｏｖｅｍｂｅｒ１０－１２，２００４，Ｈｏｎｇｋｏｎｇ

【非特許文献３】Ｒ．Ｗ．Ｌｉｎｄｅｍａｎ，Ｙ．Ｙａｎａｇｉｄａ，Ｈ．Ｎｏｍａ，Ｋ．Ｈｏｓａｋａ，Ｋ．Ｋｕｗａｂａｒａ：“Ｔｏｗａｒｄｓ　Ｆｕｌｌ－Ｂｏｄｙ　Ｈａｐｔｉｃ　Ｆｅｅｄｂａｃｋ：Ｔｈｅ　Ｄｅｓｉｇｎ　ａｎｄ　Ｄｅｐｌｏｙｍｅｎｔ　ｏｆ　ａ　Ｓｐａｔｉａｌｉｚｅｄ　Ｖｉｂｒｏｔａｃｔｉｌｅ　Ｆｅｅｄｂａｃｋ　Ｓｙｓｔｅｍ”ＶＲＳＴ‘０４，Ｎｏｖｅｍｂｅｒ１０－１２，２００４，Ｈｏｎｇｋｏｎｇ

【発明の開示】

【発明が解決しようとする課題】

【００１１】

上記従来の技術によれば、実際の仮想物体の表面位置と、知覚する物体表面位置にずれが生じてしまう。接触提示装置でよく使用されている単純な振動ＤＣモータの時定数は、約１００ｍｓｅｃであり、図１１の時間ｔ１２には約１００ｍｓｅｃ以上を要することになる。この時定数の振動モータを使用している場合、人体の移動速度が１ｍ／ｓであるとすると、図１１の例では、仮想物体表面を知覚する位置に１０ｃｍ以上の大きな位置ずれ誤差が生じてしまう。また、ヘッドマウントディスプレイなどを装着し、視覚的に仮想物体を知覚しながら、このような接触提示装置を使用する場合には、この誤差によりユーザに大きな違和感を与えることになる。

【００１２】

従って、人体が仮想物体に触れたタイミングで、適切に振動刺激を与えることができなかった。

【００１３】

また、振動モータの電圧を、起動時に一時的に設定値よりも高く設定することが一つの方法である。しかし、この方法では、目的の振動強度に達した後にオーバーシュートが大きく発生することがあり、目的の振動強度を人体に提示することが困難である。また、モータの起動時には通常、平均電流の２倍近くの電流が流れるため、起動時の電圧を高くすれば、さらに高い電流が流れることになる。このため、回路に高電流対策が必要となる。また、一時的にでも高電流が流れることは、人体に装着する接触提示装置において望ましいことではない。

【００１４】

上記課題を解決するために、本発明の目的は、人体が仮想物体に触れたタイミングで、

適切に刺激を与えることができる接触提示装置及び方法を提供する。

【００１５】

また、本発明の目的は、ユーザが違和感を感じることなく、刺激を与える接触提示装置及び方法を提供する。

【課題を解決するための手段】

【００１６】

上記の課題を解決するために、本発明の接触提示装置は、人体に刺激を与えるための刺激発生部と、人体の位置を取得するための位置検出手段と、前記位置検出手段により得られた人体の位置と、仮想物体との位置関係を判断する位置判定部と、人体と仮想物体の位置関係に基づいて前記刺激発生部に駆動信号を送る制御部とを備え、前記制御部が、人体と仮想物体が接触していないときに、第一の強度で前記刺激発生部を駆動し、人体と仮想物体が接触したときに、前記第一の強度よりも強度の強い第二の強度で刺激発生部を駆動することを特徴とする。

【００１７】

また、本発明の接触提示方法は、人体の位置を位置検出手段により取得する位置検出ステップと、前記位置検出手段により得られた人体の位置と、仮想物体との位置関係を判断する位置判定ステップと、人体と仮想物体の位置関係に基づいて、人体に刺激を与えるための刺激発生部に、制御部から駆動信号を送る制御ステップとを備え、前記制御部が、人体と仮想物体が接触していないときに、第一の強度で前記刺激発生部を駆動し、人体と仮想物体が接触したときに、前記第一の強度よりも強度の強い第二の強度で刺激発生部を駆動することを特徴とする。

【発明の効果】

【００１８】

本発明の接触提示装置及び方法は、人体が仮想物体に触れたタイミングで、適切に刺激を与えることができる。

【発明を実施するための最良の形態】

【００１９】

以下、本発明の一実施形態を、図面を用いて詳細に説明する。

【００２０】

（第一の実施形態）

第一の実施形態として、刺激発生部に振動モータを使用した例を示す。

【００２１】

図１は、本実施形態の接触提示装置の構成を示す図である。

【００２２】

図１の構成について説明を行う。人体２に装着した振動モータ１０は、人体２と仮想物体１との接触の有無、あるいは人体中の接触した部位をユーザに知覚させるために、振動刺激を発生する。図１で、振動モータ１０は指先に装着している例を示したが、人体のどの部分に装着してもよい。また、振動モータを人体の複数部位に装着しても良い。

【００２３】

図１では、人体２の位置を取得するために、マーカ８とカメラ９と情報処理装置１０１内に位置検出部３を備えている。

【００２４】

ここで、情報処理装置１０１は、一般的なパーソナルコンピュータで構成され、ＣＰＵ、メモリ（ＲＯＭ、ＲＡＭ）、外部インターフェース等を備える。このメモリに記憶されたプログラムを実行することにより、位置検出部３、位置判定部４、画像出力部７として機能する。更に、情報処理装置１０１内には、刺激発生部の駆動を制御する制御部５、記録装置６としてのハードディスク等の外部記憶装置を備える。

【００２５】

本実施形態では、マーカとカメラで人体の位置を取得する構成としたが、位置情報を取得できる方法であれば、どのような方法を用いても良い。磁気センサや加速度・角速度セ

ンサや地磁気センサなどを用いた手法を用いても良い。記録装置６には、仮想物体の位置や外観、形状の情報が記録されている。位置判定部４では、位置検出部３により出力される人体の位置と、記録装置６に記録している仮想物体との位置関係を判定する。これにより、人体と仮想物体との距離や、接触の有無を判定する。そして、制御部５では、位置判定部４の接触判定結果に基づいて、振動モータに振動の命令を行い、ユーザに仮想物体との接触を知覚させる。

【００２６】

ここで、本実施形態の概略フローを図９のフローチャートを用いて説明する。

【００２７】

図９は、本実施形態における位置検出と刺激提示に関するフローチャートである。尚、詳細については後述する。ステップＳ１０１において人体２を検出する。検出した人体の２の位置と仮想物体１の位置関係が接近しているか否かを判断し（ステップＳ１０２）、接近している場合は、第１の駆動強度で振動モータを駆動する（ステップＳ１０３）。接近していない場合は、ステップＳ１０１、Ｓ１０２の処理を繰返す。

【００２８】

ステップＳ１０４では、ステップＳ１０１と同様である。ステップＳ１０４で検出した位置により、人体２と仮想物体１が接触したか否かを判断し（ステップＳ１０５）、接触している場合、第２の駆動強度で駆動モータを駆動する。接触していない場合、ステップＳ０７で接近した状態であるか否かを判断し、判断した結果に基づき、ステップＳ１０１又はステップＳ１０４の何れかへ進む。

【００２９】

上述の詳細について説明する。

【００３０】

図１では、振動モータ１０とマーカ８の位置は、人体の同一部位であるため、位置判定部４は人体と仮想物体の接触を判定するために、マーカ位置と仮想物体との接触を判定する。また、人体の空間中での形状を求め、仮想物体との接触判定を行う方法を用いても良い。この方法では例えば、人体の複数位置に設置したマーカと予め用意した人体モデルを使用し、置検出部３で人体モデルの位置・姿勢を求める。

【００３１】

位置判定部４では、人体モデルの位置・姿勢を使用して人体と仮想物体との接触を判定するようにしても良い。この手法によると、人体モデルを使用することで、マーカを装着していない人体部分についてもその位置を推定することができ、接触判定を行うことができるようになる。

【００３２】

更に、図１では、記録装置６に記録されている仮想物体を画像出力部７を介して、ヘッドマウントディスプレイ１００に表示している。ユーザは仮想物体１を視覚的に把握するために、仮想物体が表示されたディスプレイを見ながら操作を行っても良い。

【００３３】

本実施形態では、人体が仮想物体と接触する時点より前から振動モータを起動しておくことで、振動モータが目的の振動を行うまでの時間を短縮する。

【００３４】

図２は、本実施形態における振動モータの駆動方法を説明する図である。

【００３５】

図中、上部のグラフは、時間経過と振動モータの振動強度の関係を示している。また、下部の図は時間ｔ０とｔ１における人体２と仮想物体１の位置関係を示している。具体的には、時間ｔ０に人体が仮想物体１と距離ｘまで近づき、そのまま仮想物体に接近して、時間ｔ１に接触している。

【００３６】

図２の振動強度Ｉ１を第一の振動強度（第一の強度）とする。振動強度Ｉ２は第二の振動強度（第二の強度）で、人体に仮想物体との接触を知覚させるために十分な振動強度で

ある。振動強度Ｉｔｈは人体が知覚する振動強度の最低値を示しており、第一の振動強度Ｉ１はＩｔｈ未満、第二の振動強度Ｉ２はＩｔｈ以上の強度である。

【００３７】

図２において、時間ｔ０までは振動モータに駆動の命令は送られておらず、振動モータは動作していない。時間ｔ０に、予め設定した距離ｘまで人体２と仮想物体１が接近すると、制御部５はＩｔｈ以下の振動強度Ｉ１で振動モータを駆動する。この結果、振動モータ１０の振動は、モータの過渡応答特性によりｔ０’後に振動強度Ｉ１に達する。この振動は、人体が知覚できる振動強度Ｉｔｈ以下であるので、人体は振動モータ１０が振動していることを知覚しない。

【００３８】

そして、さらに人体２と仮想物体１が接近し接触した時間ｔ１に、制御部５は振動モータ１０に振動強度Ｉ２で振動するように命令を行う。振動モータ１０は時間ｔ１にｔ１’遅れて、所定の振動強度Ｉ２に達する。この遅れ時間ｔ１’は、振動モータ１０が予め振動強度Ｉ１で駆動していたことにより、振動モータ１０が完全に停止していた状態から振動強度Ｉ２に達する時間よりも短い時間となる。

【００３９】

このような構成にすることで、人体と仮想物体の接触を判定してから、振動モータが所定の振動強度に達するまでの時間を短縮することができ、振動が人体に提示されるまでの時間ずれを低減することができるようになる。

【００４０】

前述したように、第一の振動強度Ｉ１は、人体が振動を知覚できる最低の振動強度Ｉｔｈよりも低く設定する。しかし、Ｉｔｈは振動モータの装着状態や装着位置、またはユーザの振動の感じ方の個人差によって異なるため、第一の振動強度Ｉ１を、特定の値に設定することは困難である。例えば、直接皮膚の上に装着した振動モータと、衣服を介して皮膚に振動を提示するように装着した振動モータでは、人体に与える振動強度が異なる。

【００４１】

従って、後述するように予めキャリブレーションを行うことや、センサを用いて振動強度を測定する方法などで最適な値を設定することが望ましい。また、第一の振動強度Ｉ１はＩｔｈ以下であれば、どのような強度でも良いが、振動モータの起動遅延の改善のためには、Ｉｔｈに近い値であることが望ましい。

【００４２】

また、同様に、Ｉｔｈ以上の強度に設定する第二の振動強度Ｉ２も、状況に応じて最適な値を設定する。さらにまた、第二の振動強度Ｉ２は、仮想物体との接触状態をユーザに提示するために、Ｉｔｈ以上であれば異なる強度や提示パターンであっても良い。例えば、仮想物体の特定の部位に触れた場合には、他の部位に触れたときよりも強い振動強度を提示する。また、仮想物体との接触深度が深い場合に、表面のみに接触している場合よりも強い第二の強度で、振動モータを駆動しても良い。

【００４３】

また、さらに、仮想物体表面の形状・手触りなどを提示するために、振動強度や振動提示パターンを変化させても良い。例えば、振動強度を時系列的に変化させる、連続パルス状に振動を発生させるなどの提示方法を用いても良い。

【００４４】

第一の振動強度と第二の振動強度は入力する電圧や電流、振動モータの加速度、振動モータの振動周波数（回転数）などで規定する。例えば、振動モータへの入力電圧が１Ｖの場合を第一の振動強度とし、３Ｖの場合を第二の振動強度とする。また、例えばＰＷＭ制御で振動モータを制御する場合には、デューティー比を変化させることで、第一の振動強度と第二の振動強度を変化させる。第一の振動強度と第二の振動強度の強度比は、知覚レベルに明確な差異をつけるために大きくする必要がある。本発明者の実験によると好ましくは３倍以上にすると良い。

【００４５】

尚、強度比が大きすぎると、第二の振動強度での駆動時に消費電力が上がる。あるいは、第一の振動強度での駆動時に十分な駆動が行われない、という問題がある。よって、第一の振動強度と第二の振動強度の強度比は１０倍以内にするとさらに良い。

【００４６】

ところで、一般に人体は２００Ｈｚ付近の振動を最も良く感じると言われている。そのため、人体に振動を知覚させるための第二の強度における振動モータの振動周波数は２００Ｈｚ付近であることが望ましい。また、少なくとも１００Ｈｚ～４００Ｈｚ付近であることが望ましい。逆に、人体に振動を知覚させない第一の強度での振動モータの振動周波数は１００Ｈｚ程度以下の低い周波数に設定する。また、人体は高い周波数の振動も知覚しないので、第一の振動強度は、４００Ｈｚ以上、好ましくは１ｋＨｚ以上の周波数にするようにしても良い。第一の振動強度と第二の振動強度を振動周波数で決める場合には、上記のように設定することが望ましい。

【００４７】

以上では人体と仮想物体の接触時、すなわち振動の開始時について説明してきたが、人体と仮想物体が接触しなくなり、人体への刺激を停止させる時に、振動モータを完全に停止するのではなく、振動強度を第一の振動強度にするようにしても良い。

【００４８】

この例を図３を用いて説明する。図３において、振動強度Ｉ１、Ｉｔｈ、Ｉ２は図２と同様にそれぞれ、第一の振動強度、人体が振動を知覚する最低の振動強度、第二の振動強度である。また、時間ｔ２まで人体２と仮想物体１は接触しているとし、時間ｔ２で人体２と仮想物体１は離れる。そして時間ｔ３では再び人体２と仮想物体１が接触するものとする。

【００４９】

この場合に、時間ｔ２にて振動モータを完全に停止してしまうのではなく、人体２と仮想物体１の間の距離が所定の範囲内である間は、第一の振動強度Ｉ１で振動モータを駆動する。ここで、ｔ２’は振動強度が第一の振動強度Ｉ１になるまでの時間である。振動モータは、入力信号を停止しても、しばらくは分銅の慣性で振動を継続するため、停止時にもある程度の時間を要する。

【００５０】

以上のような駆動方法にすることにより、再び人体２と仮想物体１が接触する時間ｔ３にて、素早く第二の振動強度Ｉ２で振動を提示することができるようになる。なお、人体は一定時間振動を受けると順応により、振動を感じにくくなる。すなわち、人体が振動を知覚する最低の振動強度Ｉｔｈが変化し、Ｉｔｈが比較的高い値になる。

【００５１】

このことを利用して、第二の振動強度で人体に刺激を提示する前の第一の振動強度Ｉ１よりも、人体に刺激を提示した後の第一の振動強度Ｉ１を高い強度に設定することができる。第一の振動強度Ｉ１が高くなることにより、第二の振動強度Ｉ２に到達する時間がさらに低減される効果がある。

【００５２】

次に、図２及び図３に示した距離ｘについて説明する。

【００５３】

図２及び図３の例では、人体２と仮想物体１が距離ｘ以下に接近しているときに、第一の振動強度Ｉ１で振動モータを駆動することとした。距離ｘには、人体２の移動範囲、平均的な移動速度または仮想物体１の形状や性質などから、予め適した値を設定すればよい。距離ｘは、全ての仮想物体に対して同じ値を設定しても良いし、仮想物体ごとに異なる値を設定しても良い。

【００５４】

効果を十分に得るためには、人体２と仮想物体１が接触する以前に、振動モータの振動が第一の振動強度に達している必要がある。そのため、振動モータが第一の振動強度に達する時間をｔ０’、人体の移動速度をｖとすると、ｘはｘ＞ｖ・ｔ０’となるような値を

設定することが望ましい。例えば、振動モータの起動時間ｔ０’を１００～２００ｍｓｅｃ、人体の移動速度ｖを０．１～１ｍ／ｓとすると、ｘは１～２０ｃｍよりも大きな値に設定することが望ましい。

【００５５】

また、ｘを固定の値とするのではなく、人体の移動速度の変化に合わせて随時更新するようにしても良い。例えば、人体が通常よりも早く動いている場合には、距離ｘの値を大きくする。なお、ここで人体の移動速度とは、手や腕などが動く速度、または歩く速度を含む。

【００５６】

また、人体２と仮想物体１の間がｘ以下になった場合に、必ず第一の振動強度Ｉ１で振動モータを駆動するのではなく、人体と仮想物体の相対的な動きに合わせて振動モータの動作を変化させても良い。

【００５７】

図４は球状の仮想物体１を表す図であり、仮想物体１の周囲の距離ｘの範囲には、第一の振動強度で振動モータを駆動する範囲１２がある。ここで、範囲１２の外から人体２が範囲１２に侵入する場合、仮想物体１方向に向いた方向ａで接近する場合と、仮想物体１方向でなく範囲１２を通過する方向ｂで接近する場合がある。まず、方向ａで範囲１２に侵入した場合には、仮想物体との接触が予想されるため、第一の振動強度で振動モータを駆動するように命令を行う。

【００５８】

一方、方向ｂで範囲１２に侵入した場合には、その侵入方向により、仮想物体１に接触せずに範囲１２を通過すると予想される。この場合、第一の振動強度でのモータ駆動を行わないようにする。また、方向ｂで侵入した場合にも、侵入速度が遅く、仮想物体が動く、または人体の移動方向が変化する事により、仮想物体１との接触が予想される場合には、第一の振動強度で振動モータを駆動するように命令しても良い。このような命令を行う場合には、人体の移動速度を求める必要がある。人体の移動速度を求めるためには、位置判定部で人体位置の時間変化を記録し、そこから速度を算出するようにすればよい。

【００５９】

また、以上では人体と仮想物体の間の距離が、所定の値（ｘ）以下の場合に第一の振動強度で振動モータを駆動する例を示したが、人体と仮想物体の間の距離に関係なく、常に第一の振動強度で振動モータを駆動する形態にしてもよい。図５には、人体と仮想物体の間の距離に関係なく、人体と仮想物体が接触していない時に、常に第一の振動強度で振動モータを駆動する場合の振動強度変化の例を示した。時間ｔ４及びｔ５は接触する以前の状態であるが、人体２の位置によらず、常に第一の振動強度Ｉ１で振動モータが駆動している。時間ｔ６になると、人体２と仮想物体１が接触するため、振動強度Ｉ２で振動モータを駆動する。また、時間ｔ７では、人体２が仮想物体から離れた時間であるが、その後、振動モータは第一の振動強度で駆動する。

【００６０】

ここで、前述したように、人体に振動を提示した後（第二の振動強度で駆動した後）は、人体が振動に順応し、Ｉｔｈは比較的高い値になる。Ｉｔｈの上昇に伴い、第一の振動強度を比較的高い強度に設定することができる。

【００６１】

図５では、人体の振動順応により、Ｉｔｈが変化する様子も示している。また、第二の振動強度Ｉ２で駆動する前の第一の振動強度Ｉ１よりも、第二の振動強度Ｉ２で駆動した後の第一の振動強度Ｉ１’は高い強度となっている。なお、図５では、一定の時間、第一の振動強度Ｉ１’で駆動した後に、第一の振動強度Ｉ１の強度まで低下させている。これは、人体の振動順応が薄れ、Ｉｔｈの強度が低下してしまい、振動強度Ｉ１’の振動を人体が知覚することを防ぐためである。

【００６２】

以上のような構成によると、比較的高い第一の振動強度Ｉ１’で振動モータが動作して

いる間に、再び第二の振動強度で動作する命令が行われた場合には、さらに早く第二の振動強度に達することができるようになる。

【００６３】

次に、第一の振動強度と第二の振動強度の設定方法について説明する。簡便な設定方法は、予め、特定、またはある範囲の強度を第一の振動強度と第二の振動強度とすることである。

【００６４】

しかし、前述したように、振動モータの装着状態、装着位置、またはユーザの振動の感じ方の個人差により異なる。よって、事前にユーザごとにキャリブレーションを行い、第一の振動強度と第二の振動強度を決定することが望ましい。キャリブレーションでは、ユーザごと、装着位置ごとに振動強度を変化させユーザに刺激を提示し、ユーザが刺激を知覚しない振動強度範囲に第一の振動強度を設定する。また、ユーザが振動を知覚しやすい振動強度範囲に第二の振動強度を設定する。この方法により、ユーザごとの振動の感じ方の個人差を低減することができ、また人体部位ごとの装着状態の影響も低減できるようになる。

【００６５】

また、振動モータの振動状態や人体との接触状態をセンサで測定し、第一の振動強度と第二の振動強度の設定に用いても良い。

【００６６】

図６には振動モータ１０と人体２の間にセンサ２０を導入した例を示している。図６においてセンサ２０は例えばひずみゲージや加速度センサである。センサ２０の情報は制御部に送られて、接触提示装置を使用しながら第一の振動強度または第二の振動強度を再設定することができる。このような構成にすることにより、例えば接触提示装置の使用中に装着状態に変化が生じた場合にも、適切な振動強度で振動モータを駆動することができる。

【００６７】

より具体的には、ひずみゲージを使用した場合、振動モータと人体との接触状態を監視し、接触が弱くなった場合には、第一の振動強度と第二の振動強度の強度を高く再設定する。逆に、接触が強くなった場合には、第一の振動強度と第二の振動強度の強度を低く再設定する。

【００６８】

（第二の実施形態）

第一の実施例では、人体への刺激提示方法として振動モータを使用した方法について述べた。しかし、本発明は振動モータに限定することなく、他の刺激方法にも有効である。

【００６９】

すなわち、駆動に時間がかかるアクチュエータを使用した刺激発生方法において、人体と仮想物体の接触前に、人体が刺激を知覚しないレベルで駆動を開始しておくことで、刺激の発生遅れを解消することができるようになる。

【００７０】

図７には、接触提示装置の刺激発生方法として、形状記憶合金駆動のピン型触覚ディスプレイを使用した例を示している。

【００７１】

この接触提示装置では、ピン型触覚ディスプレイ３０を、ピン形状の刺激提示部３３が人体２表面に向く方向に装着し、仮想物体との接触をピンによる刺激によって人体に提示する。図７には不図示であるが、この触覚提示装置には図１の例と同様に人体の位置検出装置や情報処理装置を備え、人体と仮想物体の接触判定に基づいて、刺激を発生する機構を備える。なお、ピン型触覚ディスプレイ３０に備えるピンは一つでも良いし、複数でも良い。

【００７２】

複数のピンを備えるピン型触覚ディスプレイを用いる場合、人体と仮想物体の接触状態

によって、駆動するピンを選択することが好適である。また、図７では指先にピン型触覚ディスプレイ３０を装着する例を示したが、指先以外の人体部位に装着しても良いし、複数のピン型触覚ディスプレイ３０を人体に装着しても良い。

【００７３】

図８にはピン型触覚ディスプレイ３０のピンを形状記憶合金３１で駆動するための構成例を示している。図の簡単のため、図８では、ピン１本を形状記憶合金３１で駆動するための構成を示している。形状記憶合金は例えばＴｉ－Ｎｉ系の合金で、熱を加えることにより、もとの状態に戻る特性（形状回復力）を持つ。この力は、低温での柔らかな形状記憶合金を変形させるために必要な力に比べ大きな力となる。また、Ｔｉ－Ｎｉ系の形状記憶合金は抵抗が高いので、通電により発熱し変形が起こるため、電気的な制御により簡単に動作させることができる。

【００７４】

図８のピン型ディスプレイ３０では、形状記憶合金３１に通電を行うことにより、形状記憶合金３１が発熱し収縮する方向に変形する。そして、形状記憶合金３１が収縮することによって、刺激提示部３３が図の上方向に動き、人体２を刺激する。形状記憶合金３１への通電を停止すると、冷却により形状記憶合金３１は柔らかくなり、バイアスばね３２に引っ張られて定常状態（ピンが突出していない状態）に戻る。

【００７５】

以上の機構により、形状記憶合金を使用して、人体に刺激を発生させることができる。

【００７６】

しかし、形状記憶合金は熱により駆動するため、図７のピン型触覚ディスプレイ３０は駆動に時間を要する。そこで、本発明では、人体２と仮想物体が接触する前に、予め通電により形状記憶合金３１を加熱しておく。このときの加熱は、人体２に刺激を与えない第一の強度である。

【００７７】

すなわち、第一の強度で加熱した形状記憶合金３１は、刺激提示部３３が完全に突出しないか、突出していても人体が刺激を感じることのないレベルである。そして、人体２が仮想物体と接触をした場合には、人体に刺激を提示することのできるレベルまで形状記憶合金を駆動する第二の強度で加熱を行う。このとき、予め第一の強度で加熱していた形状記憶合金３１は、全く加熱を行っていない場合に比べ、比較的早い駆動を行うことができる。形状記憶合金３１を用いた実施例では、第一の強度と第二の強度を形状記憶合金３１に加える電流や電圧で規定すれば良い。また、実際に形状記憶合金３１の伸縮の長さや温度を計測して、特定の値や範囲を第一の強度、第二の強度としても良い。

【００７８】

以上の説明したように、本実施形態では、人体が仮想物体に接触する以前に、刺激提示手段を人体が知覚しない刺激強度範囲で予め起動させ、人体が仮想物体に接触した時に人体が知覚する刺激強度範囲の刺激を発生させる。本実施形態によれば、刺激提示手段が予め起動していることにより、刺激提示の遅延を低減することができるようになる。

【図面の簡単な説明】

【００７９】

【図１】第一の実施形態を説明するための接触提示装置である。

【図２】人体と仮想物体の位置関係と、振動モータの振動強度の関係を示す図である。

【図３】人体と仮想物体の位置関係と、振動モータの振動強度の関係を示す図である。

【図４】人体の動きと第一の強度の提示の関係について説明するための図である。

【図５】人体と仮想物体の位置関係と、振動モータの振動強度の関係を示す図である。

【図６】接触提示装置にセンサを備えたことを説明する図である。

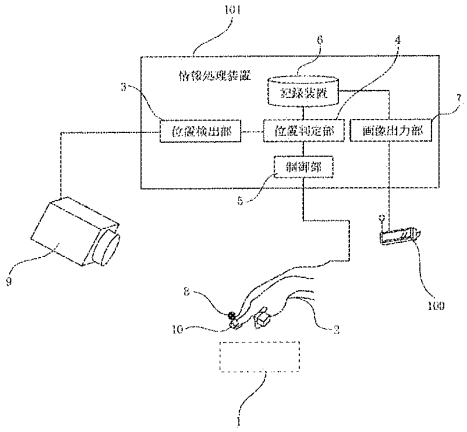
【図７】第二の実施例を説明するための接触提示装置である。

【図８】形状記憶合金を使用したピン型触覚ディスプレイについて説明するための図である。

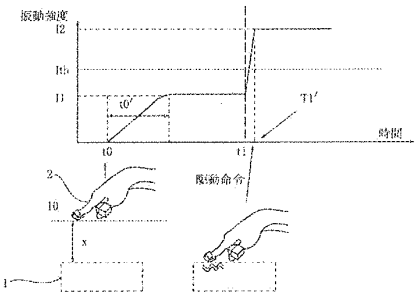
【図９】本実施形態の処理を示すフローチャートである。

【図１０】人体全体に振動モータを装着した図である。
【図１１】振動ＤＣモータを説明する図である。
【図１２】従来の接触提示装置の、振動モータの振動強度の変化を示す図である。
【符号の説明】
【００８０】
１　仮想物体
２　人体
３　位置検出部
４　位置判定部
５　制御部
６　記録装置
７　画像出力部
８　マーカ
９　カメラ
１０　振動モータ
１００　ヘッドマウントディスプレイ
１０１　情報処理装置

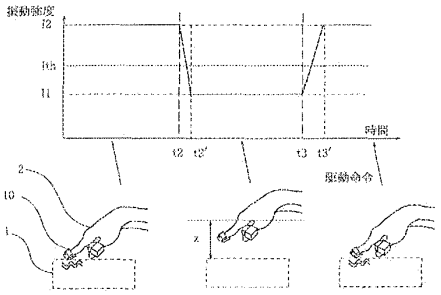
【図１】



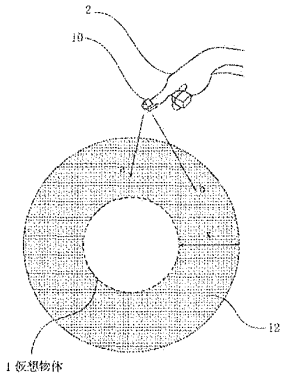
【図２】



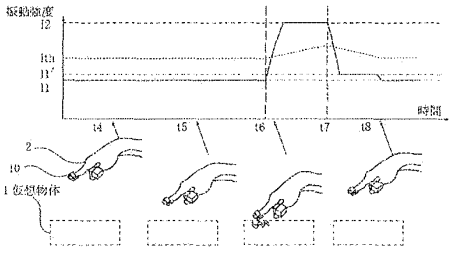
【図３】


振動強度
I2
I1h
I1
時間
t2 t2' t3 t3'
駆動命令
2
10
1
x

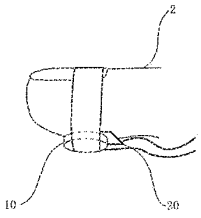
【図４】


2
10
12
1 仮想物体

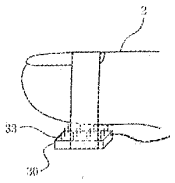
【図５】


振動強度
I2
I1h
I1'
I1
時間
t4 t5 t6 t7 t8
2
10
1 仮想物体

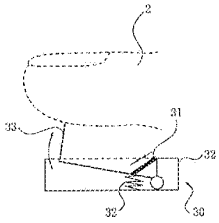
【図６】


2
10
20

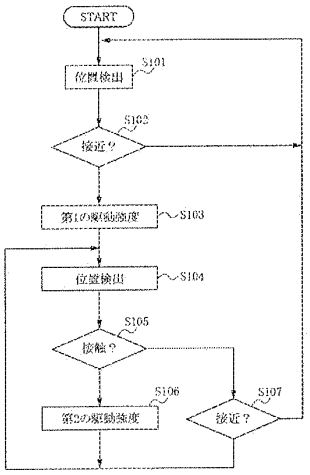
【図７】


2
33
30

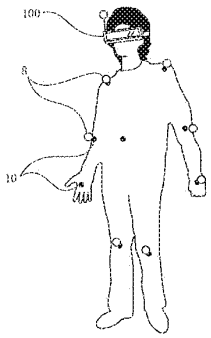
【図８】


2
31
33
32
32
30

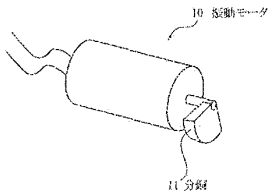
【図９】


START
位置検出
S101
接近？
S102
第1の駆動強度
S103
位置検出
S104
接触？
S105
第2の駆動強度
S106
接近？
S107

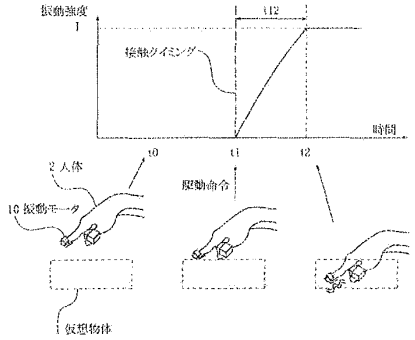
【図１０】


100
8
10

【図１１】


10 振動モータ
11 分銅

【図１２】


振動強度
I
Δt2
接触タイミング
時間
t0
t1
t2
2 人体
駆動命令
10 振動モータ
仮想物体

Espacenet

Bibliographic data: KR20110082865 (A) — 2011-07-20

SEMICONDUCTOR LIGHT EMITTING DIOD AND METHOD FOR MANUFACTURING THE SAME

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Classification: - **international:** ***H01L33/36***
- **cooperative:** **H01L33/20**; **H01L33/38**; H01L2933/0016 more

Application number: KR20100002776 20100112 Global Dossier

Priority number(s): KR20100002776 20100112

Abstract of KR20110082865 (A)

PURPOSE: A semiconductor light emitting device and a manufacturing method thereof are provided to bend the boundary surface between a second electrode exposure area and a semiconductor laminate, thereby preventing lowering of the leakage feature of a light emitting device. CONSTITUTION: A semiconductor laminate comprises first and the second major surfaces which face each other. The semiconductor laminate includes a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer. A connecting fixture is connected from the second major surface to one side of the first conductive semiconductor layer. A first electrode layer is connected to one side of the first conductive semiconductor layer through the connection fixture. A second electrode layer is formed on the second major surface of the semiconductor laminate.

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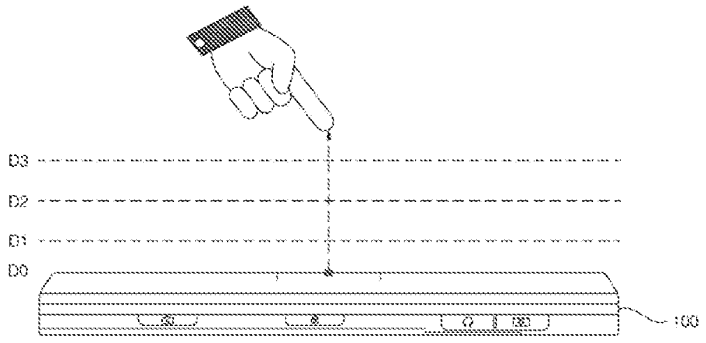
전체 청구항 수 : 총 47 항

(54) 휴대 단말기 및 그 동작제어 방법

(57) 요 약

휴대 단말기 및 그 동작 제어방법에 관한 것이다. 본 발명은, 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서, 근접센서를 통해 근접신호가 검출된 경우, 근접신호가 검출된 제1 위치를 확인하는 단계, 제1 위치를 통해 터치신호가 입력된 경우, 근접신호에 대응하는 진동신호 및 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함한다. 본 발명에 따르면, 다양한 진동을 출력함으로써, 사용자에게 입력 신호에 대한 정보를 용이하게 제공할 수 있다.

대 표 도 - 도4



특허청구의 범위

청구항 1

근접센서를 포함하는 휴대 단말기 본장 제어방법에 있어서,

상기 근접센서를 통해 근접신호가 검출된 경우, 상기 근접신호가 검출된 제1 위치를 확인하는 단계; 및

상기 제1 위치를 통해 터치신호가 입력된 경우, 상기 근접신호에 대응하는 진동신호 및 상기 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함하는 휴대 단말기 동작 제어방법.

청구항 2

제1항에 있어서,

제2 위치를 통해 터치신호가 입력된 경우, 상기 터치신호에 대응하는 진동신호를 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 3

제1항에 있어서,

상기 근접센서를 통해 근접신호가 검출된 경우, 상기 근접신호에 대응하는 진동신호를 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 4

제1항에 있어서,

상기 제1 위치를 통해 터치신호가 입력된 경우, 상기 제1 위치에 대응하는 실행화면을 표시하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 5

제1항에 있어서,

상기 조합된 진동은, 상기 근접신호에 대응하는 진동신호 및 상기 터치신호에 대응하는 진동신호를 각각 합산하거나 감산한 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 6

제1항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 7

근접센서를 포함하는 휴대 단말기 본장 제어방법에 있어서,

상기 근접센서를 통해 상기 근접센서로부터 제1 근접거리에서 근접신호를 검출하는 단계; 및

상기 제1 근접거리에서 근접신호가 검출된 후, 상기 근접센서로부터 제2 근접거리에서 근접신호가 검출된 경우, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호 및 상기 제2 근접거리에서 근접신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함하는 휴대 단말기 동작 제어방법.

청구항 8

제7항에 있어서,

상기 제1 근접거리에서 근접신호가 검출된 경우, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호를 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 9

제7항에 있어서,

상기 조합한 진동은, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호 및 상기 제2 근접거리에서 근접신호에 대응하는 진동신호를 각각 합산하거나 감산한 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 10

제7항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 11

터치스크린을 포함하는 휴대 단말기 동작 제어방법에 있어서,

상기 터치스크린의 제1 영역, 및 제2 영역을 통해 터치신호가 입력되는 경우, 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함하는 휴대 단말기 동작 제어방법.

청구항 12

제11항에 있어서,

상기 조합한 진동은, 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 각각 합산하거나 감산한 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 13

제11항에 있어서,

상기 제1 영역 및 상기 제2 영역 사이의 거리에 따라 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 14

제11항에 있어서,

상기 터치스크린의 제3 영역, 및 제4 영역을 통해 터치신호가 입력되는 경우, 상기 제1 영역 및 상기 제2 영역 사이의 거리, 및 상기 제3 영역 및 상기 제4 영역 사이의 거리 변화에 따라, 상기 제1,제2,제3 및 제4 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 15

제11항에 있어서,

상기 터치스크린의 제3 영역, 및 제4 영역을 통해 터치신호가 입력되는 경우, 상기 제1,제2 영역을 통해 입력된 터치신호 및 상기 제3,제4 영역을 통해 입력된 터치신호의 속도 차이에 따라, 상기 제1,제2,제3 및 제4 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 16

제11항에 있어서,

상기 터치스크린의 제1 영역, 및 제2 영역을 통해 입력된 터치신호에 의해, 이미지가 확대되어 터치스크린에서 표시될 수 있는 최대 크기로 표시된 경우, 제1알림진동을 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 17

제11항에 있어서,

상기 터치스크린의 제1 영역, 및 제2 영역을 통해 입력된 터치신호에 의해, 이미지가 축소되어 터치스크린에서

표시될 수 있는 최소 크기로 표시된 경우, 제2알림진동을 출력하는 단계를 더 포함하는 휴대 단말기 동작 제어방법.

청구항 18

제11항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 19

터치스크린 및 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서,

상기 근접센서에서 둘 이상의 근접신호가 검출된 경우, 상기 둘 이상의 근접신호 각각에 대응하는 진동신호를 조합한 진동을 출력하는 단계;

상기 터치스크린을 통해 둘 이상의 터치신호가 입력된 경우, 상기 둘 이상의 터치신호 각각에 대응하는 진동신호를 조합한 진동을 출력하는 단계; 및

상기 근접센서에서 하나 이상의 근접신호가 검출되고, 상기 터치스크린을 통해 하나 이상의 터치신호가 입력된 경우, 상기 근접신호에 대응하는 제1진동신호 및, 상기 터치신호에 대응하는 제2진동신호를 조합한 진동을 출력하는 단계;를 포함하는 휴대 단말기 동작 제어방법.

청구항 20

제19항에 있어서,

상기 둘 이상의 근접신호는 상기 근접센서를 통해 서로 다른 근접속도로 검출되는 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 21

제19항에 있어서,

상기 둘 이상의 근접신호는 상기 근접센서를 통해 서로 다른 근접면적으로 검출되는 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 22

제19항에 있어서,

상기 둘 이상의 근접신호는 상기 근접센서에 의해 서로 다른 위치에서 검출되는 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 23

제19항에 있어서,

상기 둘 이상의 터치신호는 상기 터치스크린의 서로 다른 면적을 통해 입력되는 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 24

제19항에 있어서,

상기 둘 이상의 터치신호는 상기 터치스크린을 통해 서로 다른 압력으로 입력되는 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 25

제19항에 있어서,

상기 제1진동신호는 일정한 근접속도, 근접면적, 근접거리 중 어느 하나를 특징으로 하는 근접신호에 대응하는

진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 26

제19항에 있어서,

상기 제2전동신호는 일정한 압력 및 단격 ~중 어느 하나를 특정으로 하는 터치신호에 대응하는 진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 27

제19항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 28

근접신호를 검출하는 근접센서;

하나 이상의 진동신호를 진동으로 출력하는 햅틱 모듈; 및

상기 근접센서를 통해 근접신호가 검출된 경우, 상기 근접신호가 검출된 제1 위치를 확인하고, 상기 제1 위치를 통해 터치신호가 입력된 경우, 상기 근접신호에 대응하는 진동신호 및 상기 터치신호에 대응하는 진동신호를 조합한 진동을 상기 햅틱 모듈을 통해 출력하는 제어부를 포함하는 휴대 단말기.

청구항 29

제28항에 있어서,

상기 제어부는

제2 위치를 통해 터치신호가 입력된 경우, 상기 터치신호에 대응하는 진동신호를 상기 햅틱 모듈을 통해 출력하는 것을 특징으로 하는 휴대 단말기.

청구항 30

제28항에 있어서,

상기 제어부는

상기 근접센서를 통해 근접신호가 검출된 경우, 상기 근접신호에 대응하는 진동신호를 상기 햅틱 모듈을 통해 출력하는 것을 특징으로 하는 휴대 단말기.

청구항 31

제28항에 있어서,

상기 조합된 진동은, 상기 근접신호에 대응하는 진동신호 및 상기 터치신호에 대응하는 진동신호를 각각 합산하거나 감산한 것을 특징으로 하는 휴대 단말기.

청구항 32

제28항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특징으로 하는 휴대 단말기.

청구항 33

근접신호를 검출하는 근접센서;

하나 이상의 진동신호를 진동으로 출력하는 햅틱 모듈; 및

상기 근접센서를 통해 제1 근접거리에서 근접신호를 검출하고, 상기 제1 근접거리에서 근접신호가 검출된 후, 상기 제2 근접거리에서 근접신호가 검출된 경우, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호 및 상기 제2 근접거리에서 근접신호에 대응하는 진동신호를 조합한 진동을 상기 햅틱 모듈을 통해 출력하는 제어부를 포

함하는 휴대 단말기.

청구항 34

제33항에 있어서,

상기 제어부는 상기 제1 근접거리에서 근접신호가 검출된 경우, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호를 상기 햅틱 모듈을 통해 출력하는 것을 특징으로 하는 휴대 단말기.

청구항 35

제33항에 있어서,

상기 조합한 진동은, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호 및 상기 제2 근접거리에서 근접신호에 대응하는 진동신호를 각각 합산하거나 감산한 것을 특징으로 하는 휴대 단말기.

청구항 36

제33항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특징으로 하는 휴대 단말기.

청구항 37

터치스크린;

상기 터치스크린의 제1 영역, 및 제2 영역을 통해 터치신호가 입력되는 경우, 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 제어부를 포함하는 휴대 단말기.

청구항 38

제37항에 있어서,

상기 조합한 진동은, 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 각각 합산하거나 감산한 것을 특징으로 하는 휴대 단말기.

청구항 39

제37항에 있어서,

상기 제1 영역 및 상기 제2 영역 사이의 거리에 따라 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 것을 특징으로 하는 휴대 단말기.

청구항 40

제37항에 있어서,

상기 제어부는 상기 터치스크린의 제3 영역, 및 제4 영역을 통해 터치신호가 입력되는 경우, 상기 제1 영역 및 상기 제2 영역 사이의 거리, 및 상기 제3 영역 및 상기 제4 영역 사이의 거리 변화에 따라, 상기 제1,제2,제3 및 제4 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 것을 특징으로 하는 휴대 단말기.

청구항 41

제37항에 있어서,

상기 제어부는 상기 터치스크린의 제3 영역, 및 제4 영역을 통해 터치신호가 입력되는 경우, 상기 제1,제2 영역을 통해 입력된 터치신호 및 상기 제3,제4 영역을 통해 입력된 터치신호 사이의 속도 차이에 따라, 상기 제1,제2,제3 및 제4 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 것을 특징으로 하는 휴대 단말기.

청구항 42

터치스크린:

근접신호를 검출하는 근접센서:

하나 이상의 진동신호를 진동으로 출력하는 햅틱 모듈; 및

상기 근접센서에서 둘 이상의 근접신호가 검출될 경우, 상기 둘 이상의 근접신호 각각에 대응하는 진동신호를 조합한 진동을 상기 햅틱모듈을 통해 출력하고,상기 터치스크린을 통해 둘 이상의 터치신호가 입력된 경우, 상기 둘 이상의 터치신호 각각에 대응하는 진동신호를 조합한 진동을 상기 햅틱모듈을 통해 출력하고, 상기 근접센서에서 하나 이상의 근접신호가 검출되고, 상기 터치스크린을 통해 하나 이상의 터치신호가 입력된 경우, 상기 근접신호에 각각 대응하는 하나 이상의 제1진동신호 및, 상기 터치신호에 각각 대응하는 하나 이상의 제2진동신호를 조합한 진동을 상기 햅틱모듈을 통해 출력하는 제어부를 포함하는 휴대 단말기.

청구항 43

제42항에 있어서,

상기 둘 이상의 근접신호는 상기 근접센서를 통해 서로 다른 근접속도로 검출되는 것을 특징으로 하는 휴대 단말기.

청구항 44

제42항에 있어서,

상기 둘 이상의 근접신호는 상기 근접센서를 통해 서로 다른 근접단계으로 검출되는 것을 특징으로 하는 휴대 단말기.

청구항 45

제42항에 있어서,

상기 둘 이상의 근접신호는 상기 근접센서에 의해 서로 다른 위치에서 검출되는 것을 특징으로 하는 휴대 단말기.

청구항 46

제42항에 있어서,

상기 둘 이상의 터치신호는 상기 터치스크린의 서로 다른 면적을 통해 입력되는 것을 특징으로 하는 휴대 단말기.

청구항 47

제42항에 있어서,

상기 둘 이상의 터치신호는 상기 터치스크린을 통해 서로 다른 압력으로 입력되는 것을 특징으로 하는 휴대 단말기.

명 세 서

발명의 상세한 설명

기 술 분 야

<1> 본 발명은 휴대 단말기 및 그 동작제어 방법에 관한 것으로, 보다 상세하게는 입력되는 터치신호 또는 근접신호를 분석하여, 각 신호에 대응하는 진동신호을 확인하여, 각각의 진동신호을 조합하여 진동을 출력하는 휴대 단말기 및 그 동작제어 방법에 관한 것이다.

배 경 기 술

<2> 휴대 단말기는 휴대가 가능하면서 음성 및 영상 통화를 수행할 수 있는 기능, 정보를 입출력할 수 있는 기능,

및 데이터를 저장할 수 있는 기능 등을 하나 이상 갖춘 휴대용 기기이다.

<3> 이러한 멀티미디어 기기의 형태로 구현된 휴대 단말기는, 복잡한 기능을 구현하기 위해 하드웨어나 소프트웨어적 측면에서 새로운 시도들이 다양하게 적용되고 있다. 따라서 휴대 단말기는 디스플레이 측면이나 사운드 측면의 기능 뿐 아니라 다양한 진동도 출력할 수 있다.

<4> 일반적으로 진동은 휴대 단말기에 입력되는 터치신호 또는 근접신호에 대응하여 출력되며, 진동신호도 몇 가지로 제한되어 있다. 그러나 각각 입력되는 터치신호 또는 근접신호 자체에 대한 하나의 반응으로서 진동이 출력되므로, 출력되는 진동의 다양성이 떨어지며, 사용자에게 터치신호 또는 근접신호의 입력유무에 관한 정보를 용이하게 전달하기도 어렵다.

<5> 따라서 휴대 단말기에 입력되는 터치신호 또는 근접신호를 분석하여, 터치신호의 입력 면적, 입력 압력 또는 근접신호의 입력 거리, 입력 속도, 입력 면적, 멀티 터치 등에 따른 진동신호을 조합함으로써, 다양한 진동을 통해 신호에 대한 정보를 사용자에게 제공할 수 있는 방법이 요구된다.

발명의 내용

해결 하고자하는 과제

<6> 따라서 본 발명의 목적은 다양한 형태로 입력되는 하나 이상의 터치신호 및 근접신호에 대응하는 진동신호을 조합하여 진동으로 출력함으로써, 사용자에게 입력 신호에 대한 정보를 제공할 수 있는 휴대 단말기 및 그 동작 제어방법을 제공함에 있다.

과제 해결수단

<7> 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기 동작 제어방법으로서, 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서, 상기 근접센서를 통해 근접신호가 검출된 경우, 상기 근접신호가 검출된 제1 위치를 확인하는 단계; 및 상기 제1 위치를 통해 터치신호가 입력된 경우, 상기 근접신호에 대응하는 진동신호 및 상기 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함한다.

<8> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기 동작 제어방법으로서, 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서, 상기 근접센서를 통해 상기 근접센서로부터 제1 근접거리에서 근접신호를 검출하는 단계, 상기 제1 근접거리에서 근접신호가 검출된 후, 상기 근접센서로부터 제2 근접거리에서 근접신호가 검출된 경우, 상기 제1 근접거리에서 근접신호에 대응하는 진동신호 및 상기 제2 근접거리에서 근접신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함한다.

<9> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기 동작 제어방법으로서, 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서, 터치스크린을 포함하는 휴대 단말기 동작 제어방법에 있어서, 상기 터치스크린의 제1 영역, 및 제2 영역을 통해 터치신호가 입력되는 경우, 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 단계를 포함한다.

<10> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기 동작 제어방법으로서, 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서, 터치스크린 및 근접센서를 포함하는 휴대 단말기 동작 제어방법에 있어서, 상기 근접센서에서 둘 이상의 근접신호가 검출된 경우, 상기 둘 이상의 근접신호 각각에 대응하는 진동신호를 조합한 진동을 출력하는 단계, 상기 터치스크린을 통해 둘 이상의 터치신호가 입력된 경우, 상기 둘 이상의 터치신호 각각에 대응하는 진동신호를 조합한 진동을 출력하는 단계, 상기 근접센서에서 하나 이상의 근접신호가 검출되고, 상기 터치스크린을 통해 하나 이상의 터치신호가 입력된 경우, 상기 근접신호에 대응하는 제1진동신호 및, 상기 터치신호에 대응하는 제2진동신호를 조합한 진동을 출력하는 단계를 포함한다.

<11> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기로서, 근접신호를 검출하는 근접센서, 하나 이상의 진동신호를 진동으로 출력하는 햅틱 모듈, 상기 근접센서를 통해 근접신호가 검출된 경우, 상기 근접신호가 검출된 제1 위치를 확인하고, 상기 제1 위치를 통해 터치신호가 입력된 경우, 상기 근접신호에 대응하는 진동신호 및 상기 터치신호에 대응하는 진동신호를 조합한 진동을 상기 햅틱 모듈을 통해 출력하는 제어부를 포함한다.

<12> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기로서, 근접신호를 검출하는 근접센서, 하나 이상의 진동신호를 진동으로 출력하는 햅틱 모듈, 상기 근접센서를 통해 제1 근접거리에서 근접신호를 검출하고, 상기 제1 근접거리에서 근접신호가 검출된 후, 상기 제2 근접거리에서 근접신호가 검출된 경우, 상기 제1 근접거리에서

근접신호에 대응하는 진동신호 및 상기 제2 근접거리에서 근접신호에 대응하는 진동신호를 조합한 진동을 상기 햅틱 모듈을 통해 출력하는 제어부를 포함한다.

<13> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기로서, 터치스크린,상기 터치스크린의 제1 영역, 및 제2 영역을 통해 터치신호가 입력되는 경우, 상기 제1 영역의 터치신호에 대응하는 진동신호 및 상기 제2 영역의 터치신호에 대응하는 진동신호를 조합한 진동을 출력하는 제어부를 포함한다.

<14> 또한, 상기 목적을 달성하기 위한 본 발명은, 휴대 단말기로서, 터치스크린,근접신호를 검출하는 근접센서, 하나 이상의 진동신호를 진동으로 출력하는 햅틱 모듈, 상기 근접센서에서 둘 이상의 근접신호가 검출된 경우, 상기 둘 이상의 근접신호 각각에 대응하는 진동신호를 조합한 진동을 상기 햅틱모듈을 통해 출력하고,상기 터치스크린을 통해 둘 이상의 터치신호가 입력된 경우, 상기 둘 이상의 터치신호 각각에 대응하는 진동신호를 조합한 진동을 상기 햅틱모듈을 통해 출력하고, 상기 근접센서에서 하나 이상의 근접신호가 검출되고, 상기 터치스크린을 통해 하나 이상의 터치신호가 입력된 경우, 상기 근접신호에 각각 대응하는 하나 이상의 제1진동신호 및, 상기 터치신호에 각각 대응하는 하나 이상의 제2진동신호를 조합한 진동을 상기 햅틱모듈을 통해 출력하는 제어부를 포함한다.

효 과

<15> 본 발명에 따르면, 다양한 형태로 입력되는 신호에 대응하는 다양한 진동을 출력함으로써, 사용자에게 입력 신호에 대한 정보를 용이하게 제공할 수 있다.

발명의 실시를 위한 구체적인 내용

<16> 이하에서는 도면을 참조하여 본 발명을 보다 상세하게 설명한다.

<17> 본 명세서에서 기술되는 휴대 단말기에는, 휴대폰, 스마트 폰(smart phone), 노트북 컴퓨터(notebook computer), 디지털방송용 단말기, PDA(Personal Digital Assistants), PMP(Portable Multimedia Player), 네비게이션 등이 포함된다. 또한, 이하의 설명에서 사용되는 구성요소에 대한 접미사 "모듈" 및 "부"는 단순히 본 명세서 작성의 용이함만이 고려되어 부여되는 것으로서, 그 자체로 특별히 중요한 의미 또는 역할을 부여하는 것은 아니다. 따라서, 상기 "모듈" 및 "부"는 서로 혼용되어 사용될 수도 있다.

<18> 도 1은 본 발명의 일실시예에 따른 휴대 단말기의 블럭 구성도(block diagram)이다. 도 1을 참조하여 본 발명의 일실시예에 따른 휴대 단말기를 기능에 따른 구성요소 관점에서 살펴보겠다.

<19> 도 1을 참조하면, 본 휴대 단말기(100)는, 무선 통신부(110), A/V(Audio/Video) 입력부(120), 사용자 입력부(130), 센싱부(140), 출력부(150), 메모리(160), 인터페이스부(170), 제어부(180), 및 전원 공급부(190)를 포함할 수 있다. 이와 같은 구성요소들은 실제 응용에서 구현될 때 필요에 따라 2 이상의 구성요소가 하나의 구성요소로 합쳐지거나, 혹은 하나의 구성요소가 2 이상의 구성요소로 세분되어 구성될 수 있다.

<20> 무선 통신부(110)는 방송수신 모듈(111), 이동통신 모듈(113), 무선 인터넷 모듈(115), 근거리 통신 모듈(117), 및 GPS 모듈(119) 등을 포함할 수 있다.

<21> 방송수신 모듈(111)은 방송 채널을 통하여 외부의 방송관리 서버로부터 방송 신호 및 방송관련 정보 중 적어도 하나를 수신한다. 이때, 방송 채널은 위성 채널, 지상파 채널 등을 포함할 수 있다. 방송관리 서버는, 방송 신호 및 방송 관련 정보 중 적어도 하나를 생성하여 송신하는 서버나, 기 생성된 방송 신호 및 방송관련 정보 중 적어도 하나를 제공받아 단말기에 송신하는 서버를 의미할 수 있다.

<22> 방송관련 정보는, 방송 채널, 방송 프로그램 또는 방송 서비스 제공자에 관련한 정보를 의미할 수 있다. 방송 신호는, TV 방송 신호, 라디오 방송 신호, 데이터 방송 신호를 포함할 뿐만 아니라, TV 방송 신호 또는 라디오 방송 신호에 데이터 방송 신호가 결합한 형태의 방송 신호도 포함할 수 있다. 방송관련 정보는, 이동통신망을 통하여도 제공될 수 있으며, 이 경우에는 이동통신 모듈(113)에 의해 수신될 수 있다. 방송관련 정보는 다양한 형태로 존재할 수 있다. 예를 들어, DMB(Digital Multimedia Broadcasting)의 EPG(Electronic Program Guide) 또는 DVB-H(Digital Video Broadcast-Handheld)의 ESG(Electronic Service Guide) 등의 형태로 존재할 수 있다.

<23> 방송수신 모듈(111)은, 각종 방송 시스템을 이용하여 방송 신호를 수신하는데, 특히, DMB-T(Digital Multimedia Broadcasting-Terrestrial), DMB-S(Digital Multimedia Broadcasting-Satellite), MediaFLO(Media Forward Link Only), DVB-H(Digital Video Broadcast-Handheld), ISDB-T(Integrated Services Digital Broadcast-

Terrestrial) 등의 디지털 방송 시스템을 이용하여 디지털 방송 신호를 수신할 수 있다. 또한, 방송수신 모듈(111)은, 이와 같은 디지털 방송 시스템뿐만 아니라 방송 신호를 제공하는 모든 방송 시스템에 적합하도록 구성될 수 있다. 방송수신 모듈(111)을 통해 수신된 방송 신호 및/또는 방송 관련 정보는 메모리(160)에 저장될 수 있다.

<24> 이동통신 모듈(113)은, 이동 통신망 상에서 기지국, 외부의 단말, 서버 중 적어도 하나와 무선 신호를 송수신한다. 여기서, 무선 신호는, 음성 호 신호, 화상 통화 호 신호, 또는 문자/멀티미디어 메시지 송수신에 따른 다양한 형태의 데이터를 포함할 수 있다.

<25> 무선 인터넷 모듈(115)은 무선 인터넷 접속을 위한 모듈을 말하는 것으로, 무선 인터넷 모듈(115)은 휴대 단말기(100)에 내장되거나 외장될 수 있다. 무선 인터넷 기술로는 WLAN(Wireless LAN)(Wi-Fi), Wibro(Wireless broadband), Wimax(World Interoperability for Microwave Access), HSDPA(High Speed Downlink Packet Access) 등이 이용될 수 있다.

<26> 근거리 통신 모듈(117)은 근거리 통신을 위한 모듈을 말한다. 근거리 통신 기술로 블루투스(Bluetooth), RFID(Radio Frequency Identification), 적외선 통신(IrDA, infrared Data Association), UWB(Ultra Wideband), 지그비(ZigBee) 등이 이용될 수 있다.

<27> GPS(Global Position System) 모듈(119)은 복수 개의 GPS 인공위성으로부터 위치 정보를 수신한다.

<28> A/V(Audio/Video) 입력부(120)는 오디오 신호 또는 비디오 신호 입력을 위한 것으로, 이에는 카메라(121)와 마이크(123) 등이 포함될 수 있다. 카메라(121)는 화상 통화모드 또는 촬영 모드에서 이미지 센서에 의해 얻어지는 정지영상 또는 동영상 등의 화상 프레임을 처리한다. 그리고, 처리된 화상 프레임은 디스플레이부(151)에 표시될 수 있다.

<29> 카메라(121)에서 처리된 화상 프레임은 메모리(160)에 저장되거나 무선 통신부(110)를 통하여 외부로 전송될 수 있다. 카메라(121)는 단말기의 구성 태양에 따라 2개 이상이 구비될 수도 있다.

<30> 마이크(123)는 통화모드 또는 녹음모드, 음성인식 모드 등에서 마이크로폰(Microphone)에 의해 외부의 음향 신호를 입력받아 전기적인 음성 데이터로 처리한다. 그리고, 처리된 음성 데이터는 통화 모드인 경우 이동통신 모듈(113)를 통하여 이동통신 기지국으로 송신 가능한 형태로 변환되어 출력될 수 있다. 마이크 (123)는 외부의 음향 신호를 입력받는 과정에서 발생하는 잡음(noise)를 제거하기 위한 다양한 잡음 제거 알고리즘이 사용될 수 있다.

<31> 사용자 입력부(130)는 사용자가 단말기의 동작 제어를 위하여 입력하는 키 입력 데이터를 발생시킨다. 사용자 입력부(130)는 키 패드(key pad), 돔 스위치(dome switch), 터치 패드(정압/정전), 조그 휠, 조그 스위치, 핑거 마우스 등으로 구성될 수 있다. 특히, 터치 패드가 후술하는 디스플레이부(151)와 상호 레이어 구조를 이룰 경우, 이를 터치 스크린(touch screen)이라 부를 수 있다.

<32> 센싱부(140)는 휴대 단말기(100)의 개폐 상태, 휴대 단말기(100)의 위치, 사용자 접촉 유무 등과 같이 휴대 단말기(100)의 현 상태를 감지하여 휴대 단말기(100)의 동작을 제어하기 위한 센싱 신호를 발생시킨다. 예를 들어 휴대 단말기(100)가 슬라이드 폰 형태인 경우 슬라이드 폰의 개폐 여부를 센싱할 수 있다. 또한, 전원 공급부(190)의 전원 공급 여부, 인터페이스부(170)의 외부 기기 결합 여부 등과 관련된 센싱 기능을 담당할 수 있다.

<33> 센싱부(140)는 근접센서(Proximity Sensor)(141)를 포함할 수 있다. 근접센서(141)는 접근하는 물체나, 근방에 존재하는 물체의 유무 등을 기계적 접촉이 없이 검출할 수 있도록 한다. 근접센서(141)는, 교류자계의 변화나 정자계의 변화를 이용하거나, 혹은 정전용량의 변화율 등을 이용하여 근접물체를 검출할 수 있다. 근접센서(141)는 구성 태양에 따라 2개 이상이 구비될 수 있다.

<34> 출력부(150)는 오디오 신호 또는 비디오 신호 또는 알람(alarm) 신호의 출력을 위한 것이다. 출력부(150)에는 디스플레이부(151),음향출력 모듈(153), 알람부(155), 및 햅팁 모듈(157) 등이 포함될 수 있다.

<35> 디스플레이부(151)는 휴대 단말기(100)에서 처리되는 정보를 표시 출력한다. 예를 들어 휴대 단말기(100)가 통화 모드인 경우 통화와 관련된 UI(User Interface) 또는 GUI(Graphic User Interface)를 표시한다. 그리고 휴대 단말기(100)가 화상 통화 모드 또는 촬영 모드인 경우, 촬영되거나 수신된 영상을 각각 혹은 동시에 표시할 수 있으며, UI, GUI를 표시한다.

<36> 한편, 전술한 바와 같이, 디스플레이부(151)와 터치패드가 상호 레이어 구조를 이루어 터치 스크린으로 구성되는 경우, 디스플레이부(151)는 출력 장치 이외에 입력 장치로도 사용될 수 있다. 만일, 디스플레이부(151)가 터치스크린으로 구성되는 경우, 터치 스크린 패널, 터치 스크린 패널 제어기 등을 포함할 수 있다. 이 경우, 터치 스크린 패널은 외부에 부착되는 투명한 패널로서, 휴대 단말기(100)의 내부 버스에 연결될 수 있다. 터치 스크린 패널은 접촉 결과를 주시하고 있다가, 터치입력이 있는 경우 대응하는 신호들을 터치 스크린 패널 제어기로 보낸다. 터치 스크린 패널 제어기는 그 신호들을 처리한 다음 대응하는 데이터를 제어부(180)로 전송하여, 제어부(180)가 터치입력이 있었는지 여부와 터치스크린의 어느 영역이 터치 되었는지 여부를 알 수 있도록 한다.

<37> 디스플레이부(151)는 액정 디스플레이(liquid crystal display), 박막 트랜지스터 액정 디스플레이(thin film transistor-liquid crystal display), 유기 발광 다이오드(organic light-emitting diode), 플렉시블 디스플레이(flexible display), 3차원 디스플레이(3D display) 중에서 적어도 하나를 포함할 수도 있다. 그리고, 휴대 단말기(100)의 구현 형태에 따라 디스플레이부(151)가 2개 이상 존재할 수도 있다. 예를 들어, 휴대 단말기(100)에 외부 디스플레이부(미도시)와 내부 디스플레이부(미도시)가 동시에 구비될 수 있다.

<38> 음향출력 모듈(153)은 호신호 수신, 통화모드 또는 녹음 모드, 음성인식 모드, 방송수신 모드 등에서 무선 통신부(110)로부터 수신되거나 메모리(160)에 저장된 오디오 데이터를 출력한다. 또한, 음향출력 모듈(153)은 휴대 단말기(100)에서 수행되는 기능, 예를 들어, 호신호 수신음, 메시지 수신음 등과 관련된 음향 신호를 출력한다. 이러한 음향출력 모듈(153)에는 스피커(speaker), 버저(Buzzer) 등이 포함될 수 있다.

<39> 알람부(155)는 휴대 단말기(100)의 이벤트 발생을 알리기 위한 신호를 출력한다. 휴대 단말기(100)에서 발생하는 이벤트의 예로는 호 신호 수신, 메시지 수신, 키 신호 입력 등이 있다. 알람부(155)는 오디오 신호나 비디오 신호 이외에 다른 형태로 이벤트 발생을 알리기 위한 신호를 출력한다. 예를 들면, 진동 형태로 신호를 출력할 수 있다. 알람부(155)는 호 신호가 수신되거나 메시지가 수신된 경우, 이를 알리기 위해 신호를 출력할 수 있다. 또한, 알람부(155)는 키 신호가 입력된 경우, 키 신호 입력에 대한 피드백으로 신호를 출력할 수 있다. 이러한 알람부(155)가 출력하는 신호를 통해 사용자는 이벤트 발생을 인지할 수 있다. 휴대 단말기(100)에서 이벤트 발생 알림을 위한 신호는 디스플레이부(151)나 음향출력 모듈(153)를 통해서도 출력될 수 있다.

<40> 햅틱 모듈(haptic module)(157)은 사용자가 느낄 수 있는 다양한 촉각 효과를 발생시킨다. 햅틱 모듈(157)이 발생시키는 촉각 효과의 대표적인 예로는 진동 효과가 있다. 햅틱 모듈(157)이 촉각 효과로 진동을 발생시키는 경우, 햅택 모듈(157)이 발생하는 진동의 세기와 패턴 등은 변환가능하며, 서로 다른 진동을 합성하여 출력하거나 순차적으로 출력할 수도 있다.

<41> 햅틱 모듈(157)은 진동 외에도, 접촉 피부면에 대해 수직 운동하는 핀 배열에 의한 자극에 의한 효과, 분사구나 흡입구를 통한 공기의 분사력이나 흡입력을 통한 자극에 의한 효과, 피부 표면을 스치는 자극에 의한 효과, 전극(eletrode)의 접촉을 통한 자극에 의한 효과, 정전기력을 이용한 자극에 의한 효과, 흡열이나 발열이 가능한 소자를 이용한 냉온감 재현에 의한 효과 등 다양한 촉각 효과를 발생시킬 수 있다. 햅틱 모듈(157)은 직접적인 접촉을 통해 촉각 효과의 전달할 수 있을 뿐만 아니라, 사용자의 손가락이나 팔 등의 근감각을 통해 촉각 효과를 느낄 수 있도록 구현할 수도 있다. 햅틱 모듈(157)은 휴대 단말기(100)의 구성 태양에 따라 2개 이상이 구비될 수 있다.

<42> 메모리(160)는 제어부(180)의 처리 및 제어를 위한 프로그램이 저장될 수도 있고, 입력되거나 출력되는 데이터들(예를 들어, 폰북, 메시지, 정지영상, 동영상 등)의 임시 저장을 위한 기능을 수행할 수도 있다.

<43> 메모리(160)는 플래시 메모리 타입(flash memory type), 하드디스크 타입(hard disk type), 멀티미디어 카드 마이크로 타입(multimedia card micro type), 카드 타입의 메모리(예를 들어 SD 또는 XD 메모리 등), 램, 롬 중 적어도 하나의 타입의 저장매체를 포함할 수 있다. 또한, 휴대 단말기(100)는 인터넷(internet) 상에서 메모리(150)의 저장 기능을 수행하는 웹 스토리지(web storage)를 운영할 수도 있다.

<44> 인터페이스부(170)는 휴대 단말기(100)에 연결되는 모든 외부기기와의 인터페이스 역할을 수행한다. 휴대 단말기(100)에 연결되는 외부기기의 예로는, 유/무선 헤드셋, 외부 충전기, 유/무선 데이터 포트, 메모리 카드(Memory card), SIM/UIM card 등과 같은 카드 소켓, 오디오 I/O(Input/Output) 단자, 비디오 I/O(Input/Output) 단자, 이어폰 등이 있다. 인터페이스부(170)는 이러한 외부 기기로부터 데이터를 전송받거나 전원을 공급받아 휴대 단말기(100) 내부의 각 구성 요소에 전달할 수 있고, 휴대 단말기(100) 내부의 데이터가 외부 기기로 전송되도록 할 수 있다.

<45> 인터페이스부(170)는 휴대 단말기(100)가 외부 크레들(cradle)과 연결될 때 연결된 크레들로부터의 전원이 휴대 단말기(100)에 공급되는 통로가 되거나, 사용자에 의해 크레들에서 입력되는 각종 명령 신호가 휴대 단말기(100)로 전달되는 통로가 될 수 있다.

<46> 제어부(180)는 통상적으로 상기 각부의 동작을 제어하여 휴대 단말기(100)의 전반적인 동작을 제어한다. 예를 들어 음성 통화, 데이터 통신, 화상 통화 등을 위한 관련된 제어 및 처리를 수행한다. 또한, 제어부(180)는 멀티미디어 재생을 위한 멀티미디어 재생 모듈(181)을 구비할 수도 있다. 멀티미디어 재생 모듈(181)은 제어부(180) 내에 하드웨어로 구성될 수도 있고, 제어부(180)와 별도로 소프트웨어로 구성될 수도 있다.

<47> 그리고, 전원 공급부(190)는 제어부(180)의 제어에 의해 외부의 전원, 내부의 전원을 인가받아 각 구성요소들의 동작에 필요한 전원을 공급한다.

<48> 이와 같은 구성의 휴대 단말기(100)는 유무선 통신 시스템 및 위성 기반 통신 시스템을 포함하여, 프레임(frame) 또는 패킷(packet)을 통하여 데이터(data)를 전송할 수 있는 통신 시스템에서 동작 가능하도록 구성될 수 있다.

<49> 이상 본 발명과 관련된 휴대 단말기를 기능에 따른 구성요소 관점에서 살펴보았다. 이하에서는 도 2 및 도 3을 참조하여, 본 발명과 관련된 휴대 단말기를 외형에 따른 구성요소 관점에서 더욱 살펴보겠다. 이하에서는 설명의 편의상, 폴더 타입, 바 타입, 스윙타입, 슬라이더 타입 등과 같은 여러 타입의 휴대 단말기들 중에서 터치스크린이 구비되어 있는 슬라이더 타입의 휴대 단말기를 예로 들어 설명한다. 그러나, 본 발명은 슬라이더 타입의 휴대 단말기에 한정되는 것은 아니고 전술한 타입을 포함한 모든 타입의 휴대 단말기에 적용될 수 있다.

<50> 도 2는 본 발명의 일실시예에 따른 휴대 단말기를 전면에서 바라본 사시도이다. 도 2를 참조하면, 본 휴대 단말기는 제1 바디(100A), 및 제1 바디(100A)에 적어도 일 방향을 따라 슬라이딩 가능하게 구성된 제2 바디(100B)를 포함한다.

<51> 제1 바디(100A)가 제2 바디(100B)와 중첩되게 배치된 상태를 닫힌 상태(closed configuration)라 칭할 수 있으며, 도 2에 도시된 바와 같이 제1 바디(100A)가 제2 바디(100B)의 적어도 일 부분을 노출한 상태를 열린 상태(open configuration)라 칭할 수 있다.

<52> 휴대 단말기(100)가 닫힌 상태에서 주로 대기 모드(Standby Mode)로 작동하지만 사용자의 조작에 의해 대기 모드가 해제되기도 한다. 그리고, 휴대 단말기(100)가 열린 상태에서 주로 통화 모드 등으로 작동하지만, 사용자의 조작 또는 소정 시간의 경과에 의해 대기 모드로 전환되기도 한다.

<53> 제1 바디(100A)의 외관을 이루는 케이스는, 제1 프론트 케이스(100A-1)와 제1 리어 케이스(100A-2)에 의해 형성된 공간에 각종 전자부품들이 내장된다. 제1 프론트 케이스(100A-1)와 제1 리어 케이스(100A-2) 사이에는 적어도 하나의 중간 케이스들이 추가로 배치될 수도 있다. 이와 같은 케이스들은 합성수지를 사출하여 형성되거나, 금속 재질, 예를 들어 스테인레스 스틸(STS) 또는 티타늄(Ti) 등과 같은 금속 재질을 갖도록 형성될 수도 있다.

<54> 제1 바디(100A), 구체적으로 제1 프론트 케이스(100A-1)에는 디스플레이부(151), 제1 음향출력모듈(153a), 제1 카메라(121a), 및 제1 사용자 입력부(130a)가 배치될 수 있다.

<55> 디스플레이부(151)는 정보를 시각적으로 표현하는 LCD(liquid crystal display), OLED(Organic Light Emitting Diodes) 등을 포함한다. 디스플레이부(151)는 터치패드가 레이어 구조로 중첩됨으로써, 디스플레이부(151)가 터치스크린으로 동작하여 사용자의 터치에 의한 정보의 입력이 가능하도록 구성할 수도 있다. 제 1 음향출력모듈(153a)은 리시버 또는 스피커의 형태로 구현될 수 있다. 제1 카메라(121a)는 사용자 등에 대한 이미지 또는 동영상을 촬영하기에 적절하도록 구현될 수 있다.

<56> 제1 바디(100A)와 마찬가지로, 제2 바디(100B)의 외관을 이루는 케이스는 제 2 프론트 케이스(100B-1)와 제2 리어 케이스(100B-2)에 의해 형성된다. 제2 바디(100B), 구체적으로 제2 프론트 케이스(100B-1)의 전면(front face)에는 제2 사용자 입력부(130b)가 배치될 수 있다. 제2 프론트 케이스(100B-1) 또는 제2 리어 케이스(100B-2)) 중 적어도 하나에는 제3 및 제4 사용자 입력부(130c, 130d), 마이크(123), 및 인터페이스부(170)가 배치될 수 있다.

<57> 제1 내지 제4 사용자 입력부(130a, 130b, 130c, 130d)는 사용자 입력부(130)라 통칭할 수 있으며, 사용자가 촉각적인 느낌을 주면서 조작하게 되는 방식(tactile manner)이라면 어떤 방식이든 채용될 수 있다.

<58> 예를 들어, 사용자 입력부(130)는 사용자의 푸시 또는 터치 조작에 의해 명령 또는 정보를 입력받을 수 있는 돔 스위치 또는 터치 패드로 구현되거나, 키를 회전시키는 휠 또는 조그 방식이나 조이스틱과 같이 조작하는 방식 등으로도 구현될 수 있다.

<59> 기능적인 면에서, 제1 사용자 입력부(130a)는 시작, 종료, 스크롤 등과 같은 명령을 입력하기 위한 것이고, 제2 사용자 입력부(130b)는 숫자 또는 문자, 심볼(symbol) 등을 입력하기 위한 것이다. 또한, 제3 및 제4 사용자 입력부(130c, 130d)는 휴대단말기(100) 내의 특수한 기능을 활성화하기 위한 핫 키(hot-key)로서 작동할 수 있다.

<60> 마이크(123)는 사용자의 음성, 기타 소리 등을 입력받기 적절한 형태로 구현될 수 있다. 인터페이스부(170)는 본 발명에 따른 휴대 단말기가 외부 기기와 데이터 교환 등을 할 수 있게 하는 통로가 된다. 예를 들어, 인터페이스부(170)는 유선 또는 무선으로, 이어폰과 연결하기 위한 접속단자, 근거리 통신을 위한 포트, 또는 휴대 단말기(100)에 전원을 공급하기 위한 전원공급 단자들 중 적어도 하나일 수 있다. 인터페이스부(170)는 SIM(subscriber identification module) 또는 UIM(user identity module), 정보 저장을 위한 메모리 카드 등의 외장형 카드를 수용하는 카드 소캣일 수도 있다.

<61> 제2 리어 케이스(100B-2) 측에는 휴대 단말기에 전원을 공급하기 위한 전원공급부(190)가 장착된다. 전원공급부(190)는, 예를 들어 충전 가능한 배터리로서,충전 등을 위하여 제2 바디(100B)에 착탈 가능하게 결합될 수 있다.

<62> 도 3는 도 2에 도시한 휴대 단말기의 후면 사시도이다. 도 3를 참조하면, 제2 바디(100B)의 제2 리어 케이스(100B-2)의 후면에는 휠 타입의 제5 사용자 입력부(130e)와 제2 카메라(121b)가 추가로 장착될 수 있으며, 제2 바디(100B)의 측면에는 제6 사용자 입력부(130f)가 배치될 수 있다.

<63> 제2 카메라(121b)는 제1 카메라 모듈(121a)와 실질적으로 반대되는 촬영 방향을 가지며, 제1 카메라(121a)와 서로 다른 화소를 가질 수 있다. 예를 들어, 제1 카메라(121a)는 화상 통화 등의 경우에 사용자의 얼굴을 촬영하여 상대방에 전송함에 무리가 없도록 저화소를 가지며, 제2 카메라(121b)는 일반적인 피사체를 촬영하고 바로 전송하지는 않는 경우가 많으므로 고 화소를 가지는 것이 바람직하다.

<64> 제2 카메라(121b)에 인접하게는 플래쉬(125)와 거울(126)이 추가로 배치될 수 있다. 플래쉬(125)는 제2 카메라(121b)로 피사체를 촬영하는 경우에 상기 피사체를 향해 빛을 비추게 된다. 거울(126)은 사용자가 제2 카메라(121b)를 이용하여 자신을 촬영(셀프 촬영)하고자 하는 경우에, 사용자 자신의 얼굴 등을 비춰볼 수 있게 한다.

<65> 제2 리어 케이스(100B-2)에는 제2 음향출력 모듈(미도시)가 추가로 배치될 수도 있다. 제2 음향출력 모듈은 제1 음향출력 모듈(153a)와 함께 스테레오 기능을 구현할 수 있으며, 스피커폰 모드로 통화를 위하여 사용될 수도 있다.

<66> 또한, 제2 리어 케이스(100B-2)의 일 측에는 통화 등을 위한 안테나 외에 방송신호 수신용 안테나(미도시)가 배치될 수 있다. 안테나는 제2 바디(100B)에서 인출 가능하게 설치될 수 있다. 제1 바디(100A)의 제1 리어 케이스(100A-2) 측에는 제1 바디(100A)와 제2 바디(100B)를 슬라이딩 가능하게 결합하는 슬라이드 모듈(100C)의 일부분이 배치된다. 슬라이드 모듈(100C)의 다른 부분은 제2 바디(100B)의 제2 프론트 케이스(100B-1) 측에 배치되어, 도 3에 도시한 바와 같이 외부로 드러나지 않는 형태일 수 있다.

<67> 이상에서는 제2 카메라(121b) 등이 제2 바디(100B)에 배치되는 것으로 설명하였으나, 반드시 이에 제한되는 것은 아니다. 예를 들어, 제2 카메라(121b) 등과 같이 제2 리어 케이스(100B-2)에 배치되는 것으로 설명한 구성들 중 적어도 하나 이상이 제1 바디(100A), 주로는 제1 리어 케이스(100A-2)에 장착되는 것도 가능하다. 이와 같이 구성하는 경우, 닫힌 상태에서 제1 리어 케이스(100A-2)에 배치되는 구성들이 제2 바디(100B)에 의해 보호되는 이점이 있다. 또한, 제2 카메라(121b)가 별도로 구비되지 않더라도, 제1 카메라(121a)를 회전 가능하게 형성되어 제2 카메라(121b)의 촬영 방향까지 촬영 가능하도록 구성될 수도 있다.

<68> 그리고, 리어 케이스(100A-2) 측에는 휴대 단말기에 전원을 공급하기 위한 전원공급부(190)가 장착된다. 전원공급부(190)는, 예를 들어 충전 가능한 배터리로서, 충전 등을 위하여 리어 케이스(100A-2)에 착탈 가능하게 결합될 수 있다.

<69> 도 4는 본 발명에 따른 휴대 단말기에서 사용되는 근접센서의 동작을 설명하기 위해 참조되는 도면이다. 도 4에 도시한 바와 같이, 사용자의 손가락이 디스플레이부(151)에 근접하는 경우, 제1 바디 등에 설치된 근접센서(141)가 이를 감지하여 근접신호를 출력한다. 이때, 사용자의 손가락이 D3 위치에 있는 경우와 D2 혹은 D1 위

치에 있는 경우, 서로 다른 근접신호를 출력하도록 구성할 수 있다. 즉, 근접센서에 검출물체가 접근하여 근접신호가 출력되는 거리를 검출거리(Sn)라고 하는데, 이러한 검출거리가 서로 다른 근접센서를 복수로 사용하여, 각 근접센서에서 출력되는 근접신호를 비교하면 근접물체가 어느 정도 근접하였는지 알 수 있다.

<70> 또한, 검출영역이 서로 다른 근접센서를 복수로 배치하여 이들 근접센서 중에서 어느 근접센서로부터 근접신호가 출력되는지를 파악하여, 검출물체가 디스플레이부(151)의 어느 영역으로 접근하는지 여부와, 검출물체가 디스플레이부(151)에 근접하여 이동하는지 여부 등을 식별할 수 있다. 이에 따라, 제어부(180)는 사용자의 손가락 등이 디스플레이부(151)에 근접한 정도 및 근접 위치 등에 따라 다양한 동작 제어를 수행할 수 있다.

<71> 도 5a 내지 도 5b 는 근접센서가 근접신호를 출력하는 근접영역과 촉각 효과를 발생하는 햅팁영역에 대한 설명에 참조되는 도면이다. 먼저, 도 5a의 (a)에 도시한 바와 같은, 아이콘이나 메뉴 항목 등과 같은 오브젝트가 디스플레이부(151)에 표시된 경우, 오브젝트가 표시된 영역을 중앙의 제1 영역(A)과 경계에 인접한 제2 영역(B)으로 구분하고, 제1 영역(A)과 제2 영역(B)에서 서로 다른 세기나 패턴을 갖는 촉각 효과가 발생하도록 구성할 수 있다. 예컨대, 제2 영역(B)를 터치한 경우에 비해 제1 영역(A)을 터치한 경우 더 큰 진동이 출력되도록 구성할 수 있다.

<72> 만일, 근접신호와 함께 사용하는 경우, 촉각 효과가 발생하는 햅팁영역과 근접신호가 검출되는 근접영역이 서로 다르게 정의될 수 있다. 즉, 햅팁영역을 근접영역보다 좁게 설정하거나 혹은 햅팁영역을 근접영역보다 넓게 설정할 수 있다. 예컨대, 도 5a의 (a)에서, 제1 영역(A)과 제2 영역(B)을 포함하는 영역을 근접영역으로 하고, 제1 영역(A)을 햅팁영역으로 구성할 수 있다.

<73> 또한, 도 5a의 (b)에 도시한 바와 같이, 오브젝트가 표시된 영역을 3개의 영역(A, B, C)으로 구분하거나, 혹은 도 5a의 (c)에 도시한 바와 같이 n 개의 영역으로 구분하여, 구분된 각 영역마다 서로 다른 세기나 패턴을 갖는 촉각 효과가 발생하도록 구성할 수 있다. 이와 같은 영역을 구분하는 경우에도, 근접영역과 햅팁영역은 서로 다르게 정의될 수 있다.

<74> 디스플레이부(151)에 근접하는 정도에 따라 근접영역이 크기가 달라지도록 구성할 수도 있다. 즉, 도 5b의 (a)에 도시한 바와 같이, 디스플레이부(151)에 근접하는 정도에 따라 근접영역이 'C', 'B', 'A'로 점차 작아지도록 구성하거나, 혹은 이와 반대로 점차 커지도록 구성할 수도 있다. 이 경우에도, 도 5b의 (b)에 도시한 'H'영역과 같이, 촉각 효과가 발생하는 햅팁영역은 디스플레이부(151)에 근접 정도와 무관하게 일정한 크기의 영역이 되도록 구성할 수도 있다.

<75> 도 6은 본 발명의 제1 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도이다.

<76> 도 6에 도시된 바와 같이, 제어부(180)는 입력될 수 있는 터치신호 및 근접신호에 대한 진동신호를 각각 설정한다(S400). 상기 진동신호는 제어부(180)에 의해 자동으로 설정될 수도 있고, 사용자에 의해 생성된 진동신호로 설정될 수 있다. 진동신호은 입력되는 터치신호 및 근접신호의 특징에 따라 상이하게 설정될 수 있으며, 예를 들어, 터치신호가 일정한 면적을 갖고 입력되는 경우, 터치신호가 일정한 압력을 갖고 입력되는 경우, 터치신호가 멀티터치로 입력되는 경우에 따라 진동신호가 각각 설정될 수 있다. 또한, 근접신호가 일정한 근접면적을 갖고 입력되는 경우, 근접신호가 일정한 근접거리를 갖고 입력되는 경우, 근접신호가 일정한 근접속도를 갖고 입력되는 경우, 근접신호가 멀티터치로 입력되는 경우도 각각 진동신호가 설정될 수 있다. 또한, 단순하게 터치신호가 입력된 경우, 근접신호가 입력된 경우 2개의 진동신호만 설정될 수도 있다.

<77> 다음, 제어부(180)는 터치신호 및 근접신호 중 적어도 하나가 입력되는지 판단한다(S405). 근접신호 및 터치신호가 동시에 입력될 수도 있으며, 복수의 터치신호만 입력되거나 복수의 근접신호만 입력될 수도 있다. 터치신호는 터치스크린에서 검출된 값을 기초로 판단할 수 있으며, 근접신호는 근접센서(141)로부터 검출된 값을 기초로 판단할 수 있다.

<78> S405 단계 판단결과, 터치신호 또는 근접신호가 입력되지 않은 경우, 제어부(180)는 진동신호를 출력하지 않는다.

<79> 한편, S405 단계 판단결과, 터치신호 또는 근접신호가 입력된 경우, 제어부(180)는 입력된 신호를 분석하고, 입력된 신호에 대응하는 하나 이상의 진동신호를 확인한다(S410). 다음, 제어부(180)는 확인된 진동신호를 조합한다(S415). 제어부(180)는 하나 이상의 진동신호를 가산하거나 감산하여 조합할 수 있다. 진동신호의 조합방법은 분석된 신호에 따라 제어부(180)가 자동적으로 설정할 수 있으며, 사용자에 의해 조합방법이 선택될 수 있다.

<80> 다음, 제어부(180)는 조합된 진동신호를 햅팁 모듈(157)을 통해 출력한다(S420).

<81> 도 7은 본 발명의 제2 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도이다.

<82> 도 7에 도시된 바와 같이, 제어부(180)는 하나 이상의 메뉴아이콘을 포함하는 화면을 디스플레이부(151)에 표시한다(S500). 상기 메뉴아이콘이란 하위메뉴로 진입하기 위해 선택될 수 있는 메뉴아이콘일 수 있으며, 특정 기능을 수행하기 위한 아이콘, 또는 하나 이상의 이미지일 수 있다.

<83> 다음, 제어부(180)는 근접센서(141)를 통해 상기 하나 이상의 메뉴아이콘 중 특정 메뉴아이콘의 위치에서 근접신호가 검출되는지 판단한다(S505). S505 판단 결과, 특정 메뉴아이콘의 위치에서 근접신호가 검출되지 않은 경우, 제어부(180)는 진동신호를 출력하지 않는다.

<84> 한편 S505 판단 결과, 특정 메뉴아이콘의 위치에서 근접신호가 검출된 경우, 제어부(180)는 검출된 근접신호에 대응하는 진동신호를 햅틱 모듈(157)을 통해 출력한다(S510). 여기서 검출된 근접신호에 대응하는 단일한 진동신호가 진동으로서 출력된다. 다음, 제어부는 S505 단계에서 근접신호가 검출된 위치의 특정 메뉴아이콘으로 터치신호가 입력되는지 판단한다(S515). 여기서 터치신호는 터치스크린을 통해 입력될 수 있다.

<85> S515 판단 결과, 상기 특정 메뉴아이콘으로 터치신호가 입력되지 않은 경우, 제어부(180)는 상기 특정 메뉴아이콘과 다른 메뉴아이콘으로 터치신호가 입력되는지 판단한다(S525). S525 판단 결과, 다른 메뉴아이콘으로도 터치신호가 입력되지 않은 경우 제어부(180)는 진동신호를 출력하지 않는다. 한편, S525 판단 결과, 다른 메뉴아이콘으로 터치신호가 입력된 경우, 제어부(180)는 입력된 터치신호에 대응하는 진동신호를 햅틱 모듈(157)을 통해 출력한다(S530). 다음, 제어부(180)는 터치신호가 입력된 메뉴아이콘에 해당하는 화면을 디스플레이부(151)에 표시한다(S535).

<86> 한편, S515 판단 결과, 상기 특정 메뉴아이콘으로 터치신호가 입력된 경우, 제어부(180)는 S505 단계에서 검출된 근접신호에 대응하는 진동 신호 및 S515 단계에서 입력된 터치신호에 대응하는 진동 신호를 조합한 진동을 햅틱 모듈(157)을 통해 출력한다(S520). 각각의 진동 신호는 합산되거나 감산되어 진동으로 출력될 수 있다. 다음, 제어부(180)는 터치신호가 입력된 메뉴아이콘에 해당하는 화면을 디스플레이부(151)에 표시한다(S535).

<87> 도 8은 본 발명의 제3 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도이다.

<88> 도 8에 도시된 바와 같이, 제어부(180)는 하나 이상의 메뉴아이콘을 포함하는 화면을 디스플레이부(151)에 표시한다(S600).

<89> 다음, 제어부(180)는 근접센서(141)를 통해, 근접센서(141)와의 거리가 제1 근접거리인 근접신호가 검출되는지 판단한다(S605). S605 판단 결과, 제1 근접거리인 근접신호가 검출되지 않은 경우, 제어부(180)는 진동신호를 출력하지 않는다.

<90> 한편, S605 판단 결과, 제1 근접거리인 근접신호가 검출된 경우, 제어부(180)는 검출된 제1 근접거리의 근접신호에 대응하는 진동신호를 햅틱 모듈(157)을 통해 출력한다(S610). 다음, 제어부(180)는 근접센서(141)와의 거리가 제2 근접거리인 근접신호가 검출되는지 판단한다(S615). S615 판단 결과, 제2 근접거리인 근접신호가 검출되지 않은 경우, 제어부(180)는 진동신호를 출력하지 않는다.

<91> 한편, S615 판단 결과, 제2 근접거리인 근접신호가 검출된 경우, S605 단계에서 검출되는 제1 근접거리의 근접신호에 대응하는 진동신호 및 S615 단계에서 검출되는 제2 근접거리의 근접신호에 대응하는 진동신호를 조합한 진동을 햅틱 모듈(157)을 통해 출력한다.

<92> 도 9는 본 발명의 제4 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도이다.

<93> 도 9에 도시된 바와 같이, 제어부(180)는 하나 이상의 영역을 포함하는 화면을 디스플레이부(151)에 표시한다(S700). 상기 하나 이상의 영역에서 각 영역은 이미지, 문서, 키패드, 또는 메뉴아이콘으로 이루어질 수 있다. 상기 영역은 사용자에 의해 설정될 수 있으며, 화면을 일정하게 분할하여 각 영역으로 지정할 수도 있다. 하나 이상의 영역을 통해 터치신호 또는 근접신호가 입력됨으로써, 멀티터치에 의한 진동이 출력될 수 있다.

<94> 다음, 제1 영역에서 터치신호가 입력된다(S705). 여기서, 제1영역 및 제2영역에서 입력된 신호는 터치신호 뿐 아니라, 근접센서(141)를 통해 검출된 근접신호일 수 있다.

<95> 다음, 제어부(180)는 제2 영역에서 터치신호가 입력되는지 판단한다(S710). S710 판단 결과, 제2 영역에서 터치신호가 입력되지 않은 경우, 제어부(180)는 제1영역의 터치신호에 대응하는 진동신호를 햅틱 모듈(157)을 통해

출력한다. 상기 제1 영역에서 터치신호 및 상기 제2 영역에서 터치신호는 동시에 입력될 수 있다.

<96> 한편, S710 판단 결과, 제2 영역에서 터치신호가 입력된 경우, 제어부(180)는 제1영역의 터치신호에 대응하는 진동신호 및 제2영역의 터치신호에 대응하는 진동신호를 조합한 진동을 햅틱 모듈(157)을 통해 출력한다.

<97> 상기 조합한 진동 신호는 상기 제1 영역에서 터치신호 및 상기 제2 영역에서 터치신호가 입력되는 방법에 따라 다르게 출력될 수 있다. 예를 들어, 제1 영역 및 제2 영역 사이의 거리에 따라 달라질 수 있다. 제1 영역 및 제2 영역 사이의 거리가 일정거리 이하인 경우는 각각의 진동신호를 감산하여 진동을 출력할 수 있고, 일정거리 이상인 경우에는 각각의 진동신호를 합산한 진동을 출력할 수 있다.

<98> 또한, 각각의 터치신호가 입력되는 영역 사이의 거리가 실시간으로 변하는 경우, 변화하는 거리에 따라 진동을 다르게 출력할 수 있다. 예를 들어, 제1 영역 및 제2 영역을 통해 터치신호가 입력된 후 제3 영역 및 제4 영역을 통해 터치신호가 입력되는 경우, 제1 영역과 제3 영역은 동일한 손가락으로 입력되고, 제2 영역과 제4 영역은 동일한 손가락으로 입력된다고 가정한다. 즉, 엄지손가락과 검지손가락을 이용하여 서로 다른 거리를 갖는 멀티터치가 반복적으로 발생하는 경우이다. 두 손가락을 이용하여 멀티터치가 입력되는 경우가 일반적이기 때문이다. 이때, 제1 영역 및 제2 영역 사이의 거리보다 제3 영역 및 제4 영역 사이의 거리가 넓어지는 경우, 제1 영역에서 터치신호에 대한 진동신호 및 제2 영역에서 터치신호에 대한 진동신호를 조합한 제1진동과, 제3 영역에서 터치신호에 대한 진동신호 및 제4 영역에서 터치신호에 대한 진동신호를 조합한 제2진동을 합한 최종 진동신호를 출력할 수 있다. 제1 영역 및 제2 영역 사이의 거리보다 제3 영역 및 제4 영역 사이의 거리가 좁아지는 경우, 상기 제2진동으로부터 상기 제1진동을 감산한 최종 진동신호가 출력될 수 있다.

<99> 또 다른 실시예로서, 각각의 터치신호가 입력되는 영역 사이의 거리가 변하는 속도에 따라 진동을 다르게 출력할 수 있다. 제1 영역 및 제2 영역을 통해 터치신호가 입력된 후 제3 영역 및 제4 영역을 통해 터치신호가 입력되는 경우, 제1 영역과 제3 영역은 동일한 손가락으로 입력되고, 제2 영역과 제4 영역은 동일한 손가락으로 입력된다고 가정한다. 즉, 엄지손가락과 검지손가락을 이용하여 서로 다른 속도를 갖는 멀티터치가 반복적으로 발생하는 경우이다. 이때, 제1 영역 및 제2 영역에서 터치신호 입력 후 제3 영역 및 제4 영역에서 터치신호가 입력된 시간 및 거리를 고려하여 속도를 계산하여, 상기 속도가 일정 속도 이상인 경우, 제1 영역에서 터치신호에 대한 진동신호 및 제2 영역에서 터치신호에 대한 진동신호를 조합한 제1진동과, 제3 영역에서 터치신호에 대한 진동신호 및 제4 영역에서 터치신호에 대한 진동신호를 조합한 제2진동을 합한 최종 진동신호를 출력할 수 있다. 상기 속도가 일정 속도 이하인 경우, 상기 제2진동으로부터 상기 제1진동을 감산한 최종 진동신호가 출력될 수 있다.

<100> 또 다른 실시예로서, 터치스크린을 통해 입력될 수 있는 각각의 터치신호의 거리가 최대가 되는 경우, 이에 대한 정보를 알릴 필요가 있다. 여기서 각각의 터치신호의 최대거리는 터치스크린에서 터치신호가 입력될 수 있는 최대 직선거리보다 같거나 짧을 수 있다. 예를 들어, 입력된 각각의 터치신호에 의해 이미지가 확대되어 디스플레이부(151)에 표시될 수 있는 최대 사이즈로 표시된 경우, 더 이상 이미지를 확대하기 어렵다는 정보를 알릴 수 있어야 한다. 따라서, 각 영역에서 터치신호에 대한 진동신호를 조합한 진동 이외의 제1알림진동을 별도로 출력할 수 있으며, 각 영역에서 터치신호에 대한 진동신호를 조합한 진동을 출력하지 않고, 제1알림진동만을 출력할 수도 있다. 또한, 터치스크린을 통해 입력될 수 있는 각각의 터치신호의 거리가 최소가 되는 경우, 이에 대한 정보를 알릴 필요가 있다. 여기서 각각의 터치신호의 최소거리는 터치스크린에서 터치신호가 입력될 수 있는 최소 직선거리보다 같거나 길 수 있다. 예를 들어, 입력된 각각의 터치신호에 의해 이미지가 축소되어 디스플레이부(151)에 표시될 수 있는 최소 사이즈로 표시된 경우, 더 이상 이미지를 축소하기 어렵다는 정보를 알릴 수 있어야 한다. 따라서, 각 영역에서 터치신호에 대한 진동신호를 조합한 진동 이외의 제2알림진동을 별도로 출력할 수 있다.

<101> 상기 멀티터치에서 이용되는 터치신호는 근접센서에 의해 검출된 근접신호에 모두 적용가능하다. 즉, 근접신호가 검출된 영역의 거리차이, 영역의 거리변화, 및 속도 변화의 경우에도 상기와 같은 다양한 진동패턴을 출력할 수 있다.

<102> 상기 제어부(180)는 제1 영역에서 입력되는 터치신호에 따라 제1 영역에 표시된 메뉴아이콘의 실행화면을 디스플레이부(151)에 표시할 수 있으며, 제2 영역에서 입력되는 터치신호에 따라 제2 영역에 표시된 이미지의 확대화면을 디스플레이부(151)에 표시할 수도 있다.

<103> 도 10 내지 도 11은 본 발명의 제1 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면이다.

<104> 도 10의 (a)에 도시된 바와 같이, 터치신호가 입력되는 경우 선택가능한, 진동종류1에 대한 진동신호를 표시한 화면(505) 및 진동종류3에 대한 진동신호를 표시한 화면(510)이 나타난다. 즉, 진동종류의 분류(500)에 따라 진동종류1 내지 진동종류n 에 대한 진동신호 중 1개의 진동신호가 입력되는 터치신호에 대한 진동신호로서 설정될 수 있다. 여기서 입력되는 터치신호의 압력, 면적, 멀티터치 여부는 고려되지 않는다. 또한 사용자에 의해 새롭게 생성된 진동신호가 선택될 수 있다.

<105> 도 10의 (b)에 도시된 바와 같이, 근접신호가 입력되는 경우 선택가능한 근접A의 경우 진동신호를 표시한 화면(520) 및 근접B의 경우 진동신호를 표시한 화면(525)이 나타난다. 즉, 근접신호의 진동종류 분류(515)에 따라 근접A 내지 근접N 에 대한 진동신호 중 1개의 진동신호가 입력되는 근접신호에 대한 진동신호로서 설정될 수 있다. 여기서 입력되는 근접신호의 근접속도, 근접면적, 근접거리, 멀티터치 여부는 고려되지 않는다.

<106> 근접신호의 근접거리를 고려하는 경우, 도 11의 (a)에 도시된 바와 같이, 근접거리 D1에 대한 진동신호를 표시한 화면(605) 및 근접거리 D2에 대한 진동신호를 표시한 화면(610)이 나타난다. 즉, 근접거리의 분류(600)에 따라 근접거리 D1 내지 D4에 대한 진동신호가 각각의 근접거리에 따른 진동신호로 설정된다. 여기서, D1 내지 D4에 대한 분류(600)는 자동적으로 설정될 수 있고, 사용자에 의해 설정될 수도 있다, 예를 들어, D1은 0에서 10미터, D2는 10에서 20미터로 설정될 수 있으며, D1이 0에서 20미터, D2가 20에서 40미터로 설정될 수도 있다.

<107> 근접신호의 멀티터치를 고려하는 경우, 도 11의 (b)에 도시된 바와 같이, 디스플레이부(151)에서 근접신호가 입력되는 영역, 즉, 멀티터치 영역을 복수개로 나누어 표시한 화면(620)이 나타난다. 근접신호가 입력되는 영역을 복수개로 나누는 것이므로, 디스플레이부(151)에서 근접신호가 입력될 수 있는 영역을 복수개로 나누면 된다. 즉, 멀티터치의 분류(615)에 따라 멀티터치 영역 P1 내지 P9에 대한 진동신호가 각각의 멀티터치 영역에 대한 진동신호로 설정된다. 여기서, P1 내지 P9에 대한 분류(615)는 자동적으로 설정될 수 있고, 사용자에 의해 설정될 수도 있다, 예를 들어, P1 내지 P9은 근접신호가 입력되는 영역을 균등하게 9등분하여 설정할 수 있고, 랜덤하게 영역을 분할하여 P1 내지 P9를 설정할 수 있다.

<108> 근접신호의 근접속도를 고려하는 경우, 도 11의 (c)에 도시된 바와 같이, 근접속도 V1에 대한 진동신호를 표시한 화면(630), 근접속도 V2에 대한 진동신호를 표시한 화면(635) 및 근접속도 V3에 대한 진동신호를 표시한 화면(640)이 나타난다. 즉, 근접속도의 분류(625)에 따라 근접속도 V1 내지 V9에 대한 진동신호가 각각의 근접속도에 따른 진동신호로 설정된다. 여기서, V1 내지 V9에 대한 분류(600)는 자동적으로 설정될 수 있고, 사용자에 의해 설정될 수도 있다, 예를 들어, V1은 0에서 10cm/s, V2는 10에서 20cm/s로 설정될 수 있으며, V1이 0에서 20cm/s, V2가 20에서 40cm/s로 설정될 수도 있다.

<109> 도 12 내지 도 13은 본 발명의 제2 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면이다.

<110> 도 12의 (a)에 도시된 바와 같이, 메뉴 선택을 위한 복수의 메뉴아이콘이 표시된 화면(700)이 표시된다. 메뉴를 선택하기 위한 신호가 입력되는 경우, 제어부(180)는 입력된 신호를 분석한다. 분석 결과, 입력신호는 근접신호 및 터치신호를 포함하며, 근접신호가 검출된 후 터치신호가 입력되는 형태이다. 도 12의 (b)에 도시된 바와 같이, 터치신호에 대해 설정된 진동신호는 진동종류3 에 대한 진동신호(705)이고, 도 12의 (c)에 도시된 바와 같이, 근접신호에 대해 설정된 진동신호는 근접B 에 대한 진동신호(710)이다. 따라서 근접신호가 일정시간동안 유지된 후 메뉴아이콘이 터치되는 경우, 도 12의 (d)에 도시된 바와 같이, 진동종류3 에 대한 진동신호(705) 및 근접B 에 대한 진동신호(710)를 더한 진동(715)이 출력된다. 각 진동신호를 감산하여 진동을 출력할 수도 있으며, 조합 방식은 자동적으로 설정되거나 사용자에 의해 설정될 수 있다.

<111> 도 13의 (a)에 도시된 바와 같이, 디스플레이부(151)의 밝기를 조절하기 위한 밝기 조절메뉴가 표시된 화면(800)이 표시된다. 밝기를 선택하기 위한 신호가 입력되는 경우, 제어부(180)는 입력된 신호를 분석한다. 분석 결과, 입력신호는 근접신호 및 터치신호를 포함하며, 근접신호가 검출된 후 터치신호가 입력되는 형태이다. 도 13의 (b)에 도시된 바와 같이, 터치신호에 대해 설정된 진동신호는 진동종류1 에 대한 진동신호(805)이고, 도 13의 (c)에 도시된 바와 같이, 근접신호에 대해 설정된 진동신호는 근접A 에 대한 진동신호(810)이다. 따라서 근접신호가 일정시간동안 유지된 후 메뉴아이콘이 터치되는 경우, 도 13의 (d)에 도시된 바와 같이, 근접A 에 대한 진동신호(810)로부터 진동종류1 에 대한 진동신호(805)를 감산한 진동(815)이 출력된다.

<112> 도 14 내지 도 15는 본 발명의 제3 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면이다.

<113> 도 14의 (a)에 도시된 바와 같이, 사용자의 손, 귀 또는 얼굴이 디스플레이부(151)에 표시된 화면(900)과 점점

가까워지거나 멀어지는 경우, 근접센서(141)는 근접신호를 검출하고, 제어부(180)는 검출된 근접신호를 분석한다. 분석 결과, 입력신호는 근접거리 D1에서 입력되는 근접신호 및 근접거리 D3에서 입력되는 근접신호를 포함한다. 도 14의 (b)에 도시된 바와 같이, 근접거리 D1에 대한 진동신호(905) 및 근접거리 D3에 대한 진동신호(910)가 설정된다. 화면(900)과의 거리가 D3에서 D1로 변화하는 경우, 도 14의 (c)에 도시된 바와 같이, 근접거리 D3에 대한 진동신호(910)로부터 근접거리 D1에 대한 진동신호(905)를 감산한 진동신호(915)이 출력된다. 한편, 화면(900)과의 거리가 D1에서 D3로 변화하는 경우, 도 14의 (d)에 도시된 바와 같이, 근접거리 D3에 대한 진동신호(910) 및 근접거리 D1에 대한 진동신호(905)를 합산한 진동(920)이 출력된다. 진동신호을 감산하거나 합산하는 조합방법을 서로 바꿀 수 있다.

<114> 제1 근접거리에서 입력되는 근접신호 및 제2 근접거리에서 입력되는 근접신호를 포함하는 신호가 입력되어, 각 근접거리에 대한 진동신호을 조합하여 진동을 출력하는 햅틱 단말기 동작 제어방법은 도 15의 (a)에 도시된 바와 같이, 음악 재생시 디스플레이부(151)를 통해 동작 버튼이 선택되는 경우 작용 가능하다. 음악 재생에 의한 사운드 출력과 별개의 진동이 출력되므로, 사용자는 음악 재생에 방해받지 않고, 동작 버튼이 정확히 입력되었다는 사실을 진동을 통해 확인할 수 있다. 또한, 동영상 재생시 동작 버튼이 선택되는 경우에도, 도 15의 (b)에 도시된 바와 같이, 본 발명이 적용 가능하다. 사용자는 동영상 재생에 방해받지 않고, 동작 버튼이 정확히 입력되었다는 사실을 출력되는 진동을 통해 확인할 수 있다.

<115> 도 16 내지 도 18은 본 발명의 제4 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면이다.

<116> 도 16의 (a)에 도시된 바와 같이, 이미지가 표시된 화면(1100)에 터치신호가 어레잉역을 통해 멀티터치 신호로 입력되는 경우, 제어부(180)가 입력된 터치신호를 분석한다. 분석 결과, 입력신호는 멀티터치 영역의 P1 영역으로 입력되는 터치신호 및 멀티터치 영역의 P9 영역으로 입력되는 터치신호를 포함한다. 도 16의 (b)에 도시된 바와 같이, 멀티터치 영역 P1에 대한 진동신호(1105) 및 멀티터치 영역 P9에 대한 진동신호(1110)가 설정된다. 따라서 도 16의 (c)에 도시된 바와 같이, 멀티터치 영역 P9에 대한 진동신호(1110)로부터 멀티터치 영역 P1에 대한 진동신호(1105)를 감산한 진동(1115)이 출력된다.

<117> 터치신호가 멀티터치 영역의 어레잉역을 통해 멀티터치 신호로 입력되는 경우의 또 다른 실시예가 도 17 내지 도 18에서 설명된다.

<118> 도 17의 (a)에 도시된 바와 같이, 라디오 수신시, 12개의 동작 버튼이 표시된 디스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정할 수 있다. 9개의 영역 중 P1영역 및 P9영역을 통해 터치신호가 입력될 경우, 멀티터치 영역 P9에 대한 진동신호(1209)로부터 멀티터치 영역 P1에 대한 진동신호(1201)를 감산한 진동(1210)이 출력된다. 숫자 입력이 가능한 키패드가 표시된 디스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정하여, P2영역 및 P6영역을 통해 터치신호가 입력된 경우, 도 17의 (b)에 도시된 바와 같이, 멀티터치 영역 P2에 대한 진동신호(1202) 및 멀티터치 영역 P6에 대한 진동신호(1206)를 합산한 진동(1220)이 출력된다. 숫자 및 문자 입력이 가능한 키패드가 표시된 디스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정하여, P2영역 및 P8영역을 통해 터치신호가 입력된 경우, 도 17의 (c)에 도시된 바와 같이, 멀티터치 영역 P2에 대한 진동신호(1202) 및 멀티터치 영역 P8에 대한 진동신호(1206)를 합산한 진동(1230)이 출력된다.

<119> 한편, 도 17의 (b)와 같은 터치신호가 입력된 후 바로 도 17의 (c)와 같은 터치신호가 입력된 경우, 터치신호가 입력된 영역사이의 거리가 변경된 경우이므로, 도 17의 (b)의 진동(1220) 및 도 17의 (c)의 진동(1230)을 조합한 진동이 출력될 수 있다. 또한, 도 17의 (b)와 같은 터치신호가 입력된 후 도 17의 (c)와 같은 터치신호가 입력된 경우, 터치신호 입력을 속도에 따라 서로 다른 진동이 출력될 수 있다.

<120> 도 18의 (a)에 도시된 바와 같이, 썸네일로 표시된 이미지 목록이 표시된 디스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정하여, P1영역 및 P9영역을 통해 터치신호가 입력된 경우, 멀티터치 영역 P9에 대한 진동신호(1209)로부터 멀티터치 영역 P1에 대한 진동신호(1201)를 감산한 진동(1240)이 출력된다. 목수의 메뉴가 표시된 경우, 도 18의 (b)에 도시된 바와 같이, 멀티터치 영역 P9에 대한 진동신호(1209) 및 멀티터치 영역 P1에 대한 진동신호(1201)를 합산한 진동(1250)이 출력된다. 적어도 30개의 날짜메뉴가 표시된 다스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정하여, P2영역 및 P8영역을 통해 터치신호가 입력될 경우, 도 18의 (c)에 도시된 바와 같이, 멀티터치 영역 P2에 대한 진동신호(1202) 및 멀티터치 영역 P8에 대한 진동신호(1208)를 합산한 진동(1260)이 출력된다.

<121> 즉, 디스플레이부(151)의 일정영역에 복수의 메뉴아이콘이 표시되는 경우, 디스플레이부(151)의 일정영역에 멀티터치 영역을 설정할 수 있으며, 멀티터치 영역의 개수는 복수의 메뉴아이콘의 개수와 독립적으로 결정될 수 있다. 따라서 서로 다른 메뉴아이콘을 멀티터치한 경우라도, 동일한 진동신호이 출력될 수 있다.

<122> 도 19 내지 도 22는 본 발명에 따른 휴대 단말기의 동작 제어방법을 다양한 일실시예와 함께 설명하기 위해 참고되는 도면이다.

<123> 도 19의 (a)에 도시된 바와 같이, 사용자의 손, 귀 또는 얼굴이 디스플레이부(151)의 화면(1400)과 서로 다른 속도로 점점 가까워지거나 멀어지는 경우, 근접센서(141)는 근접신호를 검출하고, 제어부(180)는 검출된 근접신호를 분석한다. 분석 결과, 입력신호는 근접속도 V1으로 입력되는 근접신호 및 근접속도 V9로 입력되는 근접신호를 포함한다. 도 19의 (b)에 도시된 바와 같이, 근접속도 V1에 대한 진동신호(1405) 및 근접속도 V9에 대한 진동신호(1410)가 설정된다. 따라서 근접신호의 근접속도가 V9에서 V1로 변화하는 경우, 도 19의 (c)에 도시된 바와 같이, 근접속도 V9에 대한 진동신호(1410)로부터 근접속도 V1에 대한 진동신호(1405)를 감산한 진동(1415)이 출력된다.

<124> 서로 다른 속도의 근접신호가 검출되는 경우의 또 다른 실시예가 도 20에서 설명된다. 도 20의 (a)에 도시된 바와 같이, 멀티태스킹을 위한 메뉴 버튼에 대한 근접신호의 근접속도가 V9에서 V1으로 변화하는 경우, 근접속도 V9에 대한 진동신호(1509)로부터 근접속도 V1에 대한 진동신호(1501)를 감산한 진동(1510)이 출력된다. 이미지 확대를 위한 메뉴 버튼에 대한 근접신호의 근접속도가 V1에서 V9로 변화하는 경우, 도 20의 (b)에 도시된 바와 같이, 근접속도 V9에 대한 진동신호(1509) 및 근접속도 V1에 대한 진동신호(1501)를 합산한 진동(1520)이 출력된다.디스플레이부(151)의 환경설정를 위한 메뉴 버튼에 대한 근접신호의 근접속도가 V2에서 V8로 변화하는 경우, 도 20의 (c)에 도시된 바와 같이, 근접속도 V8에 대한 진동신호(1508) 및 근접속도 V2에 대한 진동신호(1502)를 합산한 진동(1530)이 출력된다.

<125> 한편, 도 21의 (a)에 도시된 바와 같이, 메뉴 버튼이 표시된 화면(1600)에 선택을 위한 신호가 입력되는 경우, 제어부(180)가 입력된 신호를 분석한다. 분석 결과, 입력신호는 근접면적 M9로 입력되는 근접신호 및 근접면적 M1으로 입력되는 근접신호를 포함한다. 도 21의 (b)에 도시된 바와 같이, 근접면적 M9에 대한 진동신호(1610) 및 근접면적 M1에 대한 진동신호(1605)가 설정된다. 입력되는 근접신호의 근접면적이 M9에서 M1로 변화하는 경우, 도 21의 (c)에 도시된 바와 같이, 근접면적 M9에 대한 진동신호(1610)로부터 근접면적 M1에 대한 진동신호(1605)를 감산한 진동(1615)이 출력된다.

<126> 서로 다른 근접면적의 근접신호가 검출되는 경우의 또 다른 실시예가 도 22에서 설명된다. 도 22의 (a)에 도시된 바와 같이, 동영상 재생을 위한 메뉴 버튼에서 근접신호의 근접면적이 M9에서 M1로 변화하는 경우, 근접면적 M9에 대한 진동신호(1709)로부터 근접면적 M1에 대한 진동신호(1701)를 감산한 진동(1710)이 출력된다. 이미지 확대를 위한 메뉴 버튼에 대한 근접신호의 근접면적이 M1에서 M9로 변화하는 경우, 도 22의 (b)에 도시된 바와 같이, 근접면적 M9에 대한 진동신호(1709) 및 근접면적 M1에 대한 진동신호(1701)를 합산한 진동(1720)이 출력된다. 세계시간의 메뉴 버튼에 대한 근접신호의 근접면적이 M2에서 M8로 변화하는 경우, 도 22의 (c)에 도시된 바와 같이, 근접면적 M2에 대한 진동신호(1702) 및 근접면적 M8에 대한 진동신호(1708)를 합산한 진동(1730)이 출력된다.

<127> 그리고, 본 발명에 따른 휴대 단말기 및 그 동작 제어방법은 상기한 바와 같이 설명된 실시예들의 구성과 방법이 한정되게 적용될 수 있는 것이 아니라, 상기 실시예들은 다양한 변형이 이루어질 수 있도록 각 실시예들의 전부 또는 일부가 선택적으로 조합되어 구성될 수도 있다.

<128> 한편, 본 발명은 MSM(Mobile Station Modem) 등과 같이 휴대 단말기에 구비된 프로세서가 읽을 수 있는 기록매체에 프로세서가 읽을 수 있는 코드로서 구현하는 것이 가능하다. 프로세서가 읽을 수 있는 기록매체는 프로세서에 의해 읽혀질 수 있는 데이터가 저장되는 모든 종류의 기록장치를 포함한다. 프로세서가 읽을 수 있는 기록매체의 예로는 ROM, RAM, CD-ROM, 자기 테이프, 플로피디스크, 광 데이터 저장장치 등이 있으며, 또한 인터넷을 통한 전송 등과 같은 캐리어 웨이브의 형태로 구현되는 것도 포함한다. 또한 프로세서가 읽을 수 있는 기록매체는 네트워크로 연결된 컴퓨터 시스템에 분산되어, 분산방식으로 프로세서가 읽을 수 있는 코드가 저장되고 실행될 수 있다.

<129> 또한, 이상에서는 본 발명의 바람직한 실시예에 대하여 도시하고 설명하였지만, 본 발명은 상술한 특정의 실시예에 한정되지 아니하며, 청구범위에서 청구하는 본 발명의 요지를 벗어남이 없이 당해 발명이 속하는 기술분야에서 통상의 지식을 가진자에 의해 다양한 변형실시가 가능한 것은 물론이고, 이러한 변형실시들은 본 발명의

기술적 사상이나 전망으로부터 개별적으로 이해되어져서는 안될 것이다.

도면의 간단한 설명

<130> 도 1은 본 발명의 일실시예에 따른 휴대 단말기의 블럭도,

<131> 도 2는 본 발명의 일실시예에 따른 휴대 단말기의 전면 사시도,

<132> 도 3은 본 발명의 일실시예에 따른 휴대 단말기의 후면 사시도,

<133> 도 4는 근접센서의 동작을 설명하기 위해 참조되는 도면,

<134> 도 5a 내지 도 5b는 근접영역과 햅틱 영역에 대한 설명에 참조되는 도면,

<135> 도 6은 본 발명의 제1 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도,

<136> 도 7은 본 발명의 제2 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도,

<137> 도 8은 본 발명의 제3 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도,

<138> 도 9는 본 발명의 제4 실시예에 따른 휴대 단말기의 제어방법에 대한 설명에 제공되는 흐름도,

<139> 도 10 내지 도 11은 본 발명의 제1 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면,

<140> 도 12 내지 도 13은 본 발명의 제2 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면,

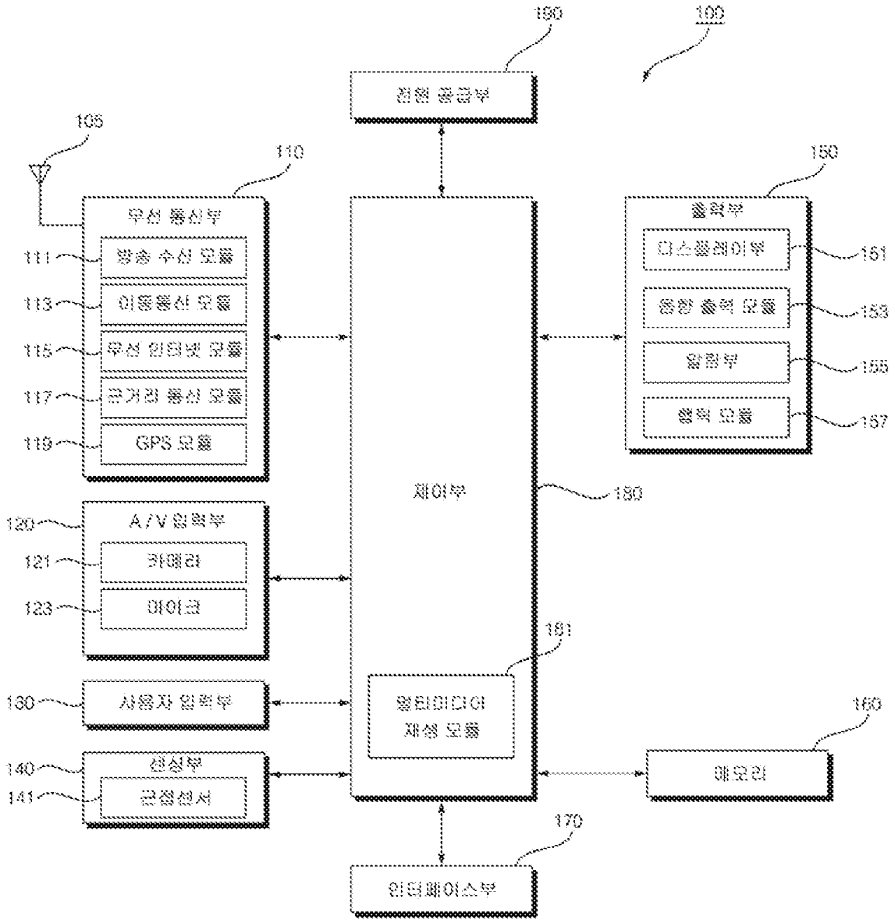
<141> 도 14 내지 도 15는 본 발명의 제3 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면,

<142> 도 16 내지 도 18은 본 발명의 제4 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면,

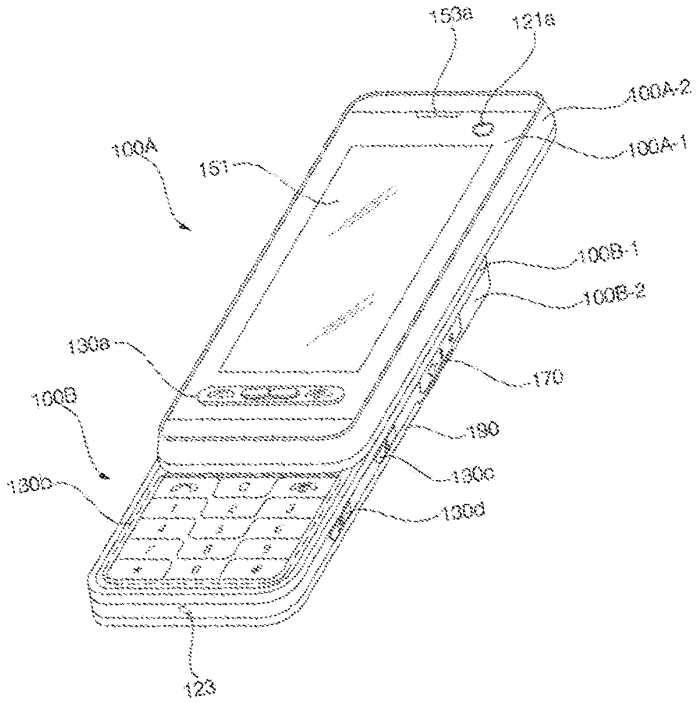
<143> 도 19 내지 도 22는 본 발명에 따른 휴대 단말기의 동작 제어방법을 다양한 일실시예와 함께 설명하기 위해 참고되는 도면이다.

도면

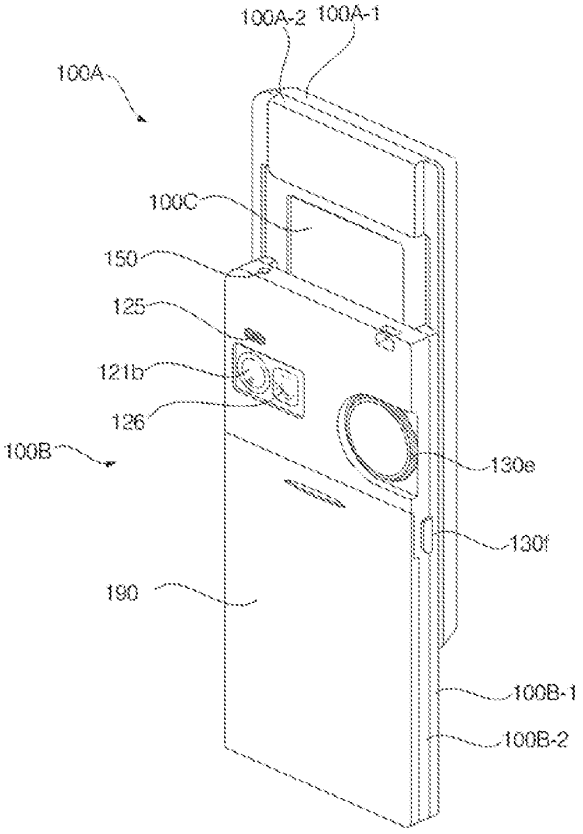
도면1


100
105
110
111
113
115
117
119
120
121
123
130
140
141
150
151
153
155
157
160
161
170
180
전원 공급부
무선 통신부
방송 수신 모듈
이동통신 모듈
무선 인터넷 모듈
근거리 통신 모듈
GPS 모듈
A/V 입력부
카메라
마이크
사용자 입력부
센싱부
근접센서
출력부
디스플레이부
음향 출력 모듈
알림부
메모리
인터페이스부
제어부
멀티미디어 재생 모듈

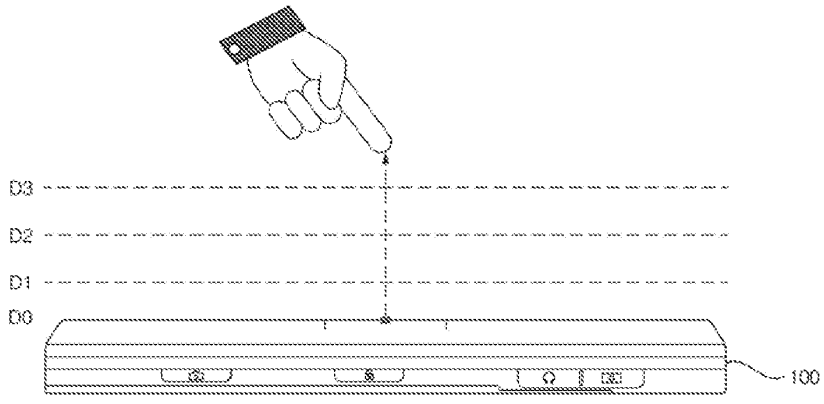
도면2


153a
121a
100A-2
100A-1
100A
151
100B-1
100B-2
130a
170
100B
190
130c
130b
130d
123

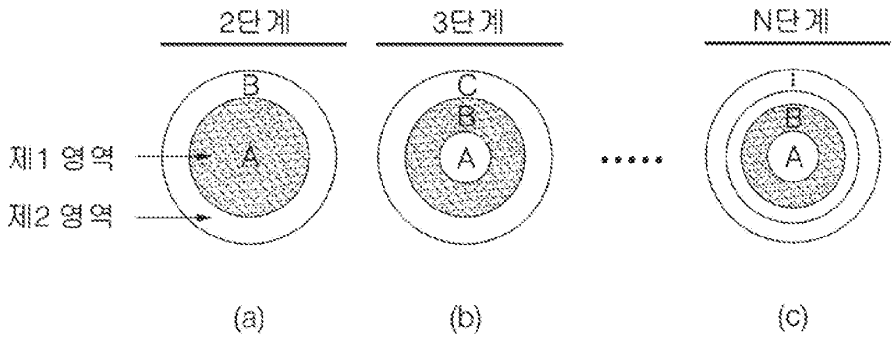
도면3


100A-2
100A-1
100A
100C
150
125
121b
126
100B
130e
130f
190
100B-1
100B-2

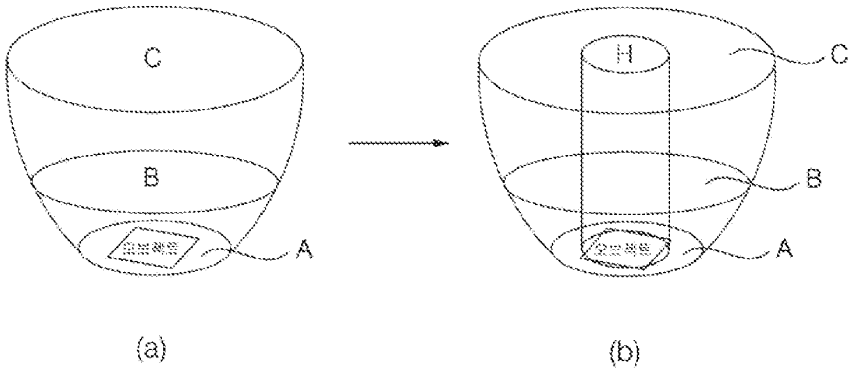
도면4


D3
D2
D1
D0
100

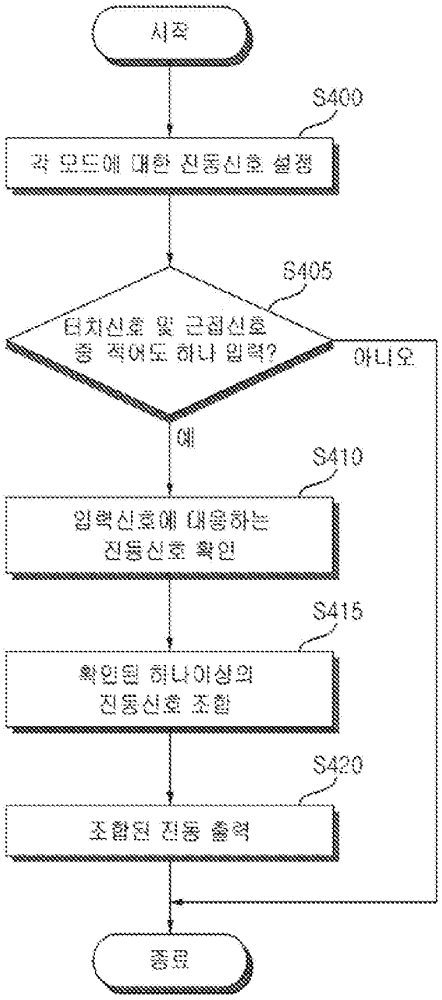
도면5a



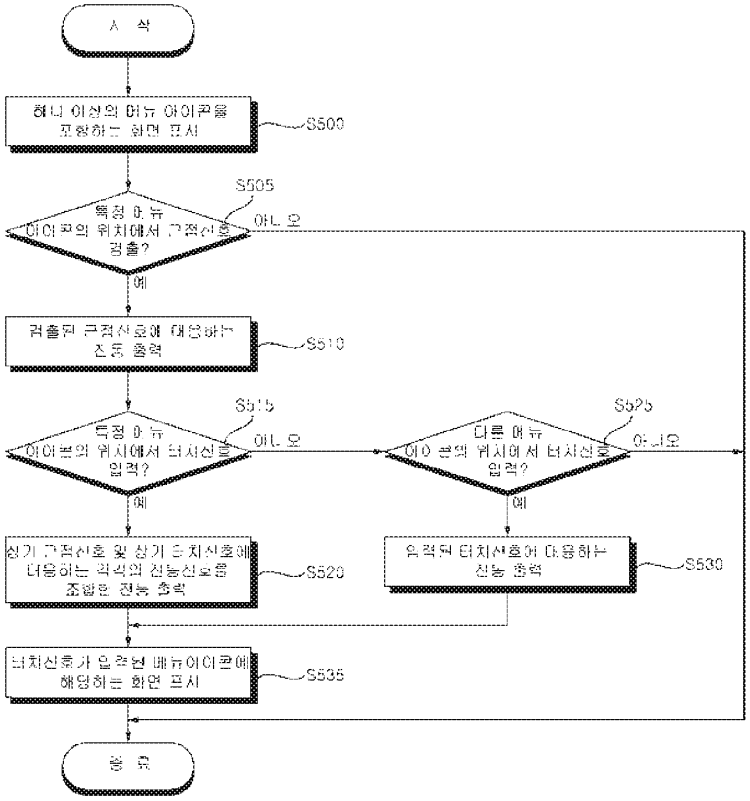
도면5b



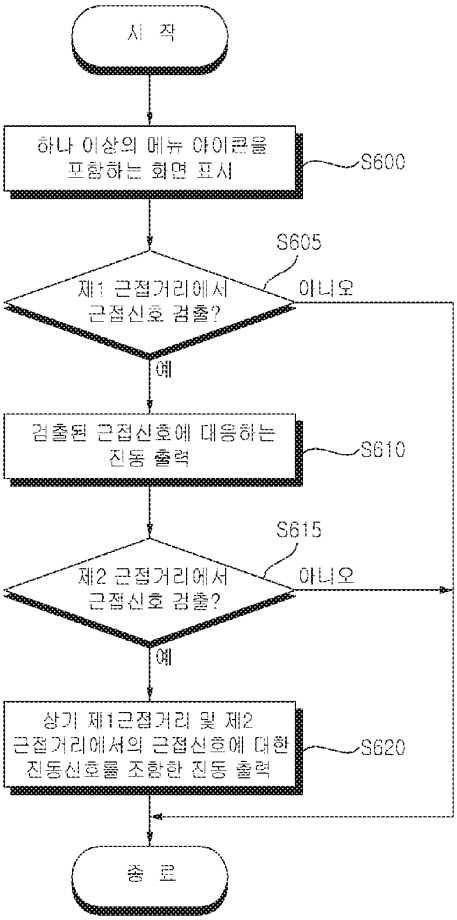
도면6


시작
S400
각 모드에 대한 진동신호 설정
S405
터치신호 및 근접신호
중 적어도 하나 입력?
아니오
예
S410
입력신호에 대응하는
진동신호 확인
S415
확인된 하나이상의
진동신호 조합
S420
조합된 진동 출력
종료

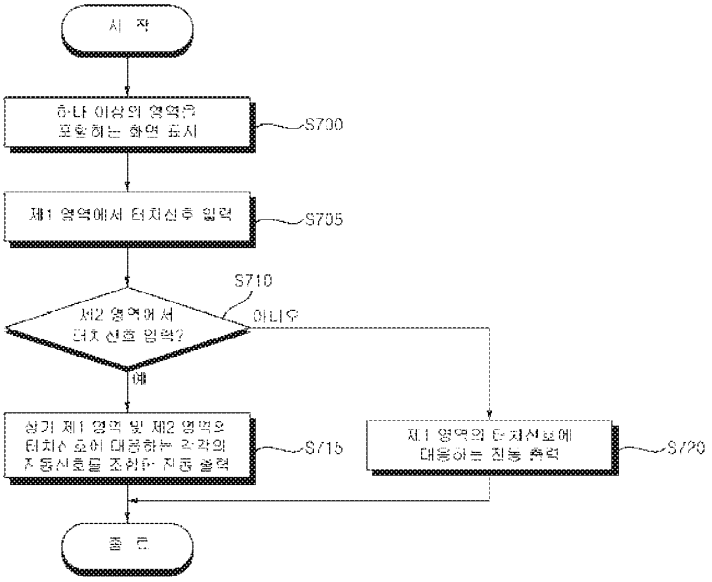
도면7


시 작
하나 이상의 메뉴 아이콘을 포함하는 화면 표시
S500
S505
특정 메뉴 아이콘의 위치에서 근접신호 검출?
아니오
예
검출된 근접신호에 대응하는 진동 출력
S510
S515
특정 메뉴 아이콘의 위치에서 터치신호 입력?
아니오
예
S525
다른 메뉴 아이콘의 위치에서 터치신호 입력?
아니오
예
상기 근접신호 및 상기 터치신호에 대응하는 각각의 진동신호를 조합한 진동 출력
S520
입력된 터치신호에 대응하는 진동 출력
S530
터치신호가 입력된 메뉴아이콘에 해당하는 화면 표시
S535
종 료

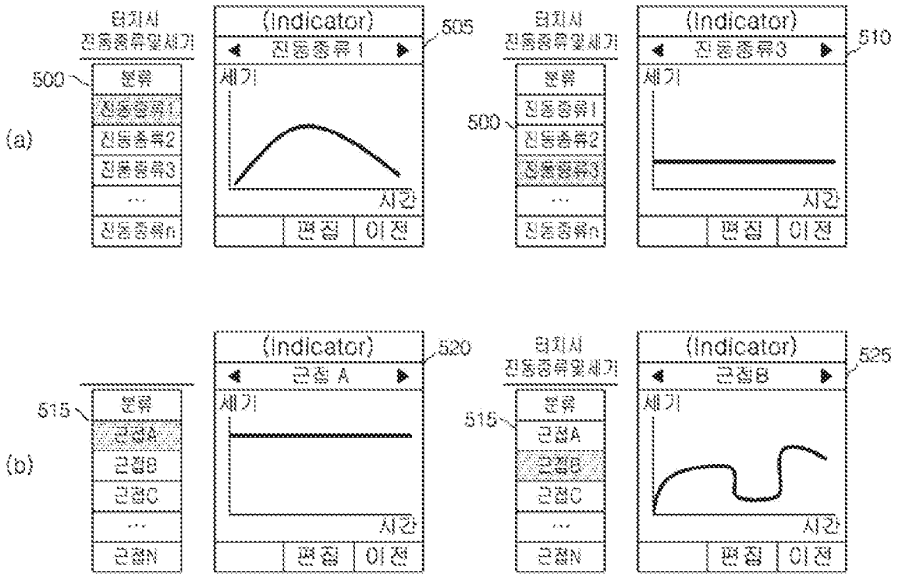
도면8


시 작
하나 이상의 메뉴 아이콘을 포함하는 화면 표시
S600
S605
제1 근접거리에서 근접신호 검출?
아니오
예
검출된 근접신호에 대응하는 진동 출력
S610
S615
제2 근접거리에서 근접신호 검출?
아니오
예
상기 제1근접거리 및 제2 근접거리에서의 근접신호에 대한 진동신호를 조합한 진동 출력
S620
종 료

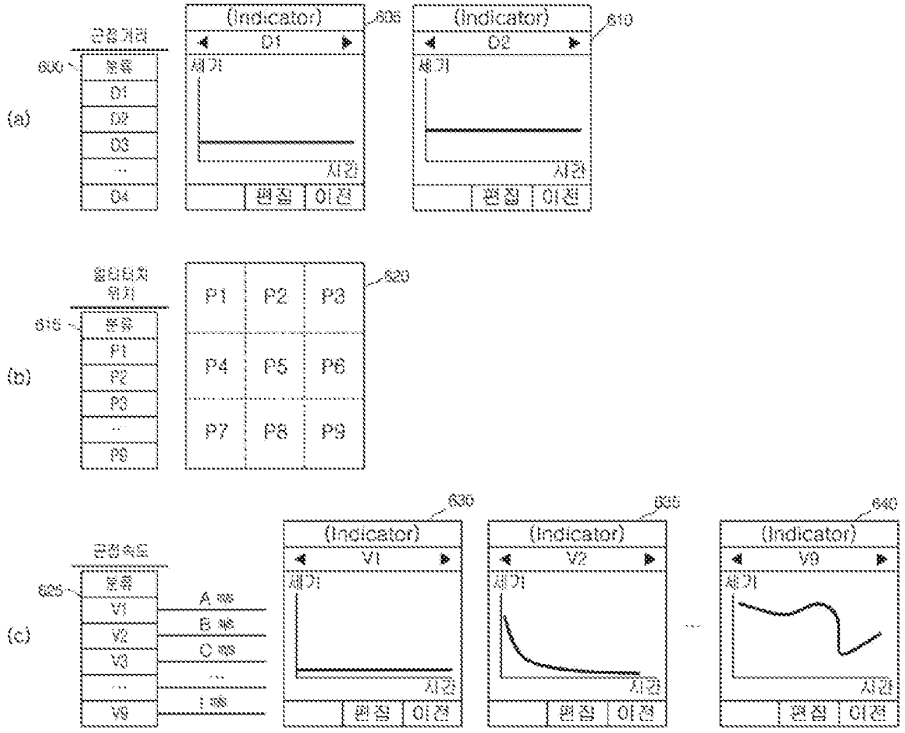
도면9


시 작
하나 이상의 영역을 포함하는 화면 표시
S700
제1 영역에서 터치신호 입력
S705
S710
제2 영역에서 터치 신호 입력?
아니오
예
상기 제1 영역 및 제2 영역은 터치신호에 대응하는 각각의 진동신호를 조합하여 진동 출력
S715
제1 영역의 터치신호에 대응하는 진동 출력
S720
종 료

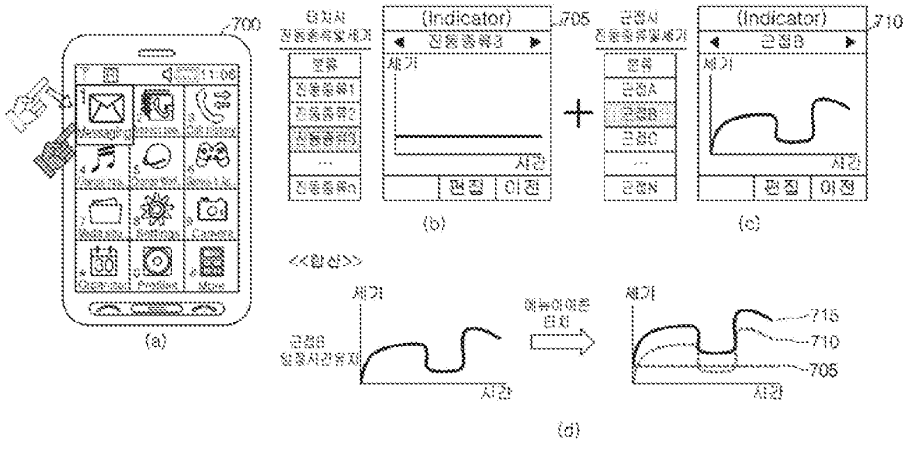
도면10


(a)
터치시 진동종류및세기
500
분류
진동종류1
진동종류2
진동종류3
...
진동종류n
(Indicator)
505
진동종류1
세기
시간
편집
이전
터치시 진동종류및세기
500
분류
진동종류1
진동종류2
진동종류3
...
진동종류n
(Indicator)
510
진동종류3
세기
시간
편집
이전
(b)
515
분류
근접A
근접B
근접C
...
근접N
(Indicator)
520
근접 A
세기
시간
편집
이전
터치시 진동종류및세기
515
분류
근접A
근접B
근접C
...
근접N
(Indicator)
525
근접B
세기
시간
편집
이전

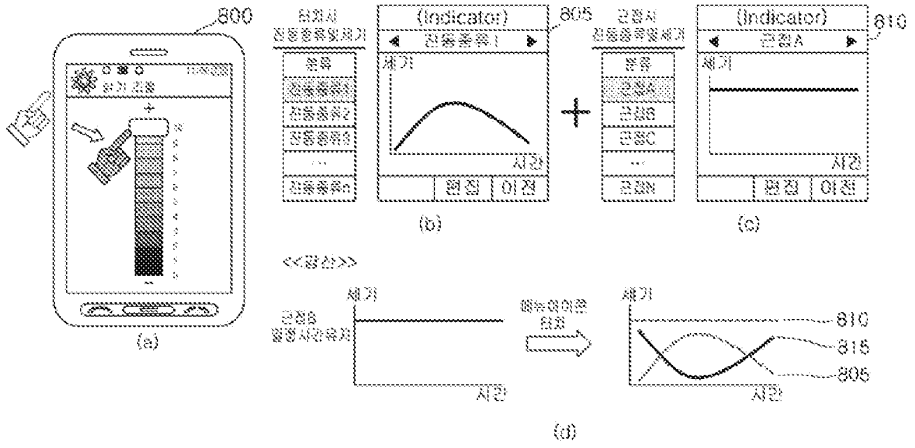
도면11



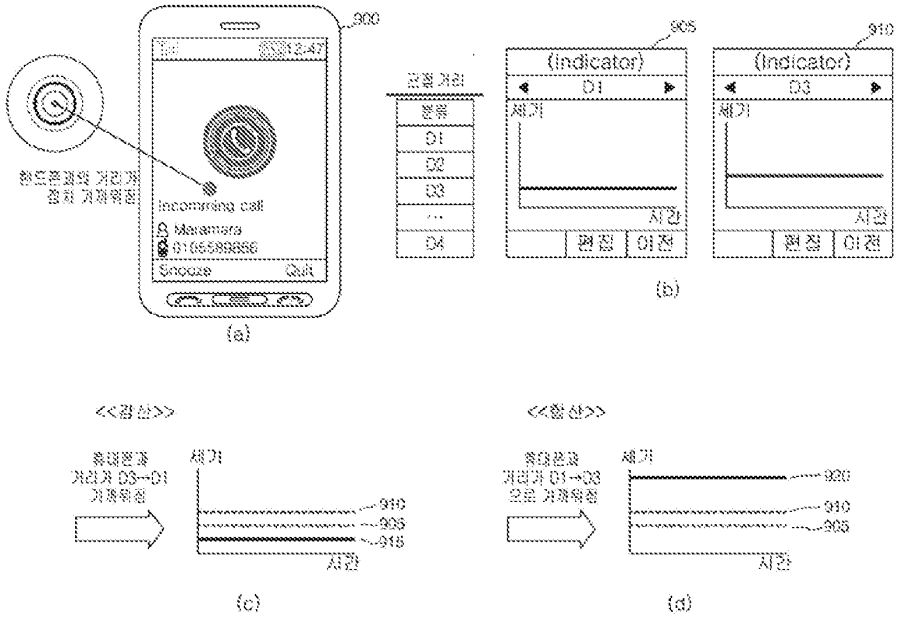
도면12



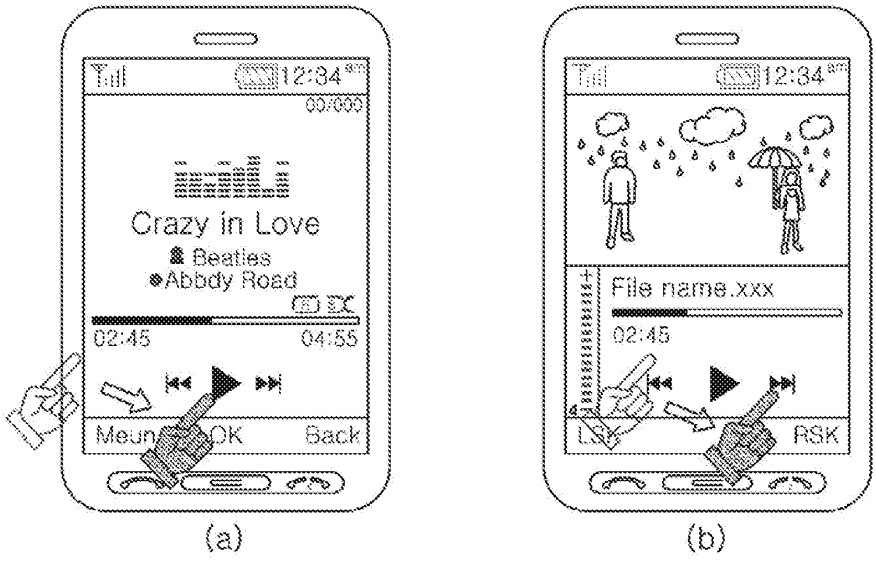
도면13


800
(Indicator)
805
(Indicator)
810
(a)
(b)
(c)
<<참조>>
(d)

도면14

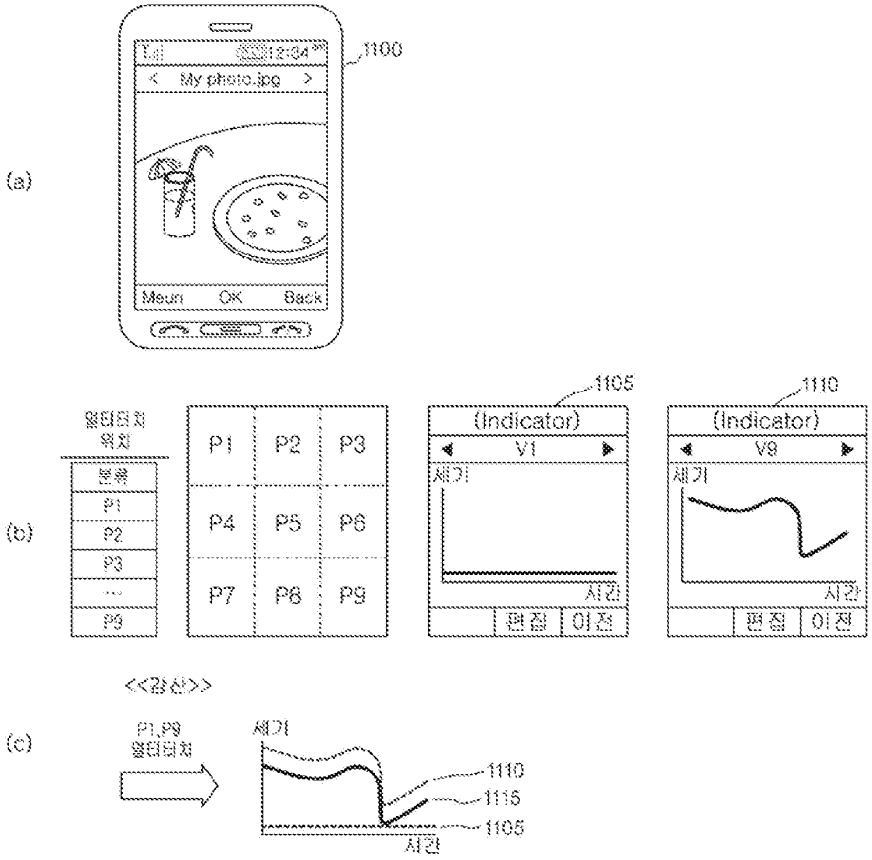

900
905
910
(Indicator)
(Indicator)
(a)
(b)
<<참조>>
<<참조>>
(c)
(d)

도면15

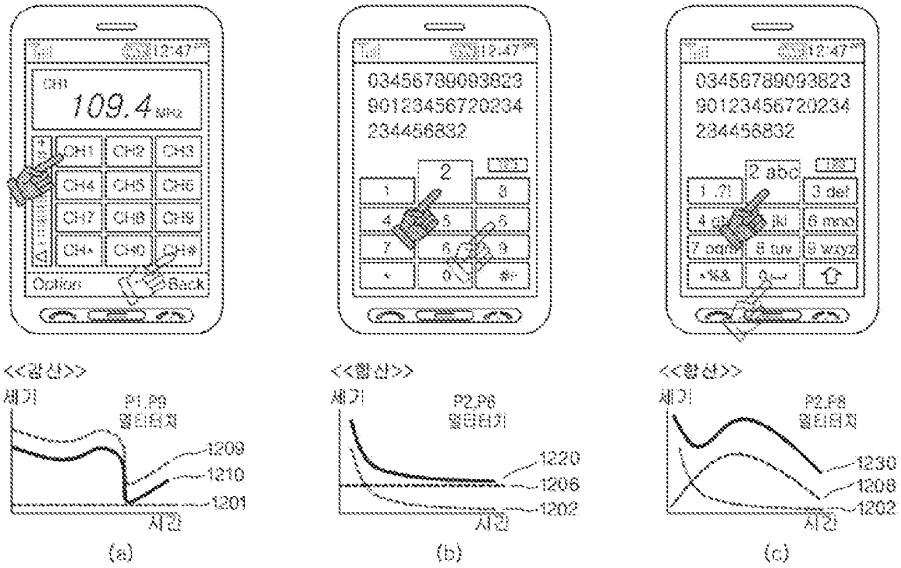

12:34
00/000
Crazy in Love
Beatles
Abbdy Road
02:45
04:55
Back
12:34
File name.xxx
02:45
RSK

(a) (b)

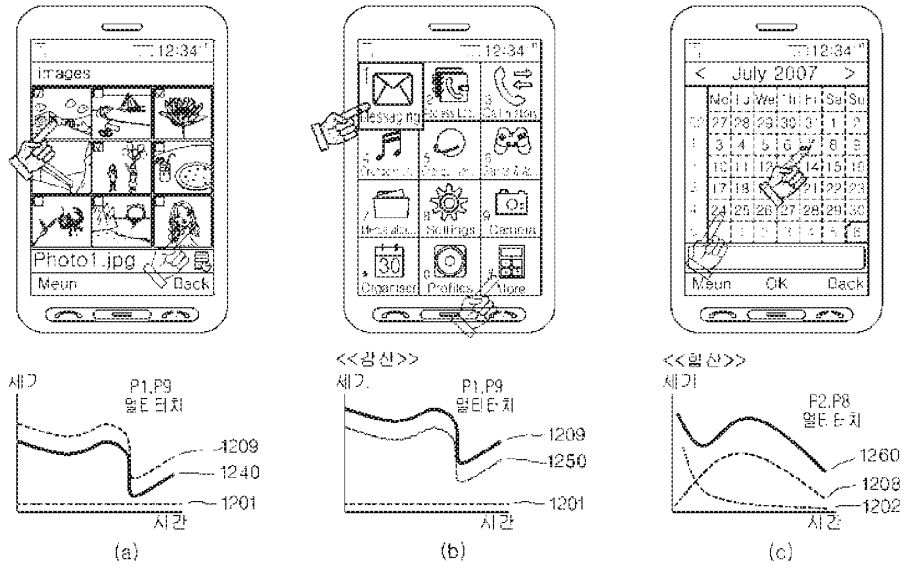
도면16


(a)
1100
My photo.jpg
Menu
OK
Back
(b)
엘리먼트 위치
분류
P1
P2
P3
...
P9
P1
P2
P3
P4
P5
P6
P7
P8
P9
1105
(Indicator)
V1
세기
시간
편집
이전
1110
(Indicator)
V9
세기
시간
편집
이전
<<감산>>
(c)
P1,P9 엘리먼트
세기
1110
1115
1105
시간

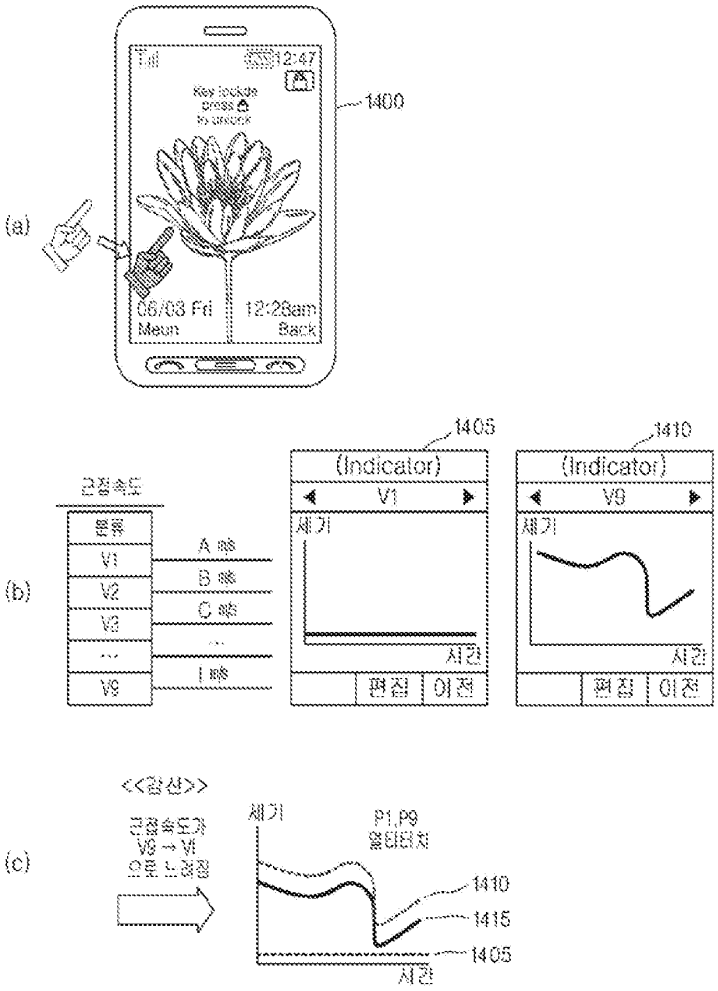
도면17


12:47
CH1
109.4 MHz
CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH*
CH0
CH#
Option
Back
03456789093823
90123456720234
234456832
2
3
4
5
6
7
8
9
*
0
#
2 abc
3 def
4 ghi
5 jkl
6 mno
7 pqrs
8 tuv
9 wxyz
*%&
0
<<감산>>
세기
P1,P9
멀티터치
1209
1210
1201
시간
(a)
<<합산>>
세기
P2,P8
멀티터치
1220
1206
1202
시간
(b)
<<합산>>
세기
P2,P8
멀티터치
1230
1208
1202
시간
(c)

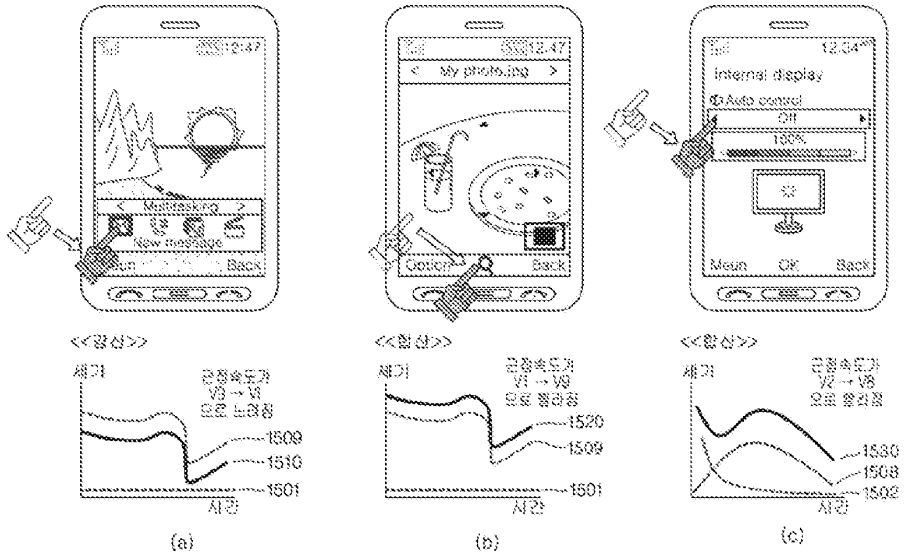
도면18


12:34
images
Photo1.jpg
Menu
Back
Messaging
Address Book
Call history
Media albu...
Settings
Games
Organiser
Profiles
Tone
< July 2007 >
Mo
Tu
We
Th
Fr
Sa
Su
Menu
OK
Back
<<감산>>
세기
P1,P9
멀티터치
1209
1240
1201
시간
(a)
<<감산>>
세기
P1,P9
멀티터치
1209
1250
1201
시간
(b)
<<합산>>
세기
P2,P8
멀티터치
1260
1208
1202
시간
(c)

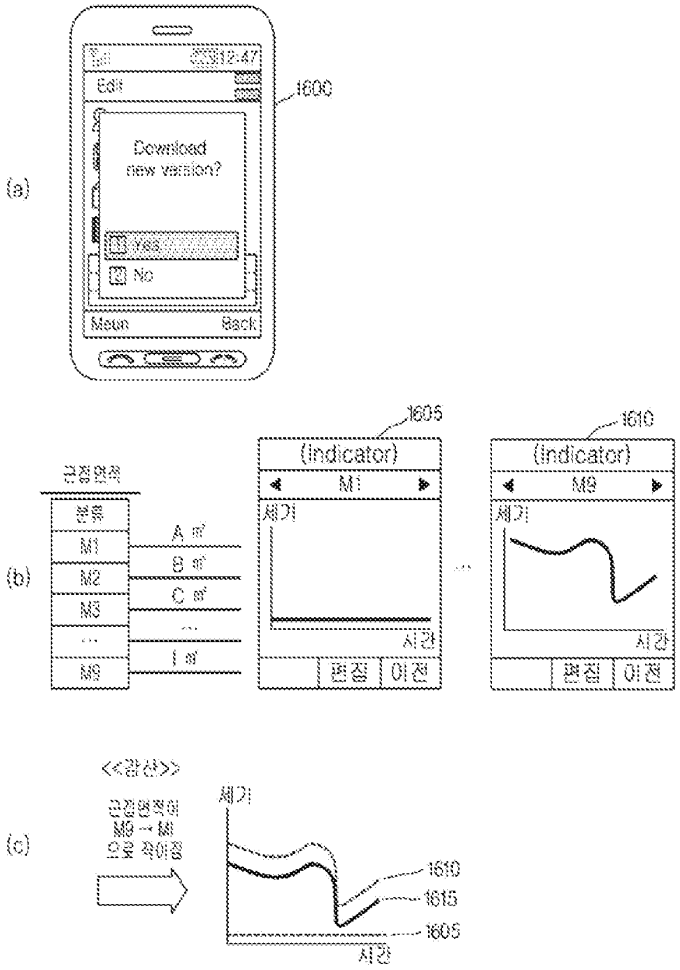
도면19


(a)
12:47
Key lockup
press
to unlock
1400
06/03 Fri
Meun
12:28am
Back
(b)
근접속도
분류
V1
V2
V3
...
V9
A 배
B 배
C 배
...
I 배
1405
(Indicator)
V1
세기
시간
편집
이전
1410
(Indicator)
V9
세기
시간
편집
이전
(c)
<<감산>>
근접속도가
V9 → V1
으로 느려짐
세기
P1,P9
올타치
1410
1415
1405
시간

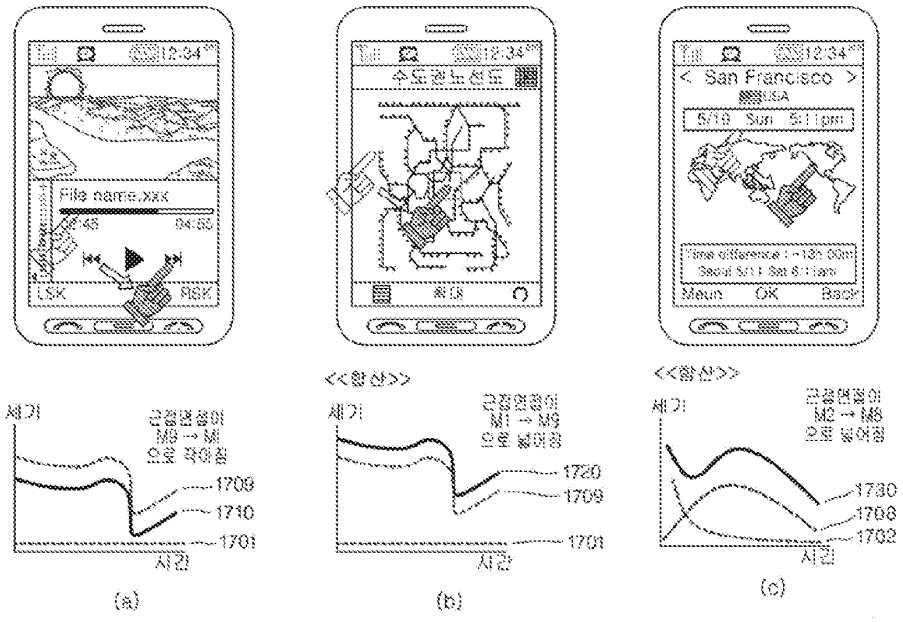
도면20


12:47
Options
New message
Sun
Back
My photo.jpg
Options
Back
12:34
Internal display
Auto control
Off
100%
Main
OK
Back
<<감성>>
세기
근접속도가
V3 → V1
으로 느려짐
1509
1510
1501
시간
(a)
<<힘센>>
세기
근접속도가
V1 → V9
으로 빨라짐
1520
1509
1501
시간
(b)
<<활신>>
세기
근접속도가
V2 → V8
으로 빨라짐
1530
1508
1502
시간
(c)

도면21


(a)
12:47
Edit
1600
Download
new version?
Yes
No
Main
Back
(b)
근접영역
분류
M1
M2
M3
M9
A ㎡
B ㎡
C ㎡
I ㎡
1605
(indicator)
M1
세기
시간
편집
이전
1610
(indicator)
M9
세기
시간
편집
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Electronic Patent Application Fee Transmittal

Application Number:	15377096
Filing Date:	13-Dec-2016
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Filer:	Carl E. Sanders/Jason Smith
Attorney Docket Number:	IMM637 (051851-0971162)

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt	
EFS ID:	34875172
Application Number:	15377096
International Application Number:	
Confirmation Number:	4030
Title of Invention:	Systems and Methods for Proximity-Based Haptic Feedback
First Named Inventor/Applicant Name:	Vahid Khoshkava
Customer Number:	34300
Filer:	Carl E. Sanders/Jason Smith
Filer Authorized By:	Carl E. Sanders
Attorney Docket Number:	IMM637 (051851-0971162)
Receipt Date:	16-JAN-2019
Filing Date:	13-DEC-2016
Time Stamp:	16:10:48
Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IMM637Transmittal0971162.pdf	91722 2a3c573b3b242500ee4280126ec5d9b4523d420d	no	2
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IMM63708a0971162.pdf	122765 1fbdee615a06f9f75dea3540da47ad6feee8ce79	no	2
Warnings:					
Information:					
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3	Other Reference-Patent/App/Search documents	US5311175A.pdf	25908331 080de645719d490abd49468c72644c6f51342b57	no	18
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4	Other Reference-Patent/App/Search documents	US6715045B2.pdf	13469214 1c04c61efeeb2196b6f77fb8cad400cb02aa29a4	no	29
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5	Other Reference-Patent/App/Search documents	US7890863B2.pdf	9514037 bd79c83419c4f53bf0f4fe2875a563e1ce31727d	no	8
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6	Other Reference-Patent/App/Search documents	US20040257339A1.pdf	17130393 6f74ba064723ea53429f005d6caea9ade91d8c3d	no	14
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Information:					
7	Other Reference-Patent/App/Search documents	US20060152497A1.pdf	16164756 c0b7d20ac6e3dd1ded297fdf83120a9d4ad8a450	no	46
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8	Other Reference-Patent/App/Search documents	US20070070044A1.pdf	8205131 a59bc150c844426059ed77a6737cf0d5a4dd8853	no	14
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11	Other Reference-Patent/App/Search documents	US20090322497A1.pdf	11337972 37ea28994a19f7b67d373307ffbc91ae1c870e43	no	35
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12	Other Reference-Patent/App/Search documents	US20100079264A1.pdf	9469127 93be9e304f2f2a42fd3865e70aa38009afbc8503	no	28
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13	Other Reference-Patent/App/Search documents	US20110138277A1.pdf	8464684 58e327810da82f6b07811e0b051e320d05ad0afd	no	8
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14	Other Reference-Patent/App/Search documents	US20110164063A1.pdf	9519863 78a1d69c30a2c98454e1abc9ee3f6656d877ceb9	no	26
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17	Foreign Reference	WO2008042745A2.pdf	14116626 21d4498fc6505aaf4a1505051838335053ef2e8f	no	20
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18	Foreign Reference	JP2008123431A.pdf	15271589 4d785710c8bfe4e807af8028a4cc0f027436ea54	no	15
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19	Foreign Reference	KR20100002776A.pdf	1419771 2013a5e82cafeaab740af1486a8ad26255739137	no	38
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Warnings:					
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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on January 16, 2019.
KILPATRICK TOWNSEND & STOCKTON LLP
By: /Jason Smith/
Jason Smith

PATENT
Attorney Docket No.: 051851-0971162
Client Ref. No.: IMM637

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Vahid Khoshkava	Confirmation No.: 4030
Application No.: 15/377,096	Examiner: Bryan E. Earles
Filed: December 13, 2016	Technology Center/Art Unit: 2625
For: SYSTEMS AND METHODS FOR PROXIMITY-BASED HAPTIC FEEDBACK	SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
Customer No.: 34300	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no

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This Supplemental Information Disclosure Statement is being filed after an action closing prosecution, but before the payment of the Issue Fee.

The Commissioner is authorized to charge the fee set forth in §1.17(p) to the firm's credit card for consideration of this paper. The Commissioner is authorized to charge any additional fee due to Deposit Account No. 20-1430.

Respectfully submitted,

Date: 1/16/2018

By: /Michael Morlock/
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Registration No. 62,245

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mmorlock@kilpatricktownsend.com

Attachment(s):

- ☒ PTO/SB/08
- ☒ Documents
- ☒ Fee
- ☐ Other

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/377,096
	Filing Date	December 13, 2016
	First Named Inventor	Vahid Khoshkava
	Art Unit	2625
	Examiner Name	Bryan E. Earles
	Attorney Docket Number	051851-0971162 (IMM637)

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	5,311,175	A	May 10, 1994	Waldman	
	2	6,715,045	B2	Mar 30, 2004	Braun et al.	
	3	7,890,863	B2	Feb 15, 2011	Grant et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	4	20040257339	A1	Dec 23, 2004	Takashi	
	5	20060152497	A1	Jul 13, 2006	Rekimoto	
	6	20070070044	A1	Mar 29, 2007	Yeh et al.	
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	8	20090140996	A1	Jun 4, 2009	Takashima et al.	
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	10	20100079264	A1	Apr 1, 2010	Hoellwarth	
	11	20110138277	A1	Jun 9, 2011	Grant et al.	
	12	20110164063	A1	Jul 7, 2011	Shimotani et al.	
	13	20120056825	A1	Mar 8, 2012	Ramsey et al.	

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Examiner Initial*	Cite No	Foreign Document Number [3]	Country Code [2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T [5]
	14	H00643998	JP	B2	Feb 18, 1994	NCR INT Inc.		
	15	2008042745	WO	A2	Apr 10, 2008	Immersion Corporation		
	16	2008123431	JP	A	May 29, 2008	Cannon KK		
	17	20100002776	KR	A	Jan 7, 2010	LG Electronics Inc.		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [5]

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/377,096
	Filing Date	December 13, 2016
	First Named Inventor	Vahid Khoshkava
	Art Unit	2625
	Examiner Name	Bryan E. Earles
	Attorney Docket Number	051851-0971162 (IMM637)

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

US005311175A

United States Patent [19]

Waldman

[11] Patent Number: 5,311,175

[45] Date of Patent: May 10, 1994

[54] METHOD AND APPARATUS FOR PRE-IDENTIFICATION OF KEYS AND SWITCHES

[76] Inventor: Herbert Waldman, 1739 52nd St., Brooklyn, N.Y. 11204

[21] Appl. No.: 607,715

[22] Filed: Nov. 1, 1990

[51] Int. Cl.[5] H03M 11/10

[52] U.S. Cl. 341/34; 341/22; 341/23; 341/27

[58] Field of Search ..... 341/21, 23, 27, 22, 341/24, 34; 200/5 A; 364/709.06, 709.12, 709.14, 709.15; 400/87, 476, 477, 479, 481, 485, 491.3; 178/17 C; 379/368, 52; 340/706, 711

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4,028,695 6/1977 Saich 341/23
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4,700,377 10/1987 Yasuda et al. ..... 341/23 X

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2016184 9/1979 United Kingdom 364/709

Primary Examiner—Donald J. Yusko
Assistant Examiner—Michael Horabik

[57] ABSTRACT

A method and apparatus for keypads, for conveying audible, visual or tactile information to a user regarding the identity, function, proper usage or potential utility of a given key or group of keys. The information being invoked by the user through superficial or proximal manipulation of the given key without having pressed or manipulated it in a way that would invoke its normal function. The primary concern of the system is as an informational adjunct to a more traditional keypad.

18 Claims, 8 Drawing Sheets

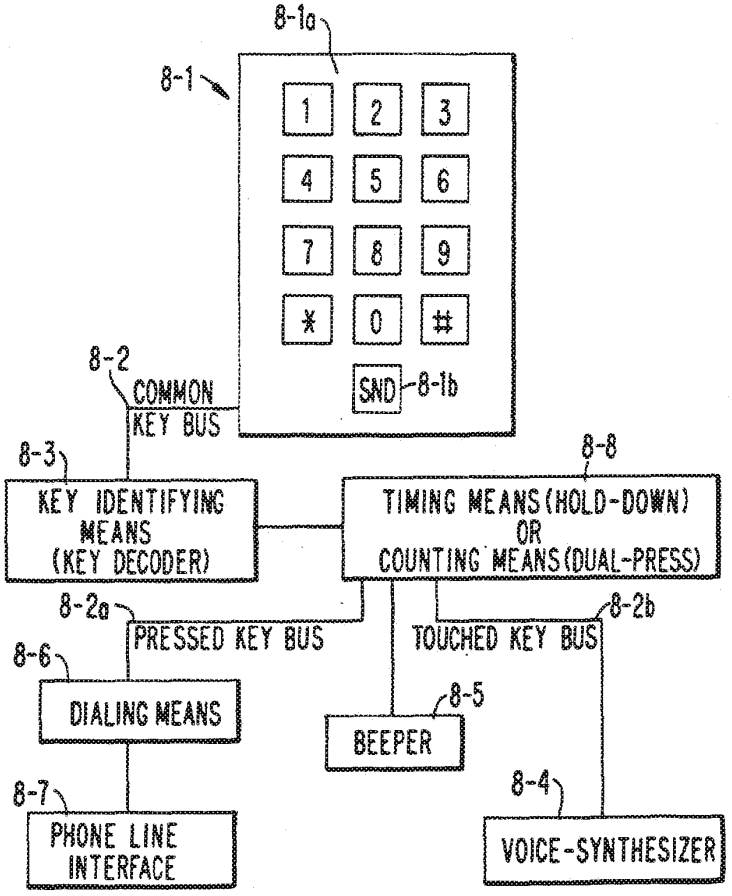


FIG. 1

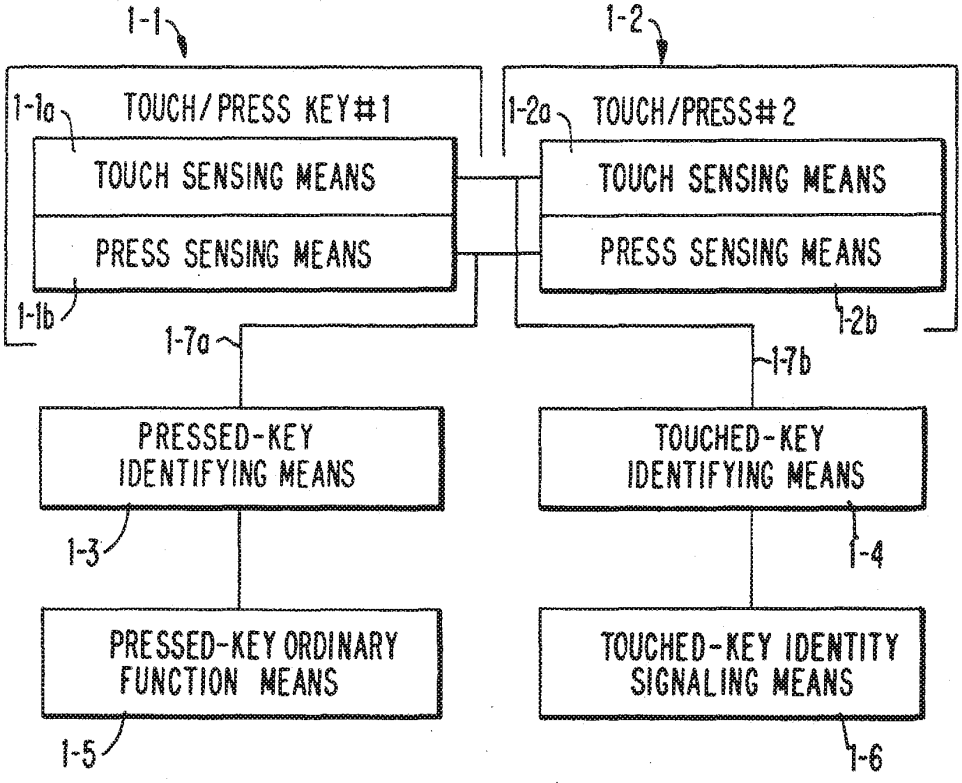

1-1
1-2
1-1a
TOUCH/PRESS KEY#1
1-2a
TOUCH/PRESS#2
TOUCH SENSING MEANS
PRESS SENSING MEANS
TOUCH SENSING MEANS
PRESS SENSING MEANS
1-1b
1-2b
1-7a
1-7b
PRESSED-KEY IDENTIFYING MEANS
TOUCHED-KEY IDENTIFYING MEANS
1-3
1-4
PRESSED-KEY ORDINARY FUNCTION MEANS
TOUCHED-KEY IDENTITY SIGNALING MEANS
1-5
1-6

FIG. 2

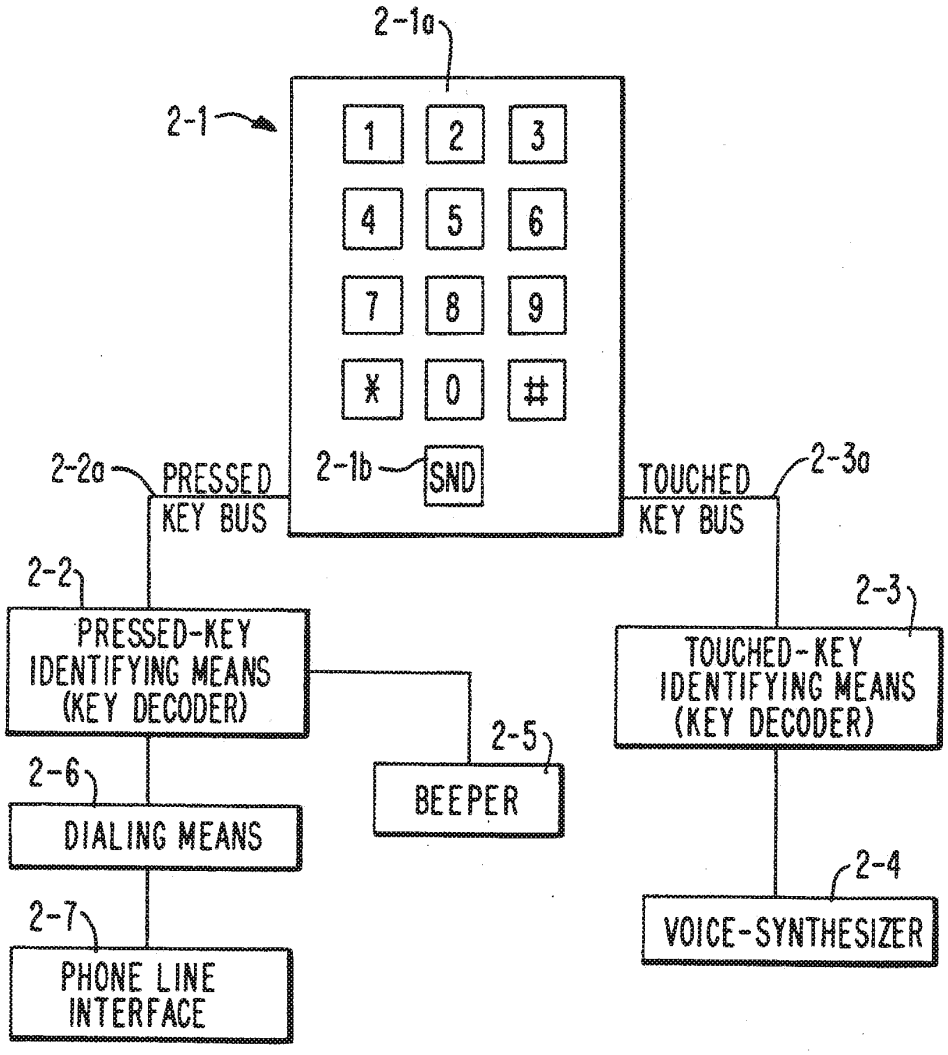

2-1a
2-1
1
2
3
4
5
6
7
8
9
*
0
#
2-1b
SND
2-2a
PRESSED KEY BUS
TOUCHED KEY BUS
2-3a
2-2
PRESSED-KEY IDENTIFYING MEANS (KEY DECODER)
2-3
TOUCHED-KEY IDENTIFYING MEANS (KEY DECODER)
2-5
BEEPER
2-6
DIALING MEANS
2-4
VOICE-SYNTHESIZER
2-7
PHONE LINE INTERFACE

FIG. 3a

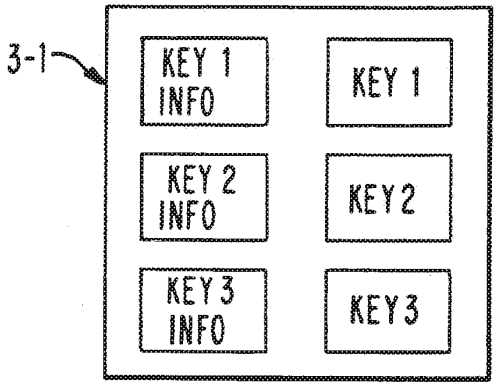


FIG. 3b

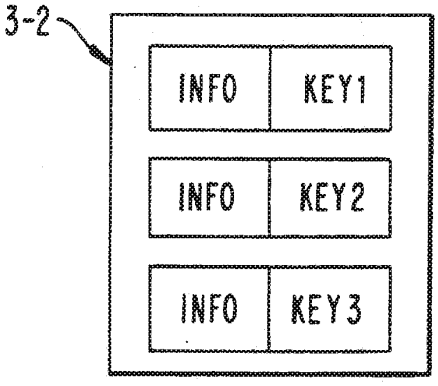


FIG. 3c

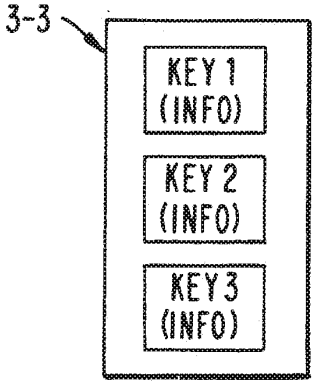


FIG. 4

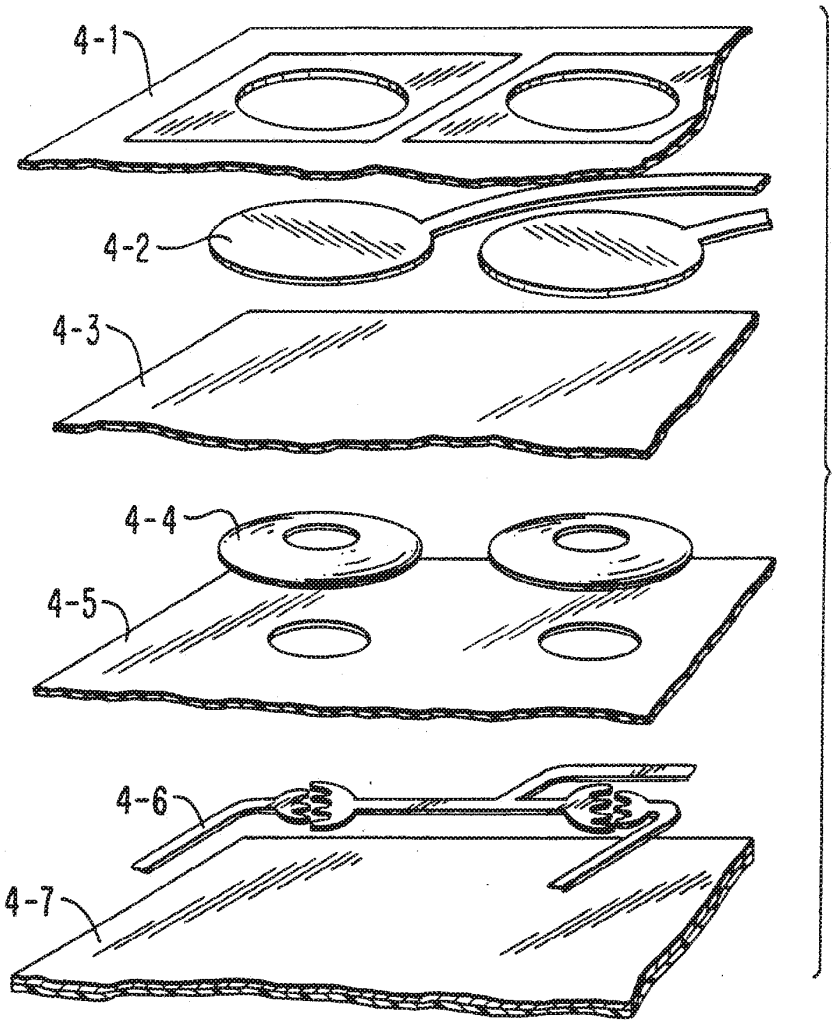


FIG. 5

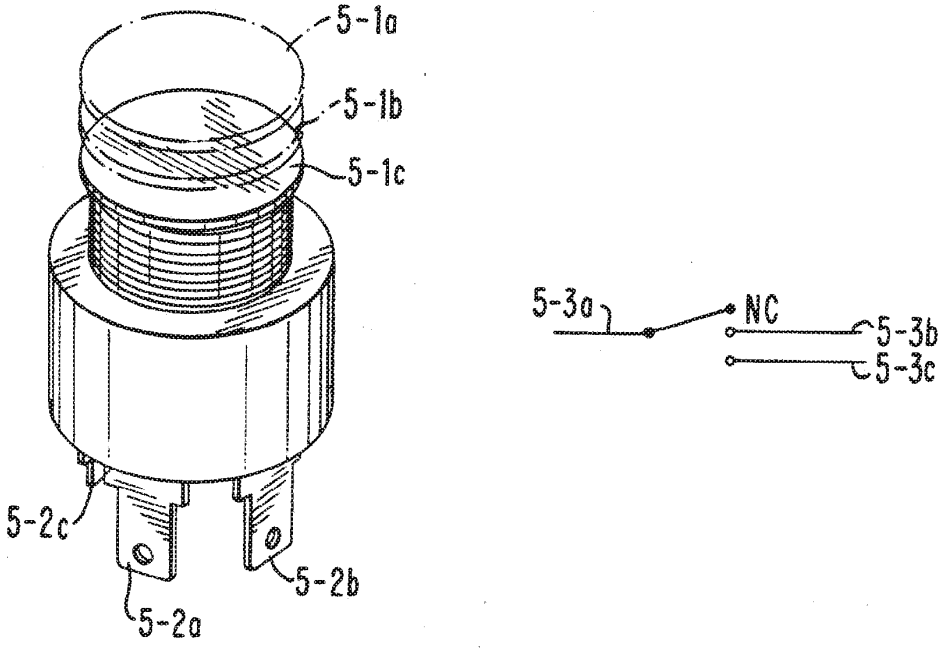


FIG. 6

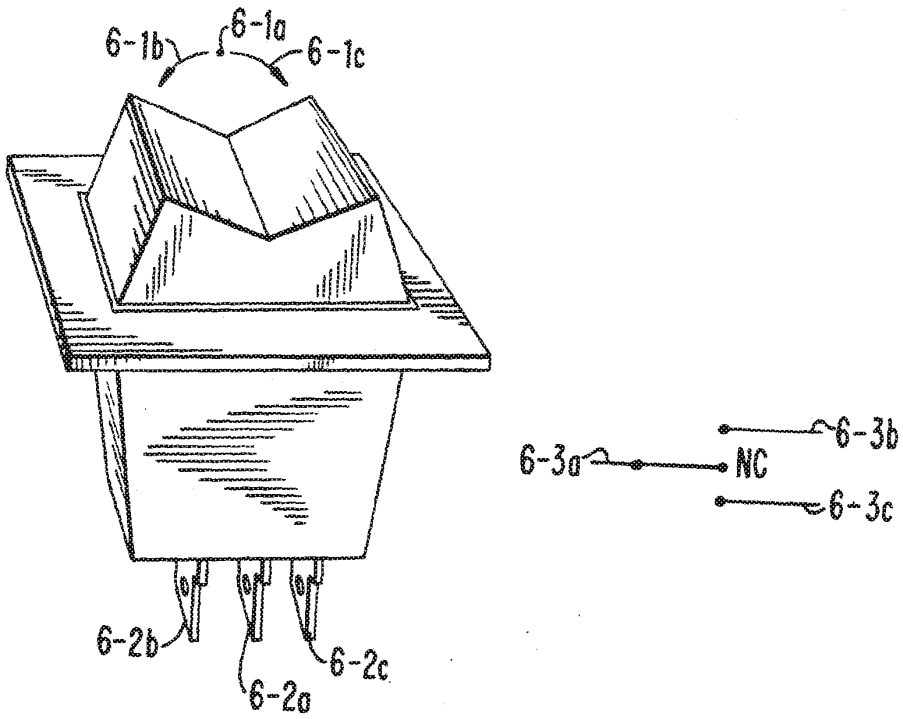


FIG. 7

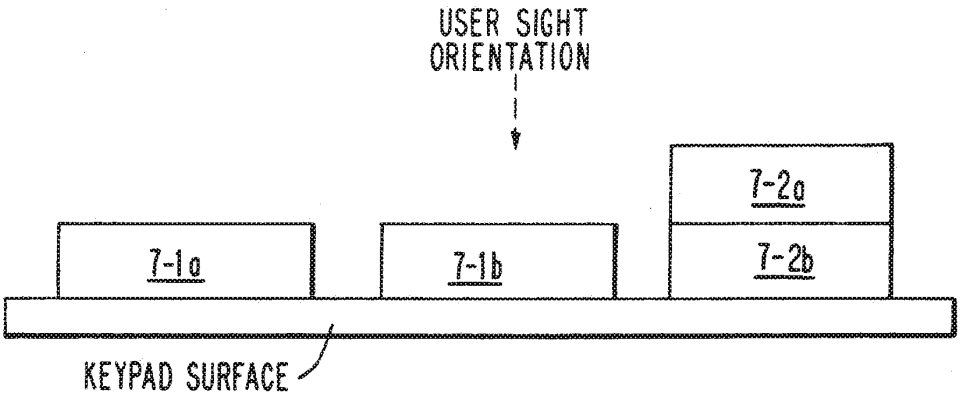
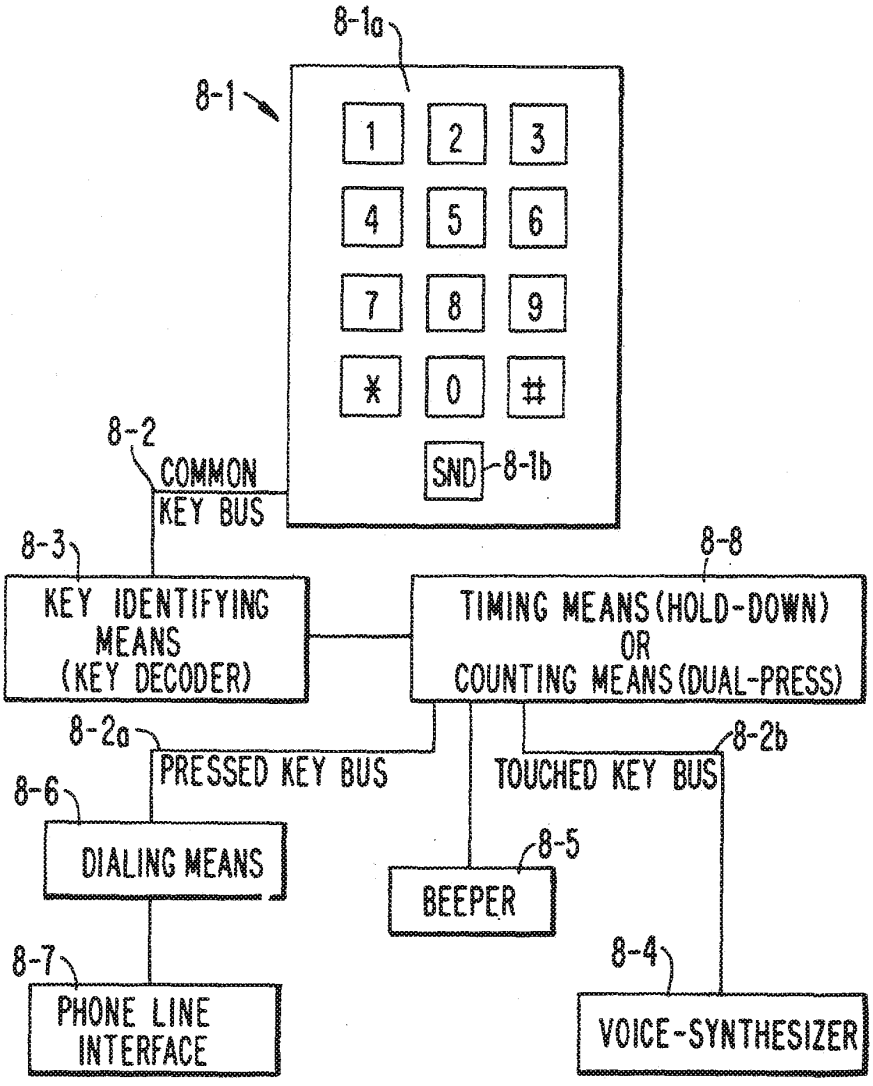


FIG. 8


8-1a
8-1
1
2
3
4
5
6
7
8
9
*
0
#
SND
8-1b
8-2
COMMON
KEY BUS
8-3
KEY IDENTIFYING MEANS (KEY DECODER)
8-8
TIMING MEANS (HOLD-DOWN) OR COUNTING MEANS (DUAL-PRESS)
8-2a
PRESSED KEY BUS
8-2b
TOUCHED KEY BUS
8-6
DIALING MEANS
8-5
BEEPER
8-7
PHONE LINE INTERFACE
8-4
VOICE-SYNTHESIZER

METHOD AND APPARATUS FOR PRE-IDENTIFICATION OF KEYS AND SWITCHES

The subject matter of this application is related to the following disclosure documents:

1. A Method for Proximity-Activated or Superficial-Contact-Activated Identification of Keys on a Pressure-Activated Keypad, Ser. No. 264,836, Sep. 7, 1990

2. A Method for Proximity-Activated or Superficial-Contact-Activated Identification of Keys on a Pressure-Activated Telephone Dialer or Keypad Particularly Adapted to Cellular and Mobile Telephones, Ser. No. 265,634, Sep. 7, 1990.

BACKGROUND OF THE INVENTION

This invention relates to key and pushbutton apparatus and a method of conveying identification, instruction, or description information about such keys or buttons, primarily when they are manipulated superficially by the user (touched) as opposed to being used in their normal fashion (pressed; i.e., having their normal functions invoked by the user). The preferred apparatus of the invention is embodied to serve this need most concisely by combining the informational key means above the ordinary functional key means in a vertical "layered" format rather than a horizontal "planar" format, such that it can be accessed informationally by a user (e.g., for identification of or instruction about the underlying ordinary function key) without actuating the (possibly erroneous or unknown) ordinary function. With audible informational means, this aspect the invention is particularly adaptable to numeric keypad/pushbutton systems with mixed functions such as modern telephone keypads, and especially suited to applications where visual distraction of the user is a problem, such as with cellular telephone keypads.

Over the past years great strides have been made in both voice-synthesis and keypad technology, and many present-day products and systems use one or both in some form. Many microprocessors and dedicated IC-circuits capable of voice-synthesis, keypad-handling, or both are available, as are many forms of matrix and pushbutton keypads utilizing both traditional (mechanical movement-and-contact) methods and more sophisticated electronic methods for non-mechanical detection of key usage. The latter include, among others, resistive and/or capacitive electrical systems using conductive or semiconductive keypad materials, low-pressure-contact matrix materials (a la LCD touch-screens), piezo-mechanical materials, as well as infra-red and other "touch-free" detection systems which detect proximity to a key rather than actual contact. Thus, as one will understand, a wide variety of such technologies is available to the present-day systems-designer for implementing both voice-synthesis and keys, and the prior art is cognizant of many techniques and applications thereof. Numerous products are also available which marry the two technologies, typically by emitting a synthesized voice message regarding the pressed key, given after a key is pressed and/or its function executes.

The prior art does not, however, disclose or anticipate the marriage of the two technologies in a form that allows a user to obtain information or instruction about a key prior to making normal use of the key by manipulating it in a superficial or characteristic manner that does not activate its normal function. The state of current electronics switching and keypad catalogs aptly

reveals this, as one can find only traditional rocker switches as a potential "off-the-shelf" embodiment of the switching needs of the invention. Even OFF-MOM-MOM mechanical pushbuttons, which are not unknown to the state of the art and could implement a system closer to the preferred embodiment than rockers, are semi-custom items not listed in short-form catalogs. No catalog hardware even approximating the preferred embodiment, which foresees a substantially zero-effort "touch-sensitive" key positioned above a substantially existent-effort "pressure-sensitive" key, is available even in semi-custom form.

It is understood, of course, that any technique which enables the user to obtain information or instruction about a key (or group of keys) before functional use of it would enhance the operation of complex keypad systems, and would particularly enhance the safe and accurate use of keypad systems (such as mobile telephones) wherein visual distraction of the user is unsafe or undesirable. There have been many articles written which describe the hazards imposed by dialing on a cellular system while manipulating an automobile, and it is obvious that any improvement or enhancement of the dialing procedure which will keep the driver's eyes on the road will be particularly advantageous and valuable. Likewise, such a device would be of immense value as a system for the handicapped, particularly the visually impaired for whom keypad use is literally a hit-or-miss affair. In both instances, the characteristic of giving identification information regarding a touched key before it is pressed and its function is executed would be of great value.

The apparatus and methods to be described enable information in a wide variety of forms to be passed to a user in a variety of ways prior to the pressing and functional invocation of a key.

The method and apparatus of the instant invention depend upon a two-level keypad system wherein a first (Touch) subsystem responds to an informational manipulation of a key and a second (Press) subsystem responds to a functional manipulation of the same key. This is accomplished most simply by vertically laminating a Touch-responsive keypad requiring little or no physical actuation pressure (such as a conductive-pad capacitive-discharge system) over the top of a traditional (mechanical throw-and-contact) Press-responsive system requiring significant actuation pressure. The former (Touch) system would then be linked to a voice-synthesizer or other information-giving means capable of decoding the Touch and passing appropriate information to the user regarding the underlying, functionally associated key.

It should be noted, however, that there are many alternative means by which the informational and keypad needs of the invention could be met. Some examples of the former are visual responses such as display messages giving help to the user regarding keypress function, or tactile feedback from the key itself for specialized identification purposes, while some examples of the latter are proximity-sensing systems rather than touch-sensing ones (e.g., infra-red), dual-throw mechanical keys wherein a moderate actuation-pressure results in the informational function while a harder pressure actuates a second throw resulting in the functional function, or even dual-press systems wherein keys are pressed once for informational use and a second time, perhaps within a given time-frame, to accomplish functional use. None of the above examples violate the spirit of the

invention, which is to provide some sort of information regarding a given key or key-group to a user without invoking the normal functionality of that key or key-group. Many implementations that would accomplish this are possible.

As one can understand, the main object of the invention is to advantageously utilize the characteristics of the many voice-generation and keypad technologies available at the present time. Numerous examples of appropriate technology are readily available in independent forms well known to the state of the art, and they can be married in a wide variety of ways to accomplish the precepts of the invention.

OBJECTIVES OF THE INVENTION

According to the concepts described above, the functional objectives of the invention is simply to provide information about a key or group of keys to the user, conveniently through the use of the key itself but without invoking the normal function of the key (and possibly suffering the consequences of incorrect usage). The simplest way to visualize the invention conceptually is as two separate but related keys adjacent to one another, wherein one is marked "Key X Information" and the adjacent key is marked "Key X." The type of information passed to the user upon invocation of "Key X Information," or the way and means by which it is passed, are inconsequential and would vary from one implementation to another. The idea is simply that some useful information regarding what will happen when "Key X" is invoked will be passed. This is a clear but awkward implementation of the concept of the invention, but not of the invention itself, which encompasses the simpler and more elegant means of associating "Key X Information" with "Key X" by combining them into a single physical key, which when used in an otherwise normal manner (e.g., touched with a fingertip) but not invoked through pressure provides "Key X Information," and when invoked through pressure executes the function of "Key X."

SUMMARY OF THE INVENTION

In a keypad system having at least one first key for effecting an ordinary function or functions when actuated in a prescribed manner by a user (such as a physically-applied pressure), at least one of said keys also having a functionally associated second key means actuated in a different prescribed manner (such as a contact with substantially zero physically-applied pressure), the system also having a user-signaling means capable of producing an informational indication to uniquely identify the associated ordinary function key to the user or likewise describe one or more useful characteristics thereof; a method wherein upon the prescribed actuation of said second key means, the system will present the associated information to the user without said first key means necessarily having been actuated or its ordinary function invoked. The apparatus of the invention accomplishes this most strongly by a vertical layering of the first and second means wherein they appear to the user as a single key, but with the second means requiring a lesser actuation effort than the first, allowing it to function informationally without actuating the second means located beneath it. The primary concern of the system of the instant invention is thus as an informational adjunct to a more traditional keypad, and the primary concern of the apparatus of the invention is to serve this need concisely by vertically associating access to both the information and ordinary function means.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a block representation of two keys incorporating Touch and Press functions.

FIG. **2** is a block representation of a simplified store & forward telephone keypad utilizing Touch and Press functions.

FIG. **3***a* is a plan view representation of a keypad employing separate informational keys.

FIG. **3***b* is a plan view representation of a keypad employing Satelite information keys.

FIG. **3***c* is a plan view representation of a keypad employing true Touch/Press combined keys.

FIG. **4** is an exploded section view of a standard "tactile-membrane" laminated keypad section including exposed conductors for Touch use.

FIG. **5** is a drawing and schematic representation of a dual-throw detente pushbutton switch with the first position requiring less effort than the second.

FIG. **6** is a drawing and schematic representation of a two-position rocker type switch suitable for use as a combined Press Key/Satellite Key.

FIG. **7** is a block side-view representation of two horizontally associated key contacts and two vertically associated key contacts on a planar surface.

FIG. **8** is an example representation of a store & forward telephone keypad & dialer with voice-synthesis key identification, capable of utilizing either a Dual-Press Protocol or a Hold-Down protocol for Touch detection with a single key bus.

STATE OF THE ART COMPONENTS

All the elements and modules of the system of the invention are well known individually in the state of the art, and are therefore shown in block form without delving into the details of their design and construction. This approach is used in order to facilitate the clarity and simplicity of the specification and to avoid undue cluttering of the drawings. Power supplies and external line or data interfaces (such as phone-line connections) are similarly not shown, except in block form where necessary.

DEFINITION OF TERMS USED

Key/Key means:

Any detection or switching means capable of signaling the occurrence of a specific mechanical user action with regard to itself, typically that of the proximity and/or contact and/or mechanical pressure of a user's finger.

Keypad:

Any arrangement of one or more keys on a substantially plar ar surface.

Press Function/Ordinary Function/Traditional Function/Execution Function:

The specific function performed by a given device in response to a specific key without regard to the invention.

Press:

Any use of a key which would invoke the ordinary function of that key.

Touch Function/Informational Function:

The function performed by a given key with regard to a functionally associated key according to the invention.

Touch:

Any use of a key which would invoke and provide for the conveyance of information about a functionally associated key, without necessarily invoking the ordinary function of said associated key.

Touch Means:

Any key or key protocol functional with regard to the above definition of a Touch.

Touch Capable Key:

Any vertically associated combination of Key means wherein layers farther from the source causing the detection or switching require a succeedingly greater effort or proximity on the part of the source to result in detection or switching.

Functionally associated:

A relationship between two keys wherein a substantially different functions are performed by each with regard to a substantially complementary purpose, e.g., a key which performs a function, associated with a key which provides information regarding said function-performing key.

Horizontally associated:

A relationship between keys primarily across a substantially planar attachment surface.

Vertically associated:

A relationship between keys primarily perpendicular to a substantially planar attachment surface.

Physically associated:

A relationship between keys consisting of having no key(s) intervening geographically between them on a given axis.

Proximally associated:

A relationship between physically and functionally associated keys consisting of having particular adjacency, coloring, labelling, or other characteristic designed to imply functional association.

(True) Touch/Press:

A vertically associated pair or set of keys wherein a key(s) upward or uppermost with regard to the user performs a Touch function(s) and the key(s) downward or lowermost with regard to the user perform a Press function(s).

Satellite Key:

A horizontally associated key or key-throw physically and proximally associated with another specific Pressable key or key-throw, performing informational actions specific to that key.

Hold-Down Protocol/Press-and-Hold Protocol:

A protocol whereby a user depresses a key uninterrupted for a given interval (or longer) in order to signify an action different from that of a depression shorter than the interval. In order to insure a positive delayed-release action of such a key, such a protocol may involve a delayed (or second) audible tone, audible phrase, or other type of system-acknowledgement of the alternate key function.

Dual-Press Protocol/Dual-Actuation Protocol:

A protocol whereby a user presses a key a second time in succession to accomplish a result different from that of a single press.

Multi-Press Protocol/Multi-Actuation Protocol:

A protocol whereby a user presses a key a predefined number of times in succession to accomplish a result different from that of a single or other number of presses.

DETAILED DESCRIPTION OF THE FIGURES

FIG. **1** is a block diagram showing Touch and Press functions residing in each of two individual keys (assemblies **1-1** and **1-2**), connected to common buses (**1-7***a* for Pressed keys and **1-7***b* for Touched Keys) that connect to means identifying the Touch source key (**1-4**) and producing a signal (**1-6**) on a Touch and identifying the Press source key (**1-3**) on a Press and executing the function(s) appropriate to it. Note that in this (preferred) embodiment the Touch sensing means (**1-1***a* and **1-2***a*), which respond to proximity or low or no finger pressure, are physically atop the Press sensing means, which respond to significant finger pressure. This, a Touch will respond in only a Touch detection, while a Press will result in both a Touch and a Press being detected. The circuitry in blocks **1-5** and **1-6** may handle this latter situation in any appropriate fashion, including aborting or altering the Touched key signal produced by **1-6**.

FIG. **2** is an exemplary system showing a simplified telephone dialing keypad (**2-1**) using a "store & forward" method whereby pressed digit keys (**2-1***a*) are buffered by a memory-equipped dialing means (**2-6**) or other memory circuit, then forwarded to the line-interface (**2-7**, including indirect interfaces such as a cellular RF-interface) by a SEND (SND, **2-1***b*) key. The illustrated system responds to a Touch (a la FIG. **1**) by decoding it (**2-3**) off the Touched Key Bus (**2-3***a*) and naming the Touched key audibly via the voice synthesizer (**2-4**), e.g., by speaking "one" when the top lefthand key is Touched, "star" if the bottom lefthand key is Touched, etc. It responds to a Press by executing the Touch functions above (since a Press implicitly causes a Touch), but also decoding the key as Pressed (**2-2**) off the Press Key Bus (**2-2***a*) and thereafter buffering the appropriate digit for dialing (**2-6**) and audibly emitting an acknowledging beep (**2-5**). Upon decoding a SND (**2-1***b*) Press, the system forwards the contents of the dialing means to the line interface (**2-7**). By confirming the identity of a Touched digit key before it is Pressed, a user can easily and consistently dial correct telephone numbers with no visual attention or input. Additionally, the system could be configured to identify the entire telephone number currently held in the dialing buffer on a SND Touch, thereby confirming the number before it is sent to the line interface by a SND Press. This latter function could also be applied to redial, memory, and other optional keys with complex functions based on previously-entered data, providing a good example of the kind of Functional and Objective Use information (described further elsewhere) that can be provided by the invention in addition to simple key-identification.

FIGS. **3***a*, **3***b* and **3***c* are a comparative plan view representation of three three-key keypads employing (respectively) separate informational keys (**3-1**), Satellite information keys (**3-2**), and true Touch/Press combined keys (**3-3**). Note that the separate key setup (**3-1**) requires a correspondi..g information key (marked "Info") for each function key, separately labelled as informational. This sort of system might be satisfactory for relaying functional or usage information, but has little utility for key-identification purposes, since the user is required to physically remove his finger from the information key and seek out the function key afterward. In contrast, although still separate, the Satellite key system (**3-2**) geographically associates the informational and functional keys more conveniently, and obviates some of the labelling requirements thereby. Note, however, that the user still has to move his finger (albeit slightly) to actuate the functional half of the pair, which makes such a system good but not foolproof for key-

identification purposes, much as blind keying can be accomplished (albeit even less reliably) on a standard telephone keypad, whose digit keys always occur in a fixed geographic relationship to one another and can be remembered. Note also that to be useful for key pre-identification purposes, the system would require either the same basic treatment as the preferred embodiment, (i.e., the "Info" half of the pair having a zero or markedly lesser actuation pressure and the functional half having a non-zero or markedly greater actuation pressure), or a distinguishable tactile (e.g., a roughened surface) or directional (e.g., a double-throw rocker-switch pad with the information-giving throws consistently to one side) characteristic allowing the information key to be readily and "blindly" recognized by the user. Some such identifying characteristic must be supplied to make such a system useful for blind keying as opposed to a traditional keypad setup.

FIG. 4 is an exploded section view of a "tactile-membrane" laminated keypad such as is commonly used and well-known to the state of the art, but additionally including conductors (4-2) exposed through holes in the face laminate (4-1) for Touch use. This example would be suitable, among others, for use with a one-conductor multiplexor-based system that responds (because of its own inherent port leakage) to the inherent capacitance of the conductor when sampled at a given frequency and sample-duration, a commonly used approach to touch-keys that requires little external circuitry. The preferred embodiments of the invention envision the principles of this type of keypad, which as represented requires a zero-effort contact for Touch purposes but a significant effort to Press. The exact mechanical effort required can be tailored by altering the semi-conical geometry of the flexible contact cup.

FIG. 5 is a drawing and schematic representation of a dual-throw OFF-MOM-MOM pushbutton switch with the first throw position 5-1*b* (which would serve the Touch purposes of the invention) requiring less mechanical throw (and therefore less total throw effort) than the second throw position 5-1*c* (which would serve the Press functions). The bottom of throw 1 would typically have a resistance type linear-detente well-known to the state of the art, used to define the actuation depth of throw 1 for the user, forced past which throw 2 would make contact. The switch could alternately be configured as an OFF-MOM1-MOM1+2 to avoid make-break-make signal conditions. For a keypad with few keys this type of switch would suffice well, but it might be an unwieldy and costly approach for more multi-key or space-critical applications, since it is larger and mechanically more complex than a typical molded or laminated unit.

FIG. 6 is a representative diagram of a two-position rocker type switch suitable for use as a combined Press Key/Satellite Key. Thrown in one direction the switch would serve the Touch purposes of the invention, while the other throw would serve the Press functions. In essence, for purposes of the invention this type of switch takes a "geographic" or "horizontally associated" approach to what the keys in FIGS. 4 and 5 do in a "stacked" or "vertically associated" fashion. This is a useable approach like the dual-throw pushbutton in FIG. 5, but might likewise prove unwieldy, costly, or space-inefficient for multi-key applications, since it is likewise larger and more mechanically complex than a typical molded or laminated unit.

FIG. 7 is a block side-view representation of two horizontally associated key contacts (7-1*a* and 7-1*b*) and two vertically associated key contacts (7-2*a* and 7-2*b*) on a planar surface, substantially indicating the difference between such associations. A user, in other words, would perceive 7-1*a* as adjacent (side-by-side) to 7-1*b*, and 7-2*a* as above (on-top-of) 7-2*b*. It can readily be seen that the user will perceive the latter as a single key, even though two separate contacts are involved. In this illustration, 7-2*a* would have a lesser (or contact or proximity) actuation pressure and provide information, while 7-2*b* would require a greater (or substantially existent) actuation pressure and would provide ordinary function. Note that without this differential actuation (i.e., if 7-2*a* and 7-2*b* had substantially the same actuation characteristics) the 7-2*a*/7-2*b* pair would essentially be nothing more than a single-throw double-pole (SPDT) switch. The superiority of a differential actuation with a functional association, however-encompassing the preferred embodiment of the invention-can readily be seen. If no tactile or geographic cue is provided to indicate to the user which of 7-1*a* and 7-1*b* provides each service, even the closest of proximal associations will not allow for pre-identification for blind keying. Such an arrangement (all else being equal) will also take up at least twice the planar area, while the extra vertical (height) differential required by 7-2*a*/7-2*b* could be negligible, using, for example, only a thin conductive film.

FIG. 8 is an example representation of a store & forward telephone keypad & dialer with voice-synthesis key identification, capable of utilizing either a Dual-Press Protocol or a Hold-Down protocol for Touch detection with a single key bus. As described elsewhere (and referring also to FIG. 2), these less preferred embodiments use timing (Hold-Down) or keypress counting (Dual Press) to discriminate between a Touch and a Press rather than separate Touch/Press contacts and buses. Note, however, that there is a single bus (8-2) only between the keypad (8-1) and the timing or keypress-counting means (8-8), since these means control the enabling flow to the Dialing (ordinary function) means (8-6 and 8-7) or the Voice-synthesizer (information) means (8-4) according to their own respective time associated or count associated parameters. Beyond this point, the system is functionally identical and equivalent to one using the preferred vertically associated embodiments, and one can easily visualize blocks 3-8 and 8-8 as constituting a transparent, time-associated bus linked to the keypad.

FORMAT OUTLINE

In order to present a clearer understanding of the specification, the following format will be used.

The implementation of the teachings of the invention will be described in connection with various device and keypad types.

At the outset we will set forth examples of some various types of information which might be generically conveyed to a user of a device incorporating the invention. We will then set forth, by way of example only, some combinations of sub-systems which might be used to implement the invention, and some exemplary embodiments in which these subsystems might be reasonably married and applied to accomplish the teachings of the invention. Finally, by way of example only, we will list and briefly discuss some common devices to which the invention might be beneficially applied.

INFORMATION TYPES

Identification Information

This is the primary and most useful sort of information with regard to the invention, since the differential key-actuation pressure under the teachings of the preferred embodiments allow quite literally for perfectly accurate "blind" keying, so long as some sort of non-visual identifying information is provided by a Touch. There are limitless types of keys with various functions which might provide apt illustration of the informational concepts of the invention, but perhaps the best and simplest is the familiar, 12-key numeric telephone keypad. Therein the invention would most likely serve to audibly pre-identify the key occupied by the user's finger prior to dialing of the digit. Thus, putting one's finger upon the "*" key without applying pressure (touching it) would result in an audible voice message saying "star," or putting it similarly on the "1" key would result in the message "one." If one simply thereafter pressed the "1" key (with one's finger already on it, having been informed), one would hear a DTMF signal or pulse-train go out onto the telephone line, accomplishing the ordinary function of the key (dialing "1" to the line) and also confirming that the ordinary function had been invoked. This is a simple form of an identification-only system that could be easily implemented according to the precepts of the invention.

Functional Help Information

Expanding upon the above example, one could likewise provide help to a user regarding the functionality of the key. Instead of simply identifying the key (e.g., saying "one"), the device might further say: "One. The one key will dial the digit one onto the telephone line." This provides the user with a description of the purpose of the key, rather than simply identifying it.

Usage Help Information

Again including the above examples, the same key might be made to say: "One. To dial a one onto the telephone line, press this key hard." This includes the identification and functionality information above, and further adds usage or "how-to" information regarding the key. This information, along with functional help, would be of significant assistance in complex key systems such as computer keypads or industrial controller keypads, wherein the functions and uses of individual keys are often not obvious and where it is likewise often difficult to make key functions "faceplate explanatory."

Objective Use Information

Expanding further, the same key might be made to say: "One. To dial a one onto the telephone line, press this key hard. Dialing this digit first will access your long-distance carrier." This includes all the preceding information, and further adds objective or "why-to" information regarding the key. This sort of information would be extremely useful in systems such as elevator keypads, wherein the contents of the floors of the building may not be obvious. In a department store, for instance, one might touch the "Floor 1" key and be given information about what is on Floor 1, e.g., "Floor 1. Lingerie, women's-wear, housewares." One could then Press the Floor 1 key to go there, or try Touching others to pre-locate other departments before Pressing the one desired. Another example of this would be objective confirmation of previously entered information, such as a telephone "memory" key configured to announce its "remembered" phone number on a touch without actually dialing or "recalling" it until it was pressed.

Informational Objectives

All of the above examples deal with a basic precept of the invention, which is to provide information about a particular key or group of keys prior to functional use or execution, the most basic and useful being simple identification. Many extant systems use and have used voice, visual display, and other feedback means during and/or post-usage, but such information (other than as a confirmation that the key's ordinary function has been actuated or accomplished) is of limited utility. To use the above elevator example, pressing the "Floor 1" key and being told, "Floor 1. Lingerie, women's-wear, housewares," while the elevator is descending is not useful if one wanted to go, say, to the Hardware department on Floor 3.

INFORMATIONAL SUBSYSTEMS

Any or all of the information discussed above could as easily be conveyed visually on a screen, and even (in either form) invoked selectively through a sub-menu invoked by the informational actuation. Other alternatives could also be used for specialized purposes, an example of which might be dynamic tactile feedback for the blind and deaf (e.g., the "1" key responding with one mechanically palpable motion or "bump" when touched, and the "2" key responding with two similar "bumps", etc.) Flashing lights could be used similarly (although the utility of doing so is more problematic), or any conventional or unconventional means which passes specific key-related information to the user.

Voice-using and display-using implementations would, however, be the most useful forms in most instances, the latter being of great benefit in devices wherein keys have complex or un-obvious functions requiring long-winded explanations, and the former being especially beneficial to the handicapped and in instances like cellular telephones wherein accurate "blind" keying is desirable because visual distraction of the user presents hazards. Many such systems, especially those conveying usage or functionality information for training or educational purposes, or those in which the invention might have limited utility to some users (e.g., a sighted person using a phone for the blind) would probably incorporate off- and/or limiting-switches to disable all or part of the invention's functions.

Various types of hardware are available for fulfilling any of the above requirements:

Voice: The archetypical modern implementation of this requires only a voice-capable IC hooked up to a audio speaker. Many such IC's and types of speakers are available, and some IC's include the subsidiary amplifier hardware necessary to drive a speaker directly. The data patterns to provide the selected words, sounds, or phonemes are often incorporated (or pre-incorporated in a manufacturer-determined format) into such IC's as a masked on-board ROM, but can also be suitably implemented using external memory components such as ROMs, PROMs or EPROMs according to the specific IC used. Many such IC's are software or firmware programmable microprocessors which could also handle keypad data acquisition and translation, as well as many other specific tasks required by particular devices. Ran-

dom-access data devices such as floppy- or hard-disks could also be used to store the necessary voice data digitally, or CD-disk systems could be employed for directly producing sounds and bypassing any on-board digital-translation steps, but random-access disks of any type could be gainfully used for very complex informational tasks or those requiring frequent changes. Even audio tapes could be employed, directly or as data-storage devices. It is also worthy of note that any such system could be made user-customizeable or configurable by including recording means as part of the hardware, allowing a user to change or tailor the informational messages according to his own needs.

Sound: In specialized applications wherein audible tones might be employed without resorting to speech, a plethora of buzzers, beepers, squawkers, tone generators and the like are available for various sounds and various purposes. Possible implementations might involve, for example, a beeper sounding a number of times indicative of the identity of the associated key (e.g., a key marked "3" could be identified by 3 short beeps), or a linear keypad might make an ascending/descending tone as one Touched the keys from left-to-right/right-to-left. In any case, such means might be easily and gainfully employed in addition to voice or display means as confirmation or warning devices, supplementing the primary Touch information in a variety of ways.

Visual: Generically we will use this term to mean the display of pictorial or alphanumeric data in a visual format, although many means for producing such are available. The simplest forms could be as rudimentary as a flashing, colored, or multi-colored light (similar to a sound-based implementation, see above), or an associated pre-printed transparency backlit only when the Touch key is invoked. For purely alphanumeric purposes, many types of traditional, segmented LED, VFD and LCD displays are available, as well as more exotic technologies for specific purposes. For more versatile (possibly pictorial) applications, a variety of pixel-matrix devices could be used, such as LCD or RGB matrix displays. It should be noted that specialized versions of the former can already be obtained for so-called "touch-screen" purposes, wherein a fixed or programmable key matrix is embedded transparently in or under the display screen. A Satellite Key, Dual-Press, or Press-and-Hold structure of the invention could be implemented using standard "touch-screen" technology, and a custom dual-level laminate with different actuation pressures could presently be used to implement the more preferred, vertically associated embodiments.

Tactile: Although the applications for this are limited (particularly to devices for the blind), many inexpensive piezo-mechanical devices are becoming available which could make a "pulse-count" tactile-feedback system practical for the purposes of the invention. Numerous temperature- and light-sensitive materials are also becoming available which change their shape or texture in response to stimulus, and which might be employed in a braille or braille-like fashion to provide more complex tactile information. A changeable "braille display" could also be conceived for use in conjunction with the operation of the invention for presenting detailed information in a purely tactile format, as for the blind and deaf.

TOUCH/PRESS KEYPAD SUBSYSTEMS

The preferred embodiment of the invention envisions what appears to the user as a single key, performing an informational function when contacted superficially and a traditional function-execution when actuated with significant finger pressure. Many hardware means could be used to effect such a system, which merely requires the superimposition of a keypad requiring no, little, or less pressure or proximity (typically contact-, proximity- or minimal-pressure-sensing) over the top of a keypad requiring some, more, or greater pressure or proximity (typically a traditional significant-pressure keypad). Both types are well known to the state of the art and have many variations, and since the concept of traditional, mechanical-pressure pushbuttons is so old and well-known as to have had its origins largely lost to history, we will not treat it here. Likewise, the concept of a minimal-pressure switch is only a technological extrapolation of a significant-pressure switch, and it can be readily seen that the former could be combined amiably with the latter. This could be approached technologically through the use of high-tech piezo-electrical components sensitive to exquisitely small pressures (also worth noting because of a lack of moving parts and because some can respond potentiometrically to mechanical stress), but the larger concept of pressure-actuated switching is still both traditional and obvious. True contact- and proximity-sensitive switches, however, are historically and technologically a more recent conceptual innovation which we will briefly exemplify:

Contact-Sensitive Switches: These types of keys are typically conductive, using the resistance, impedance, or capacitance changes caused in an exposed conductor by the contact of a finger to detect its presence. Typically they will detect an appropriate contacting surface with substantially zero pressure applied, and most are entirely insensitive to pressures above those necessary for minimal contact. Many types are well known, with the archetype perhaps being a multiplexor IC whose inherent port-leakage can be used at a specific frequency to charge a single-line conductor, which is then grounded by a touch. A less common (although still widely-used) approach is to detect contact through the electrical changes in a thermal-electric component caused by body heat.

Proximity-Sensitive Switches: These types of keys are typified by infra-red-sensitive keypads, which either passively detect the proximity of the infra-red component of body-heat, or actively generate infra-red frequencies and specifically detect occulations or reflections of their own signal. Other types of the latter could be conceived, since active-component systems can generate any sort of detectable emission for themselves-RF, for instance, or visible light or ultrasound-but infra-red types are the only ones now in common use for keypad applications.

EXEMPLARY EMBODIMENTS

The preferred embodiment of the invention envisions what appears to the user as a single key for both informational and functional purposes, performing its informational function when contacted superficially and executing its normal function when actuated with significant finger pressure. As described above, this merely requires the superimposition of a keypad requiring no, little, or less pressure or proximity over the top of a keypad requiring some, more, or greater pressure or