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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(*) 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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Related U.S. Application Data

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(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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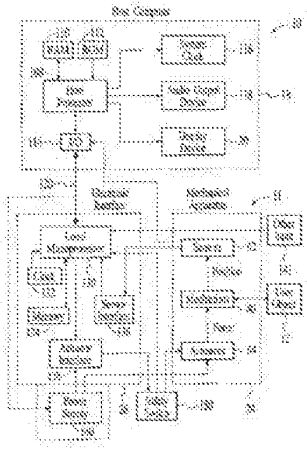
Primary Examiner—Matthew Kim
Assistant Examiner—Matthew D. Anderson
(74) *Attorney, Agent, or Firm*—Kilpatrick Stockton LLP

(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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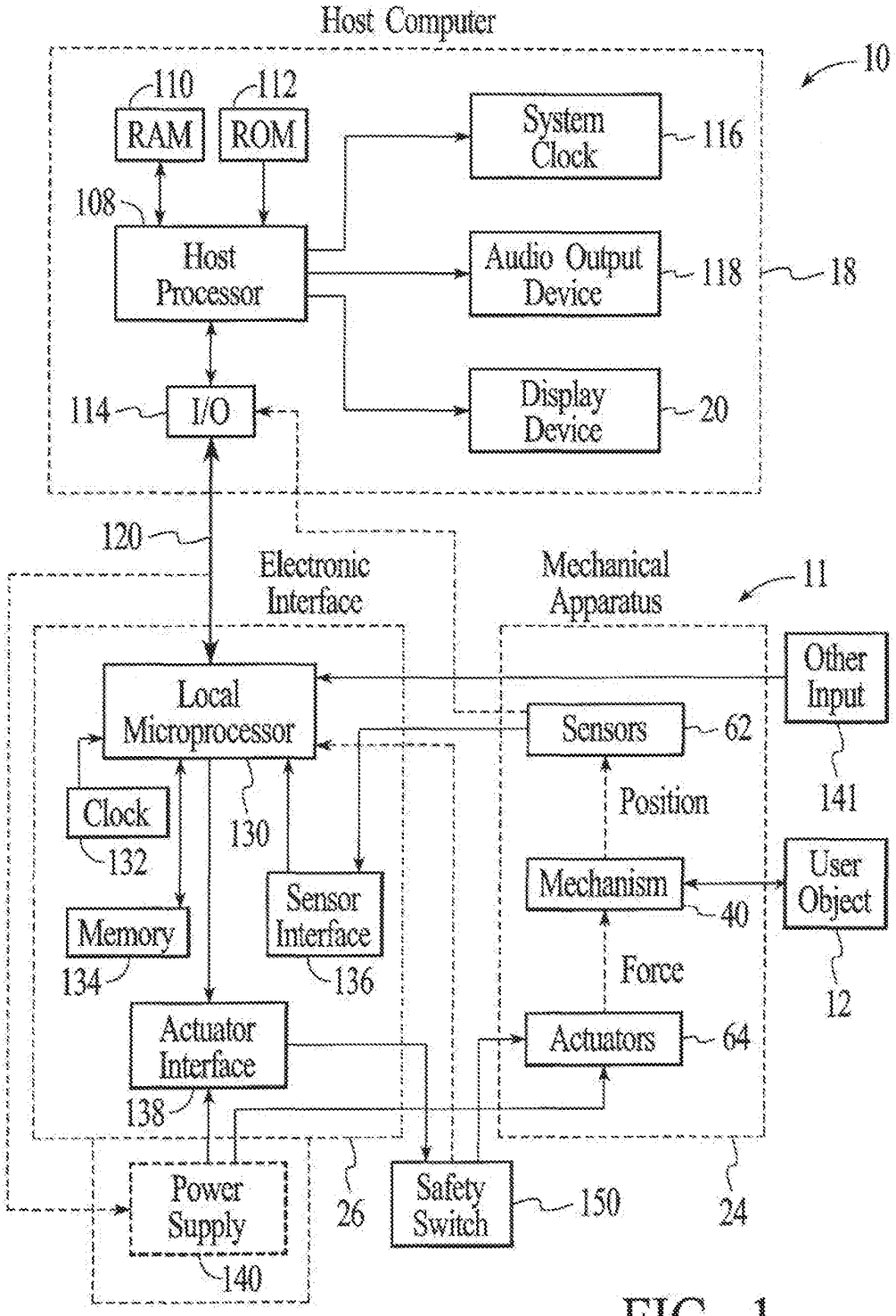
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I/O
Display Device
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Electronic Interface
Mechanical Apparatus
11
Other Input
Local Microprocessor
Sensors
62
Clock
132
130
Position
141
Mechanism
User Object
Sensor Interface
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Memory
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Force
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Actuator Interface
Actuators
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Power Supply
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Safety Switch
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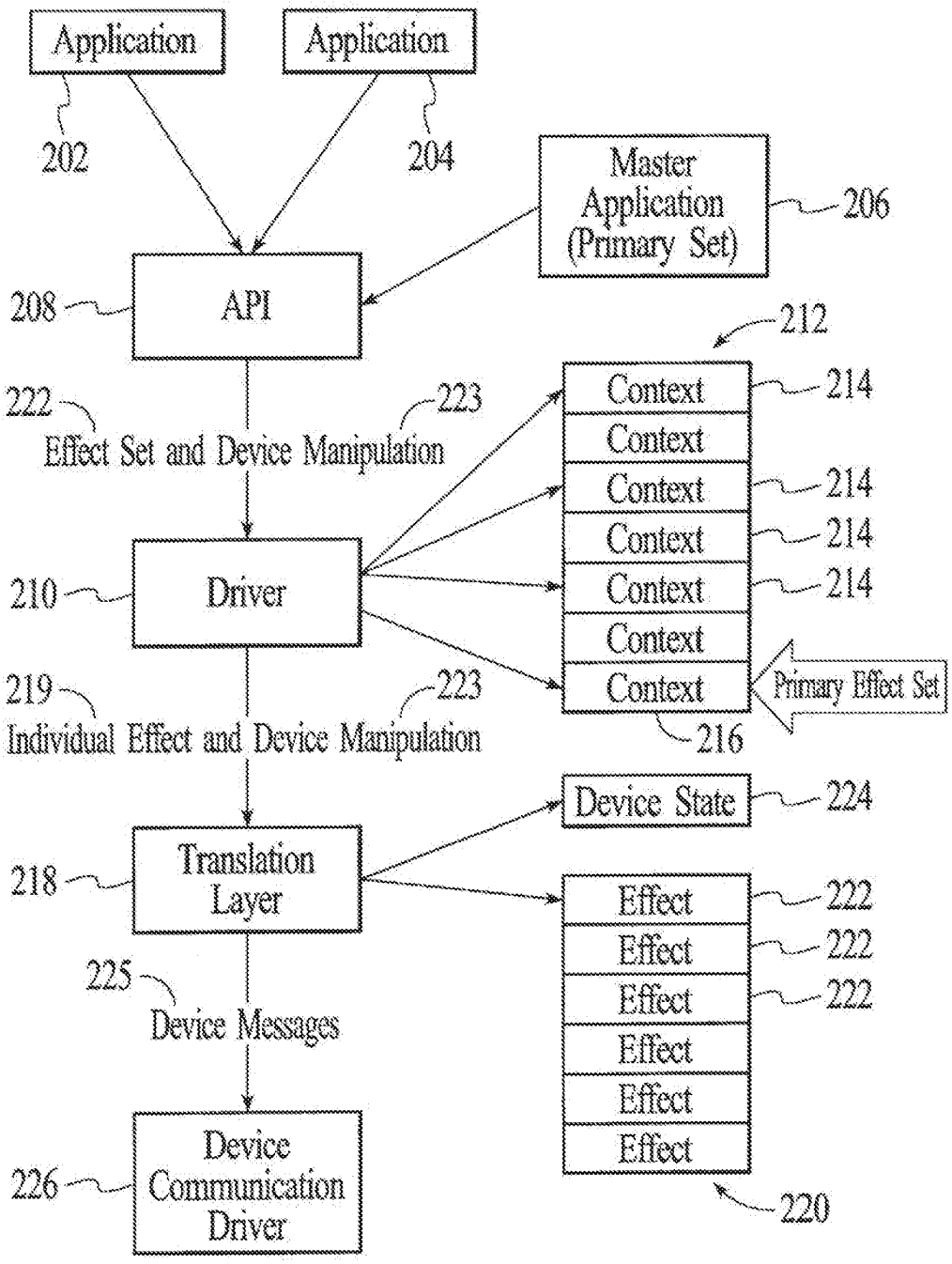
FIG. 1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210
Driver
219
Individual Effect and Device Manipulation
223
216
Device State
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Device Messages
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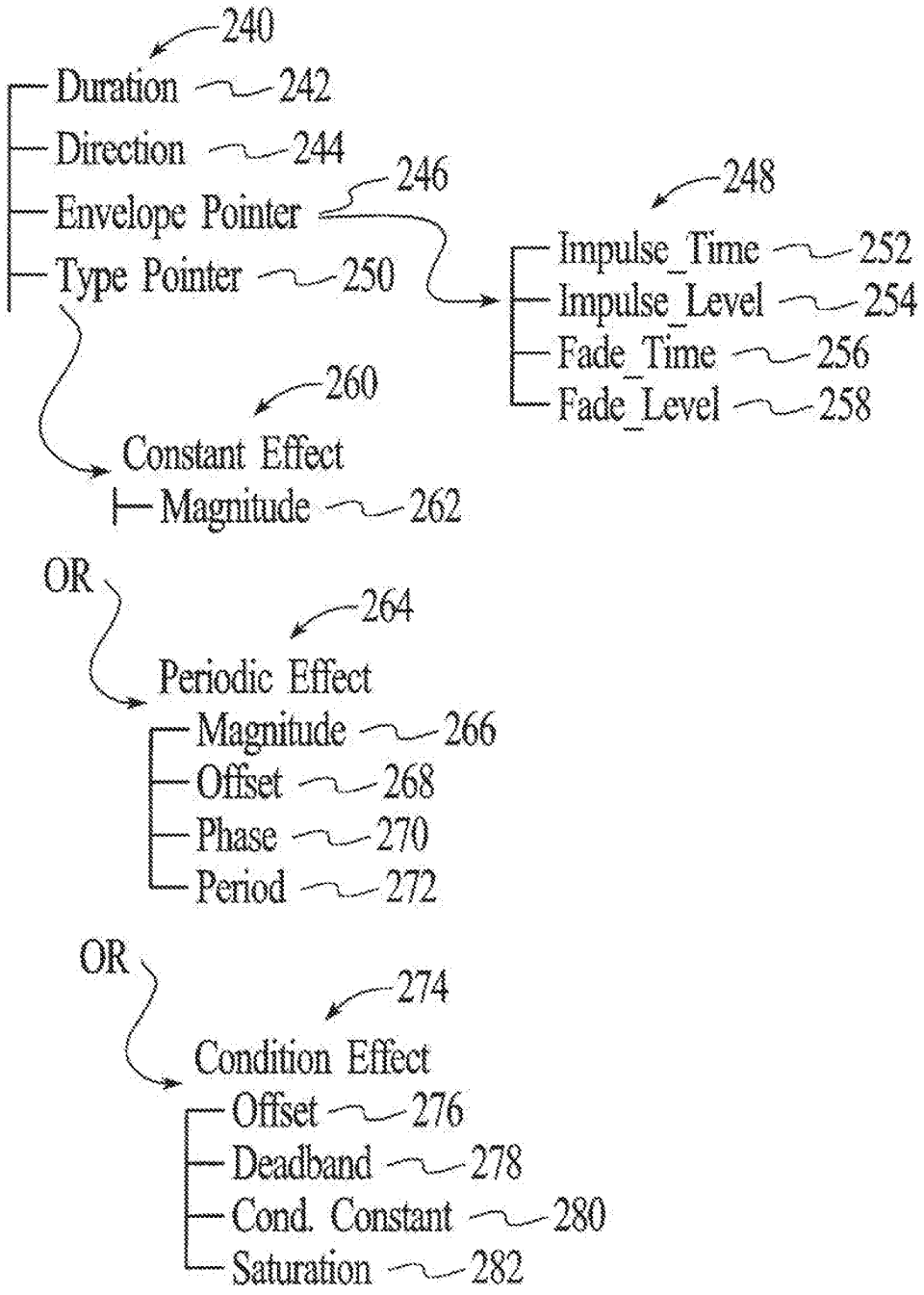
Device Communication Driver

FIG. 2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Type Pointer 250
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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

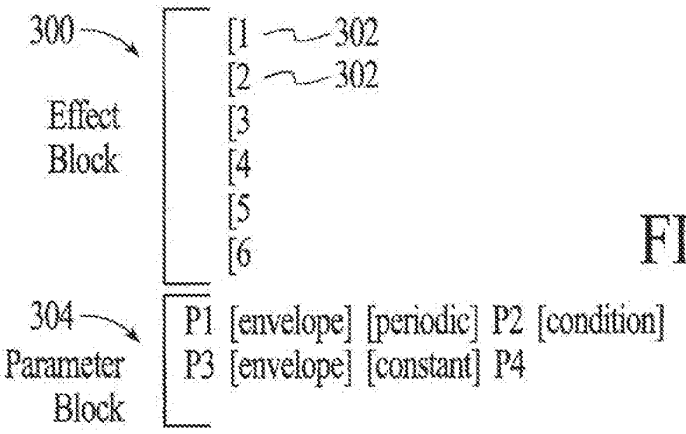

FIG. 4

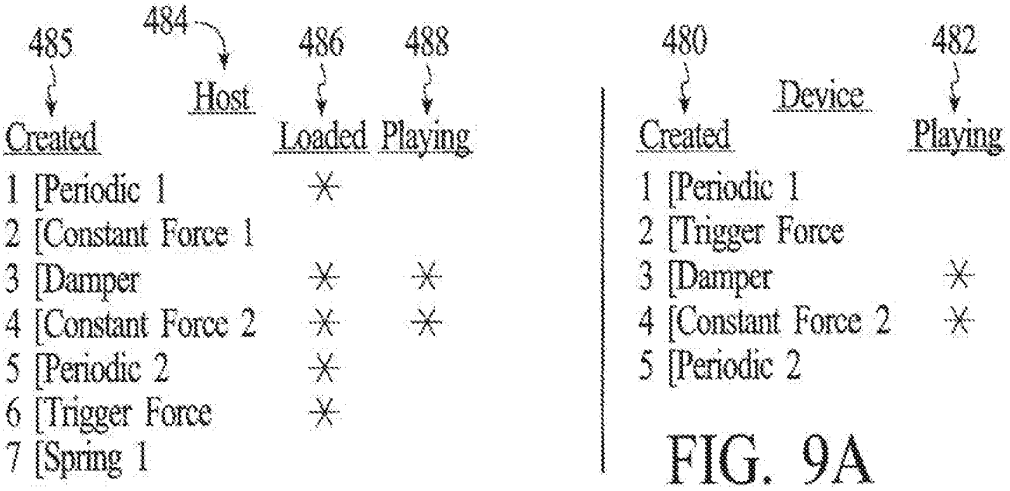

FIG. 9A

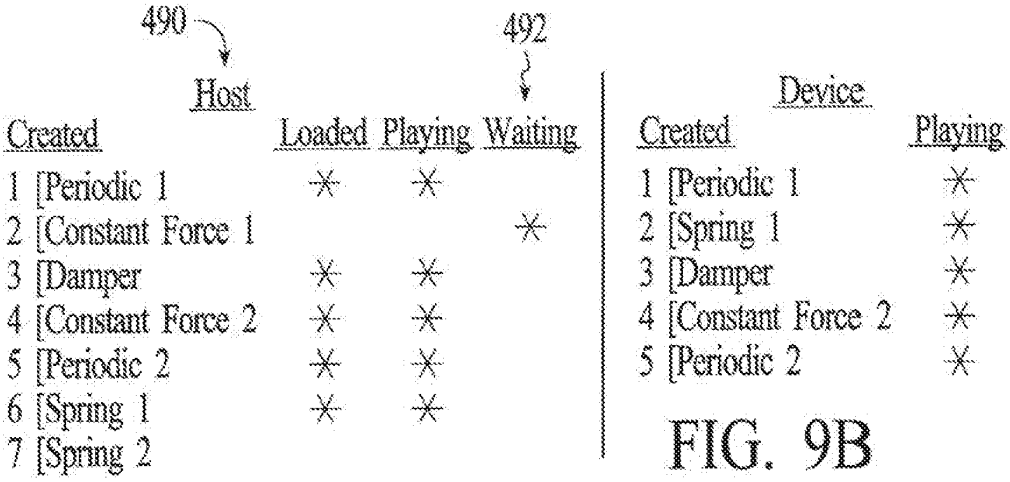

FIG. 9B

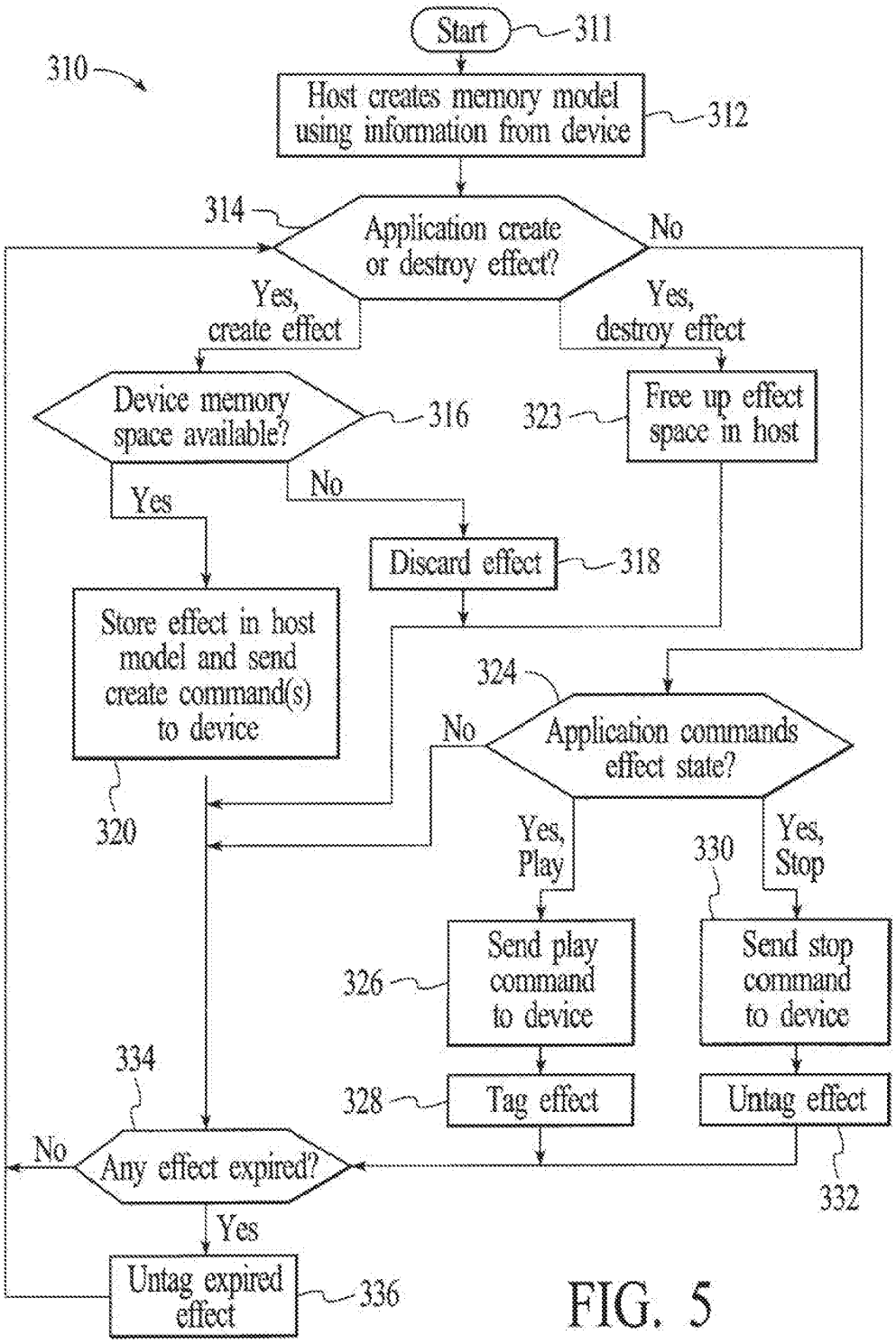
Start
311
310
Host creates memory model using information from device
312
314
Application create or destroy effect?
No
Yes, create effect
Yes, destroy effect
Device memory space available?
316
323
Free up effect space in host
Yes
No
Discard effect
318
Store effect in host model and send create command(s) 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

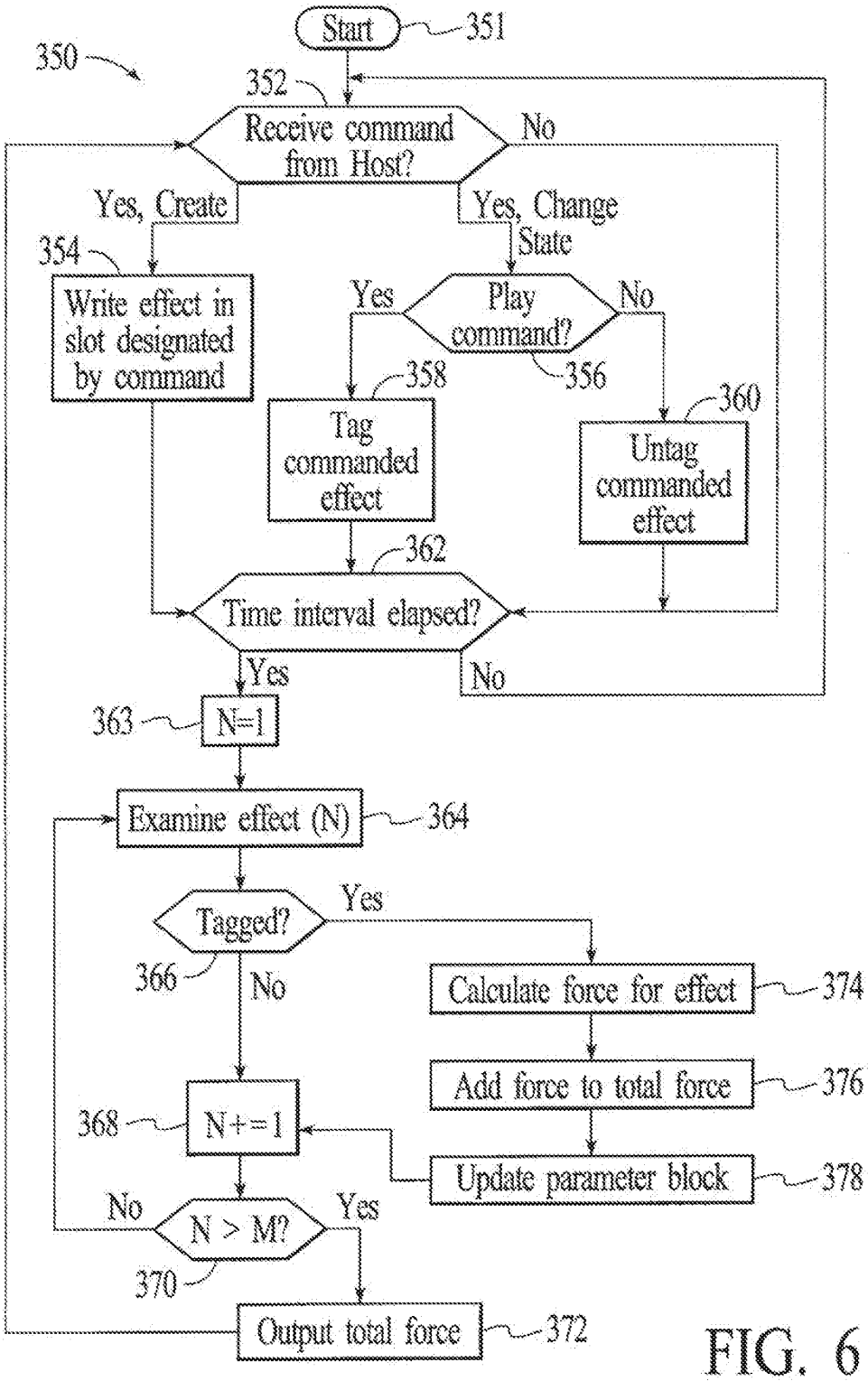
Start
351
350
352
Receive command from Host?
No
Yes, Create
Yes, Change State
354
Write effect in slot designated by command
Yes
Play command?
No
356
358
Tag commanded effect
360
Untag commanded effect
362
Time interval elapsed?
Yes
No
363
N=1
Examine effect (N)
364
Tagged?
Yes
366
No
Calculate force 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

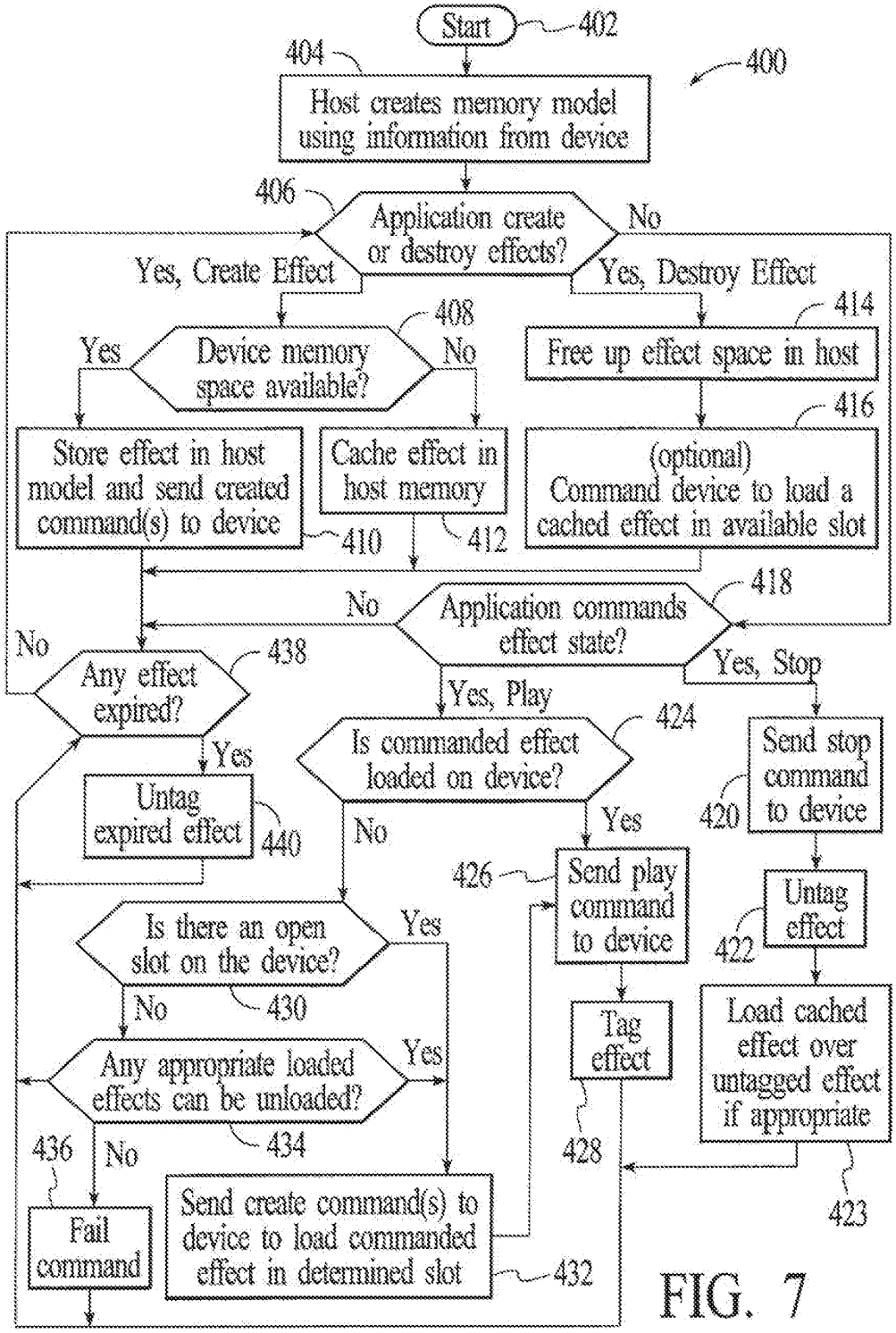
Start
402
400
404
Host creates memory model using information from device
406
Application create or destroy effects?
No
Yes, Create Effect
Yes, Destroy Effect
408
Device memory space available?
Yes
No
414
Free up effect space in host
416
(optional) Command device to load a cached effect in available 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

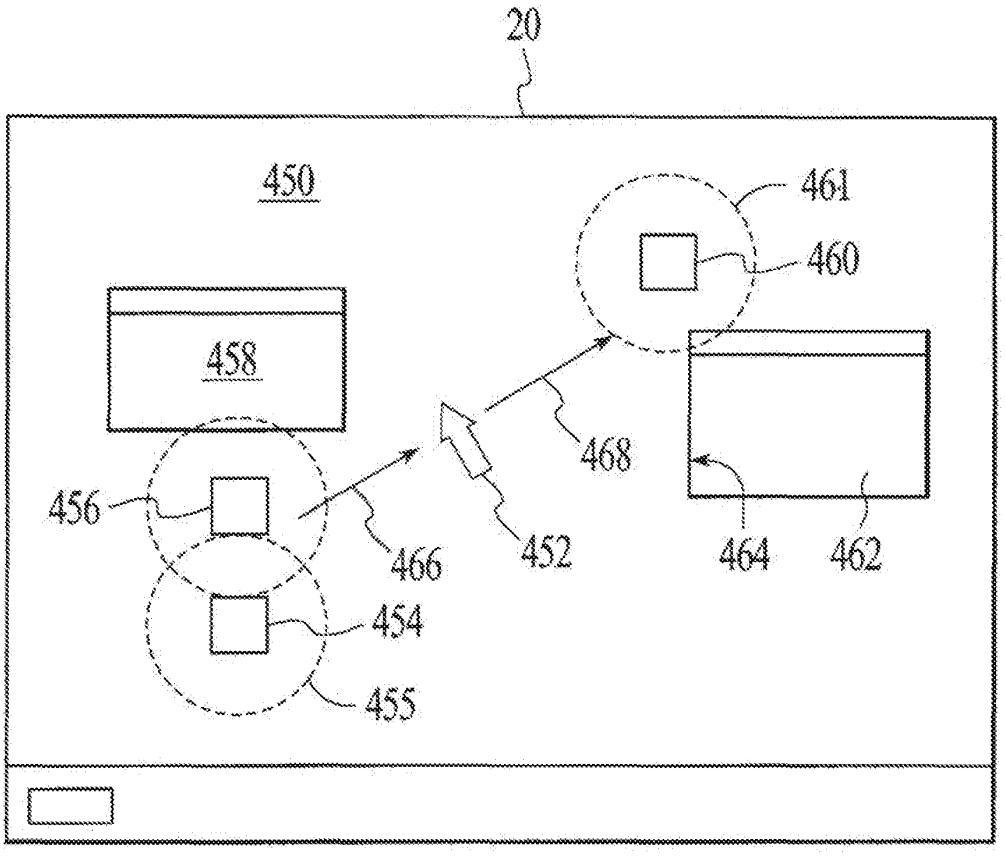

FIG. 8

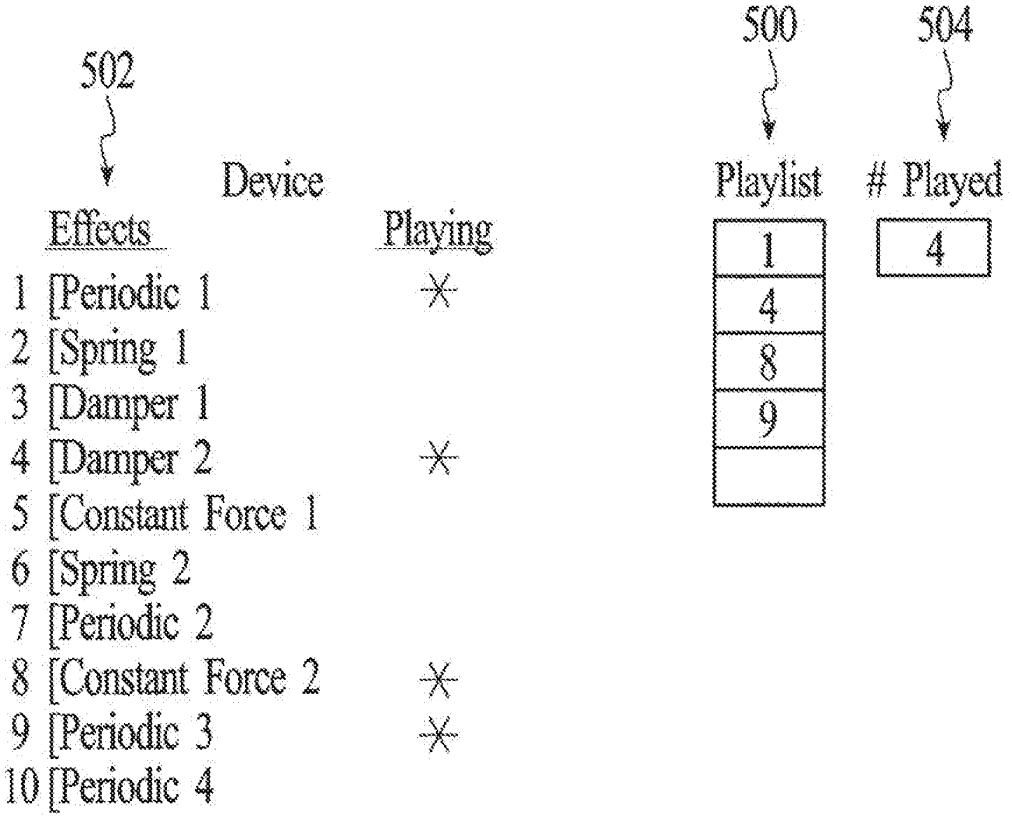
500
504
502
Device
Playlist
Played
Effects
Playing
1 [Periodic 1
2 [Spring 1
3 [Damper 1
4 [Damper 2
5 [Constant Force 1
6 [Spring 2
7 [Periodic 2
8 [Constant Force 2
9 [Periodic 3
10 [Periodic 4
1
4
8
9
4

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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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 602 days.

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(51) **Int. Cl.**
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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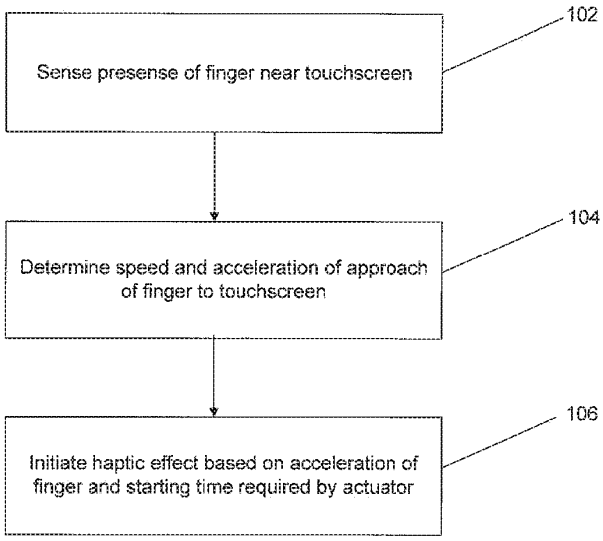
(57) **ABSTRACT**

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



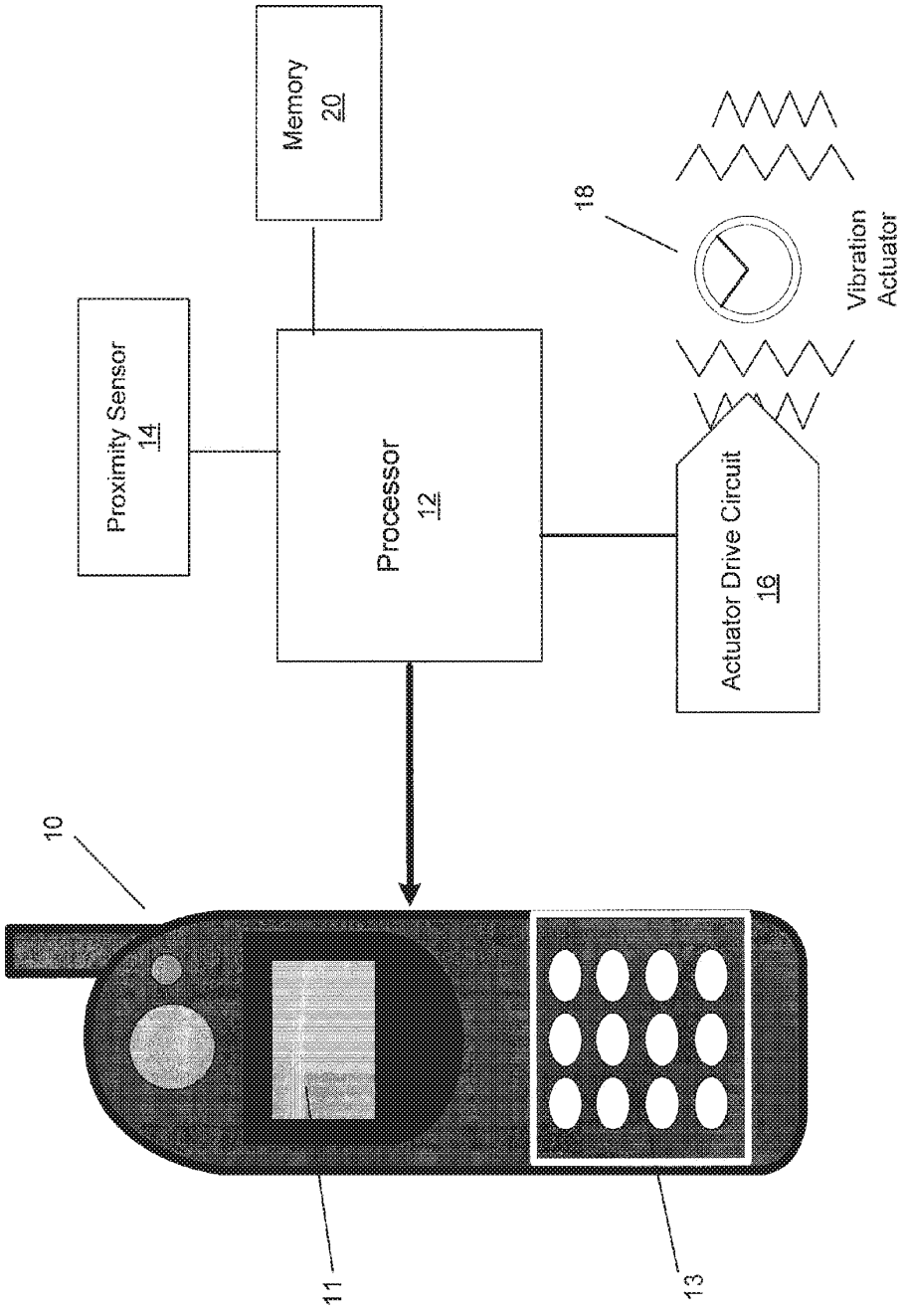

Memory
20
18
Vibration
Actuator
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
10
11
13

Fig. 1

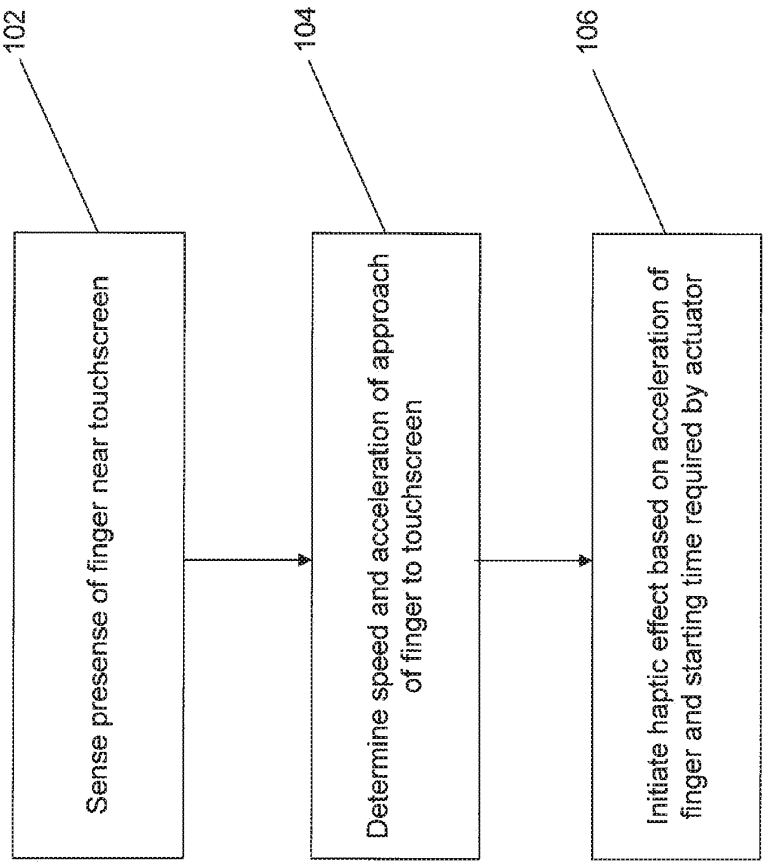


Fig. 2

EX1002 - Page 644

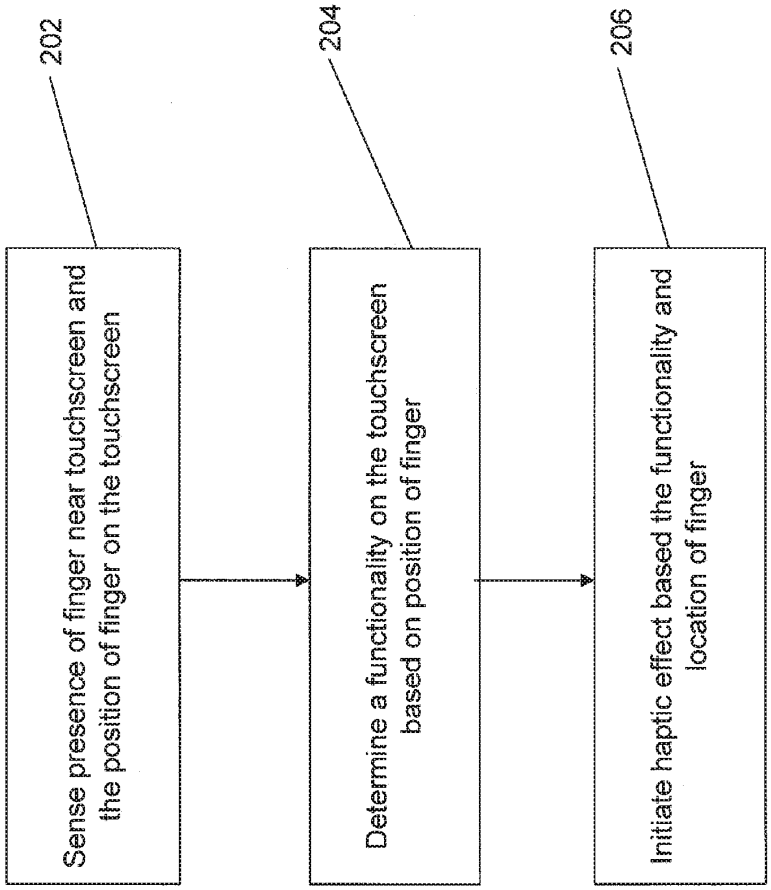


Fig. 3

EX1002 - Page 645

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.

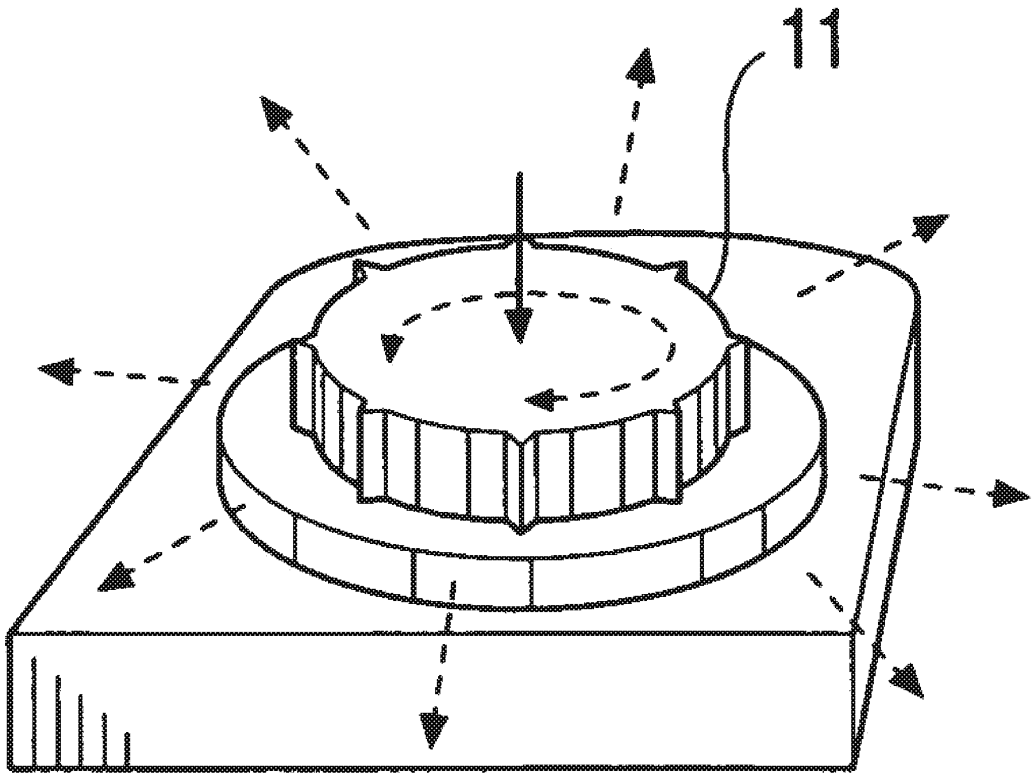


FIG. 1

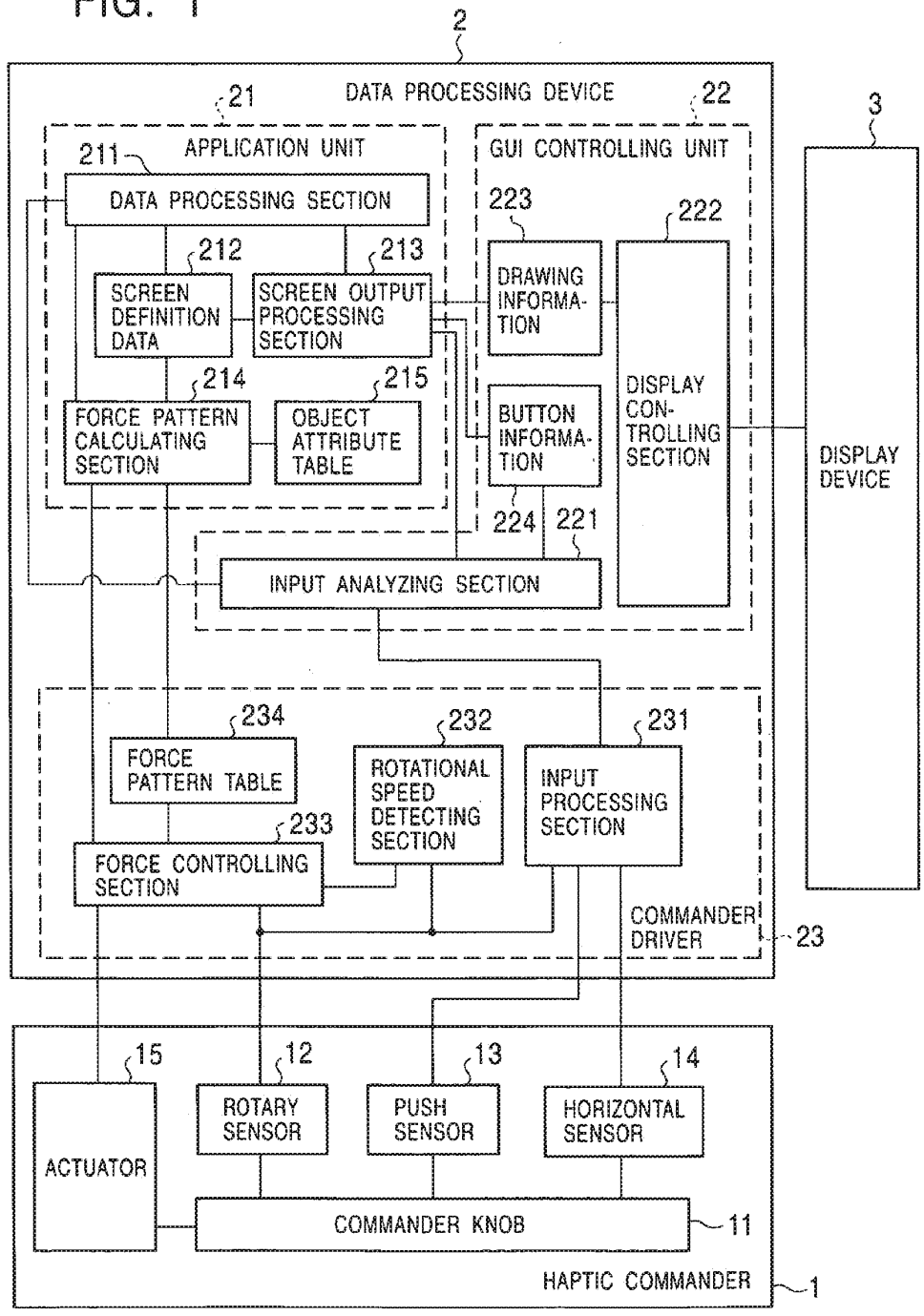

2
DATA PROCESSING DEVICE
21
22
3
APPLICATION UNIT
211
DATA PROCESSING SECTION
212
213
SCREEN DEFINITION DATA
SCREEN OUTPUT PROCESSING SECTION
214
215
FORCE PATTERN CALCULATING SECTION
OBJECT ATTRIBUTE TABLE
GUI CONTROLLING UNIT
223
222
DRAWING INFORMATION
BUTTON INFORMATION
DISPLAY CONTROLLING SECTION
DISPLAY DEVICE
224
221
INPUT ANALYZING SECTION
234
232
231
FORCE PATTERN TABLE
ROTATIONAL SPEED DETECTING SECTION
INPUT PROCESSING SECTION
233
FORCE CONTROLLING SECTION
COMMANDER DRIVER
23
15
12
13
14
ACTUATOR
ROTARY SENSOR
PUSH SENSOR
HORIZONTAL SENSOR
COMMANDER KNOB
11
HAPTIC COMMANDER
1

FIG. 2A

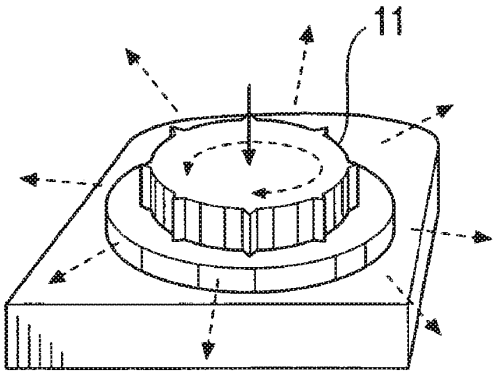


FIG. 2B

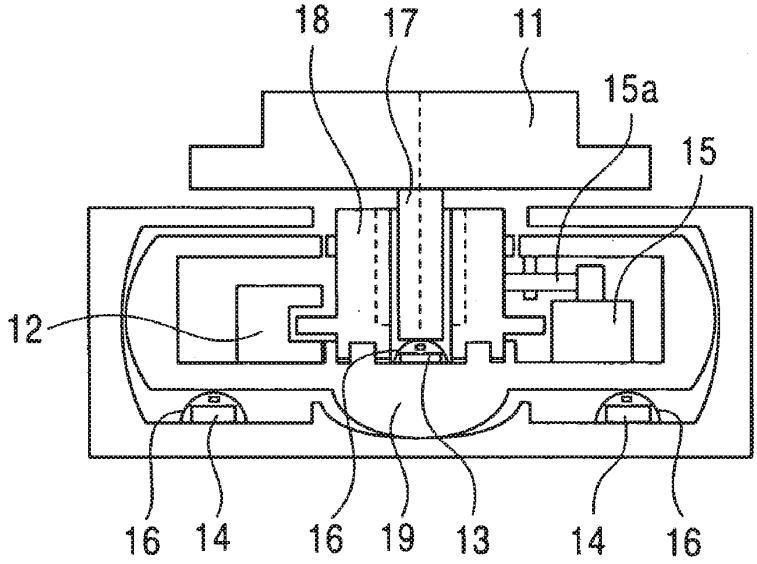


FIG. 3A

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

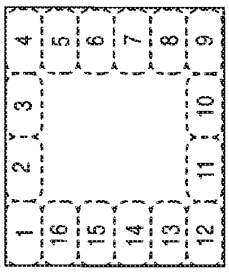


FIG. 4B

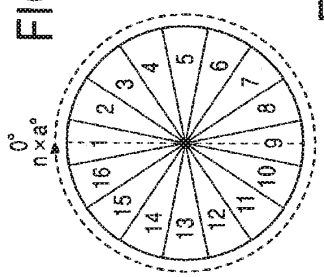


FIG. 4C

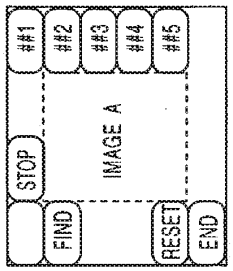


FIG. 4D

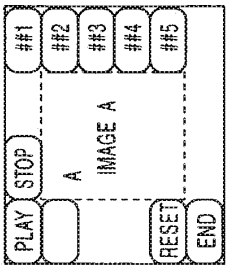


FIG. 4E

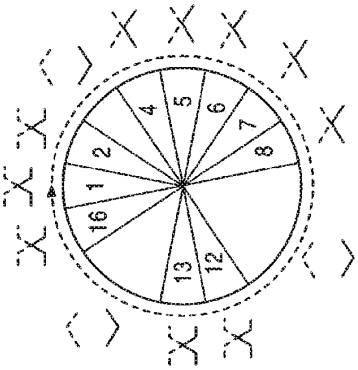


FIG. 4F

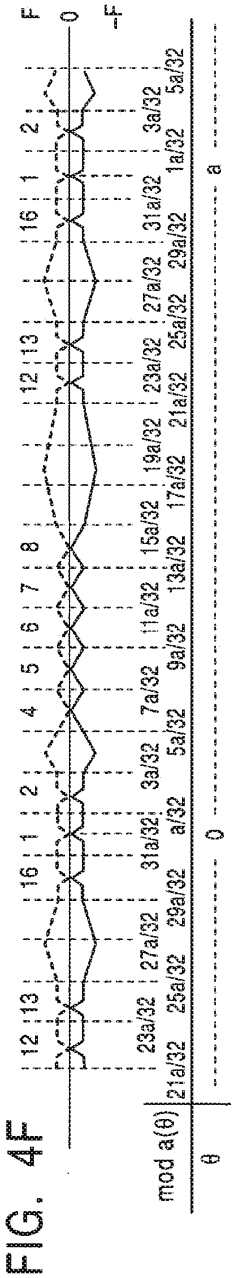


FIG. 5A

```
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

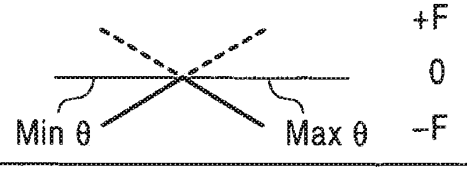
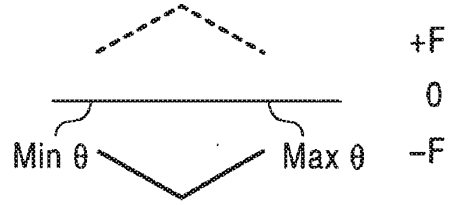
DISPLAY ELEMENT	FORCE PATTERN
COMMAND	
ITEM	
SPACE	

FIG. 6A

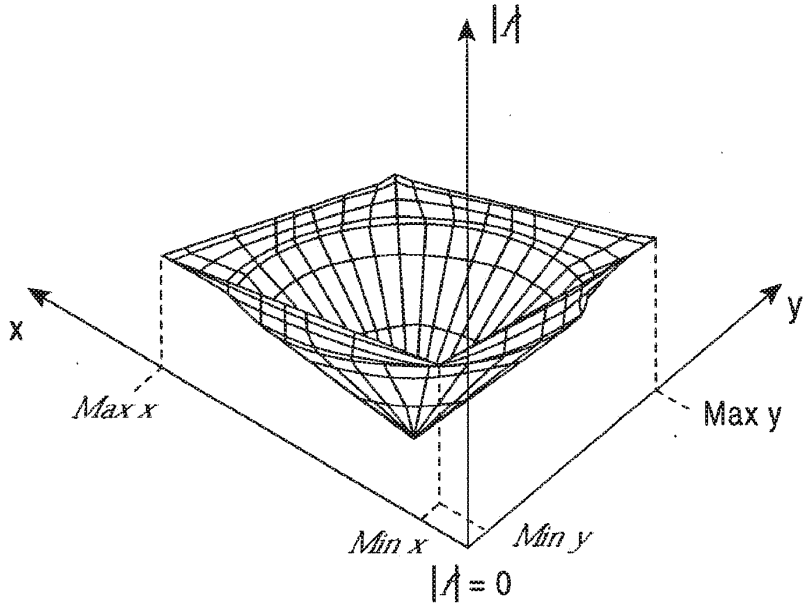
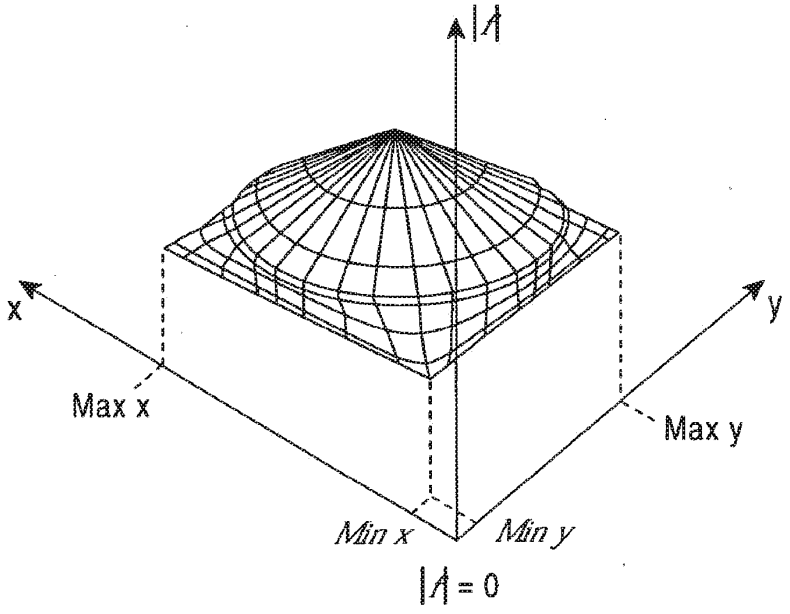


FIG. 6B



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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(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.

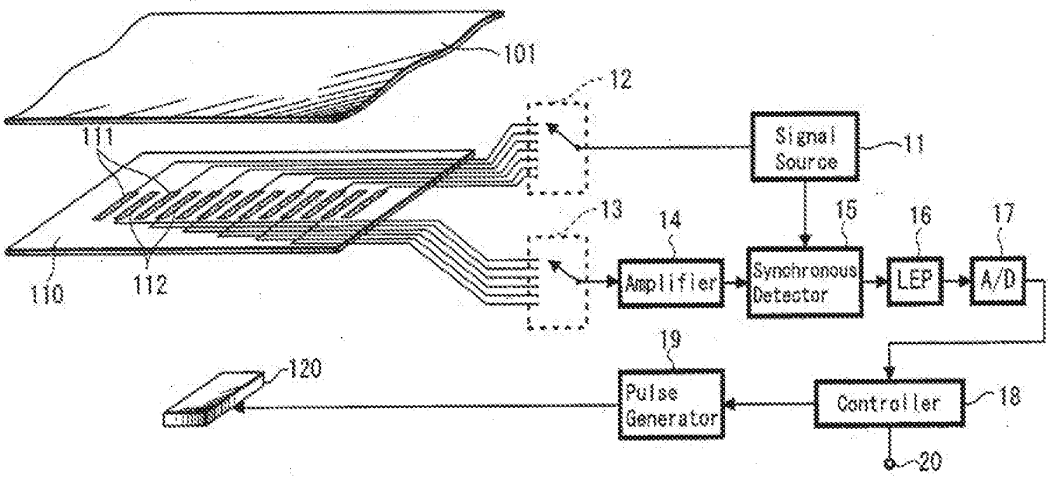


FIG. 1

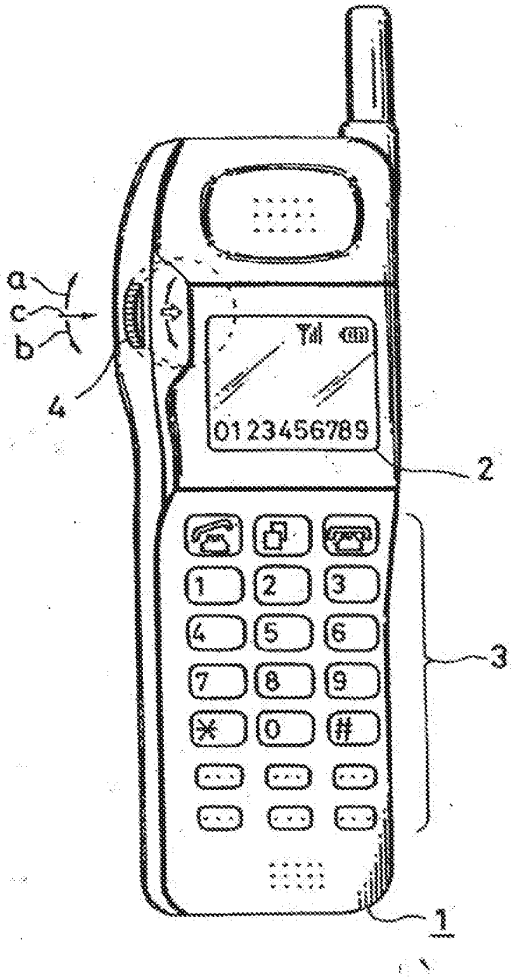


FIG. 3

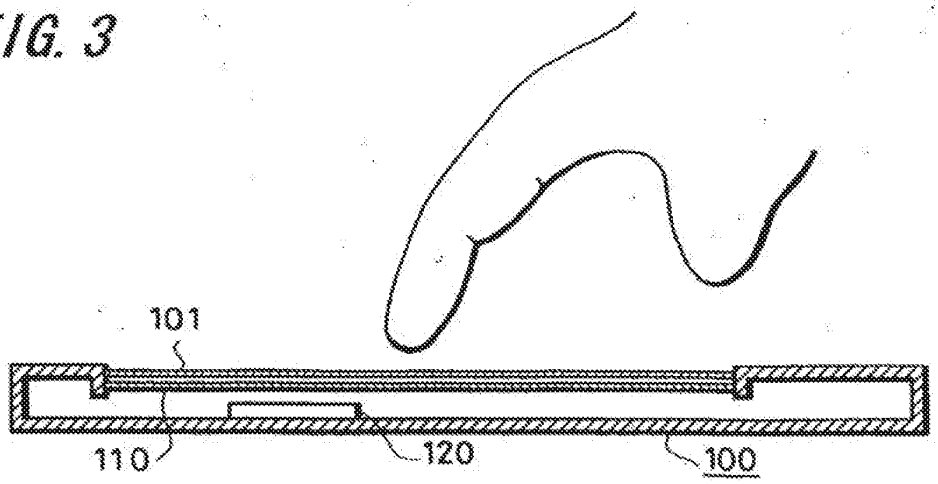
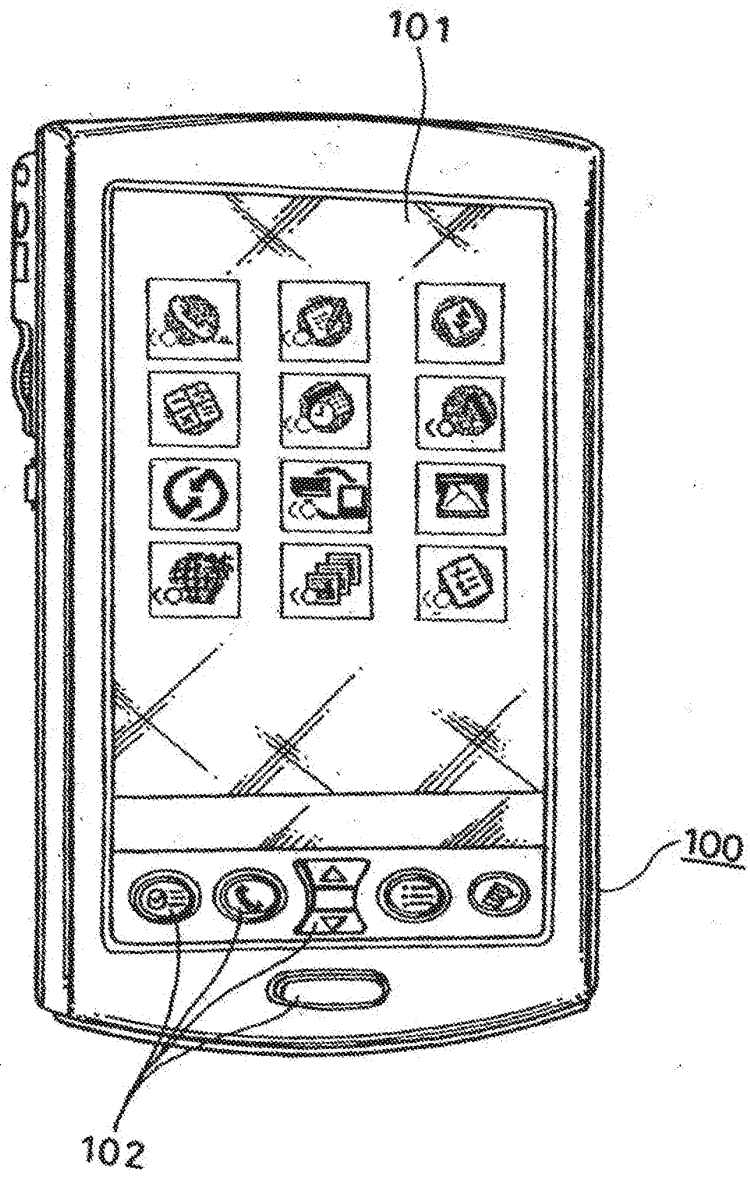


FIG. 2



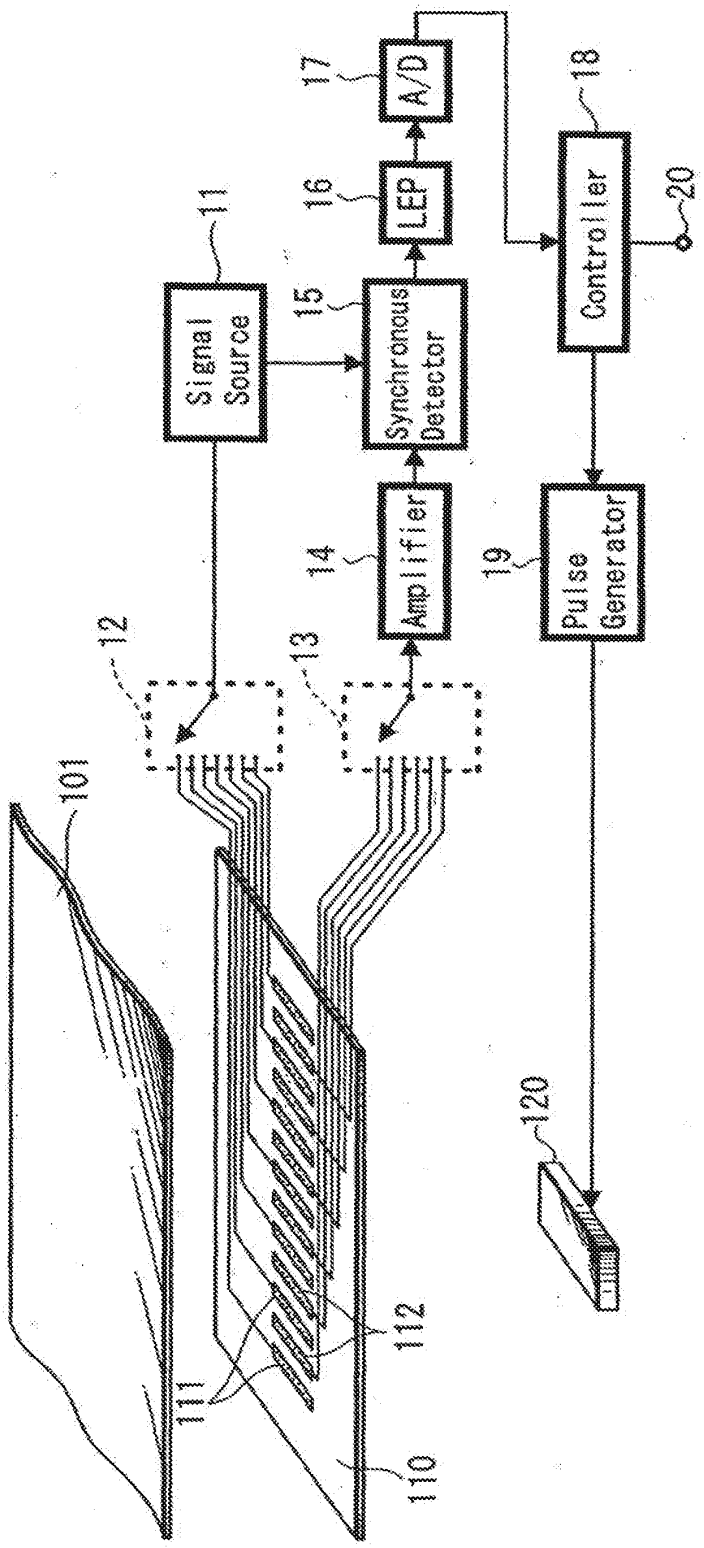


FIG. 4

EX1002 - Page 667

FIG. 5

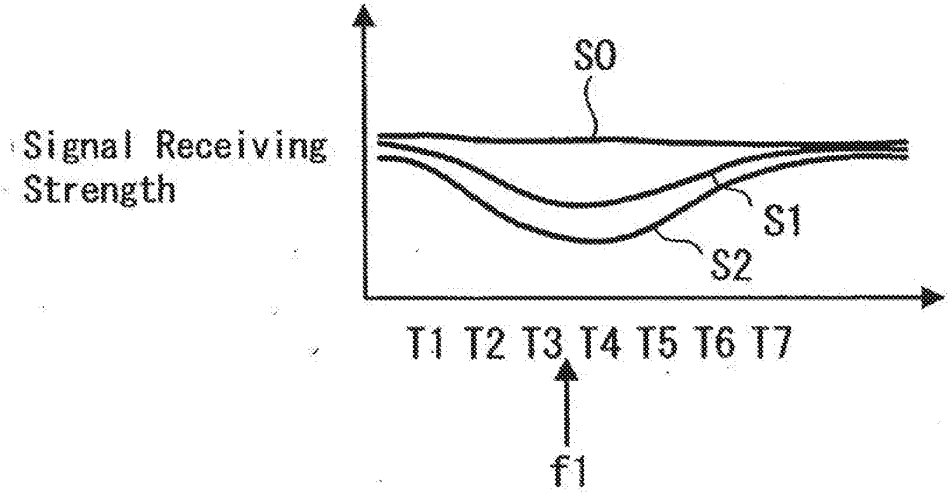

Signal Receiving Strength
S0
S1
S2
T1 T2 T3 T4 T5 T6 T7
f1

FIG. 6

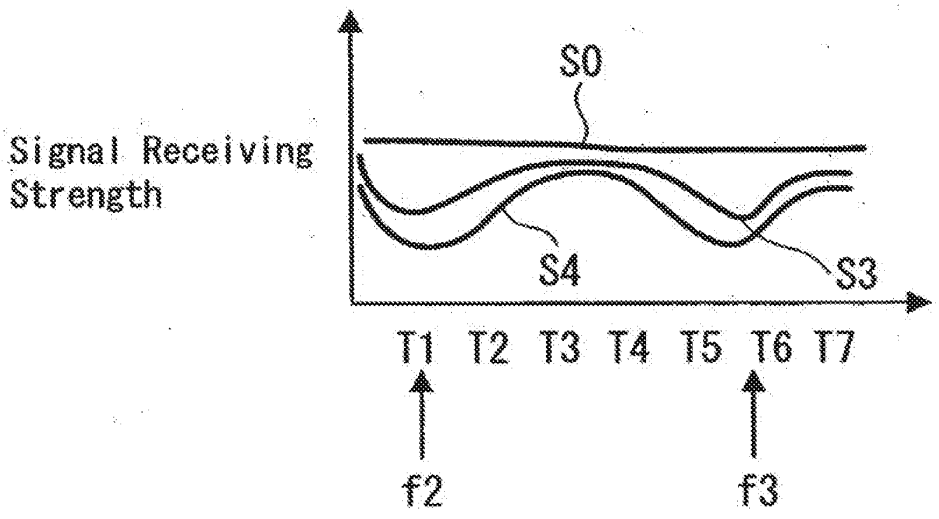

Signal Receiving Strength
S0
S4
S3
T1 T2 T3 T4 T5 T6 T7
f2
f3

FIG. 7

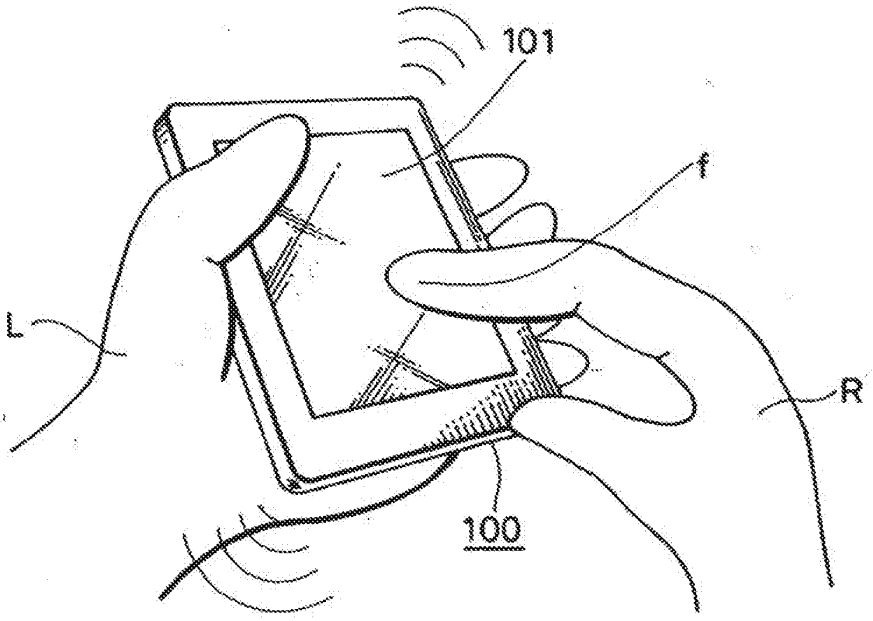


FIG. 9

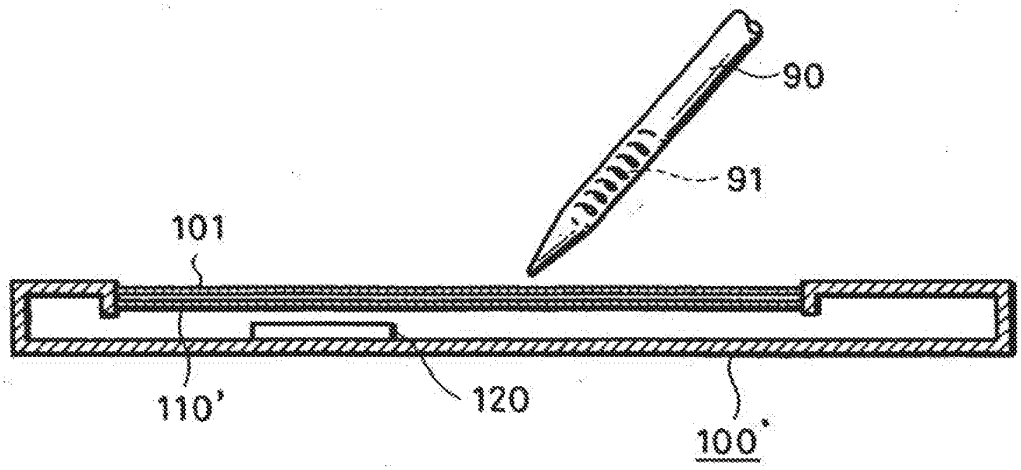
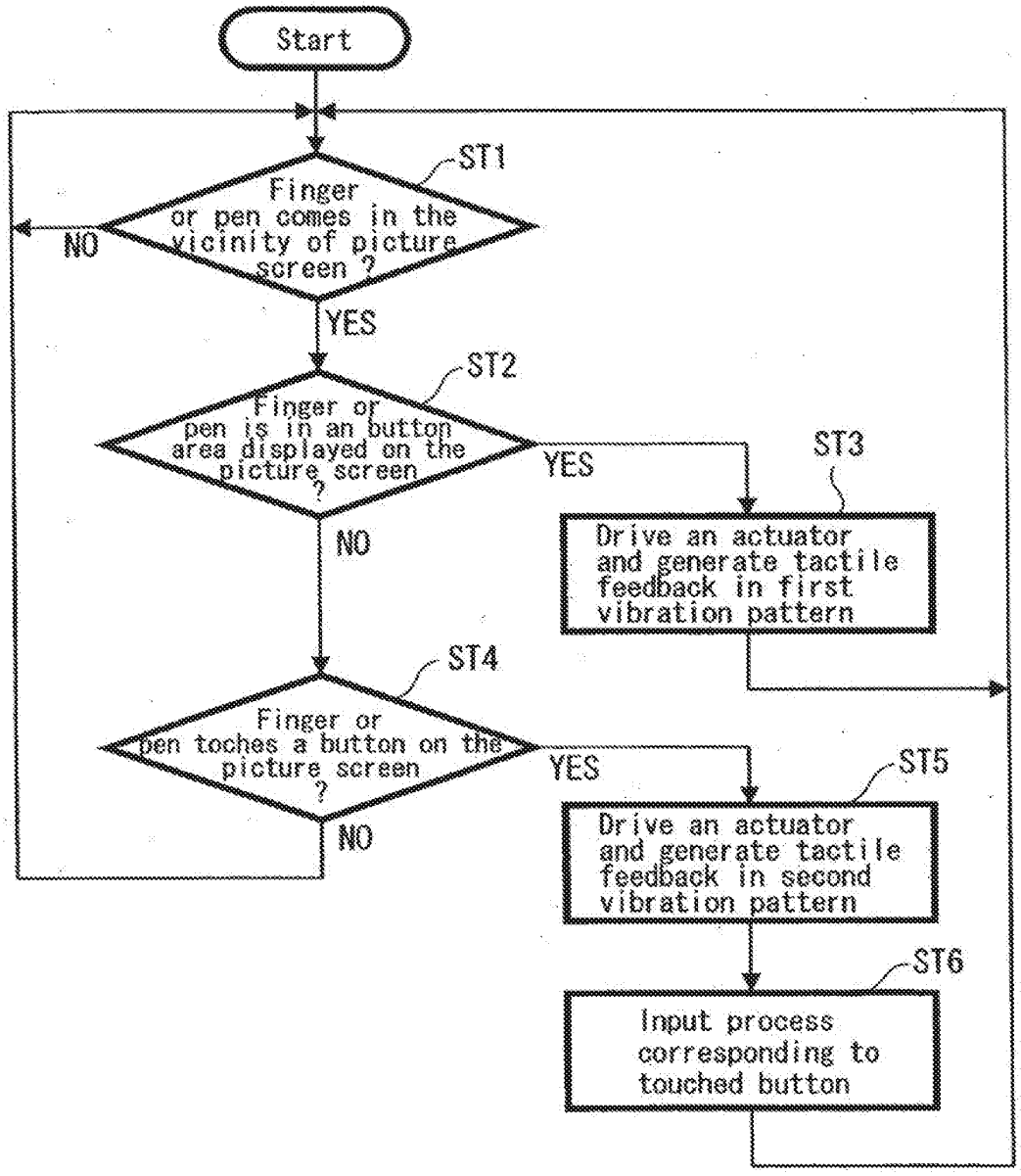


FIG. 8


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
NO
ST6
Input process corresponding to touched button

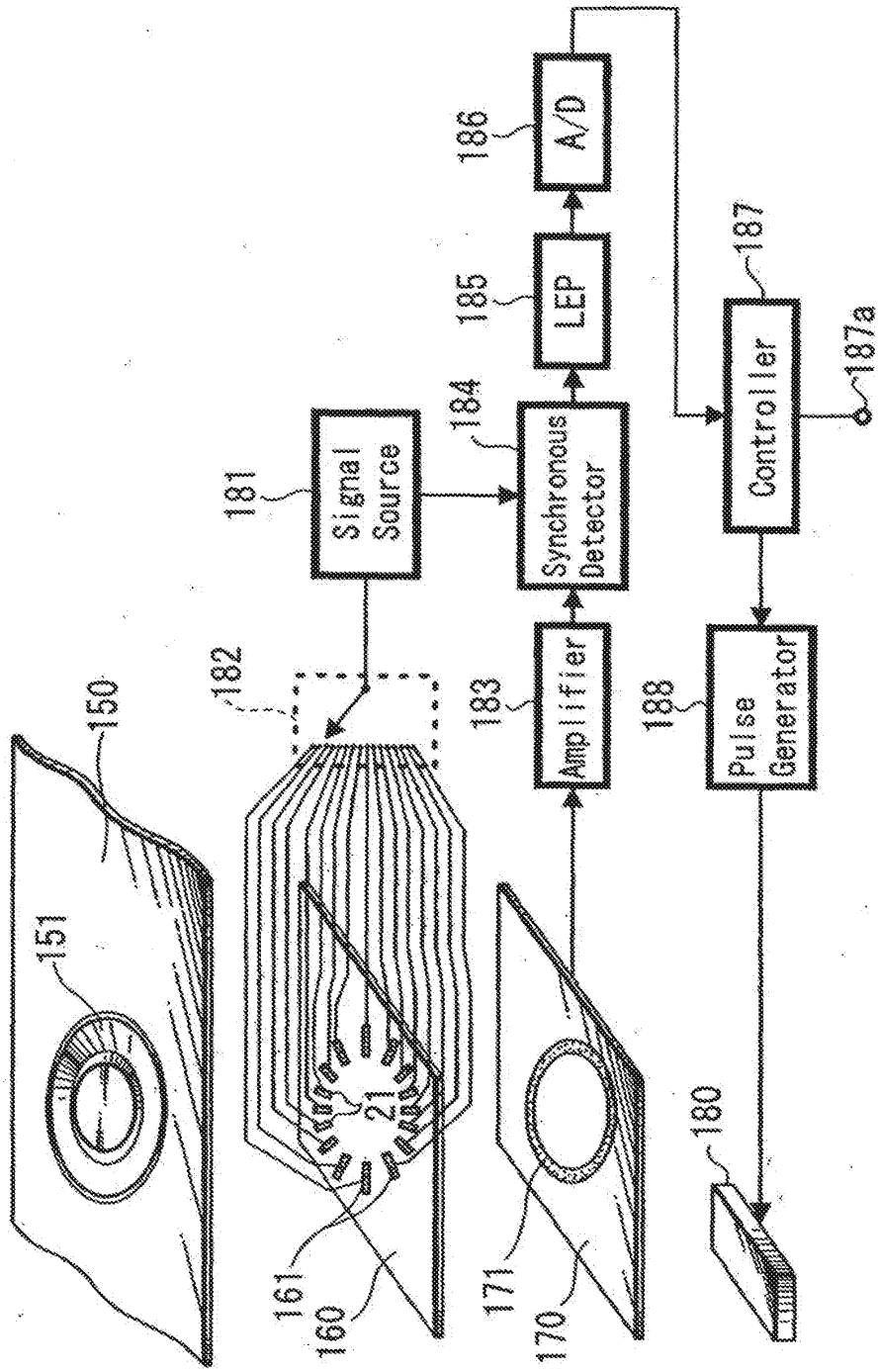


FIG. 10

EX1002 - Page 671

FIG. 11

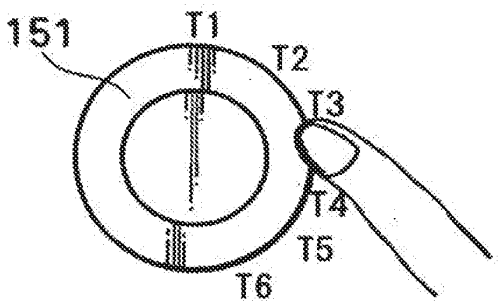

151
T1
T2
T3
T4
T5
T6

FIG. 12

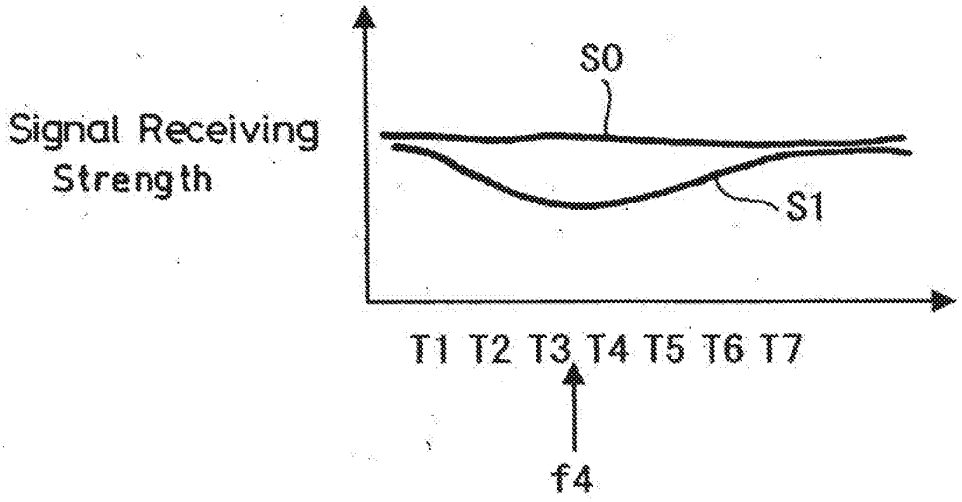

Signal Receiving Strength
S0
S1
T1 T2 T3 T4 T5 T6 T7
f4

FIG. 13

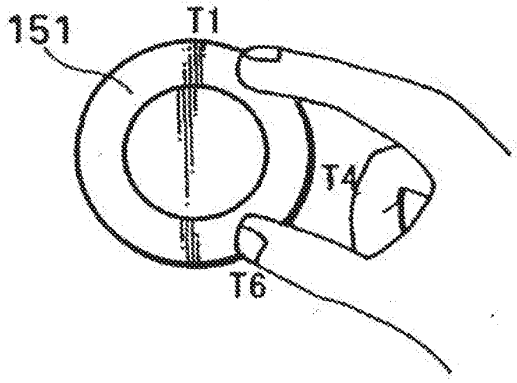

151
T1
T4
T6

FIG. 14

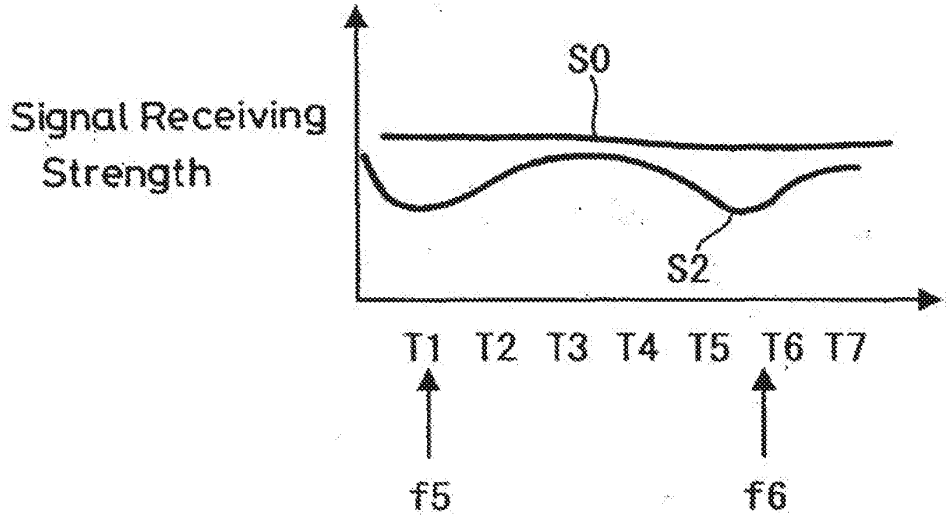

Signal Receiving Strength
S0
S2
T1 T2 T3 T4 T5 T6 T7
f5
f6

FIG. 15

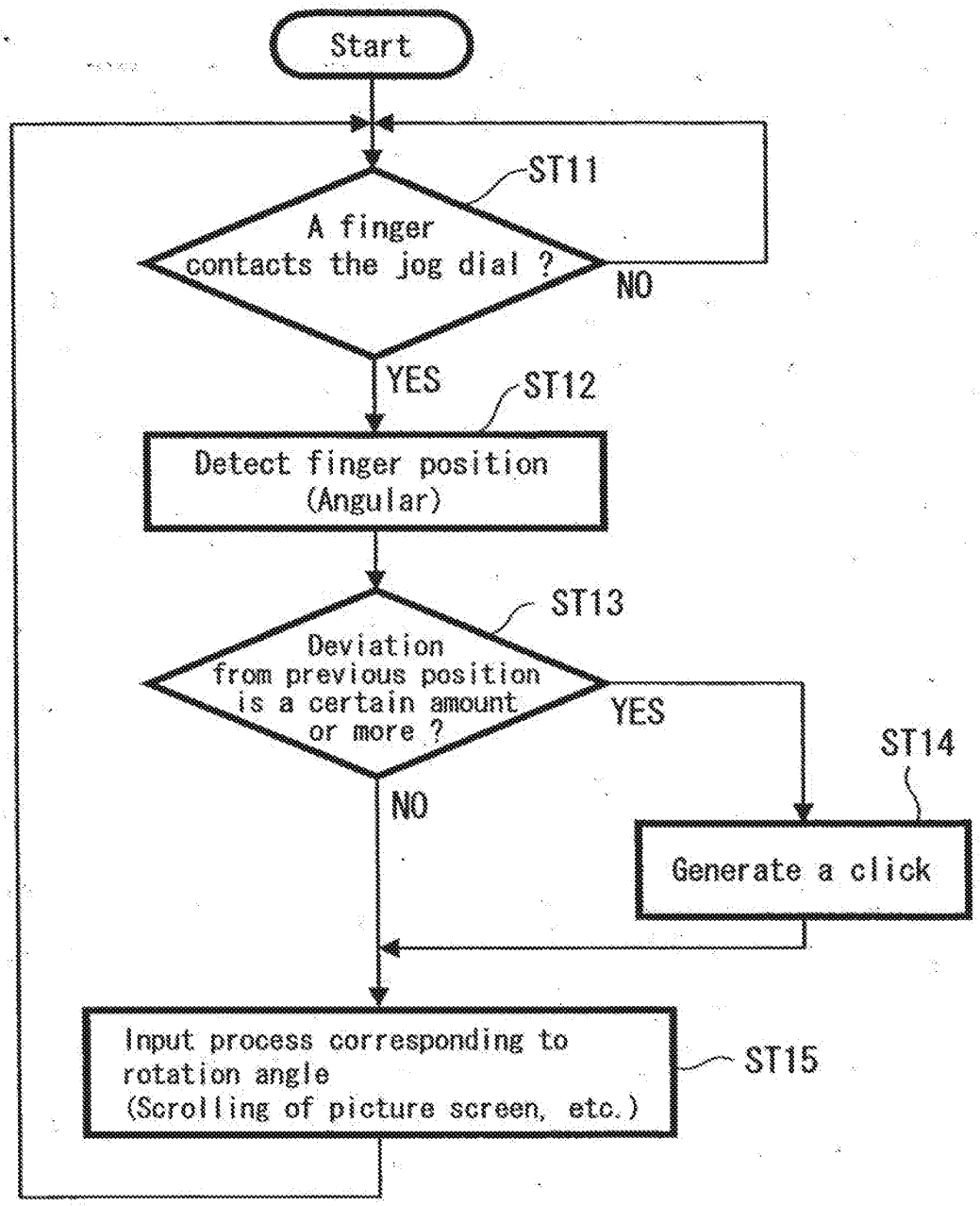
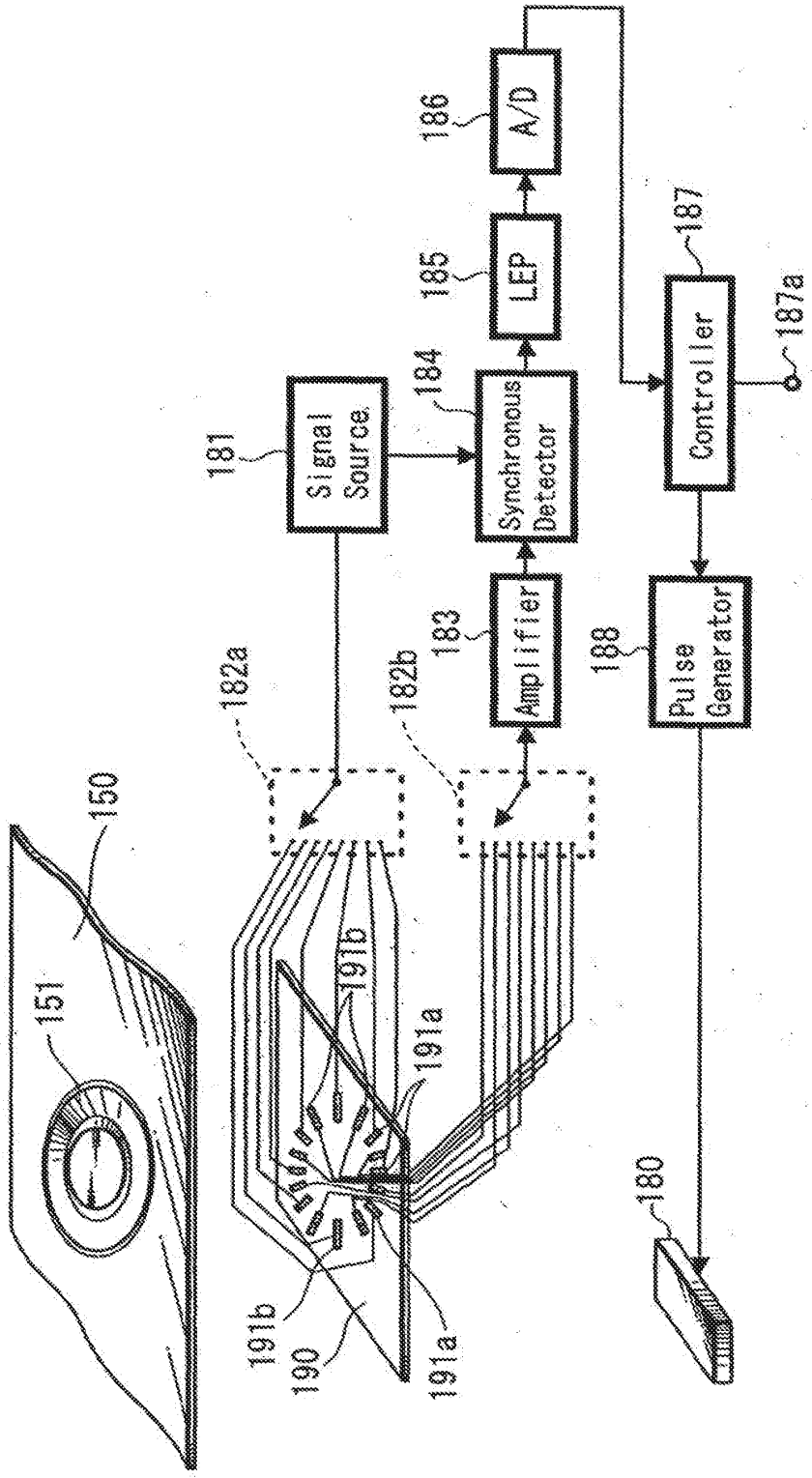

Start
ST11
A finger contacts the jog dial ?
NO
YES
ST12
Detect finger position (Angular)
ST13
Deviation from previous position is a certain amount or more ?
YES
NO
ST14
Generate a click
Input process corresponding to rotation angle (Scrolling of picture screen, etc.)
ST15

FIG. 16



EX1002 - Page 675

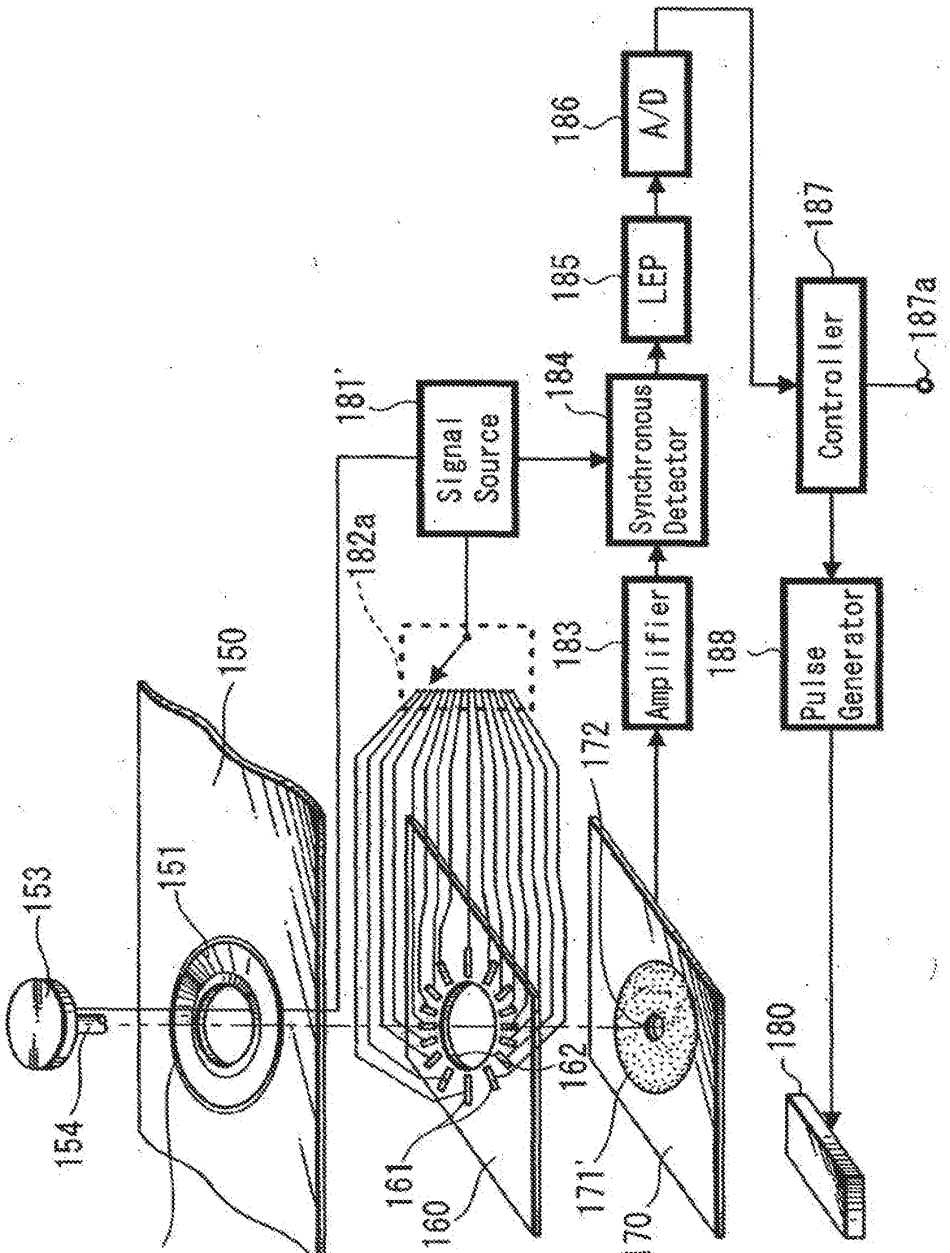
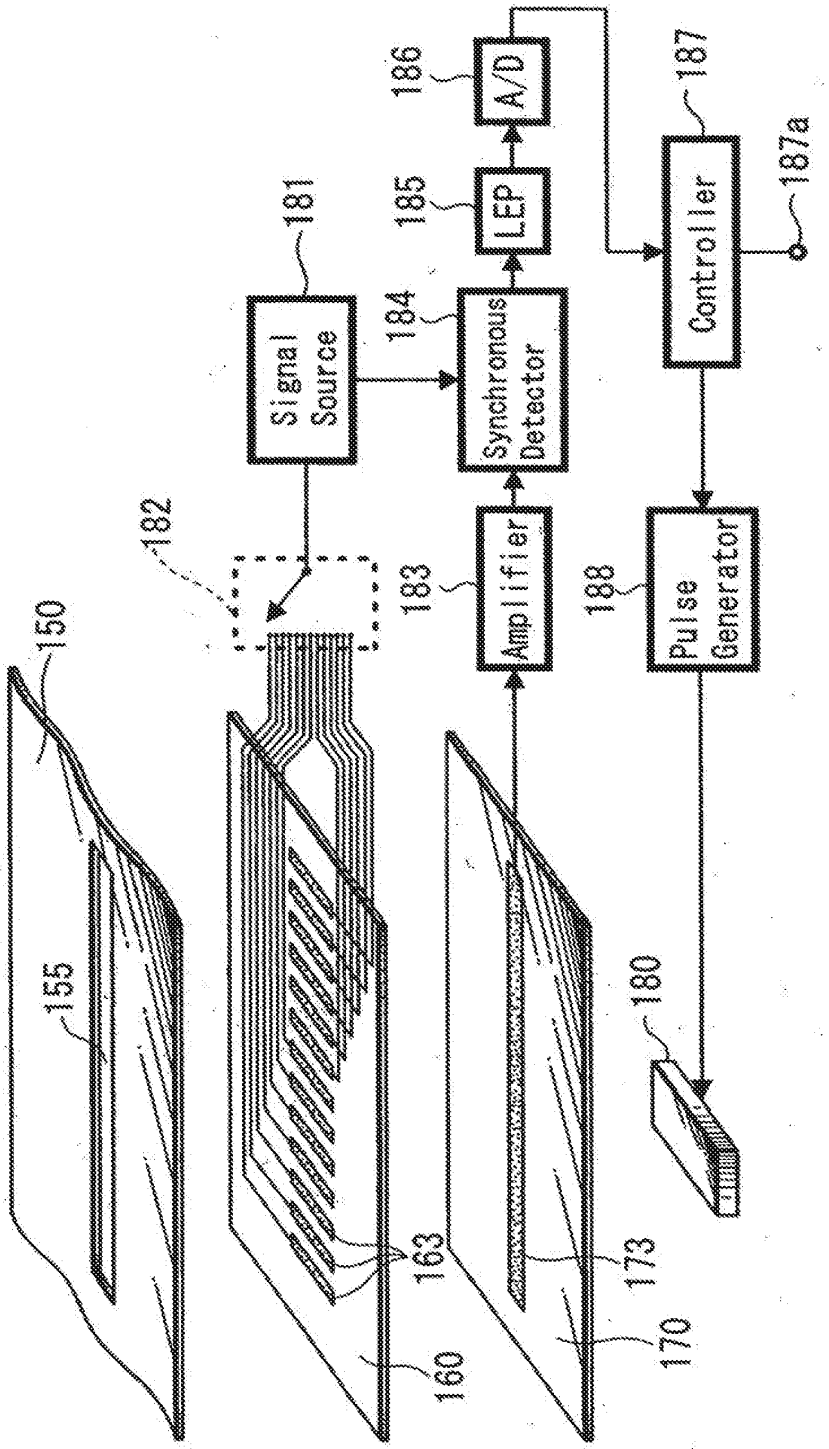


FIG. 17

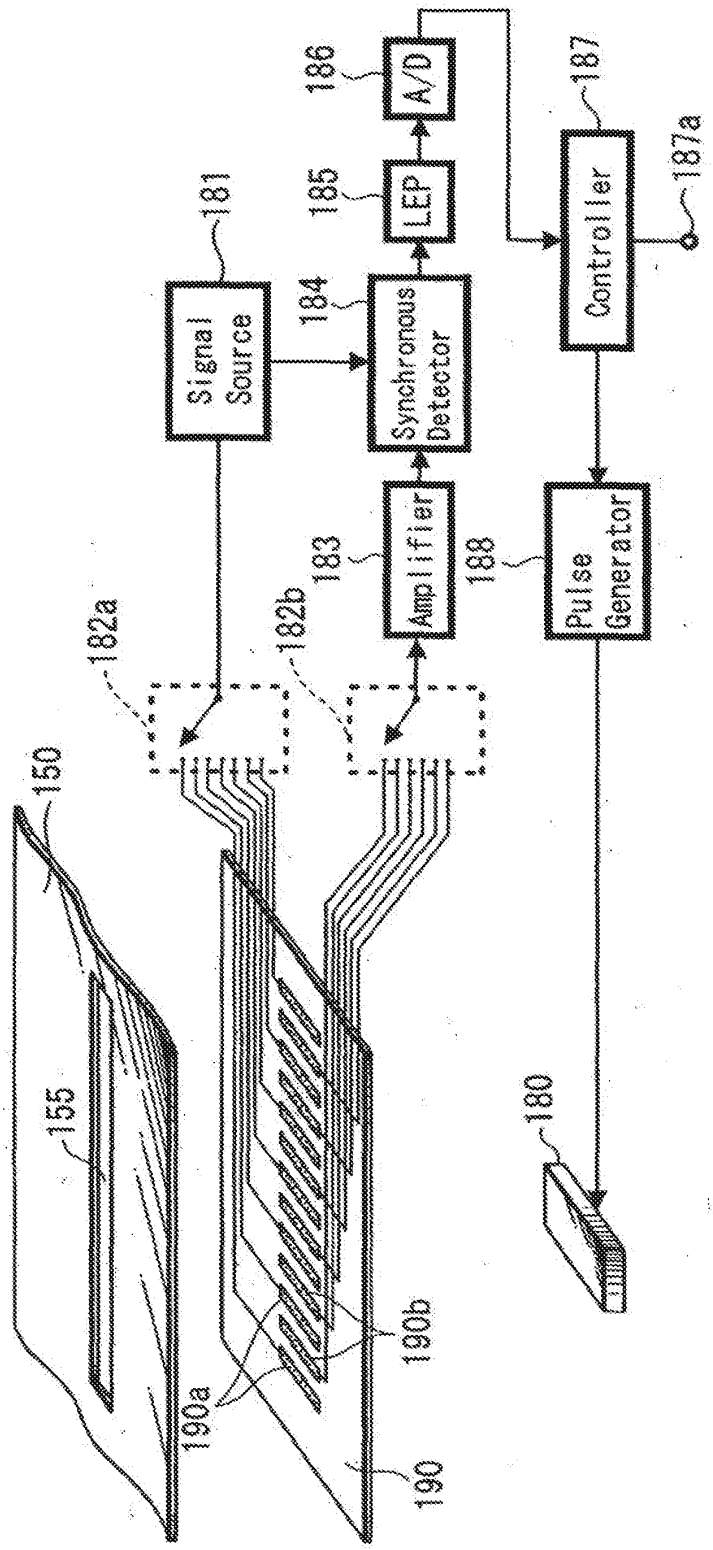
EX1002 - Page 676

FIG. 18



EX1002 - Page 677

FIG. 19



EX1002 - Page 678

FIG. 20

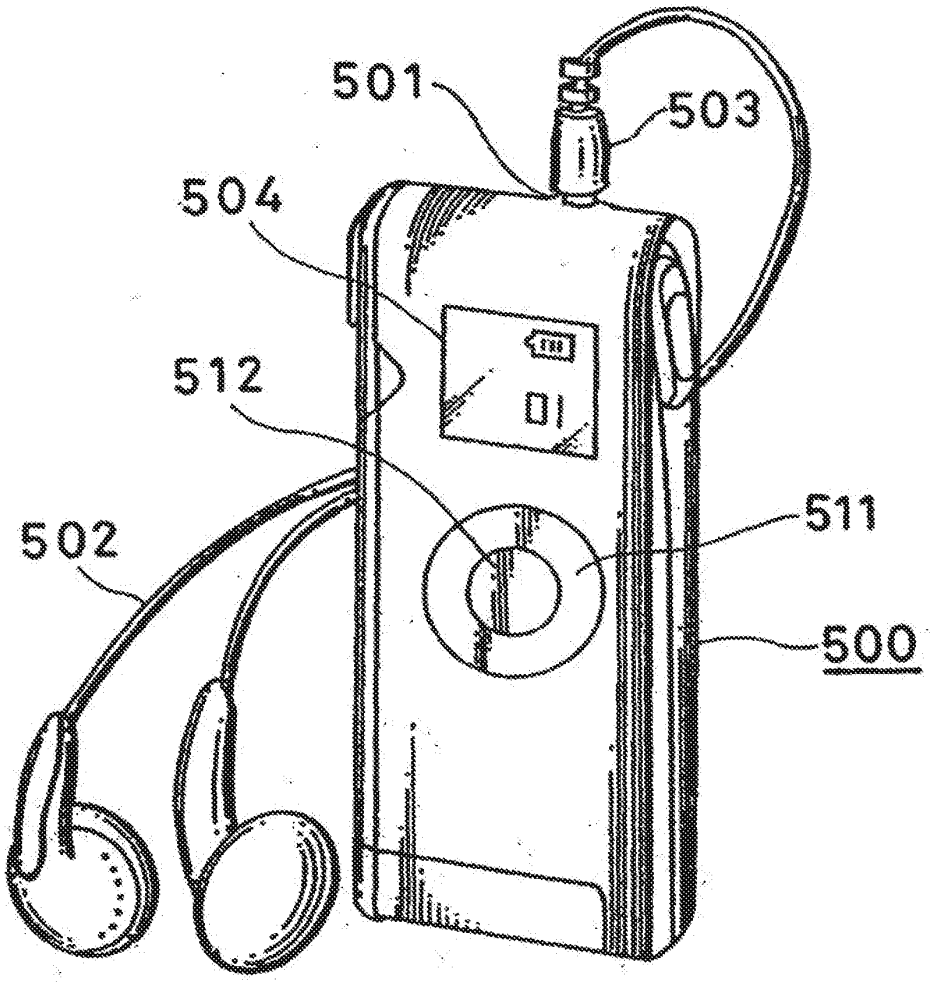


FIG. 21A

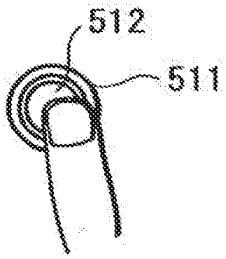


FIG. 21B

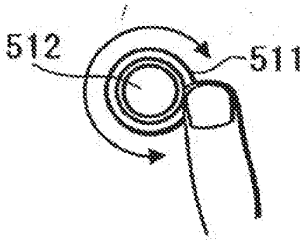


FIG. 21C

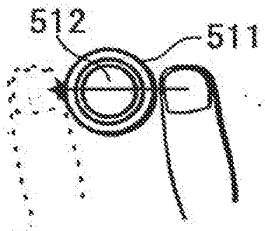


FIG. 21D

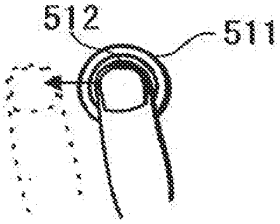


FIG. 21E

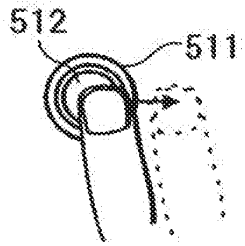


FIG. 21F

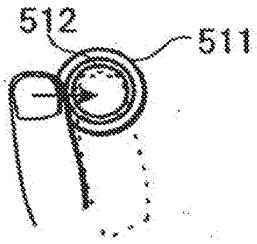


FIG. 21G

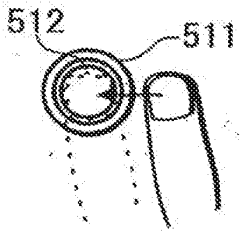


FIG. 22

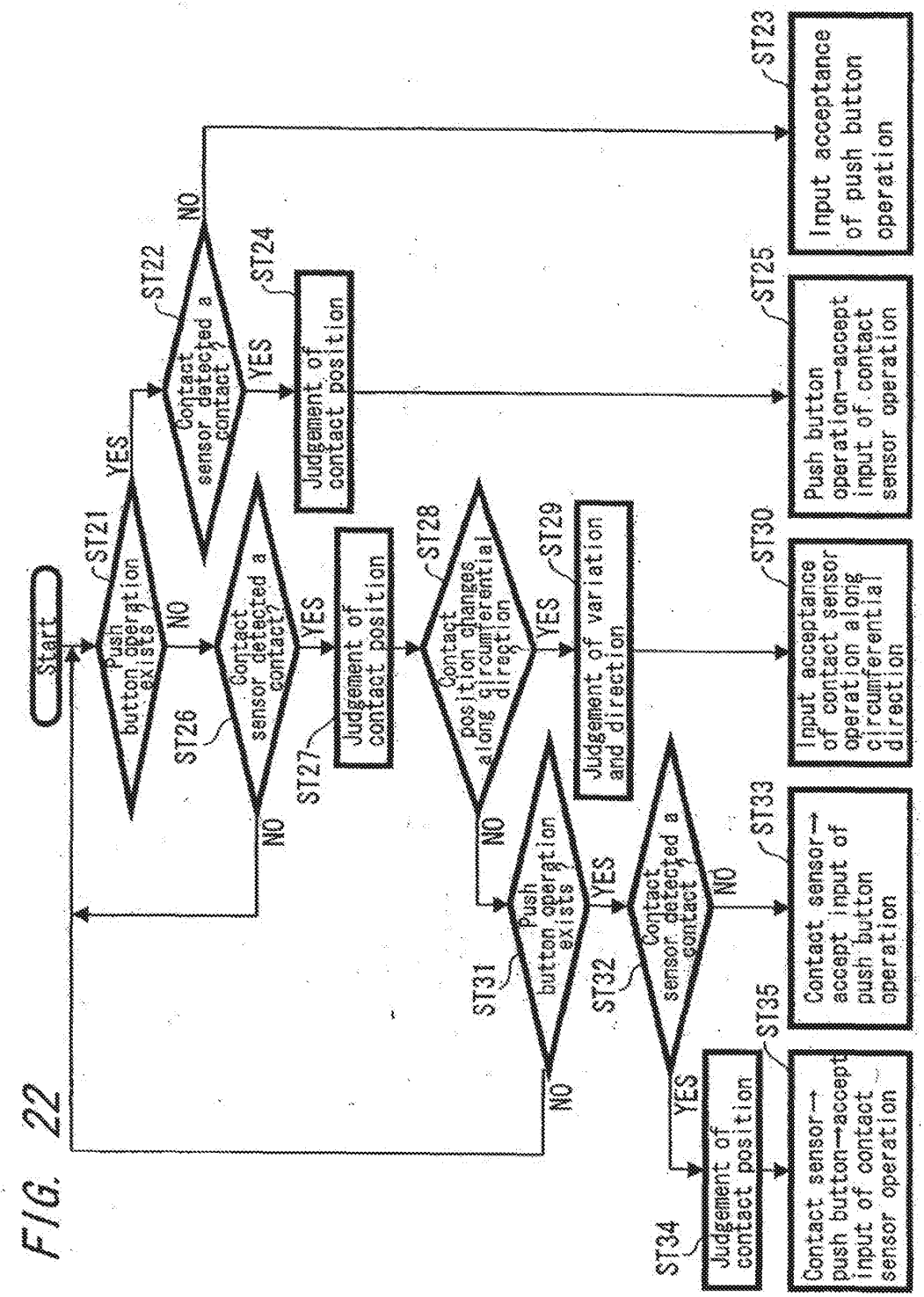

Start
ST21
Push button operation exists
YES
NO
ST22
Contact sensor detected a contact?
YES
NO
ST23
Input acceptance of push button operation
ST24
Judgement of contact position
ST25
Push button operation→accept input of contact sensor operation
ST26
Contact sensor detected a contact?
YES
NO
ST27
Judgement 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

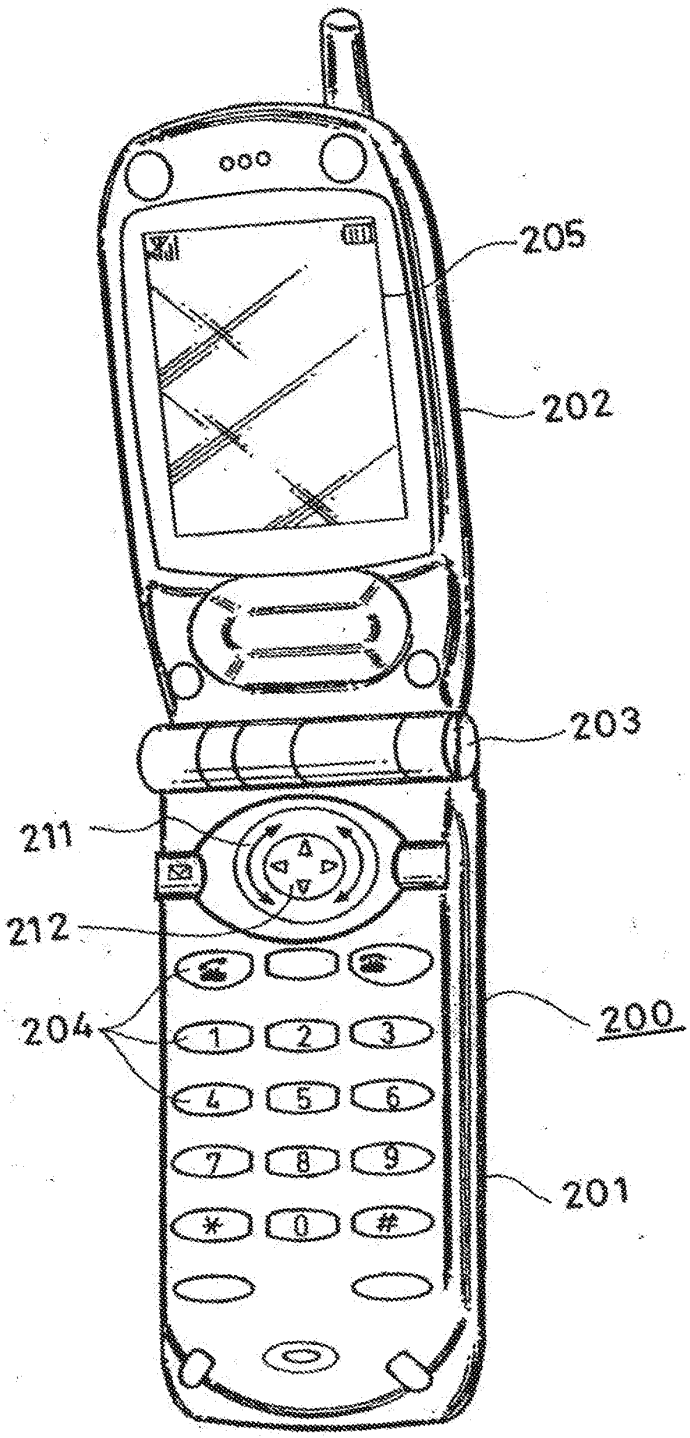


FIG. 24

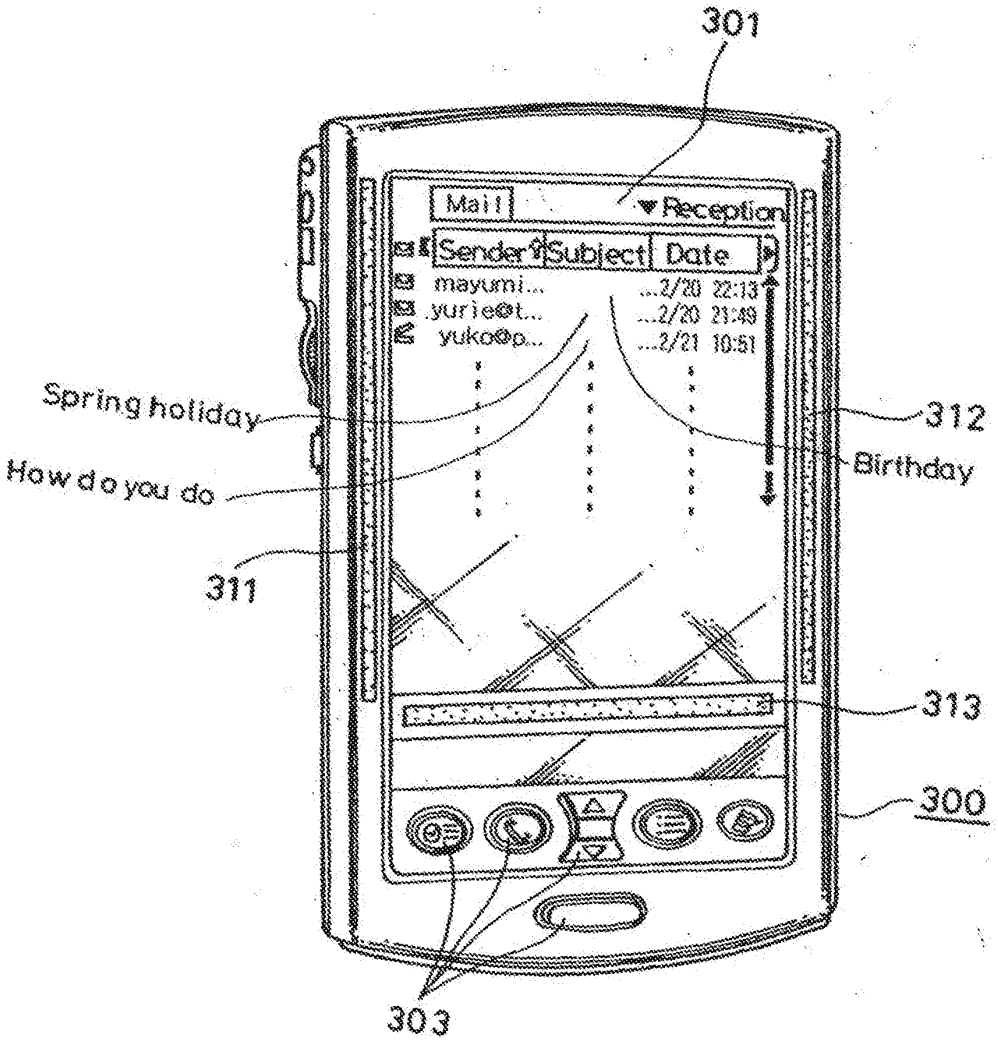

301
Mail
Reception
Sender
Subject
Date
mayumi...
yurie@t...
yuko@p...
...2/20 22:13
...2/20 21:49
...2/21 10:51
Spring holiday
How do you do
311
312
Birthday
313
300
303

FIG. 25A

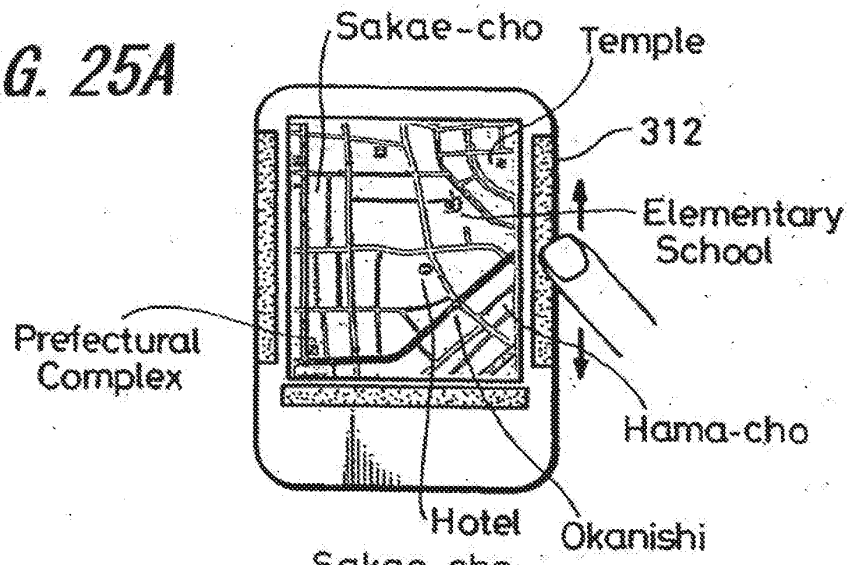


FIG. 25B

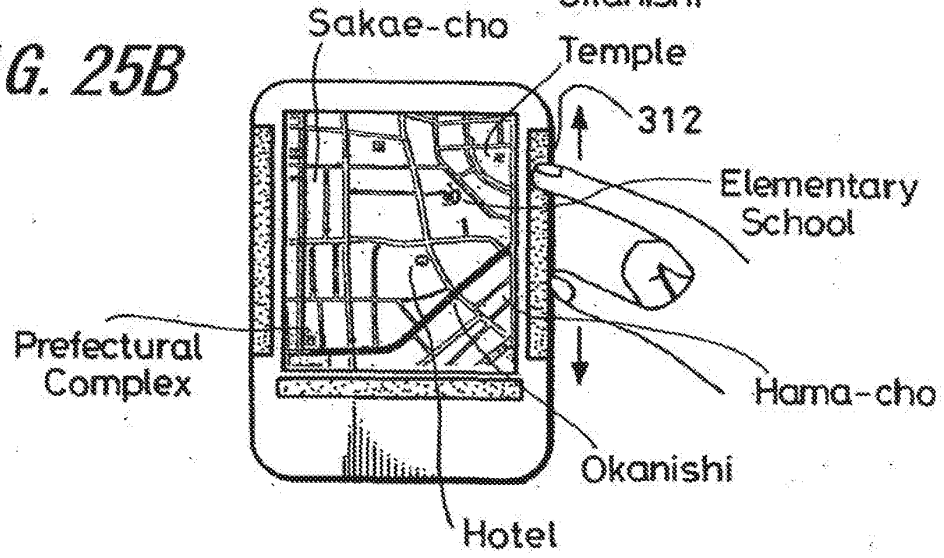


FIG. 25C

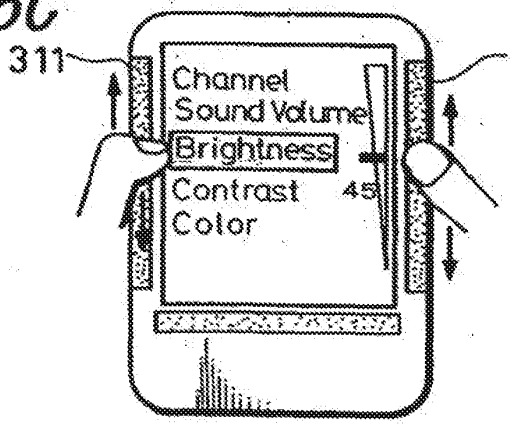


FIG. 26

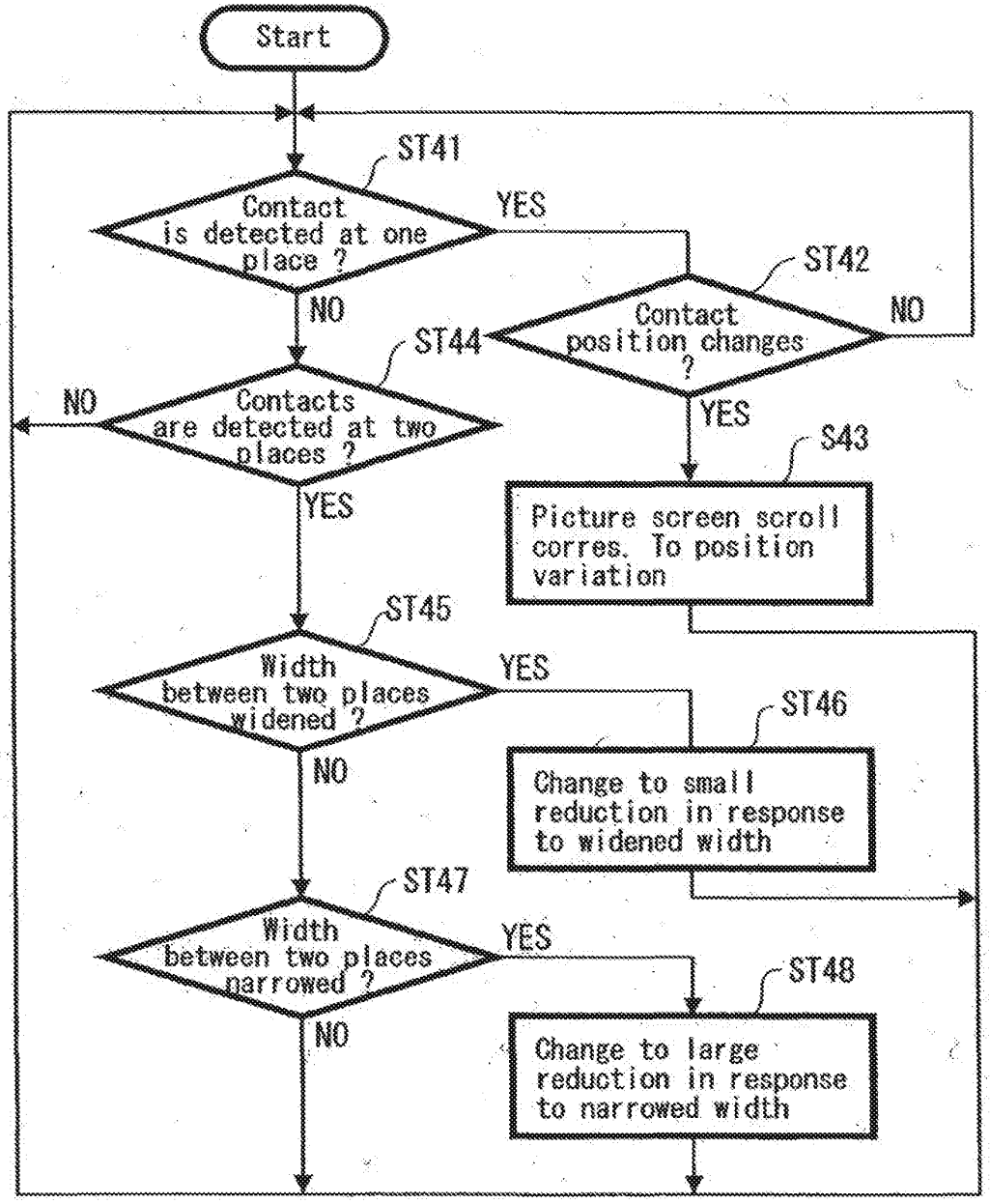

Start
ST41
Contact is detected at one place ?
YES
NO
ST42
Contact position changes ?
NO
YES
ST44
Contacts are detected at two places ?
NO
YES
S43
Picture screen scroll corres. To position variation
ST45
Width between two places widened ?
YES
NO
ST46
Change to small reduction in response to widened width
ST47
Width between two places narrowed ?
YES
NO
ST48
Change to large reduction in response to narrowed width

FIG. 27

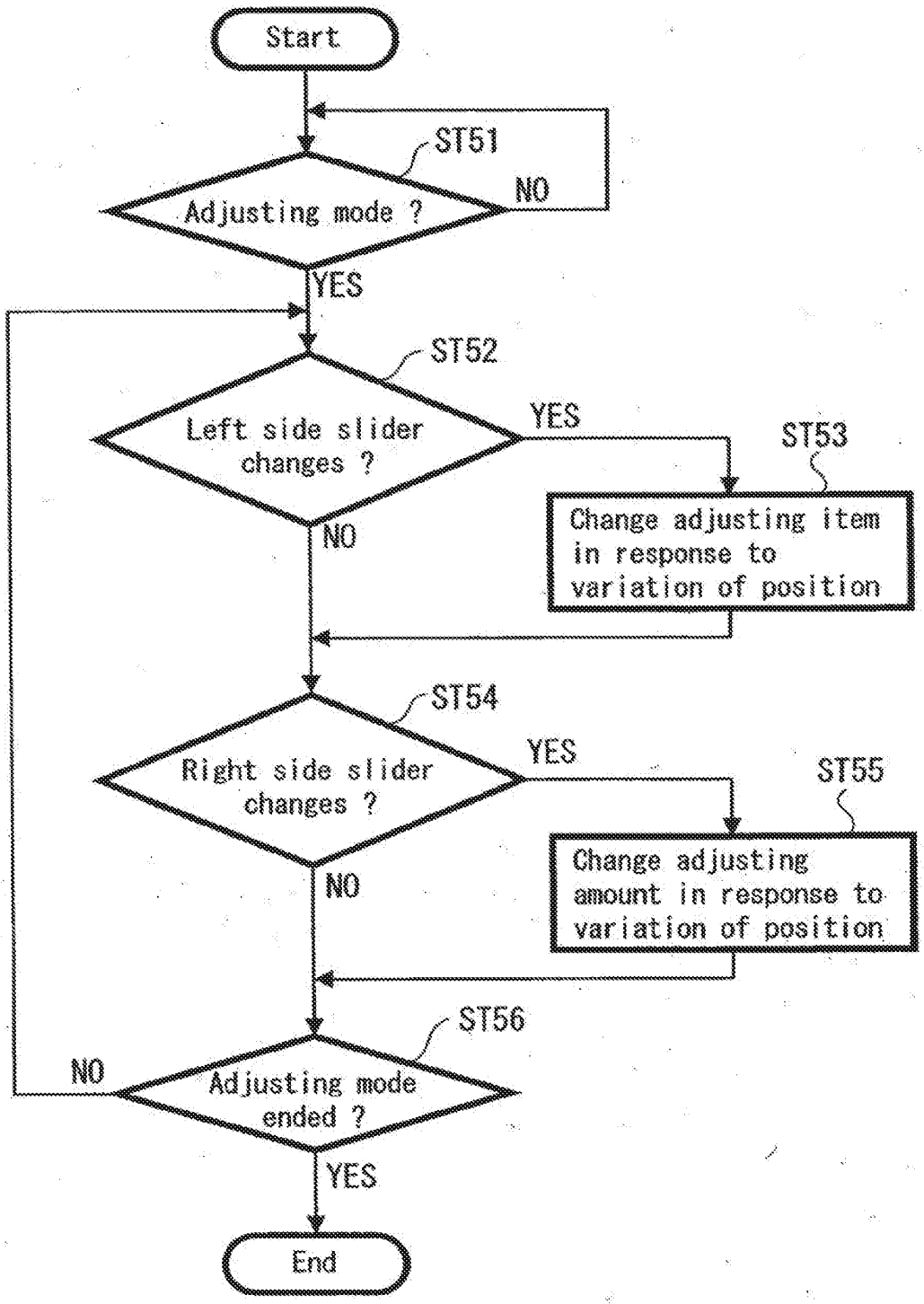

Start
ST51
Adjusting mode ?
NO
YES
ST52
Left side slider changes ?
YES
ST53
Change adjusting item in response to variation of position
NO
ST54
Right side slider changes ?
YES
ST55
Change adjusting amount in response to variation of position
NO
ST56
Adjusting mode ended ?
NO
YES
End

FIG. 28

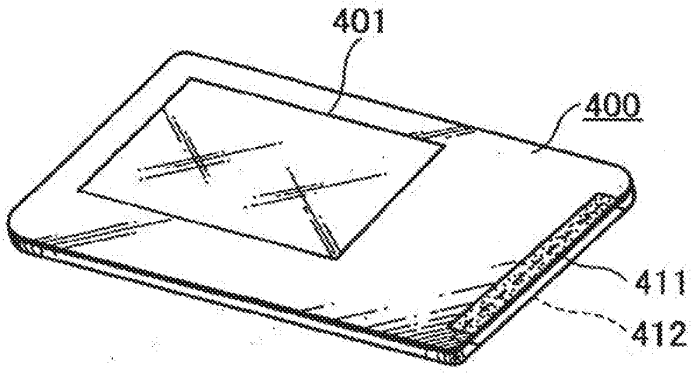


FIG. 29A

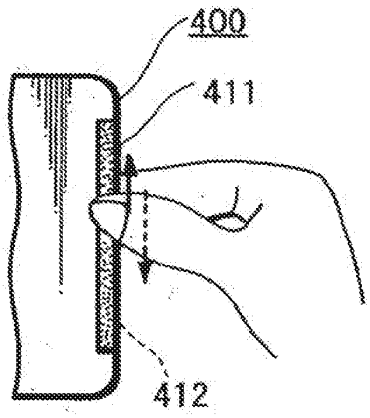


FIG. 29B

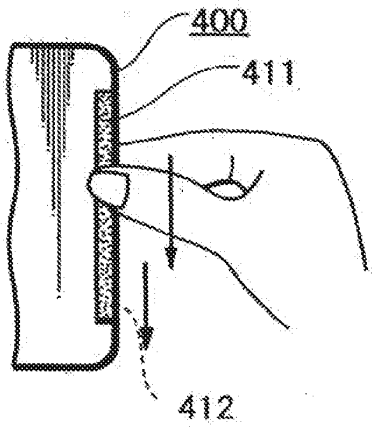
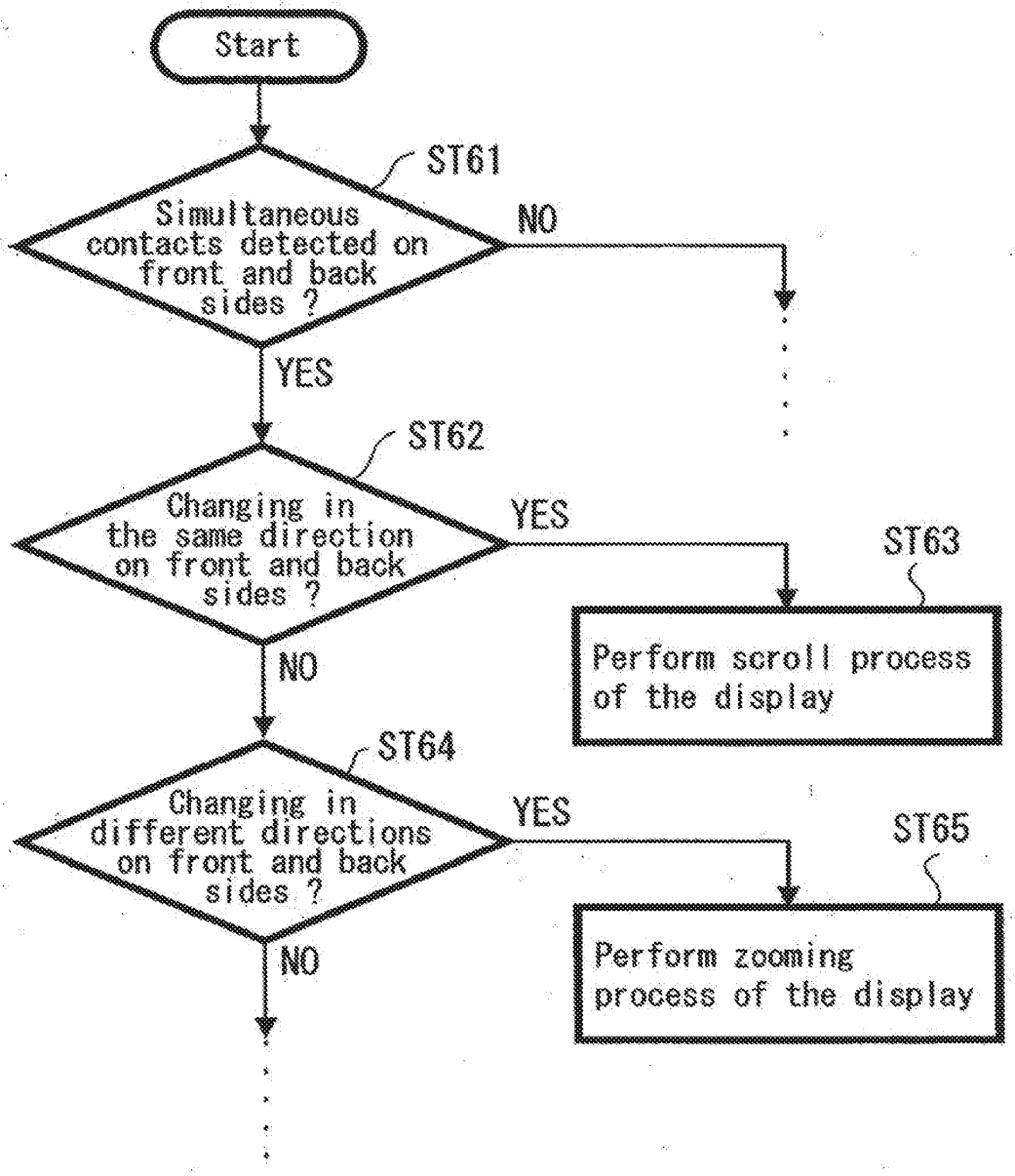


FIG. 30


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 693

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 comparatively 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 conformity 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. 21C**), 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. 21E**), an operation for touching the left edge of the annular operation unit **511** and thereafter pushing down the push button unit **512** (**FIG. 21F**), an operation for touching the right edge of the annular operation unit **511** and thereafter pushing down the push button unit **512** (**FIG. 21G**) 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 **21G** 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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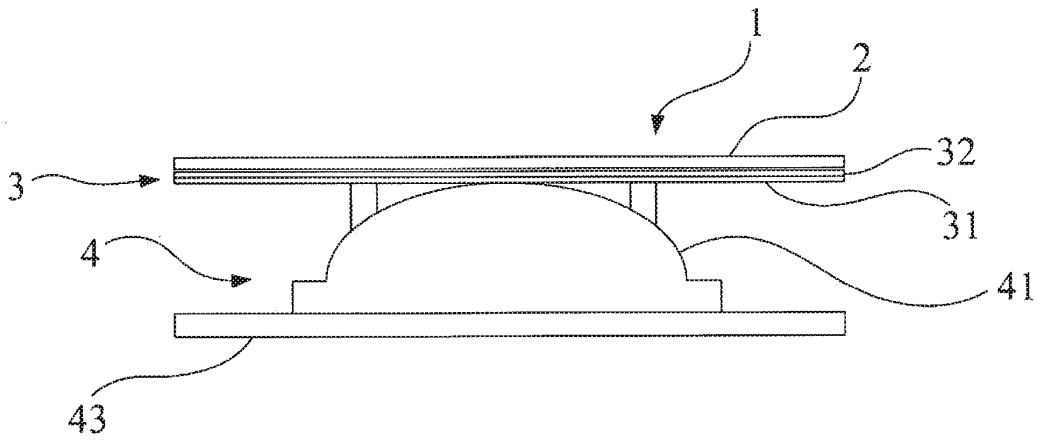
G09G 5/00 (2006.01)

(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.



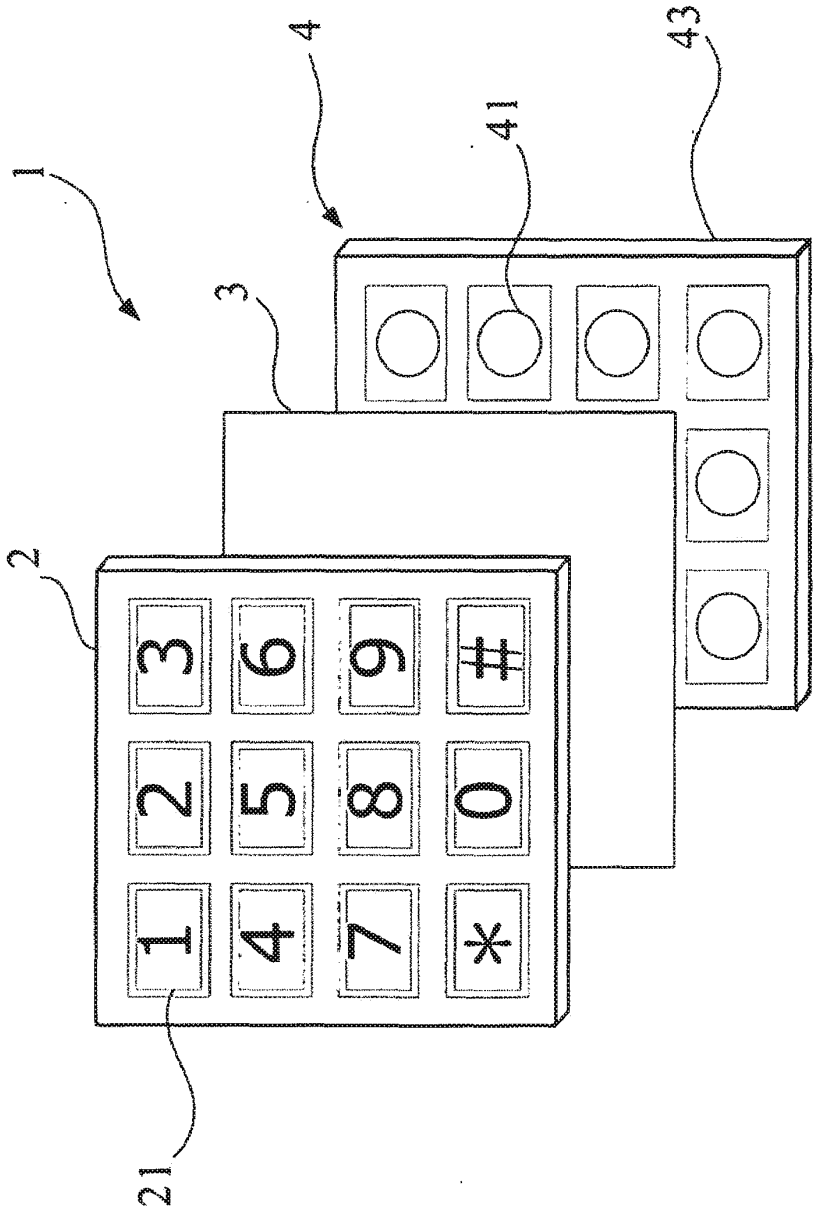


FIG. 1

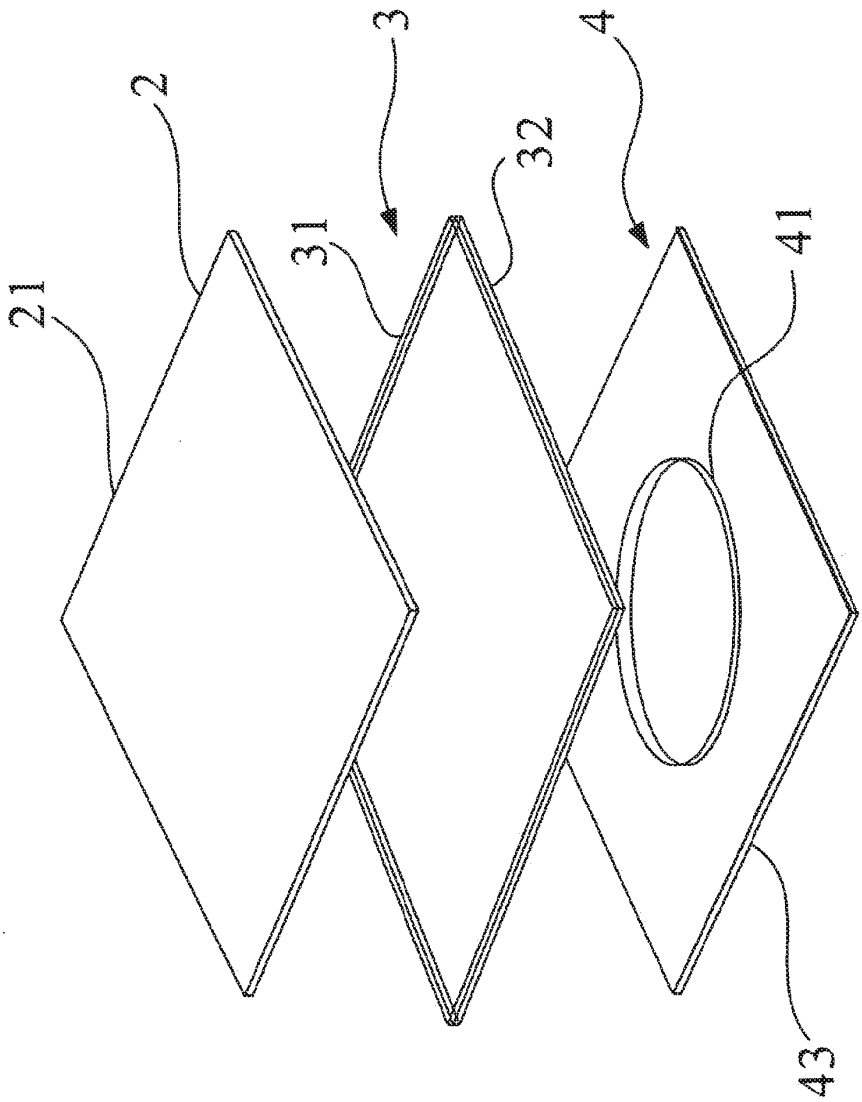


FIG. 2

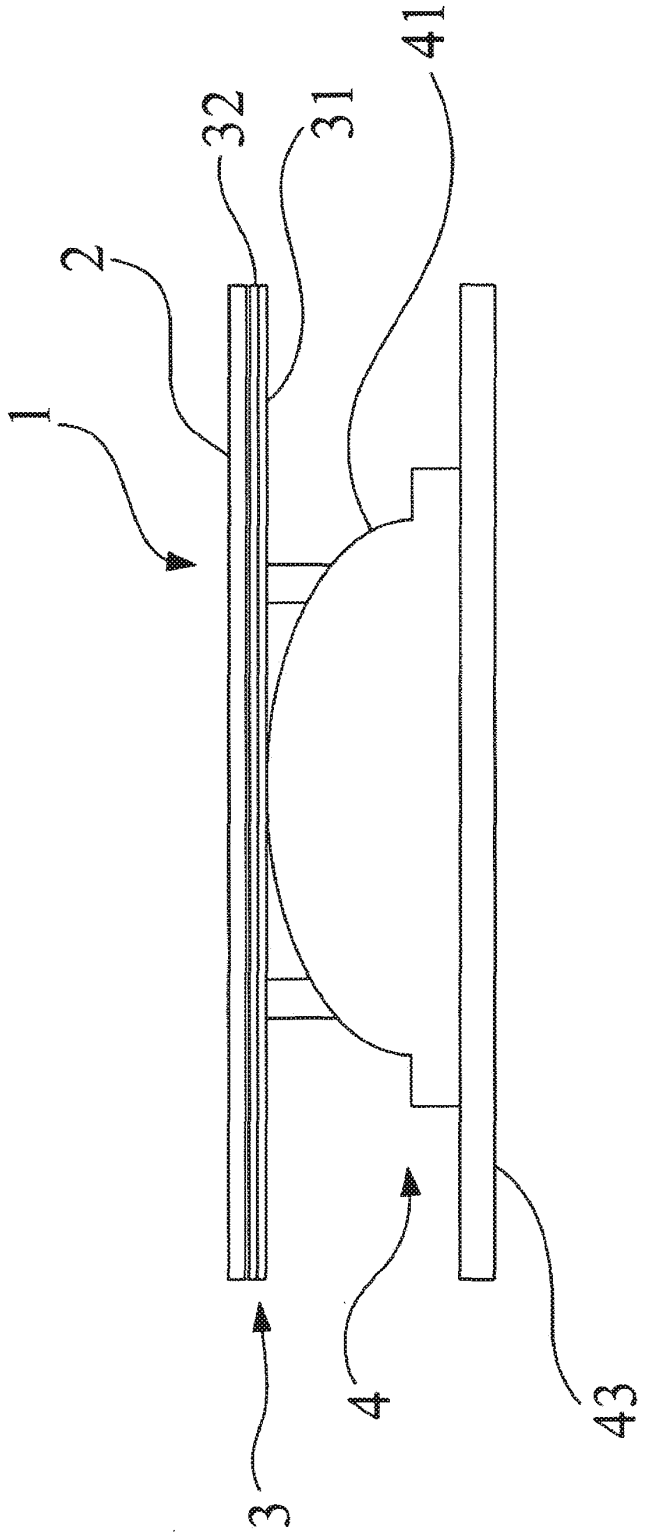


FIG. 3A

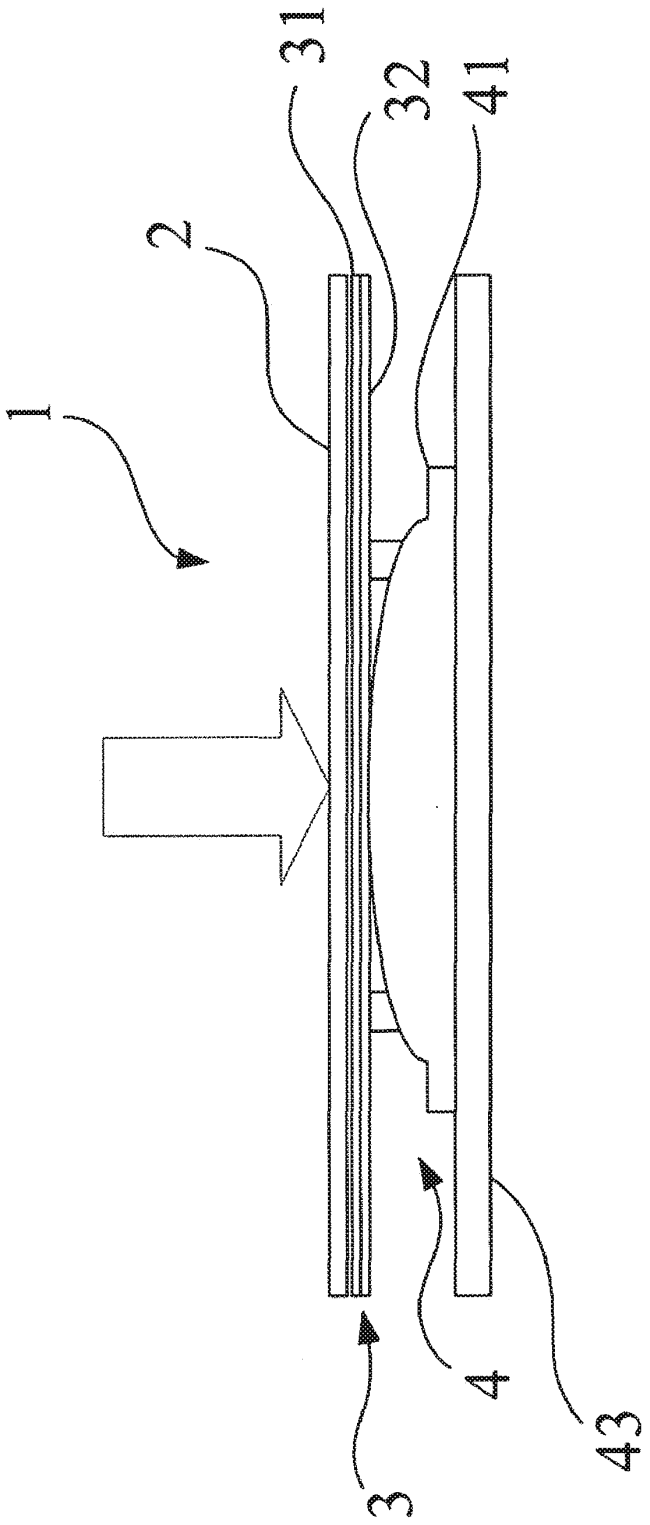


FIG. 3B

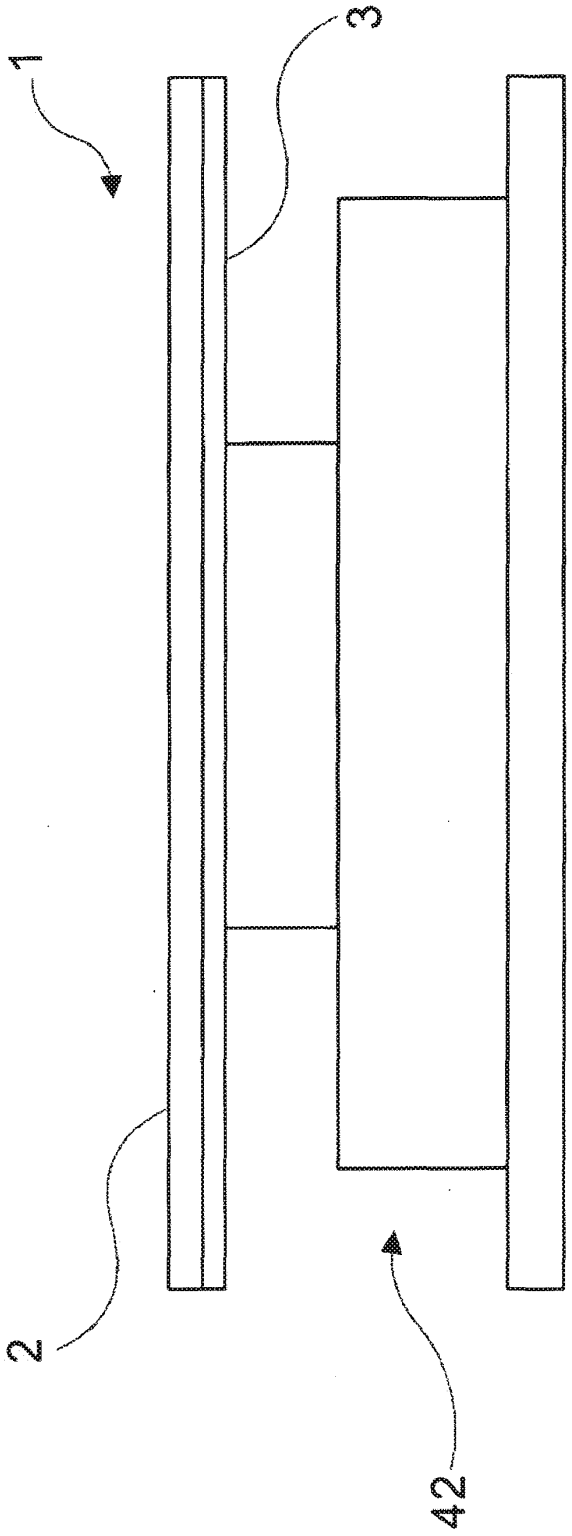


FIG. 4A

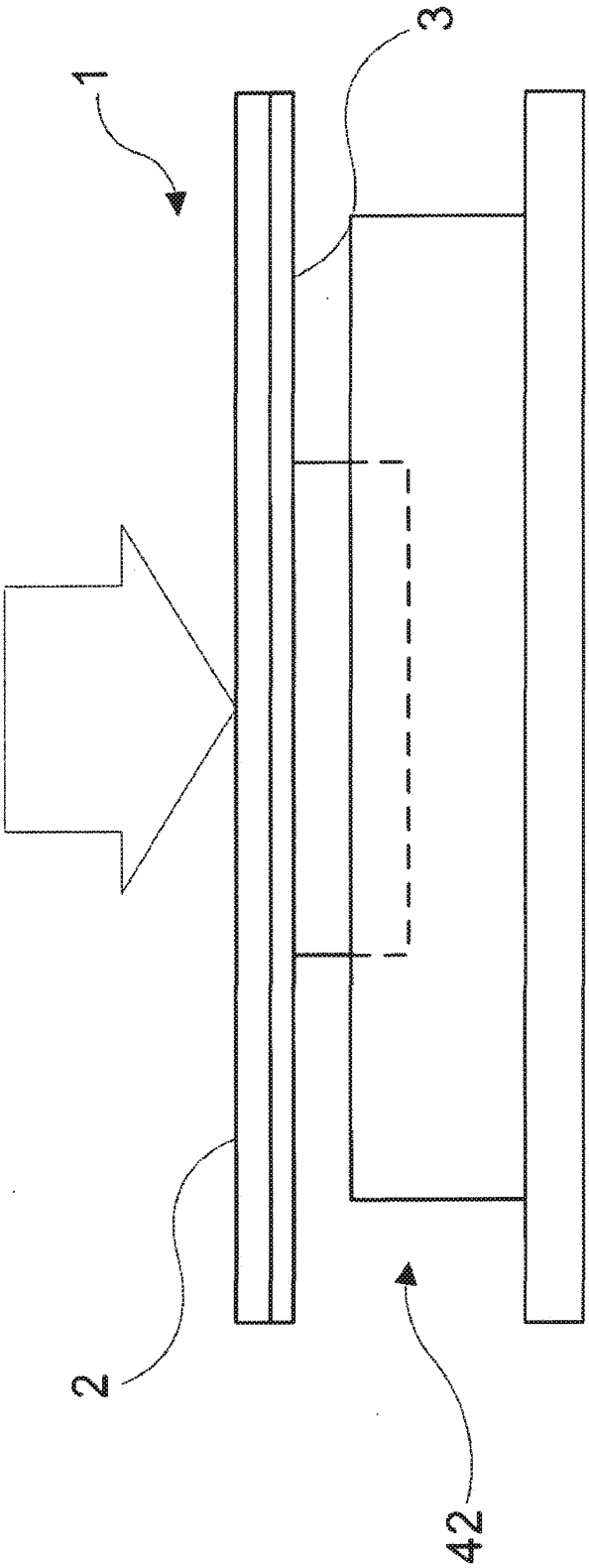


FIG. 4B

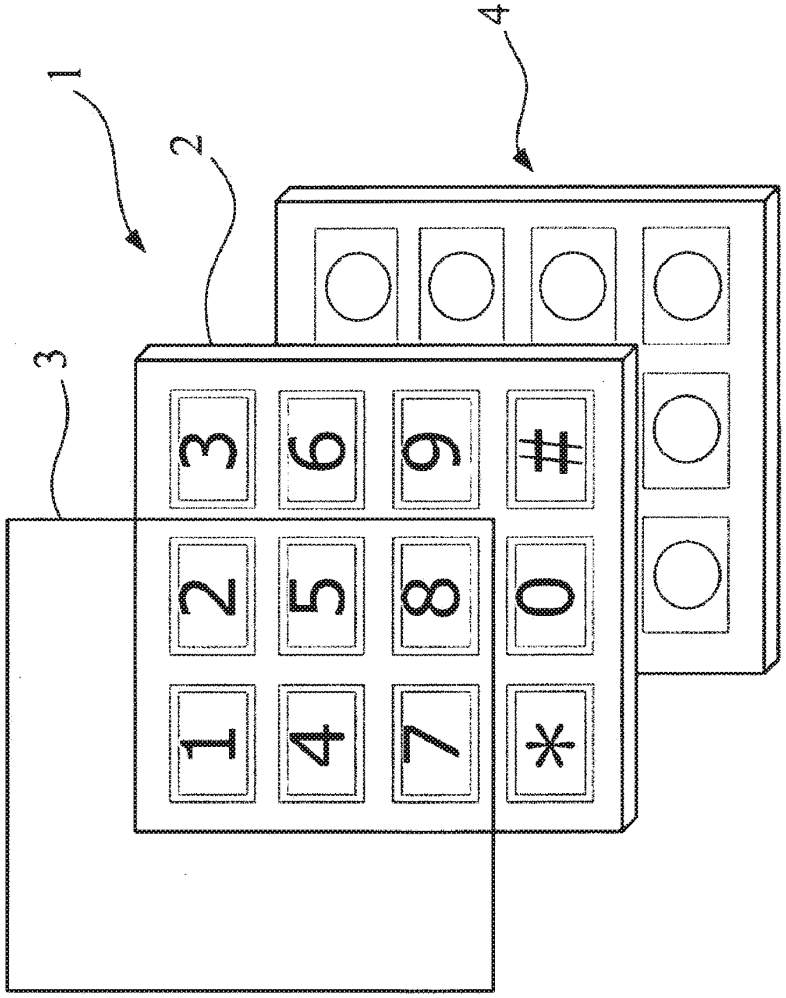


FIG. 5

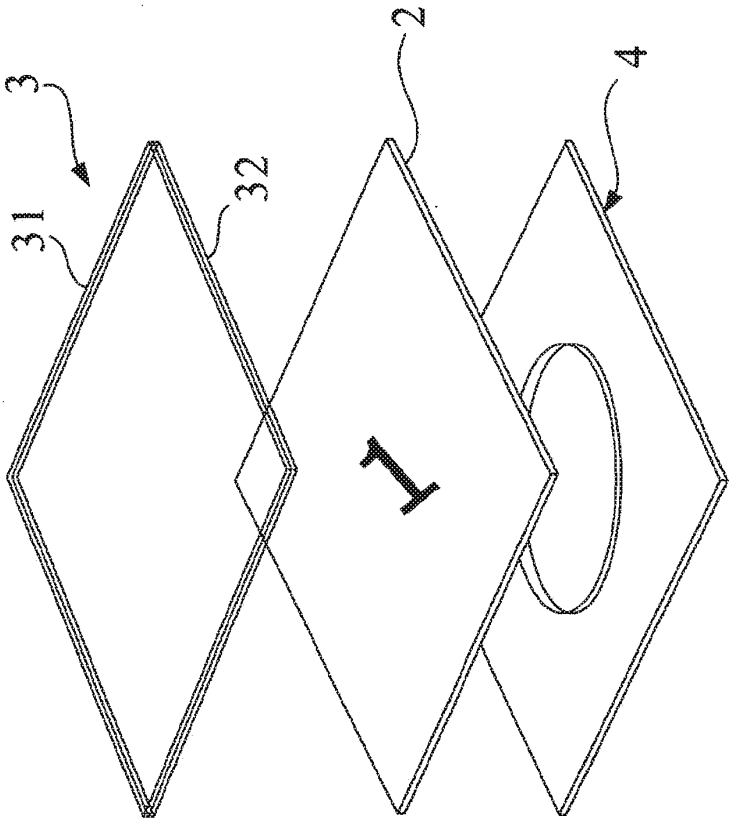


FIG. 6

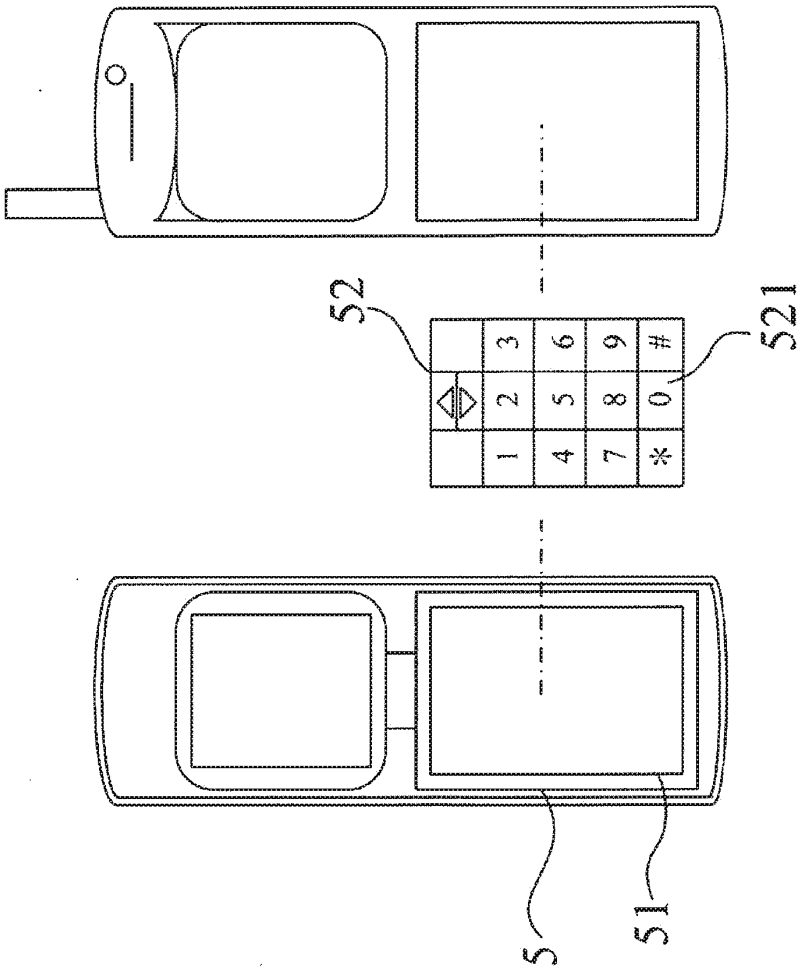


FIG. 7
(Prior Art)

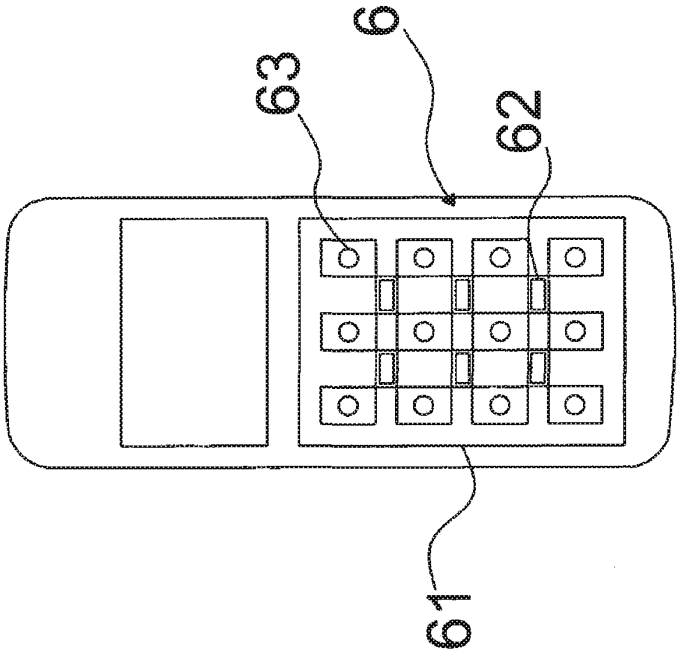


FIG. 8
(Prior Art)

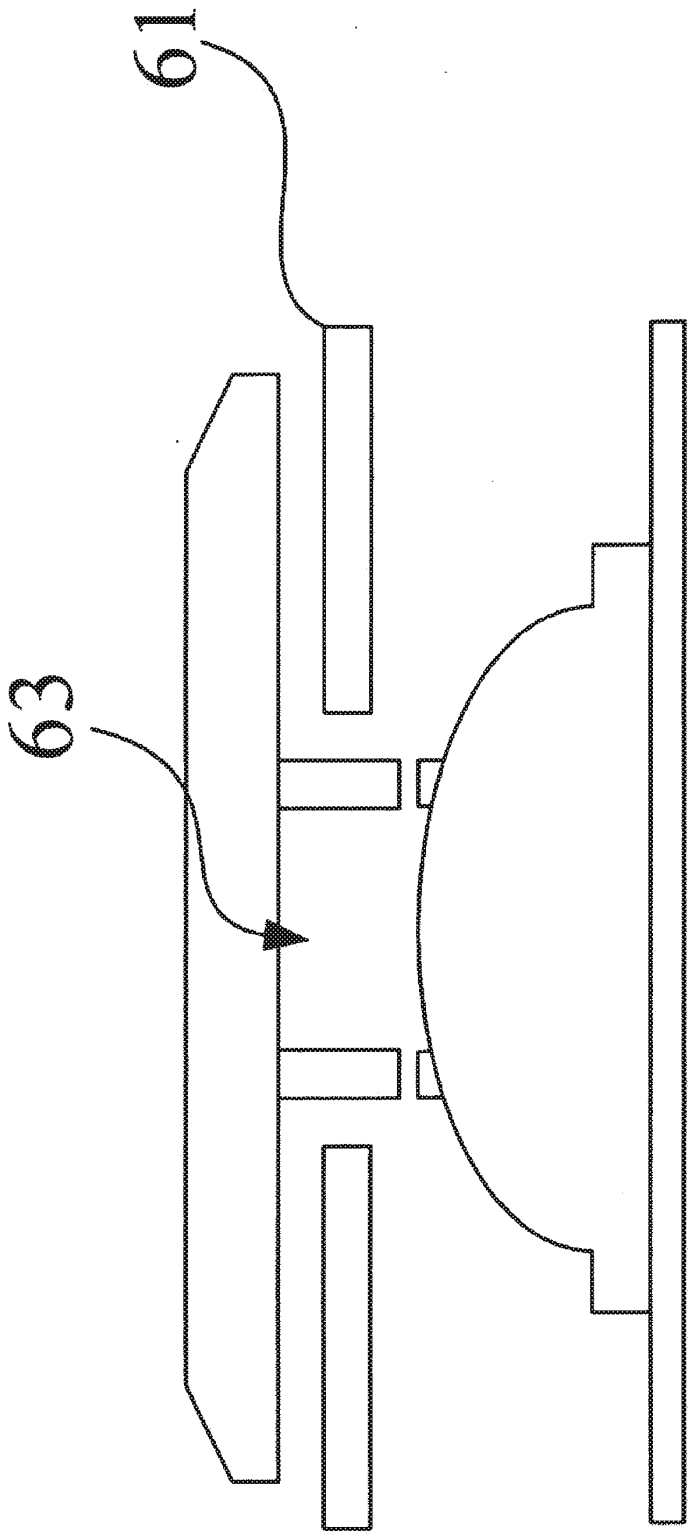


FIG. 9
(Prior Art)

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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(19) **United States**

(12) **Patent Application Publication**

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(54) **METHOD FOR PROVIDING TACTILE FEEDBACK FOR TOUCH-BASED INPUT DEVICE**

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(21) Appl. No.: **11/861,585**

(22) Filed: **Sep. 26, 2007**

Related U.S. Application Data

(60) Provisional application No. 60/908,907, filed on Mar. 29, 2007.

Publication Classification

(51) **Int. Cl.**
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.

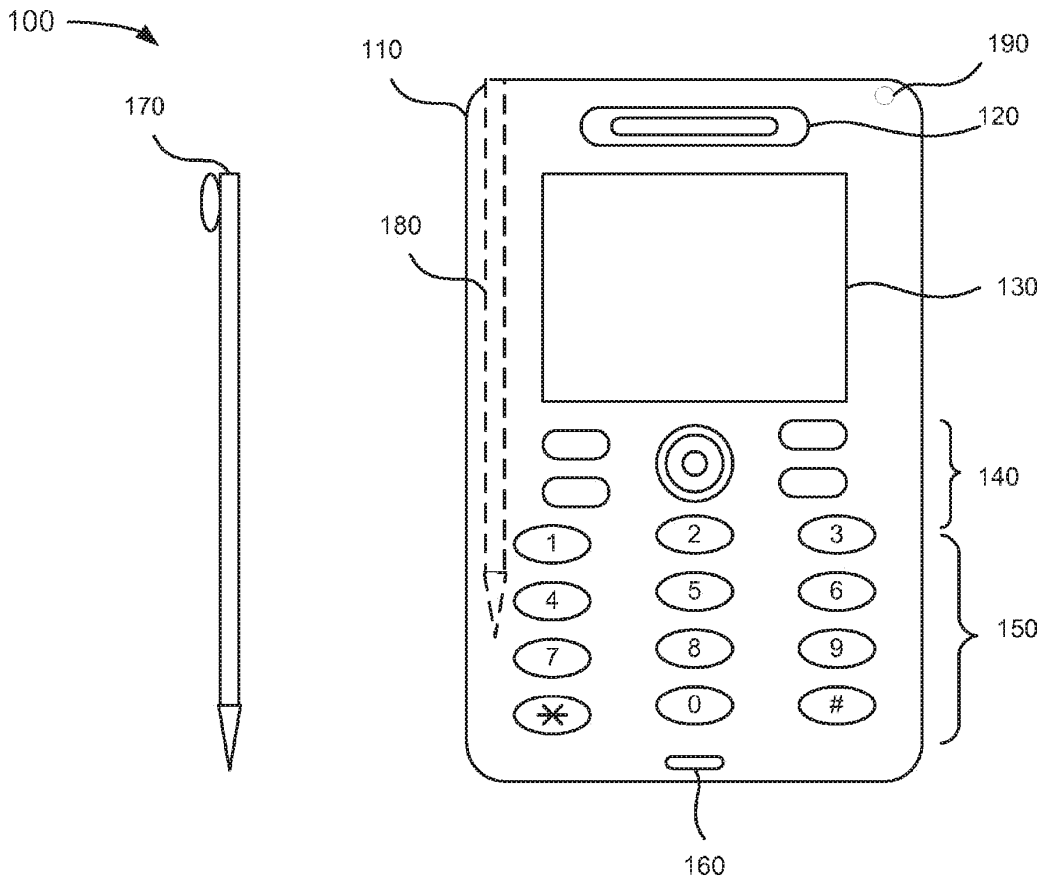
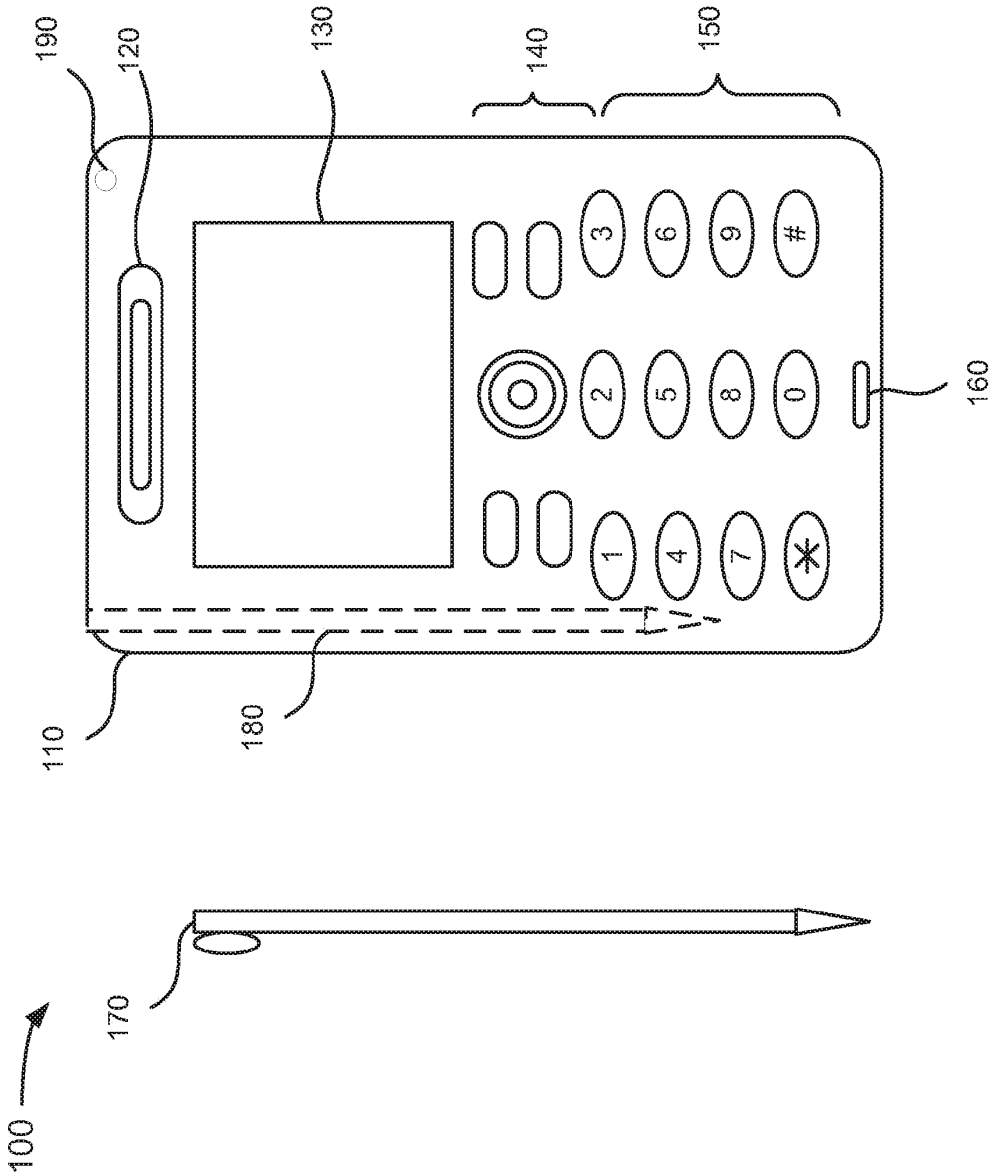


FIG. 1



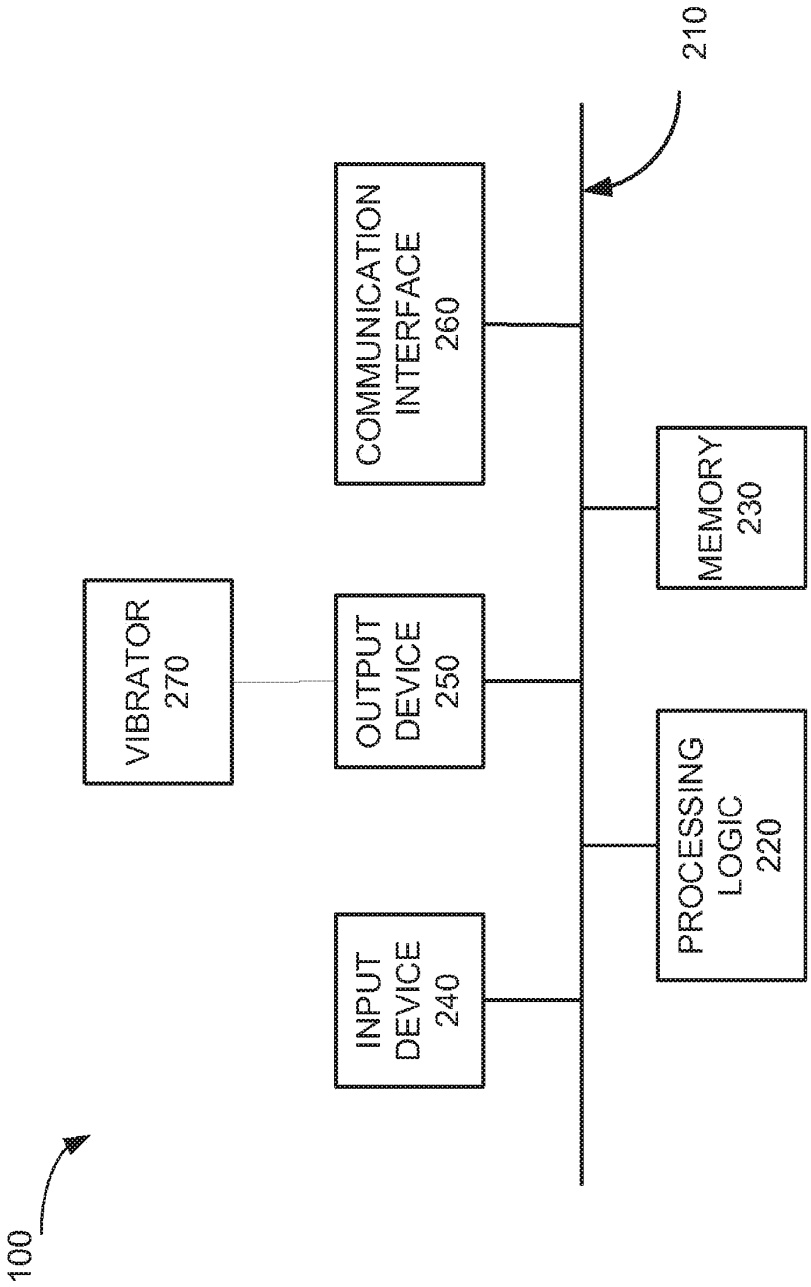

100
210
VIBRATOR 270
OUTPUT DEVICE 250
INPUT DEVICE 240
COMMUNICATION INTERFACE 260
MEMORY 230
PROCESSING LOGIC 220

FIG. 2

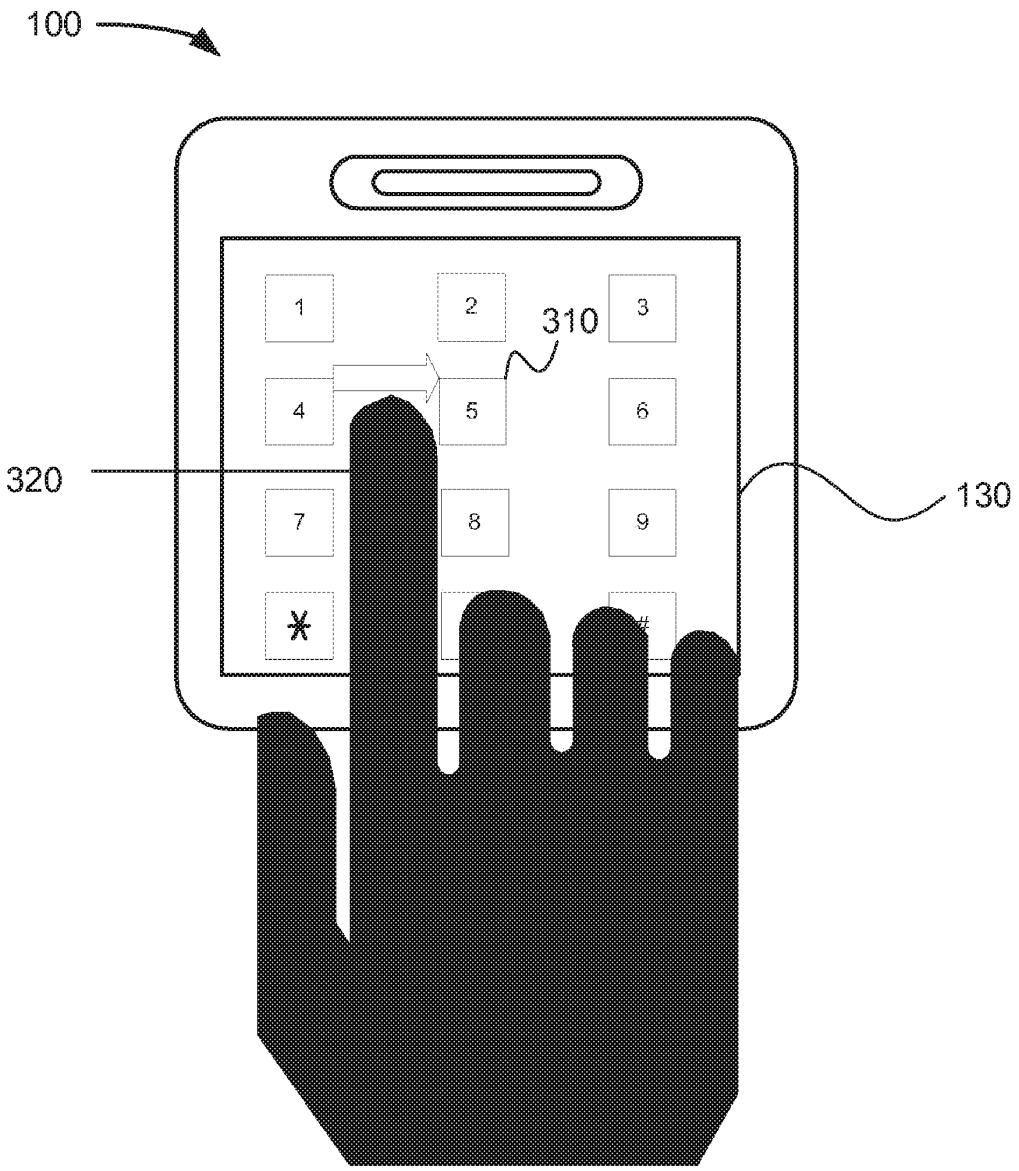


FIG. 3

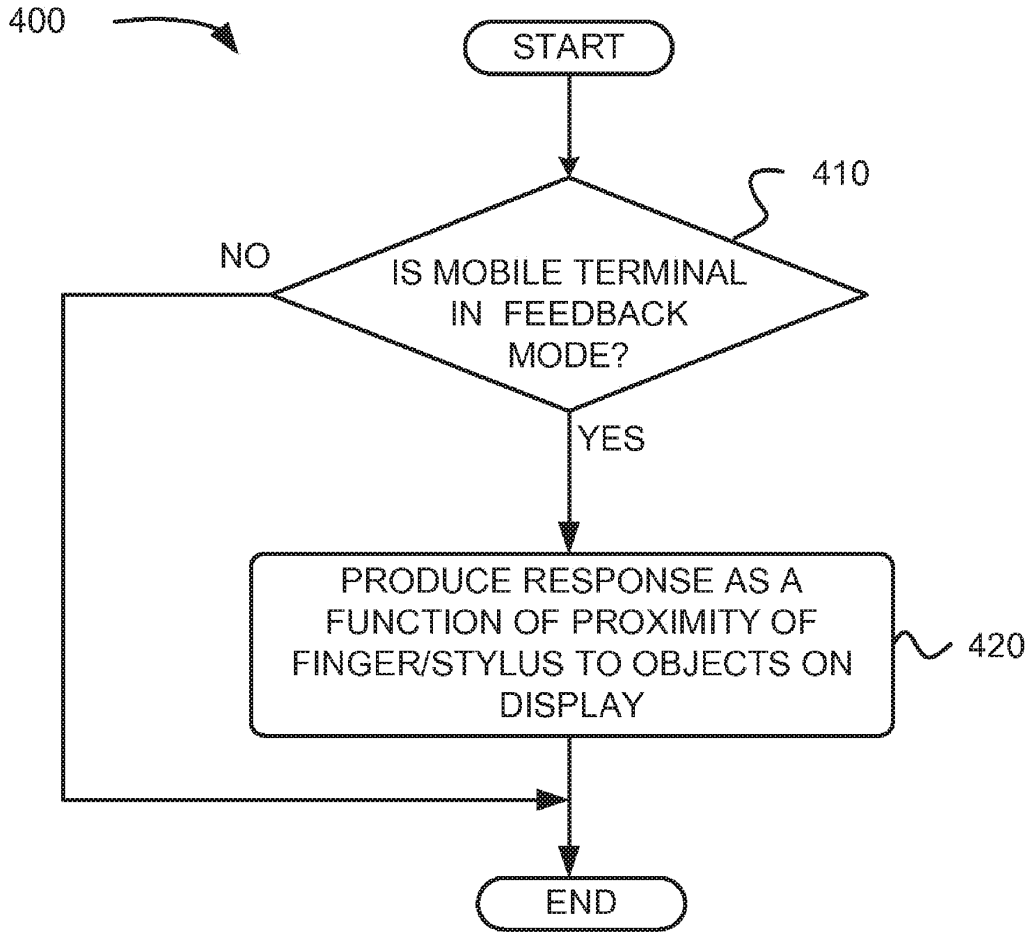

400
START
410
NO
IS MOBILE TERMINAL IN FEEDBACK MODE?
YES
PRODUCE RESPONSE AS A FUNCTION OF PROXIMITY OF FINGER/STYLUS TO OBJECTS ON DISPLAY
420
END

FIG. 4

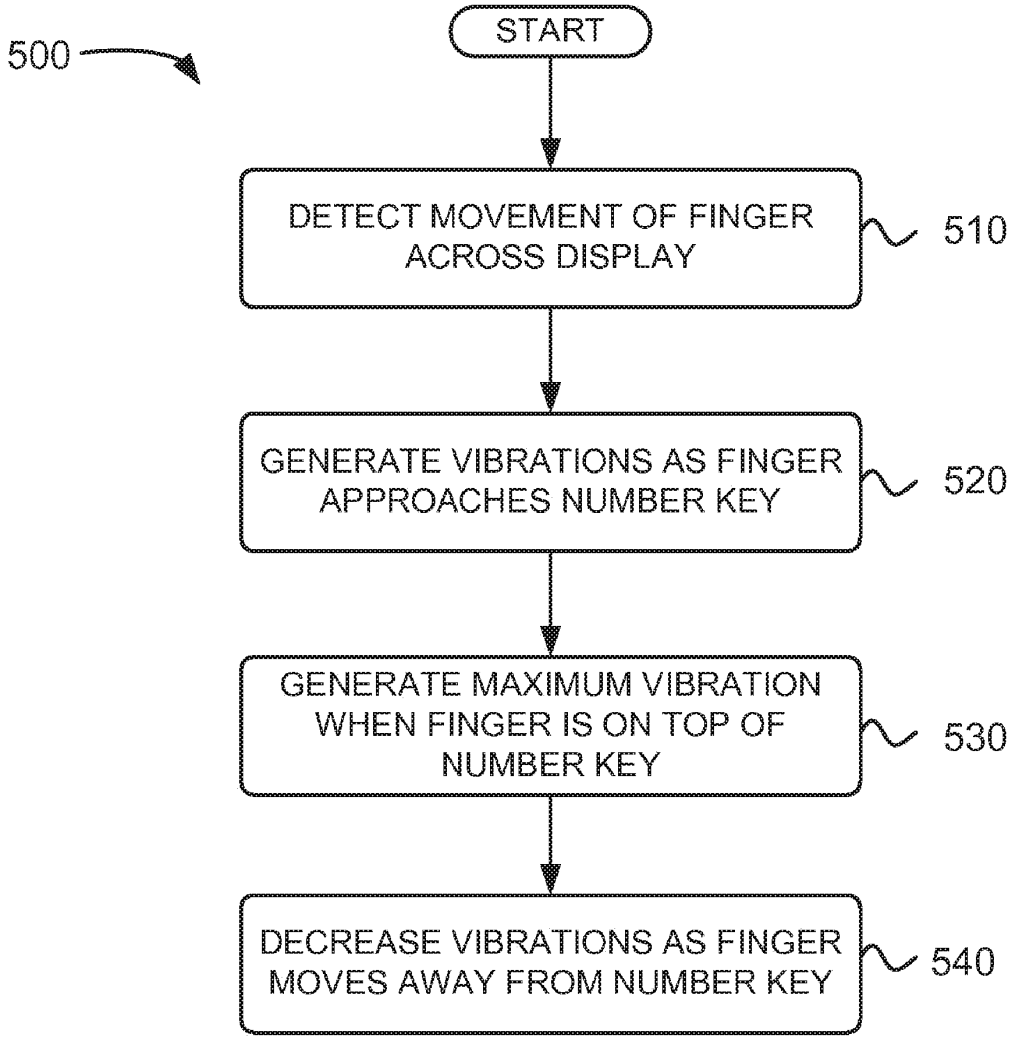

500
START
DETECT MOVEMENT OF FINGER ACROSS DISPLAY
510
GENERATE VIBRATIONS AS FINGER APPROACHES NUMBER KEY
520
GENERATE MAXIMUM VIBRATION WHEN FINGER IS ON TOP OF NUMBER KEY
530
DECREASE VIBRATIONS AS FINGER MOVES AWAY FROM NUMBER KEY
540

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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(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.

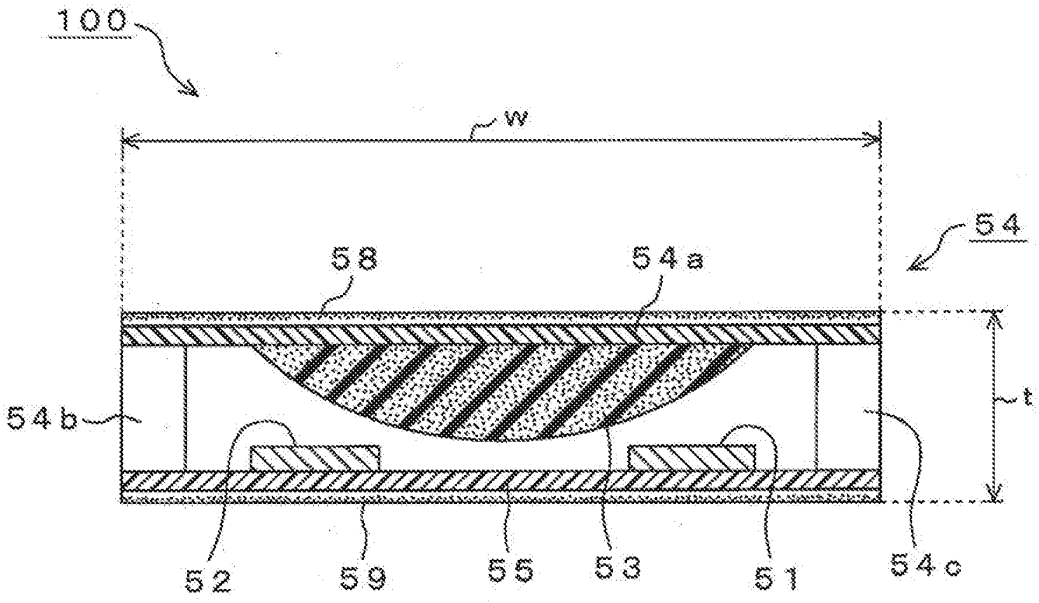


FIG. 1

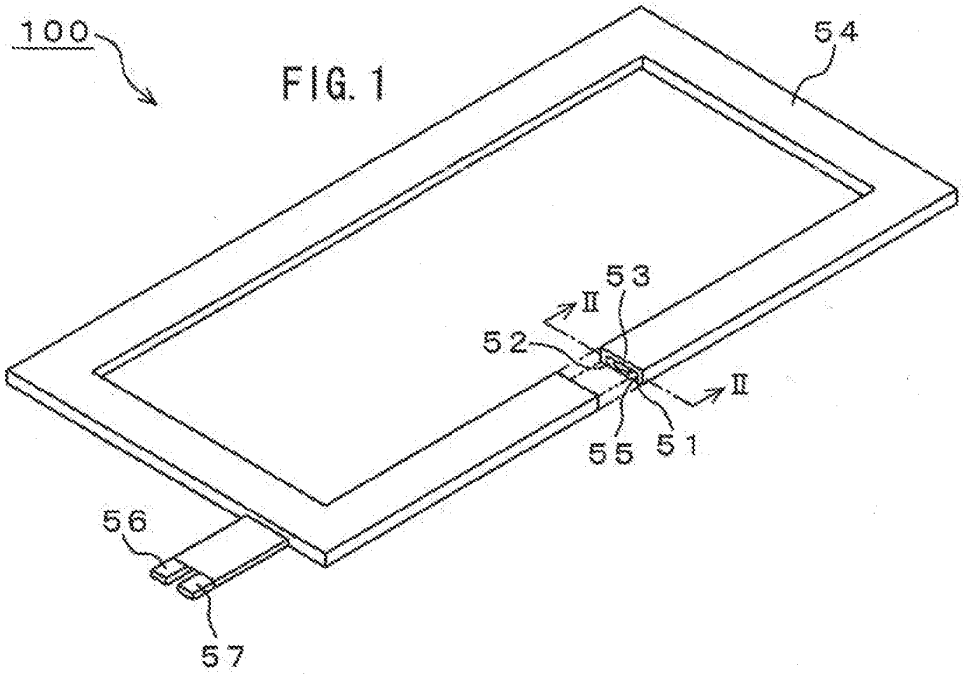


FIG. 2

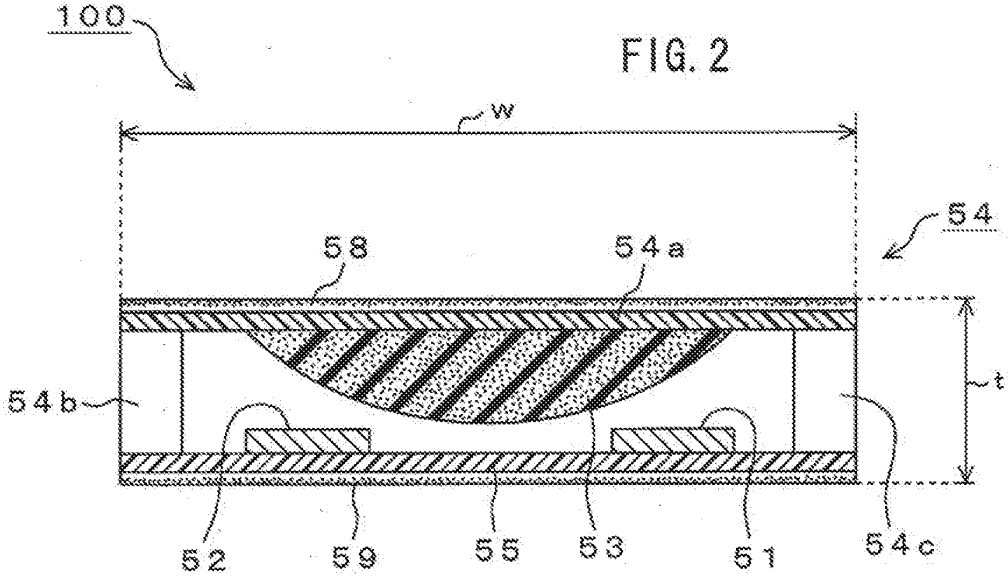
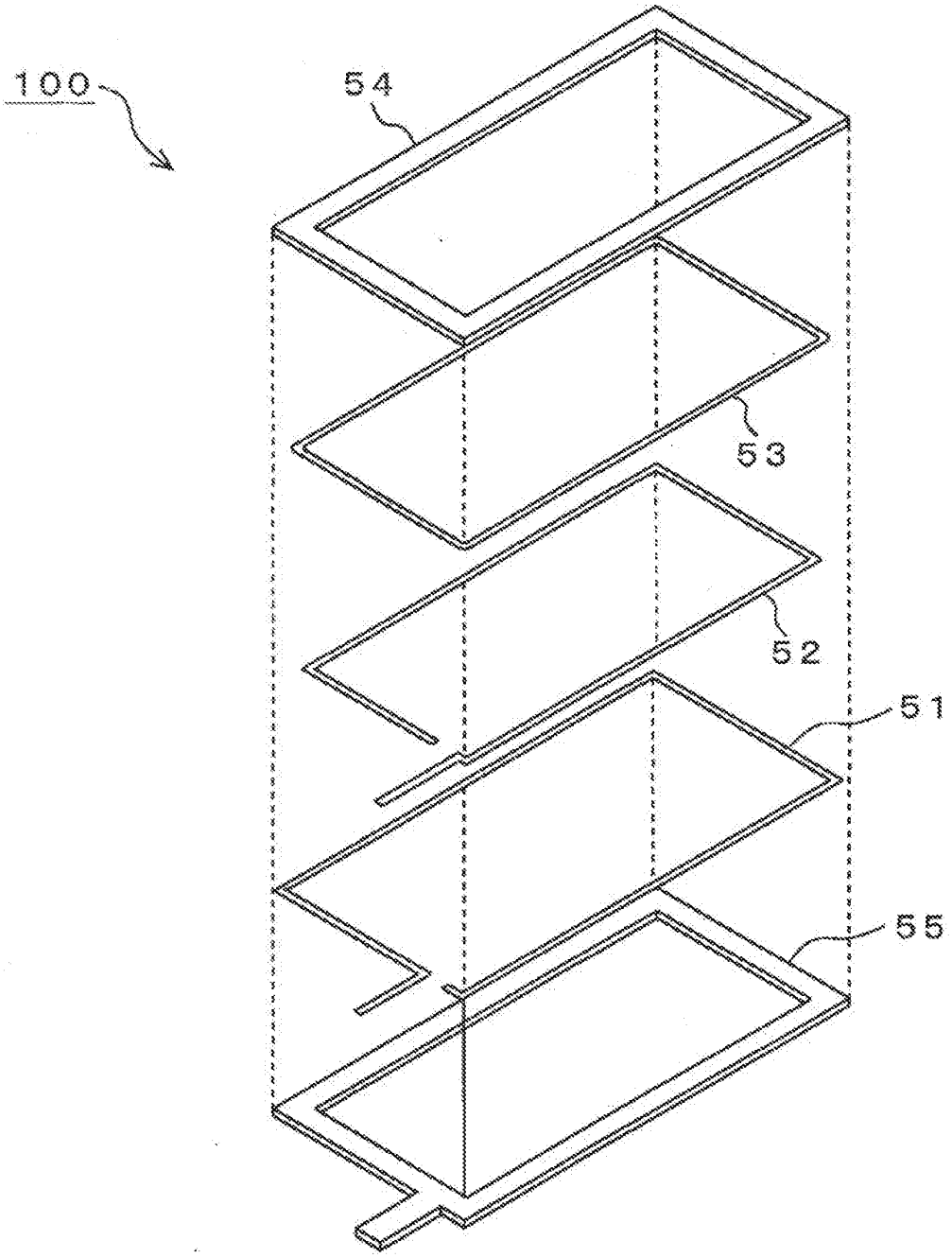


FIG. 3



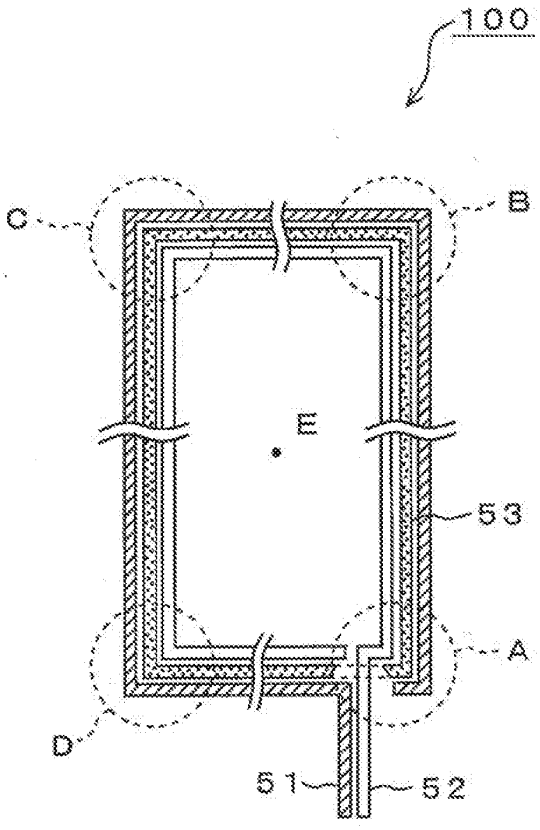


FIG. 4A

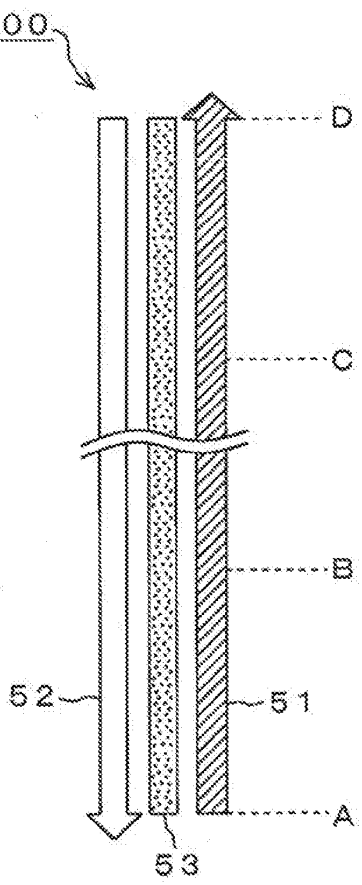


FIG. 4B

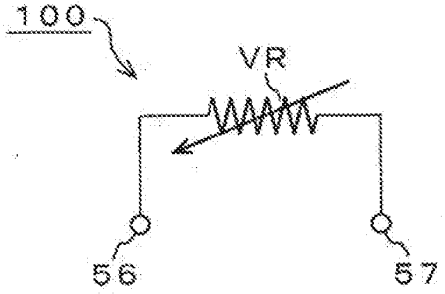
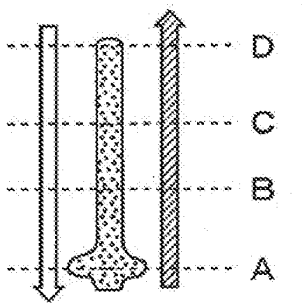
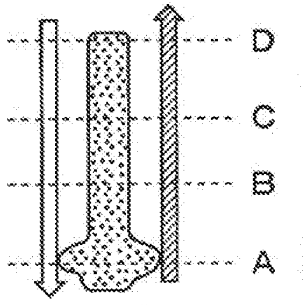
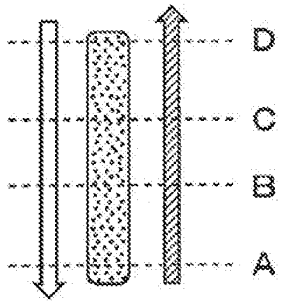
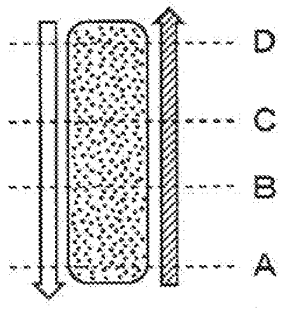


FIG. 4C

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

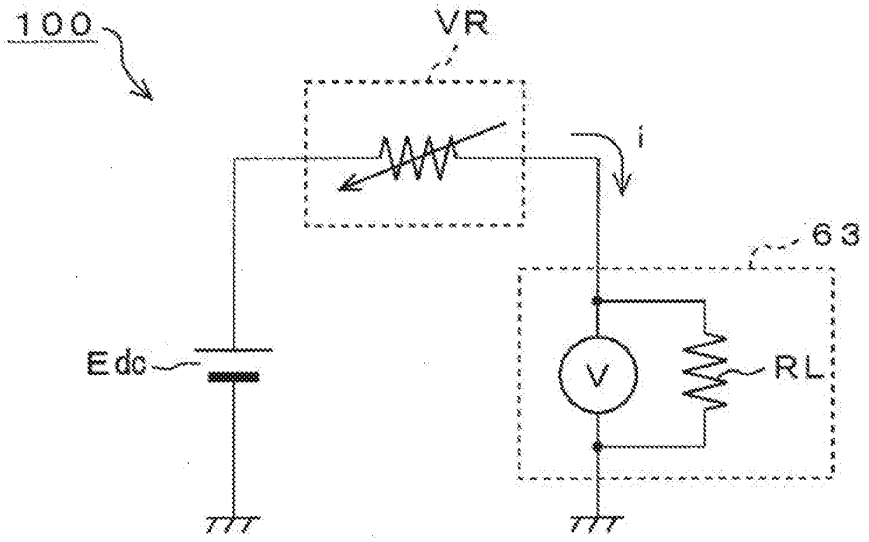


FIG. 7A

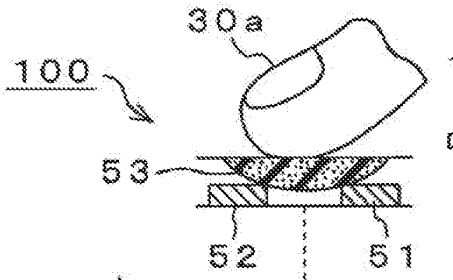
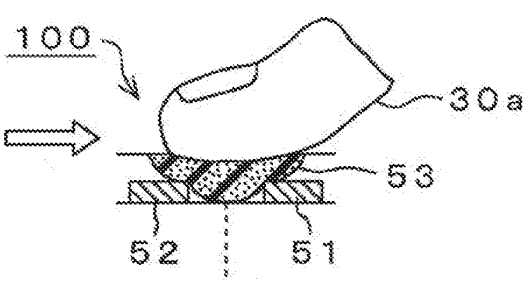


FIG. 7B



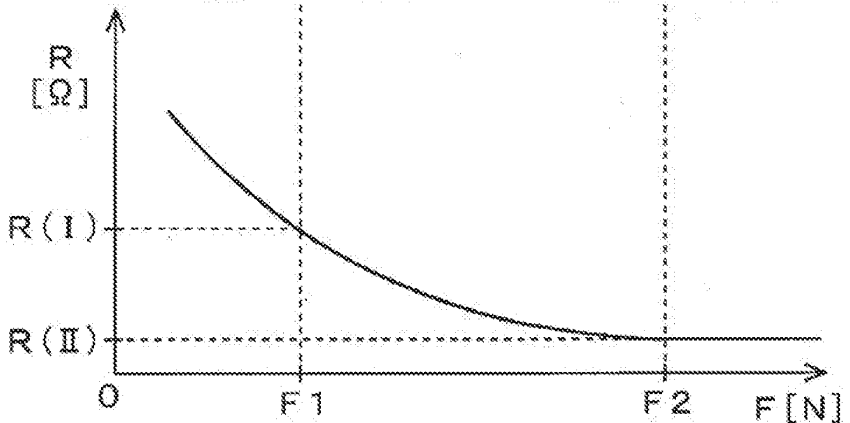


FIG. 7C

FIG. 8A FIG. 8B FIG. 8C FIG. 8D

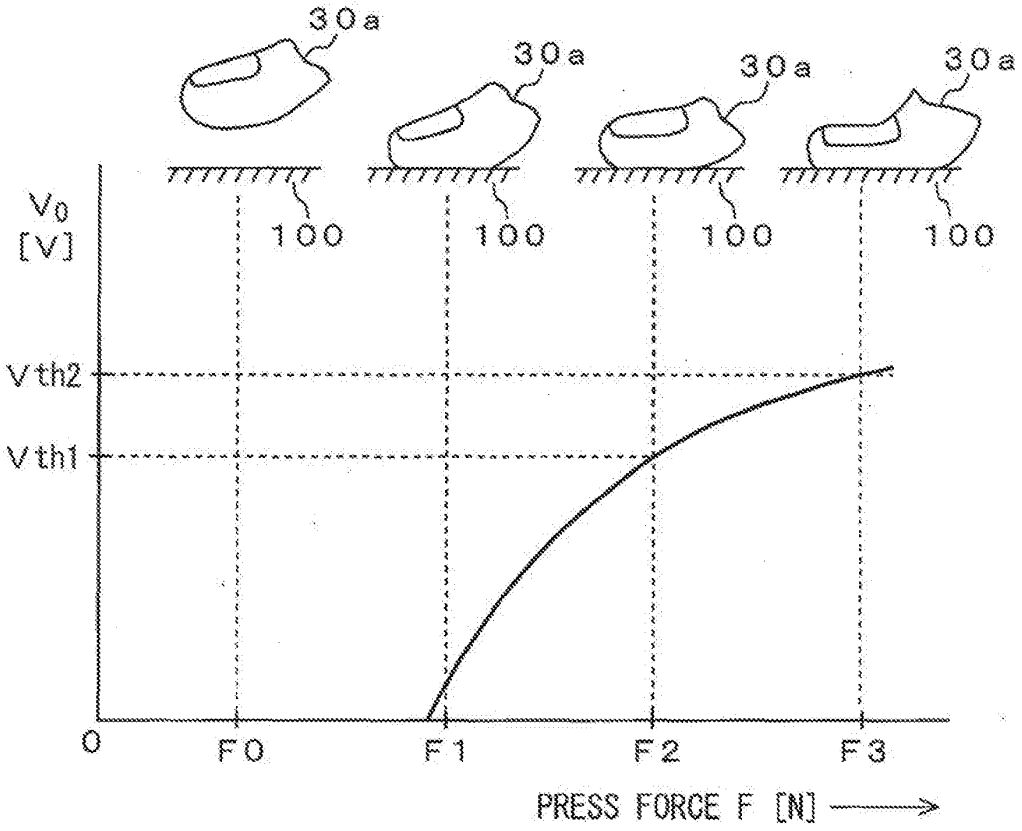


FIG. 8E

FIG. 9A

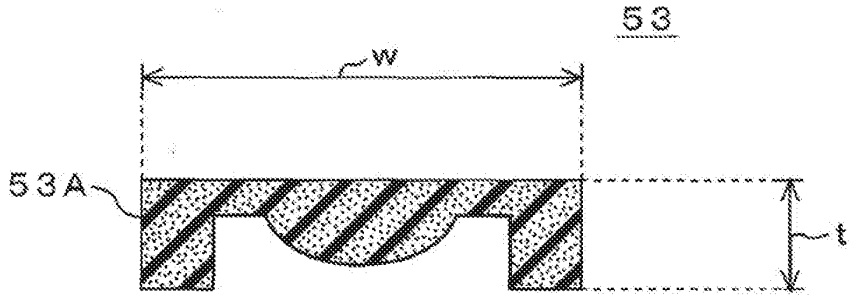


FIG. 9B

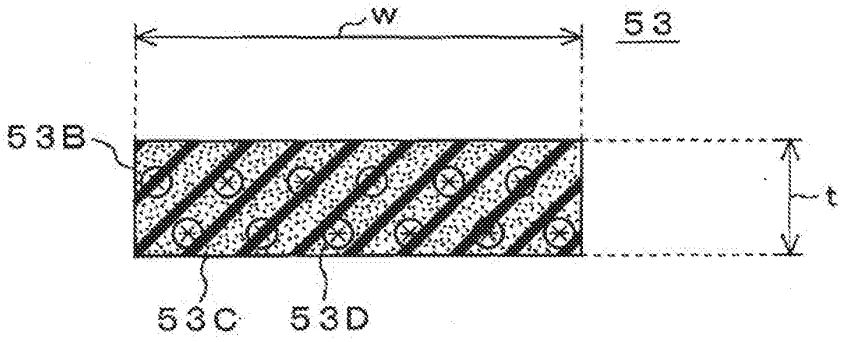


FIG. 9C

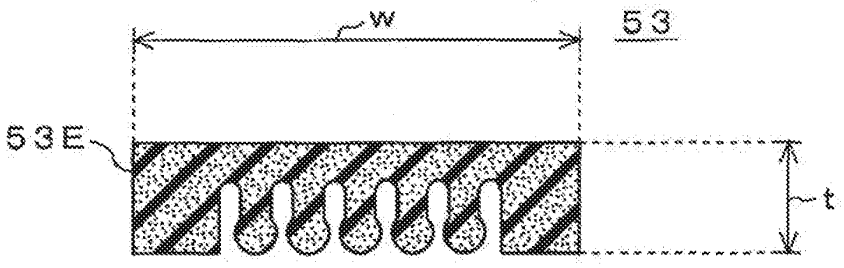


FIG. 10

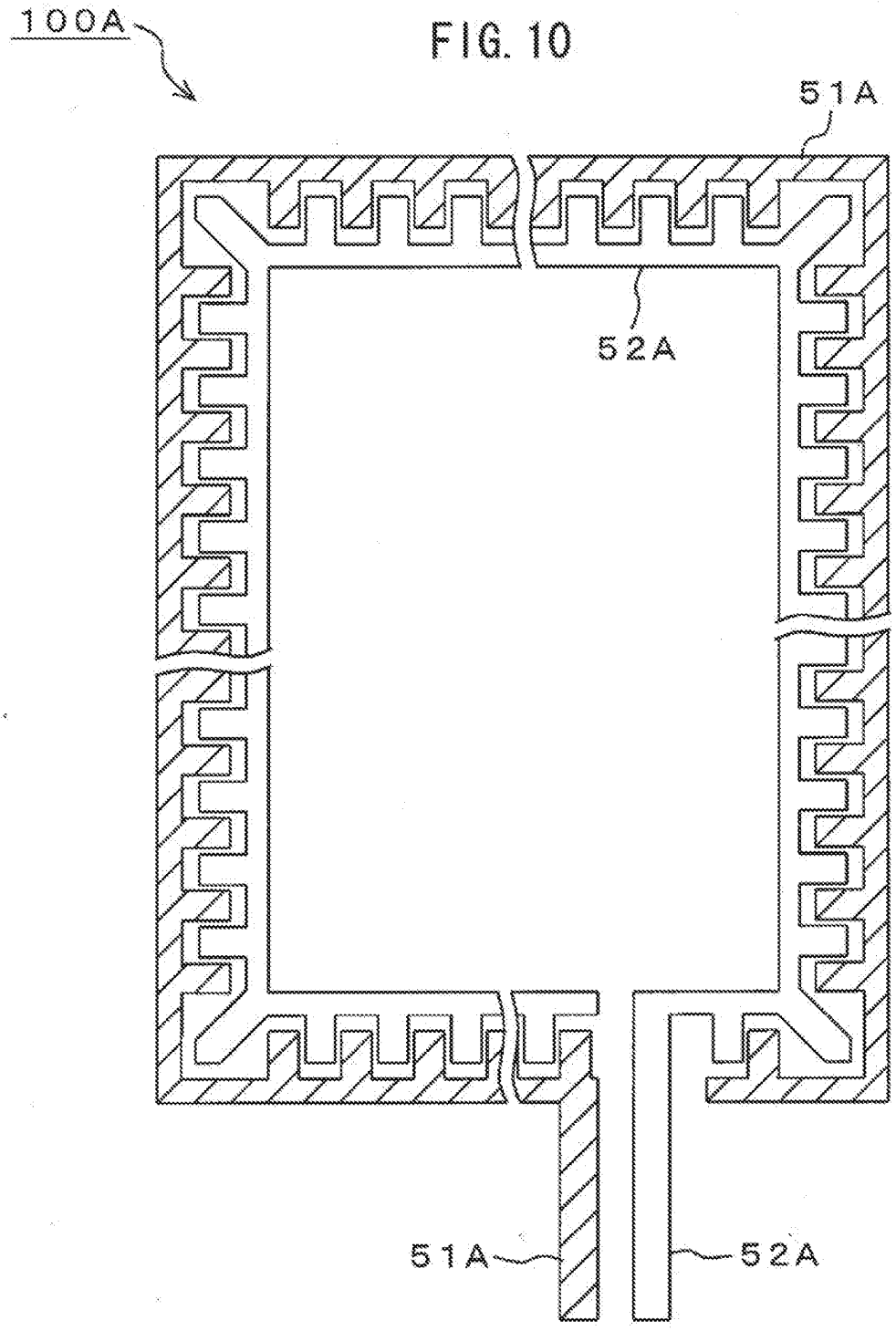


FIG. 11

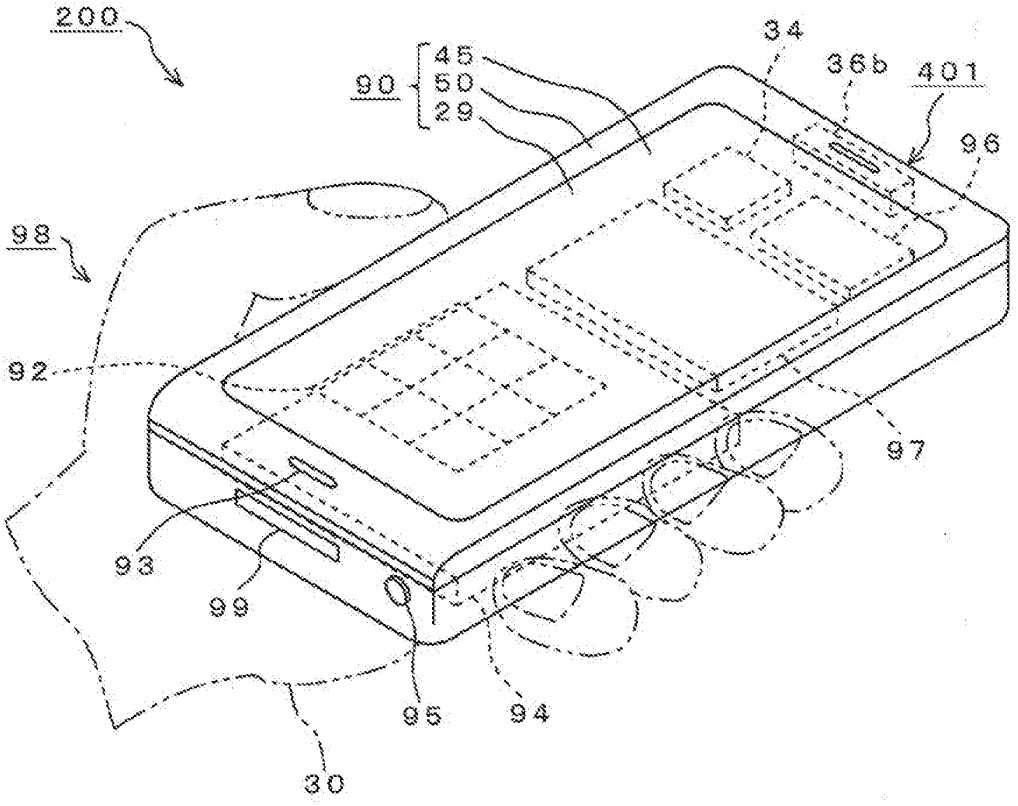


FIG. 12

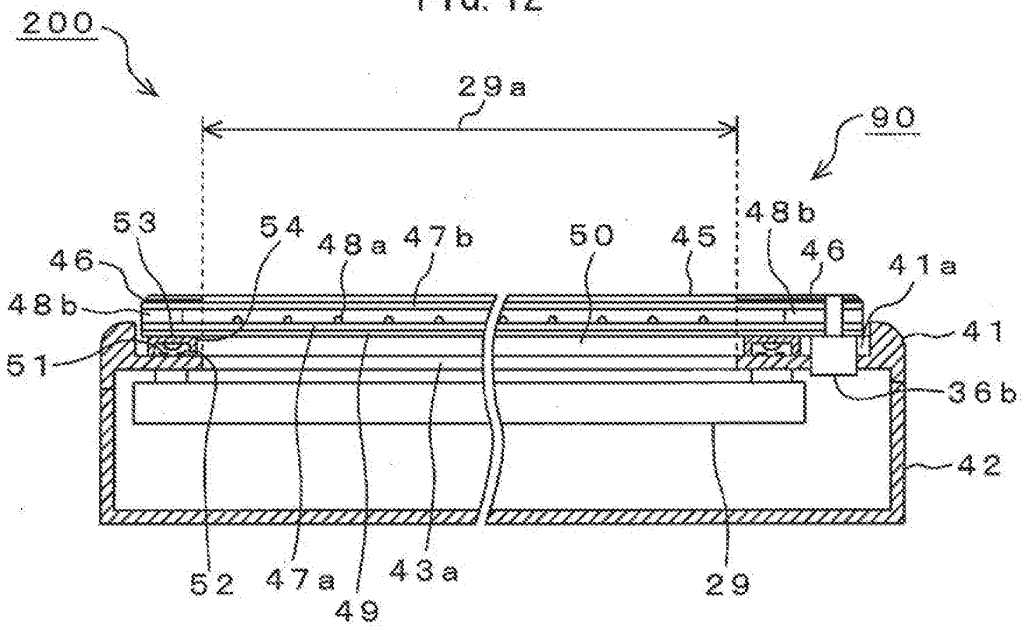
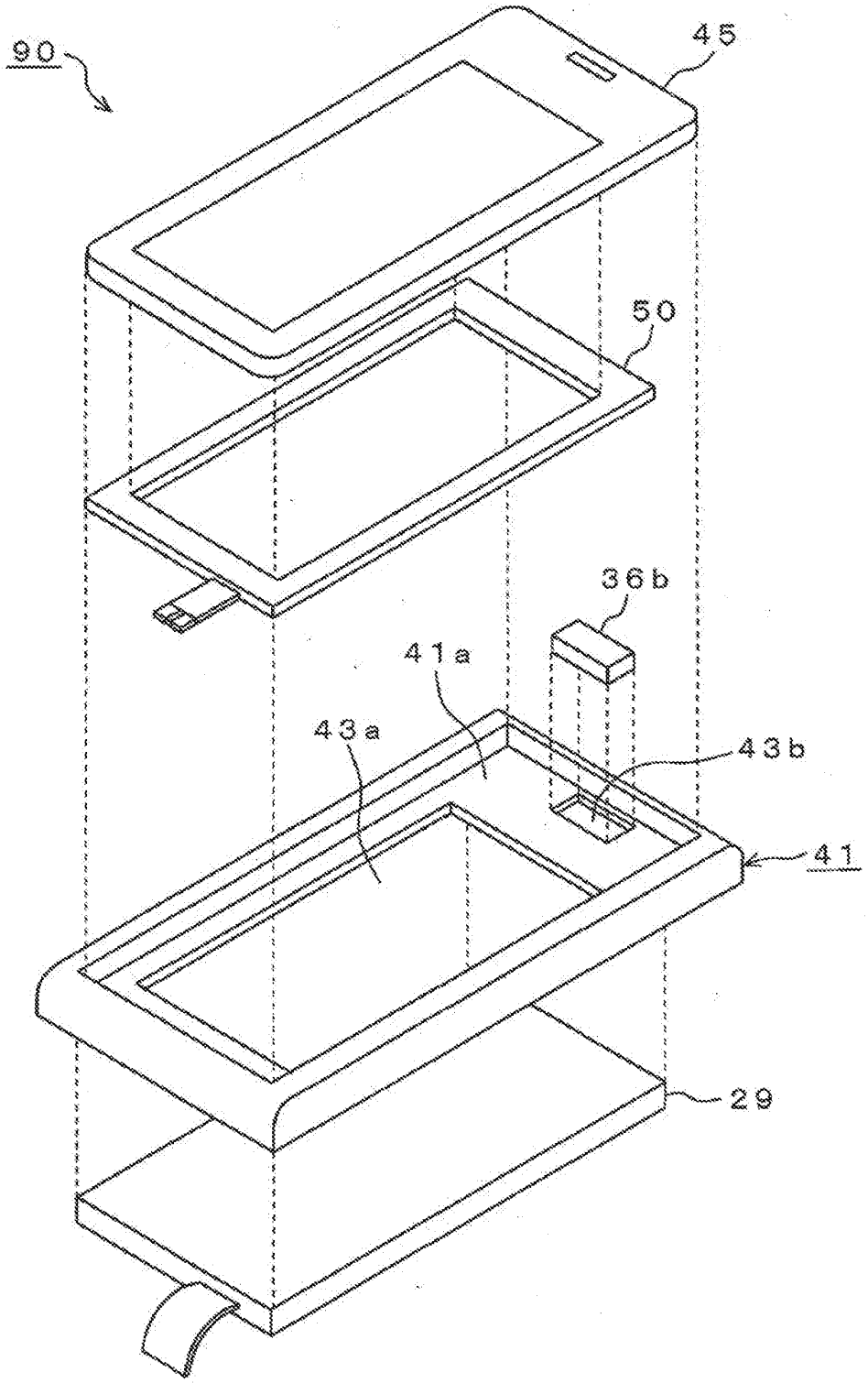

200
29a
90
53
54
48a
47b
50
45
48b
46
46
41a
48b
41
51
36b
42
52
47a
49
43a
29

FIG. 13



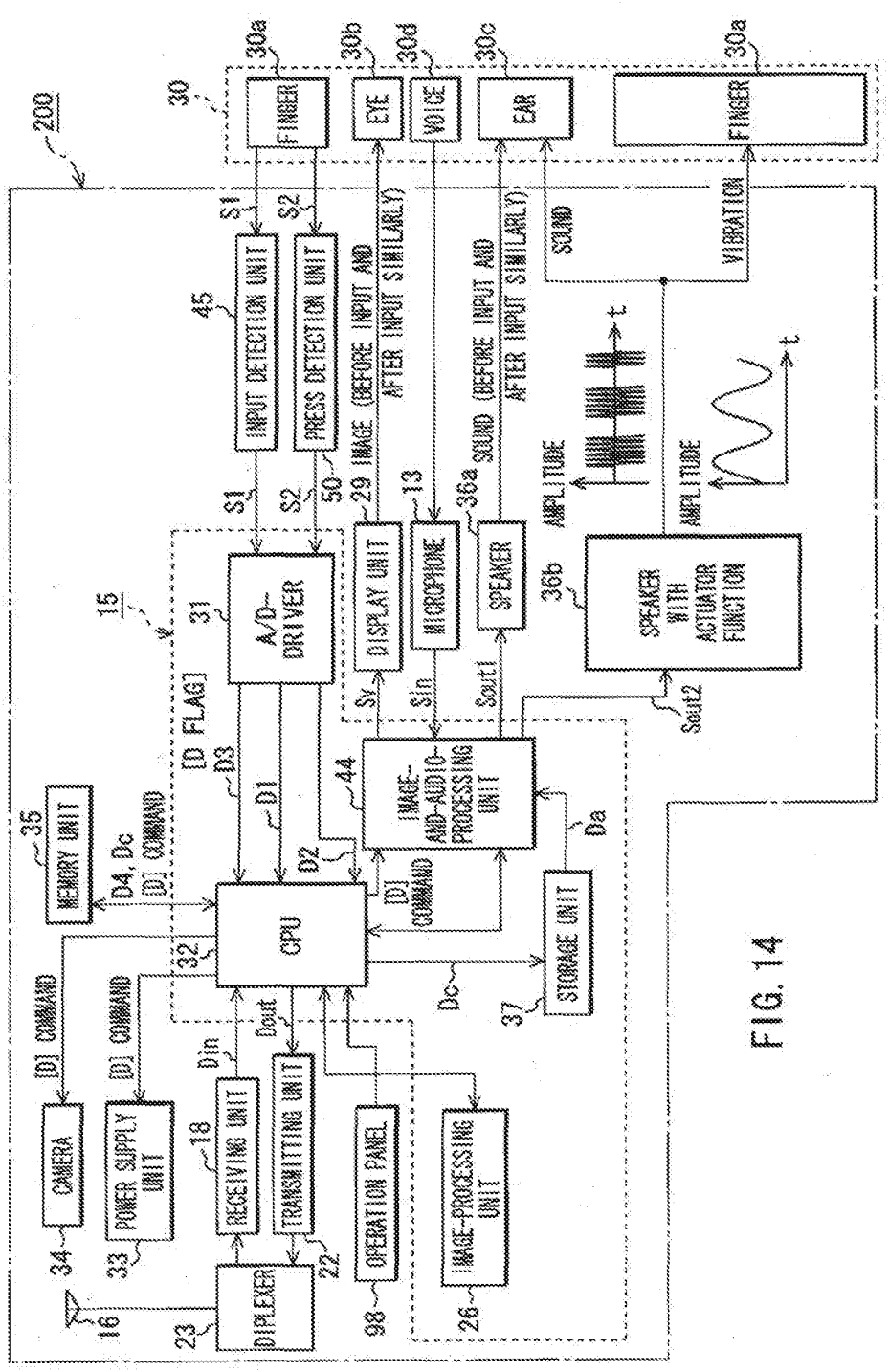

S08P1739
200
30
30a
FINGER
30b
EYE
30d
VOICE
30c
EAR
30a
FINGER
45
INPUT DETECTION UNIT
PRESS DETECTION UNIT
S1
S2
IMAGE (BEFORE INPUT AND AFTER INPUT SIMILARLY)
SOUND (BEFORE INPUT AND AFTER INPUT SIMILARLY)
SOUND
VIBRATION
AMPLITUDE
t
15
31
A/D-DRIVER
29
DISPLAY UNIT
13
MICROPHONE
36a
SPEAKER
36b
SPEAKER WITH ACTUATOR FUNCTION
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
18
RECEIVING UNIT
TRANSMITTING UNIT
22
DIPLEXER
23
16
OPERATION PANEL
98
IMAGE-PROCESSING UNIT
26

FIG. 14

FIG. 15

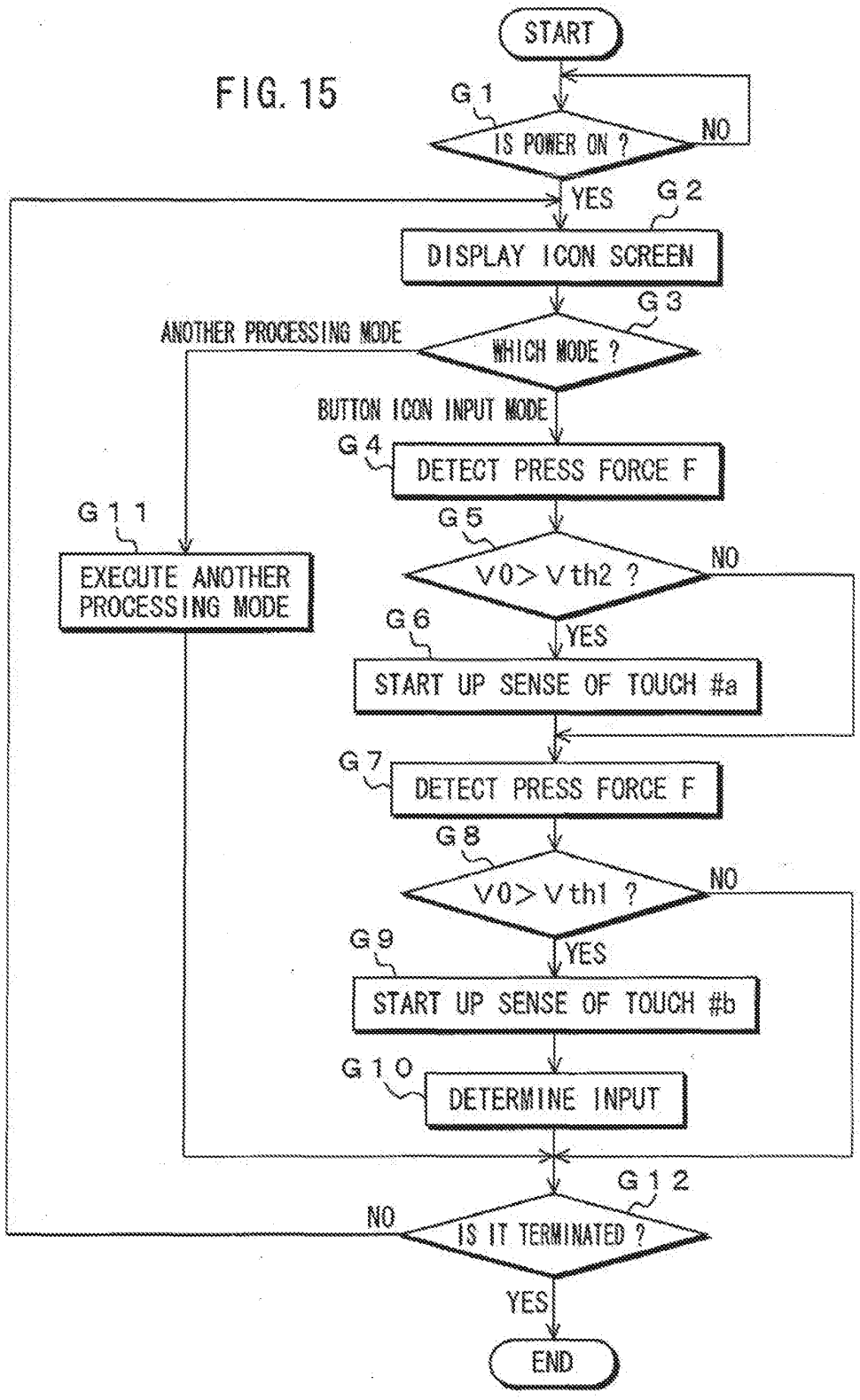

START
G1
IS POWER ON ?
NO
YES
G2
DISPLAY ICON SCREEN
G3
ANOTHER PROCESSING MODE
WHICH MODE ?
BUTTON ICON INPUT MODE
G4
DETECT PRESS FORCE F
G11
G5
EXECUTE ANOTHER PROCESSING MODE
V0>Vth2 ?
NO
G6
YES
START UP SENSE OF TOUCH #a
G7
DETECT PRESS FORCE F
G8
V0>Vth1 ?
NO
G9
YES
START UP SENSE OF TOUCH #b
G10
DETERMINE INPUT
G12
NO
IS IT TERMINATED ?
YES
END

FIG. 16

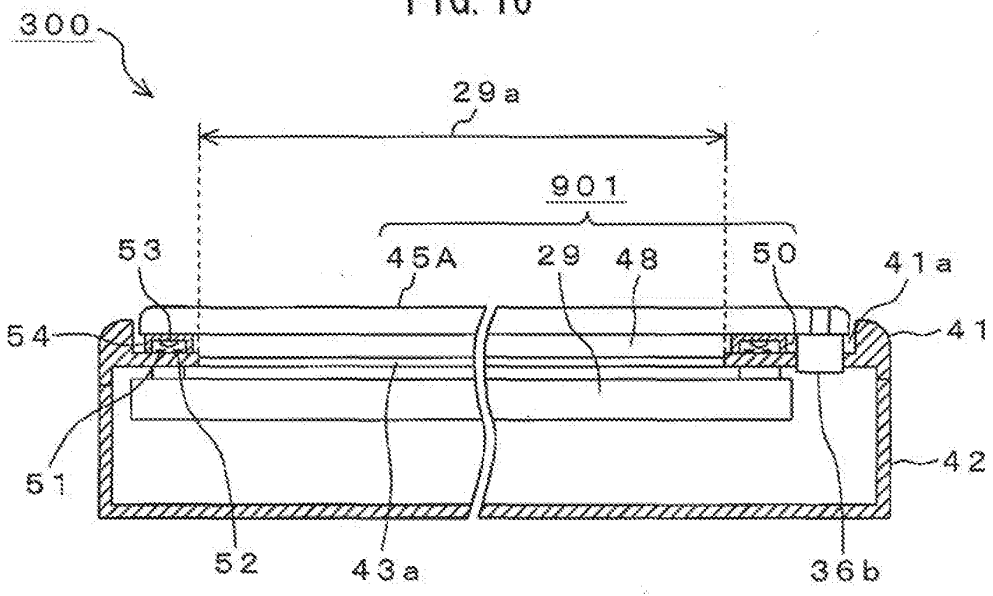


FIG. 17

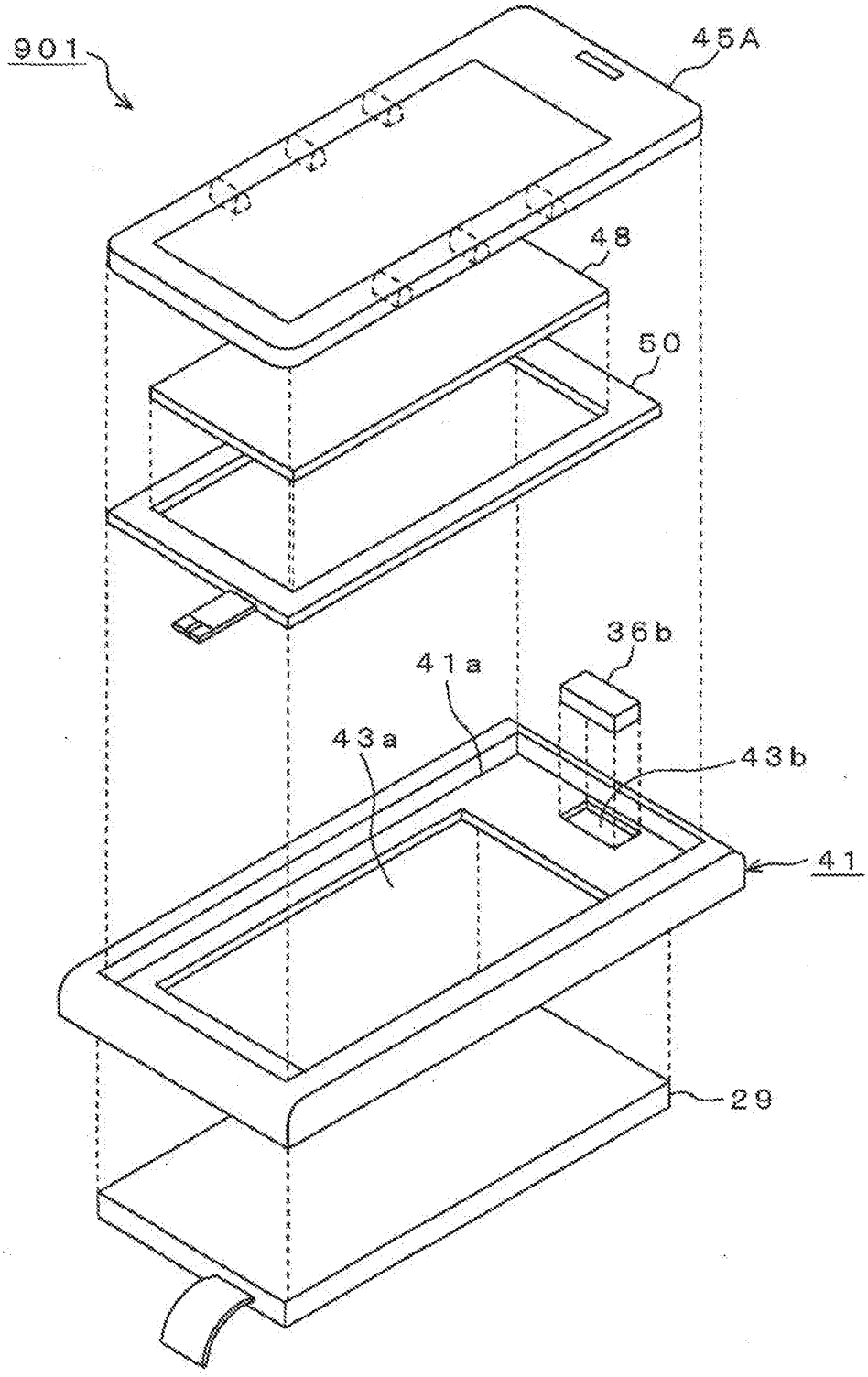


FIG. 18

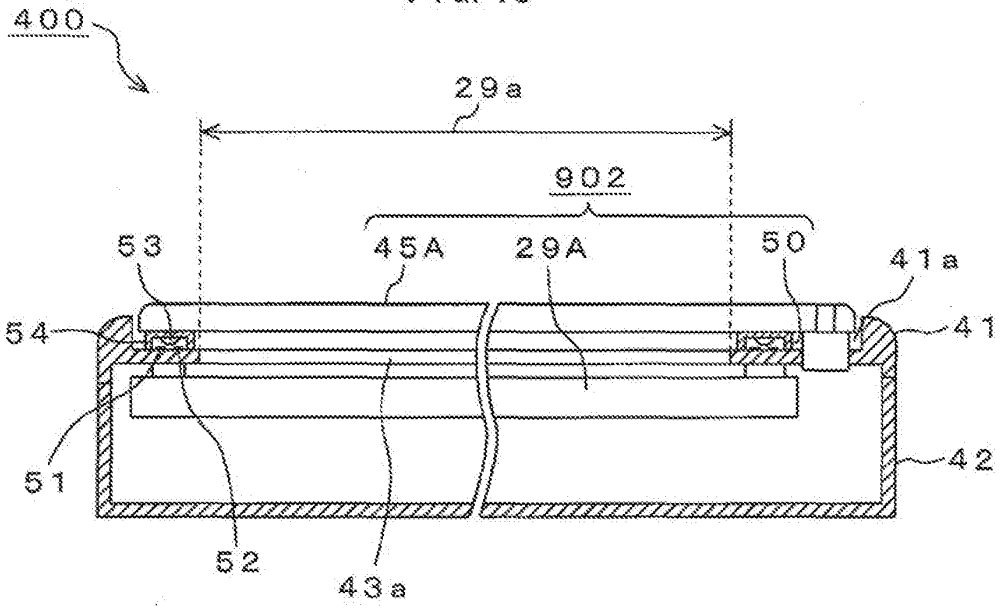


FIG. 19

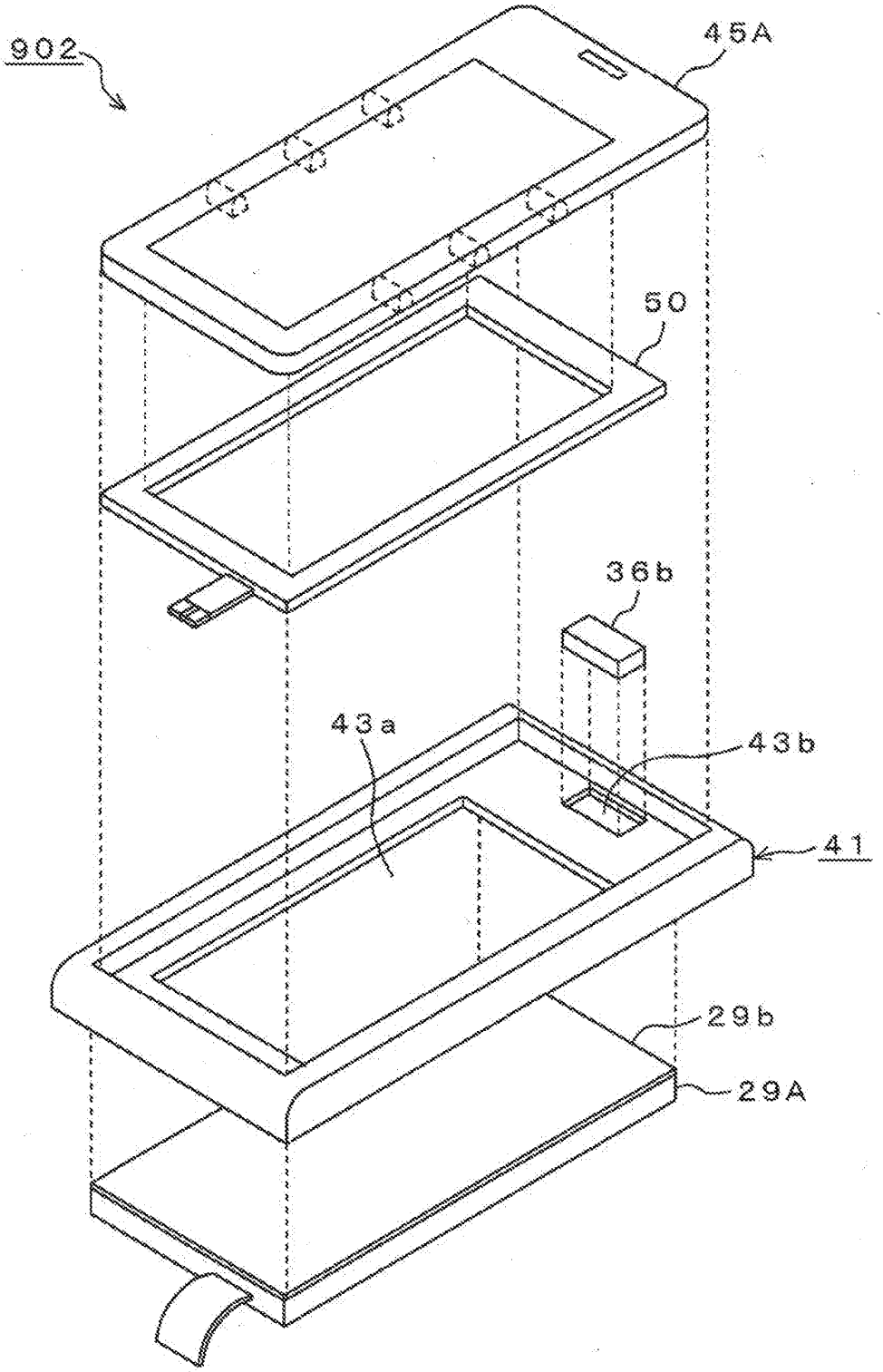


FIG. 20

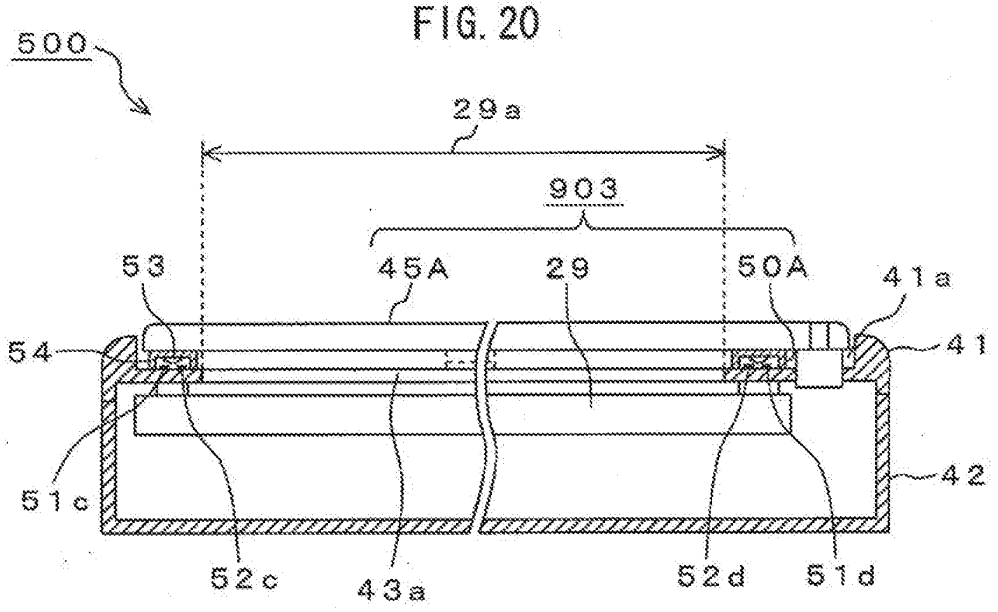


FIG. 21

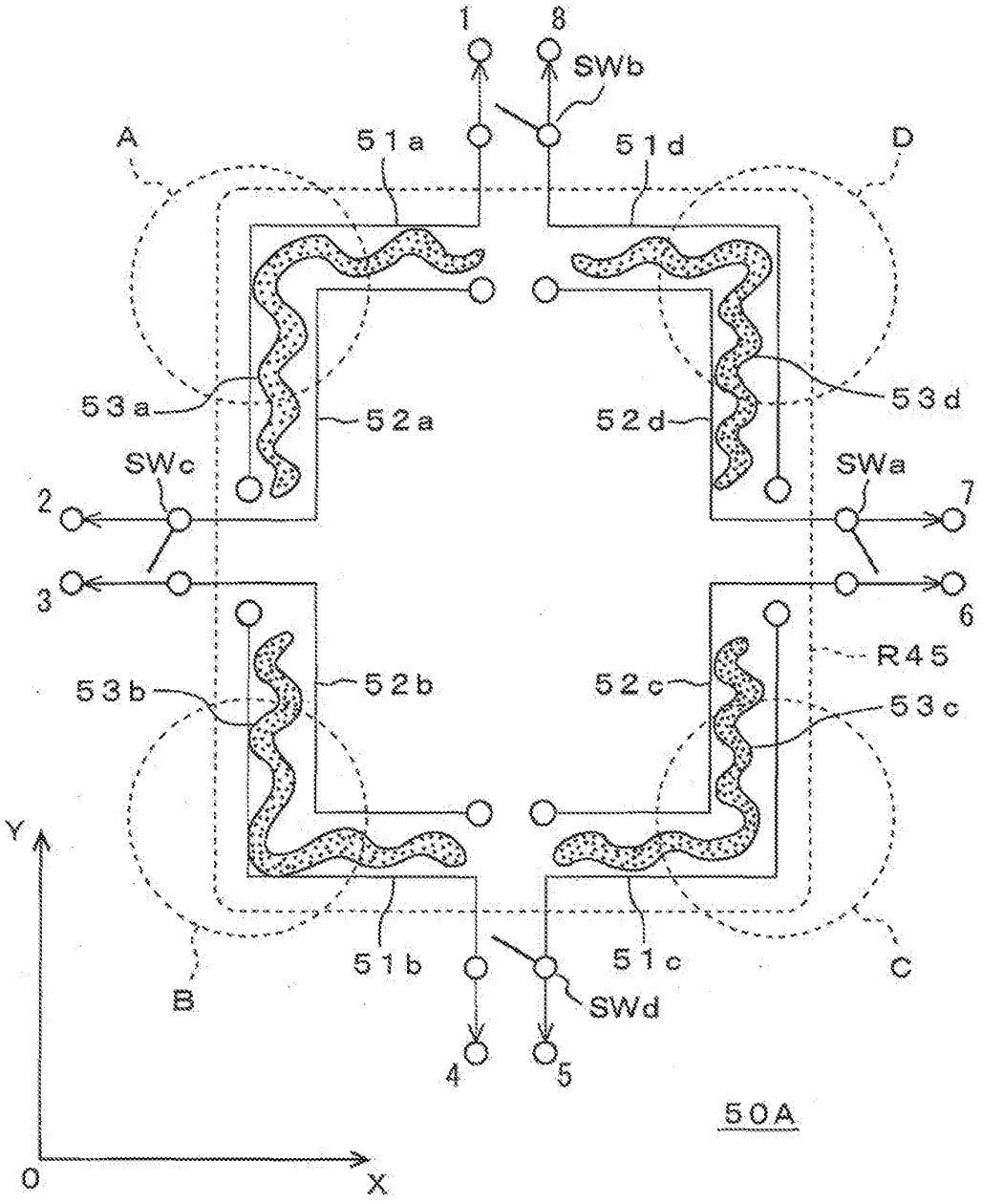

1
8
SWb
A
51a
51d
D
53a
52a
52d
53d
SWc
SWa
2
7
3
6
R45
53b
52b
52c
53c
Y
51b
51c
C
B
SWd
4
5
50A
0
X

FIG. 22

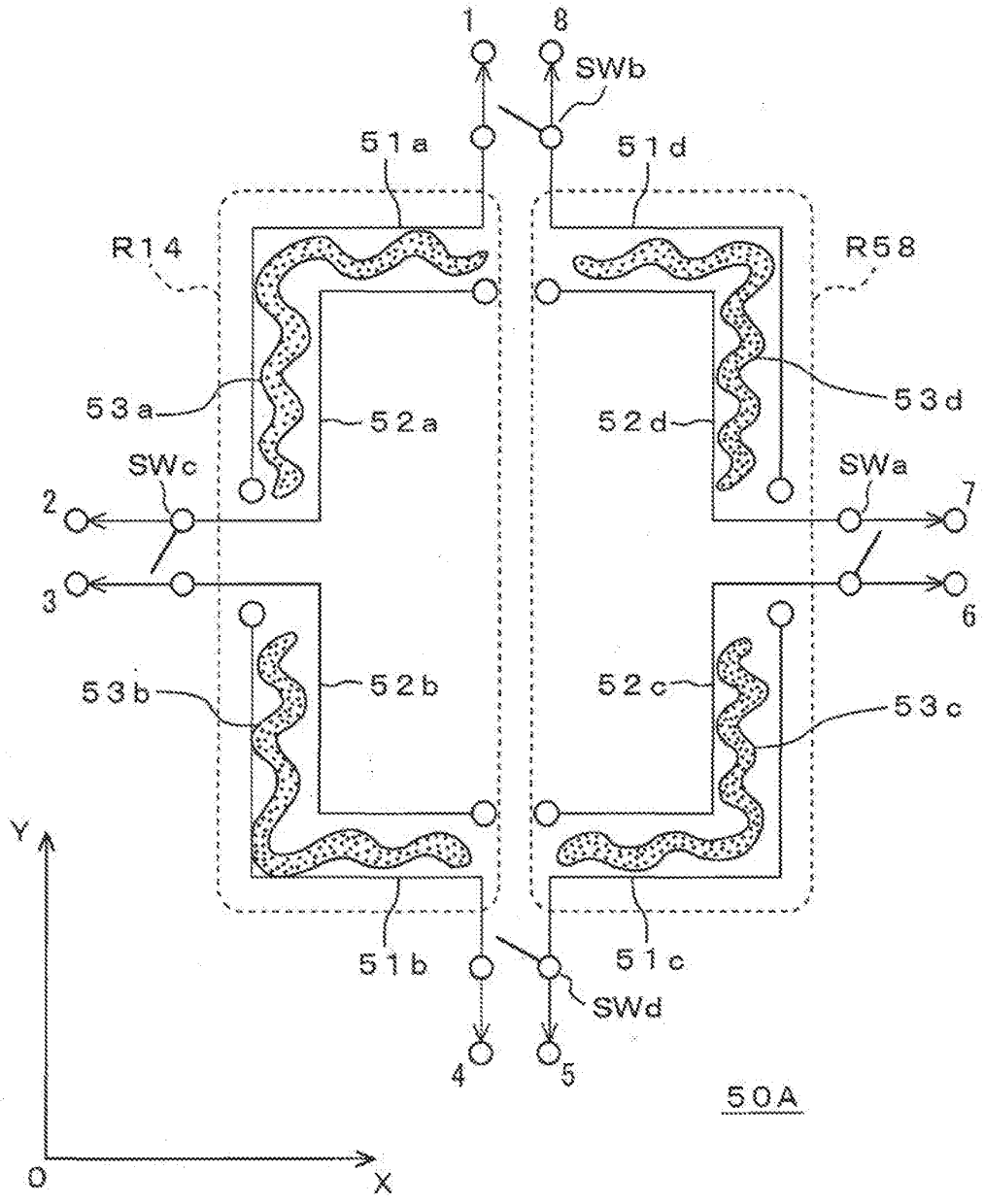

1
8
SWb
51a
51d
R14
R58
53a
52a
52d
53d
SWc
SWa
2
7
3
6
53b
52b
52c
53c
Y
51b
51c
SWd
4
5
50A
0
X

FIG. 23

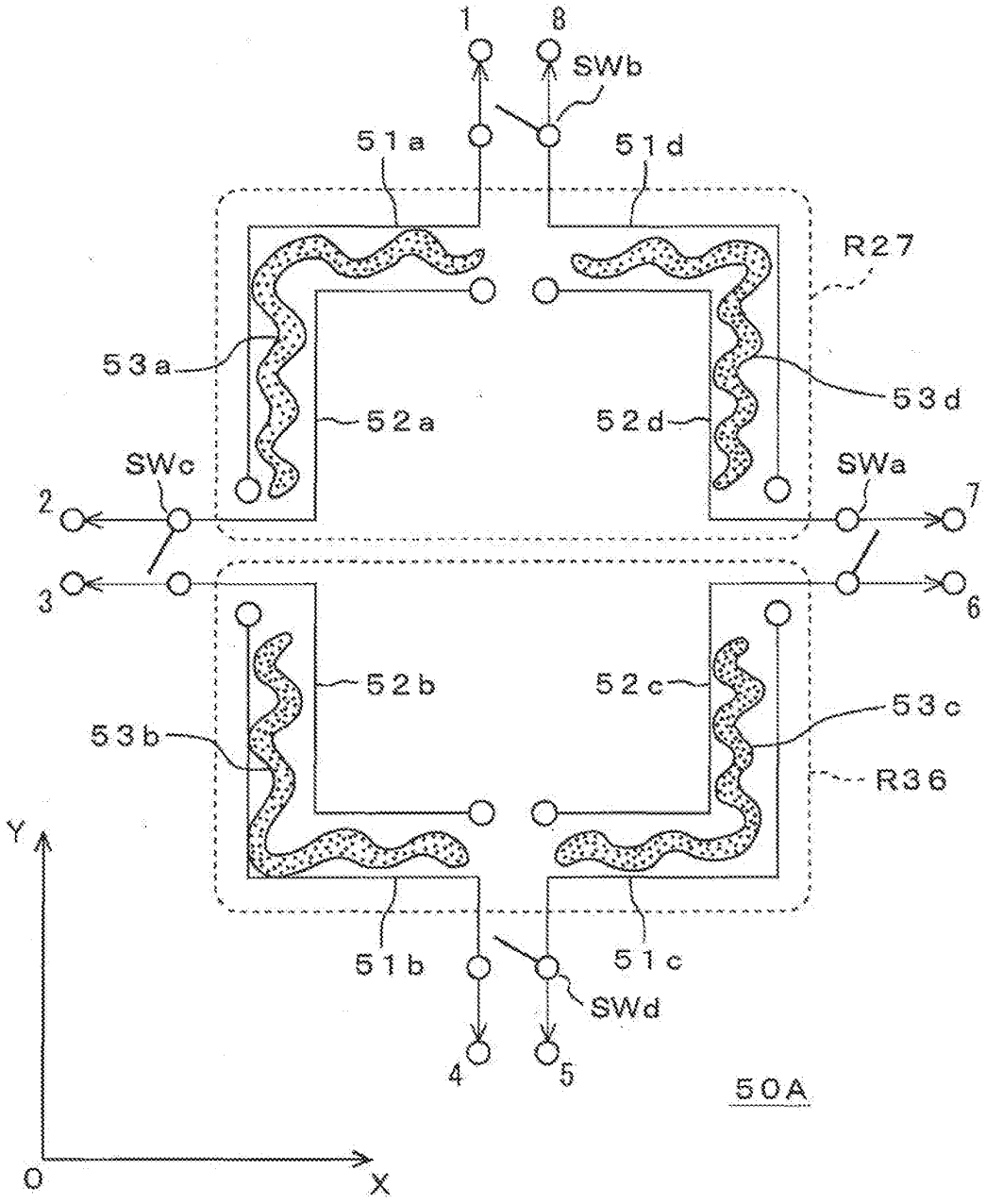

1
8
SWb
51a
51d
R27
53a
53d
52a
52d
SWc
SWa
2
7
3
6
52b
52c
53b
53c
R36
Y
51b
51c
SWd
4
5
50A
O
X

FIG. 24

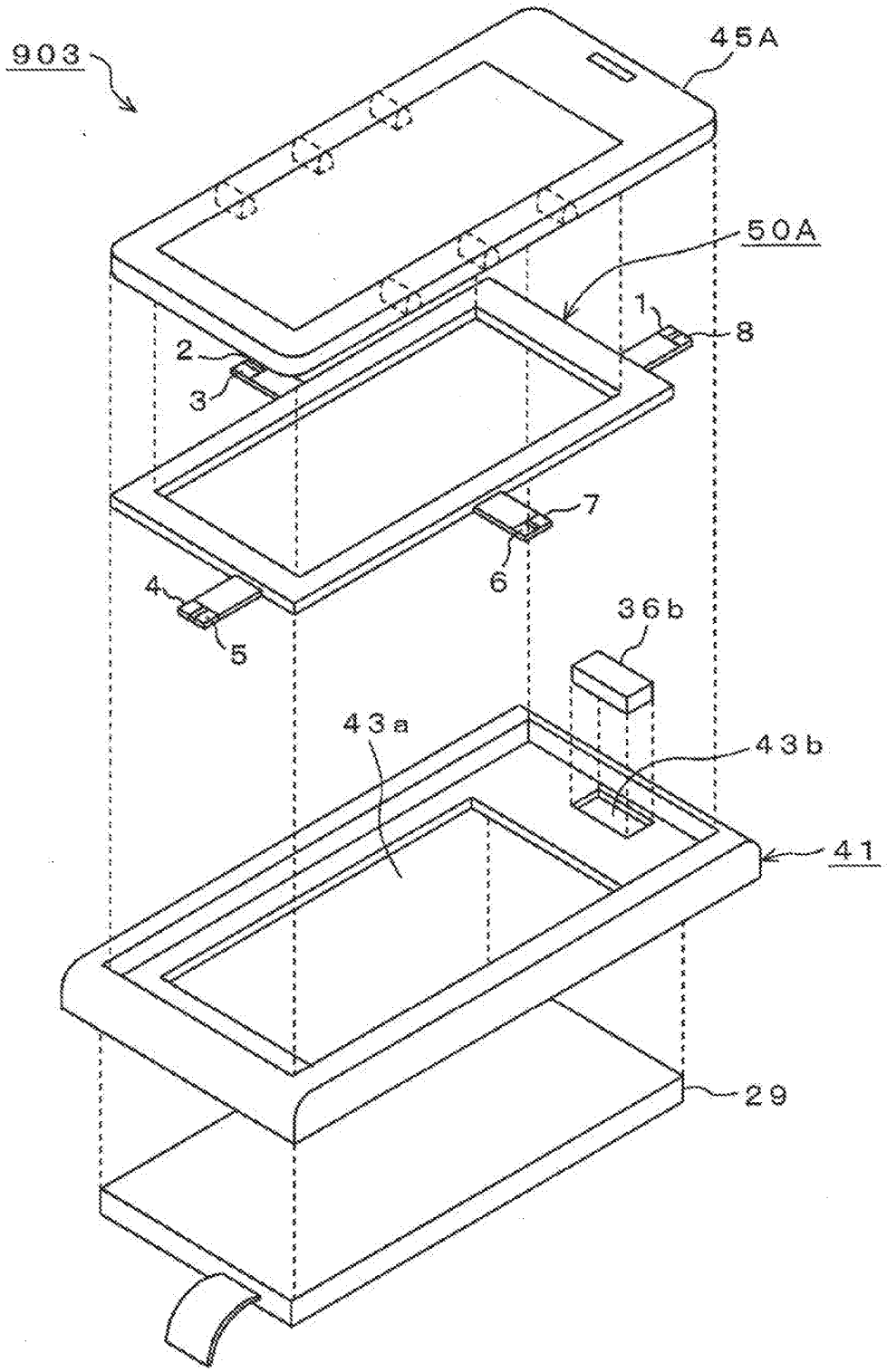


FIG. 25

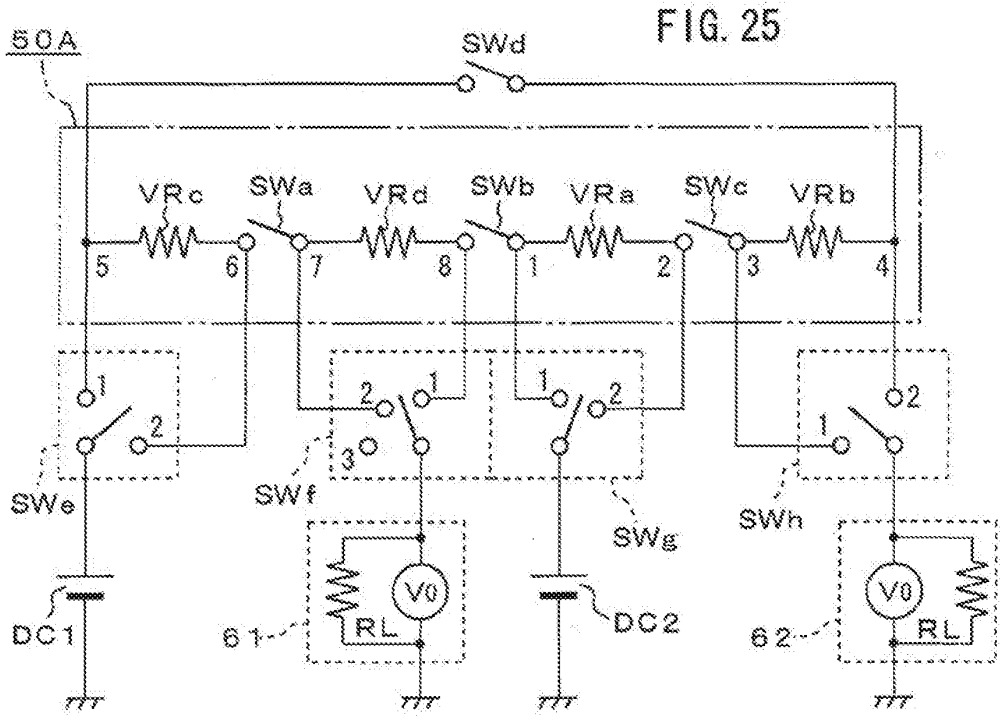

50A
SWd
VRc
SWa
VRd
SWb
VRa
SWc
VRb
5
6
7
8
1
2
3
4
SWe
SWf
SWg
SWh
DC1
DC2
61
62
V0
RL

FIG. 26

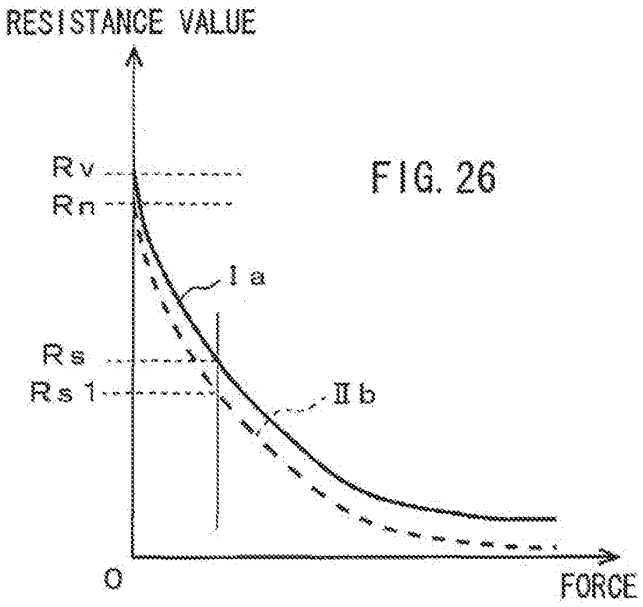
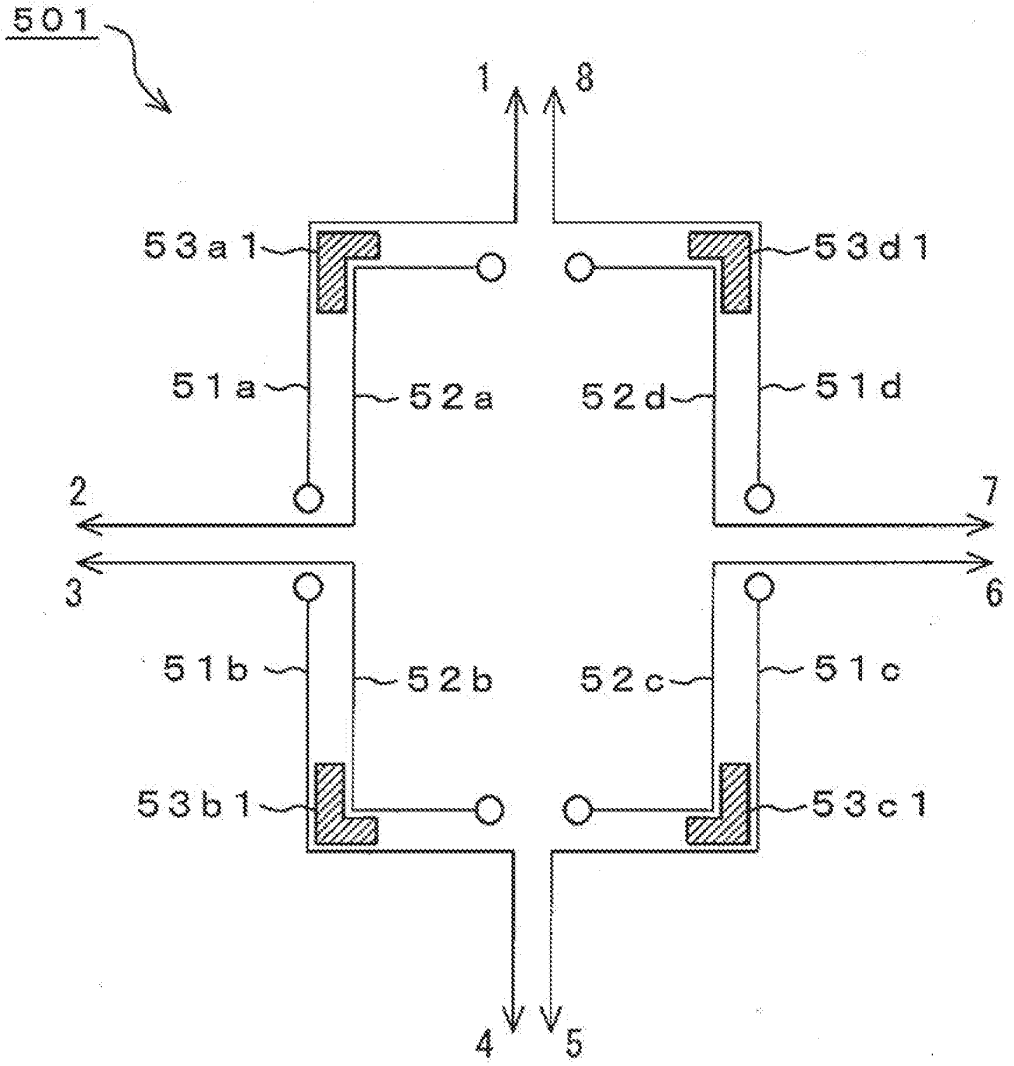

RESISTANCE VALUE
Rv
Rn
Ia
Rs
Rs1
IIb
O
FORCE

FIG. 27


501
1
8
53a1
53d1
51a
52a
52d
51d
2
7
3
6
51b
52b
52c
51c
53b1
53c1
4
5

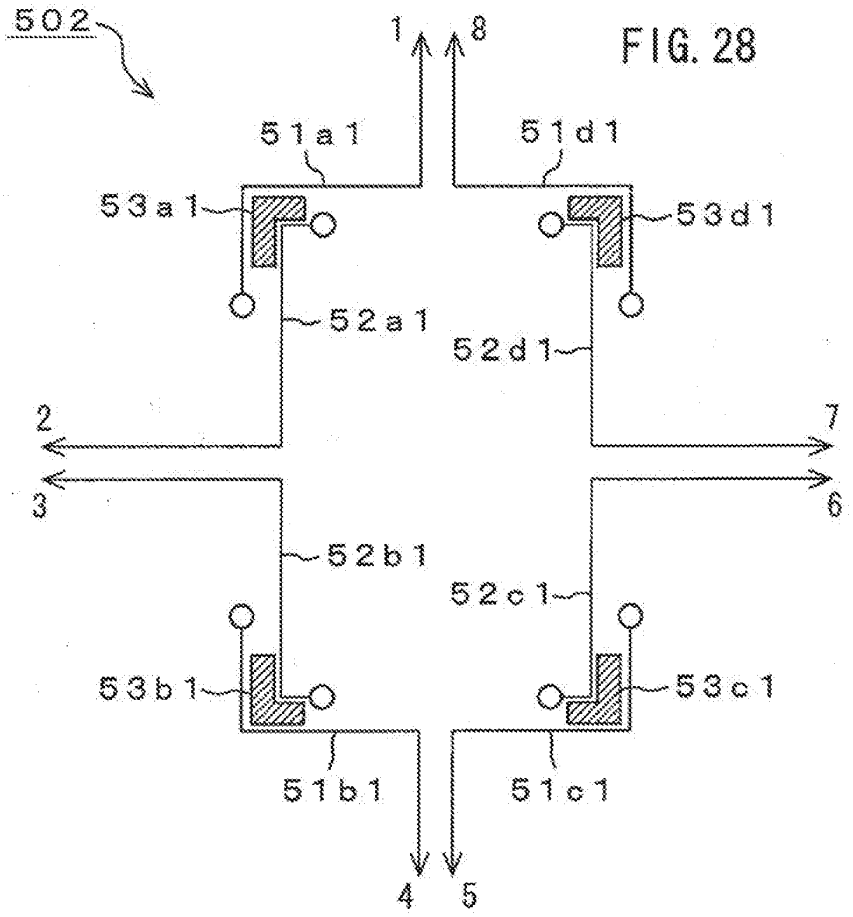

502
1
8
51a1
51d1
53a1
53d1
52a1
52d1
2
7
3
6
52b1
52c1
53b1
53c1
51b1
51c1
4
5

FIG. 28

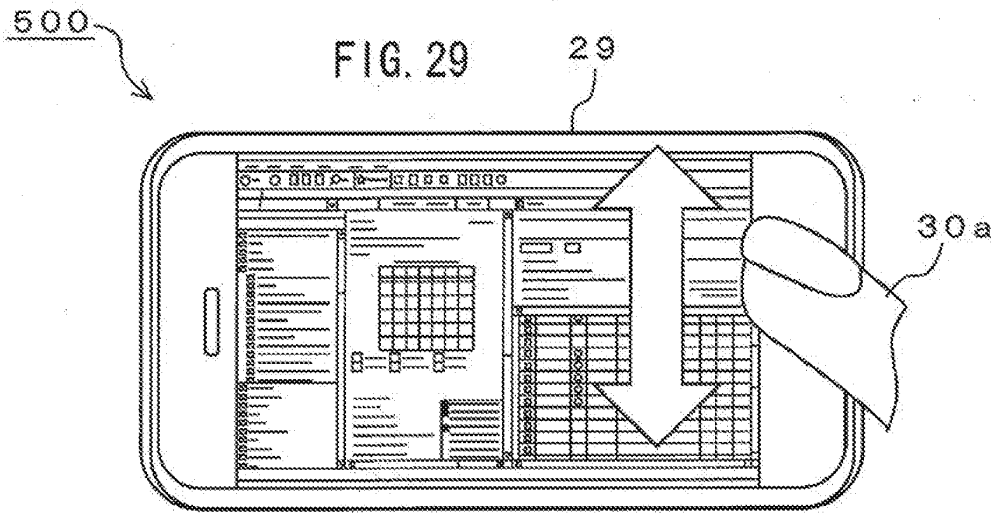

500
29
30a

FIG. 29

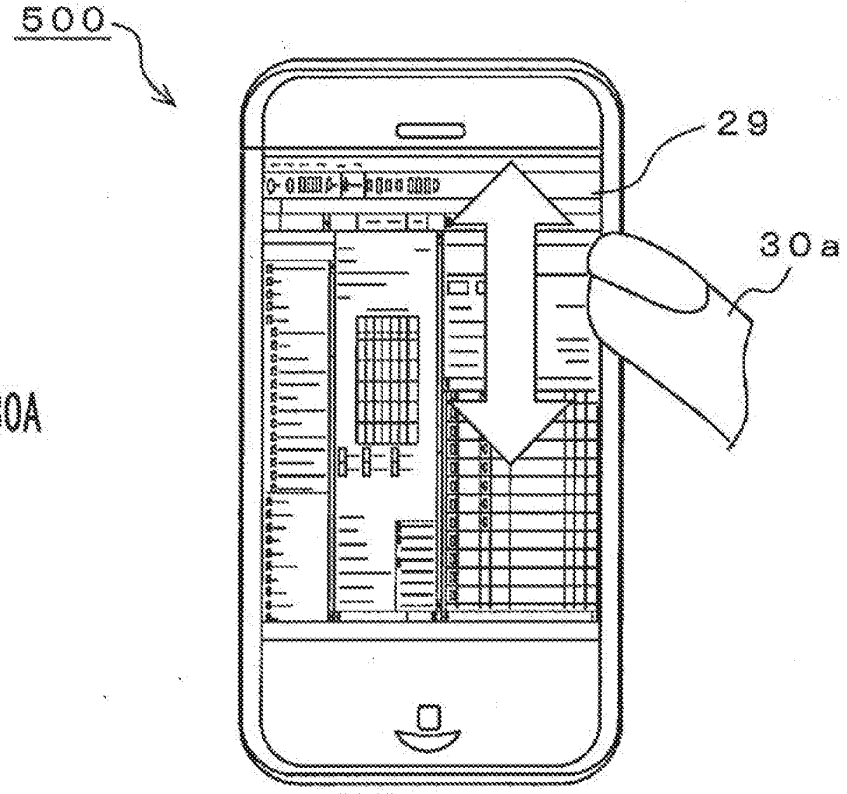


FIG. 30A

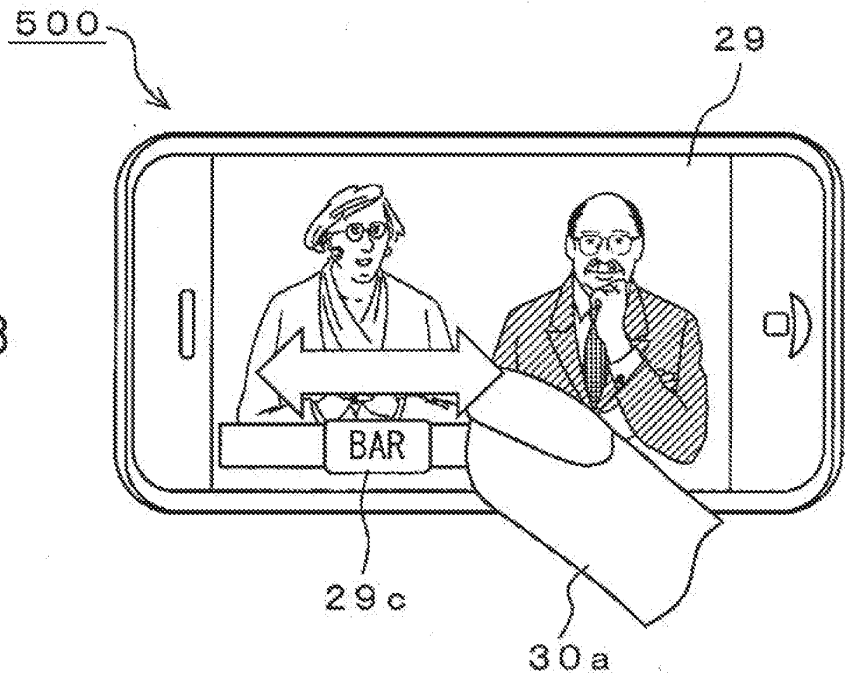


FIG. 30B

FIG. 31

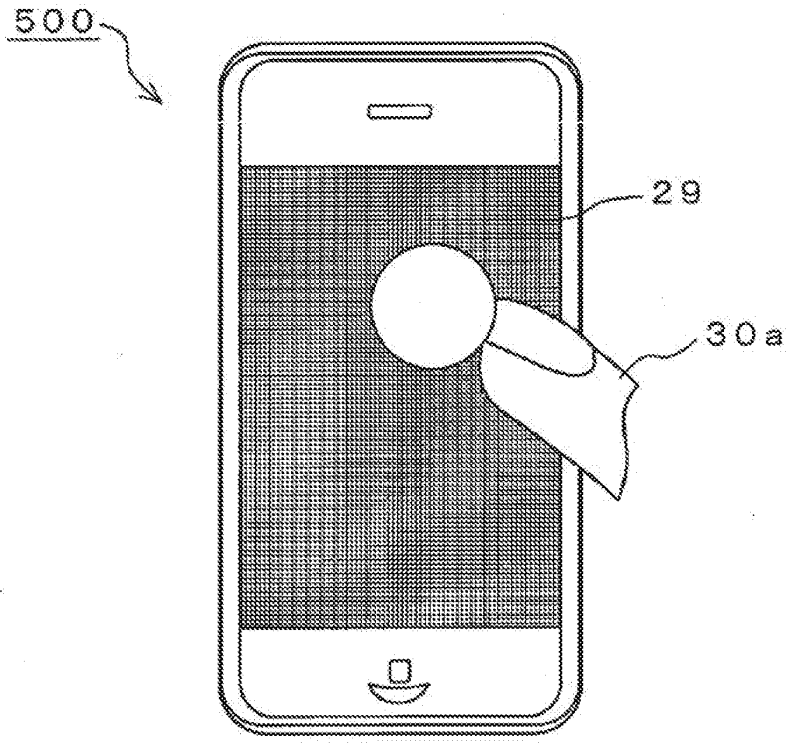


FIG. 32

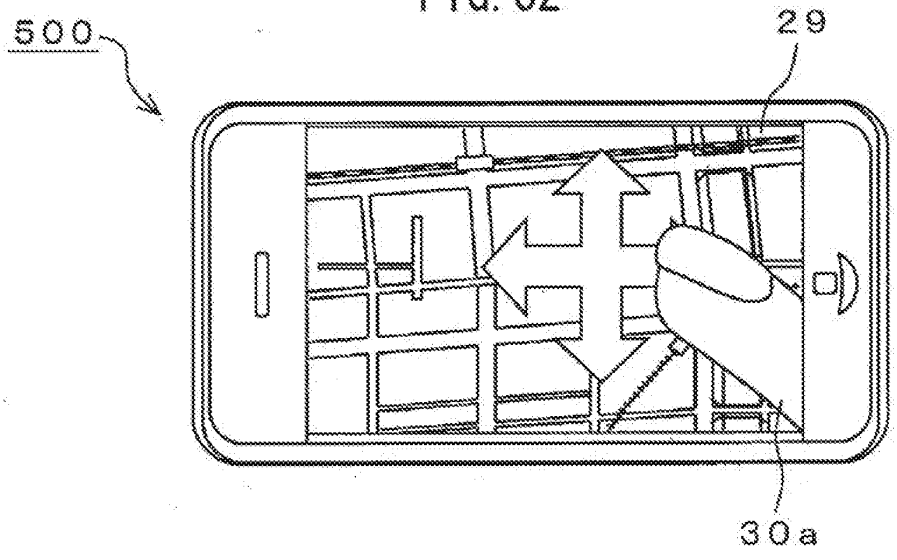


FIG. 33

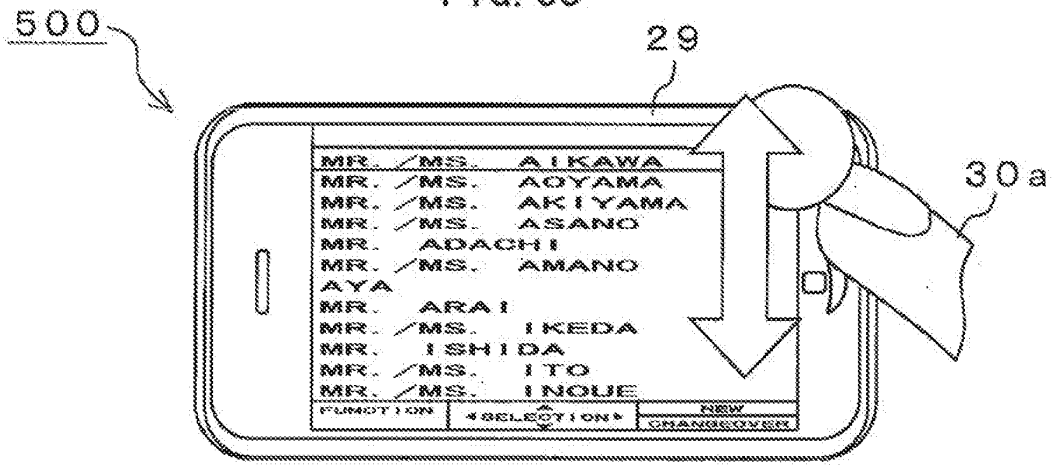

500
29
30a
MR. /MS. AIKAWA
MR. /MS. AOYAMA
MR. /MS. AKIYAMA
MR. /MS. ASANO
MR. ADACHI
MR. /MS. AMANO
AYA
MR. ARAI
MR. /MS. IKEDA
MR. ISHIDA
MR. /MS. ITO
MR. /MS. INOUE
FUNCTION
SELECTION
NEW
CHANGEOVER

FIG. 34

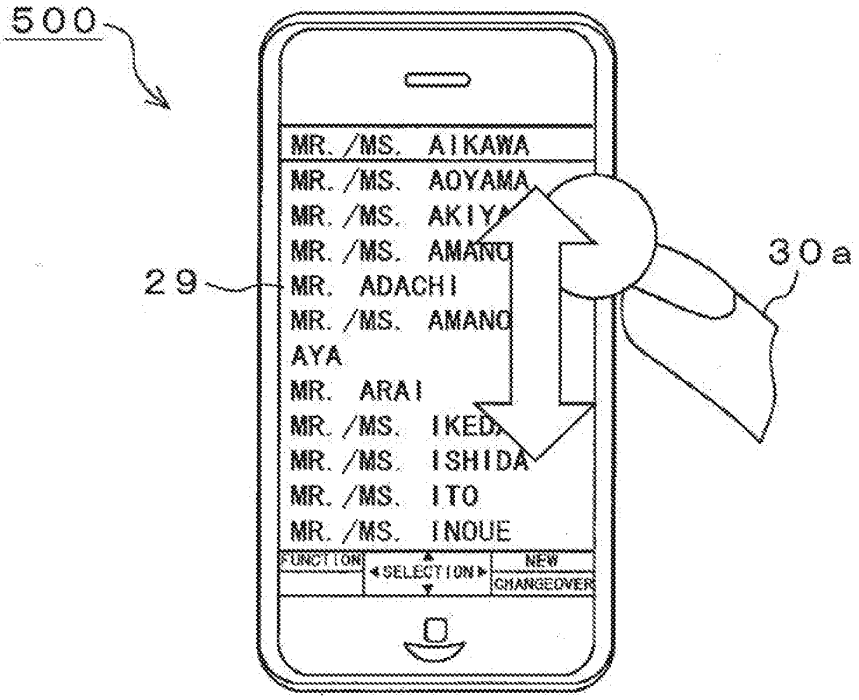

500
29
30a
MR. /MS. AIKAWA
MR. /MS. AOYAMA
MR. /MS. AKIY
MR. /MS. AMANO
MR. ADACHI
MR. /MS. AMANO
AYA
MR. ARAI
MR. /MS. IKED
MR. /MS. ISHIDA
MR. /MS. ITO
MR. /MS. INOUE
FUNCTION
SELECTION
NEW
CHANGEOVER

FIG. 35

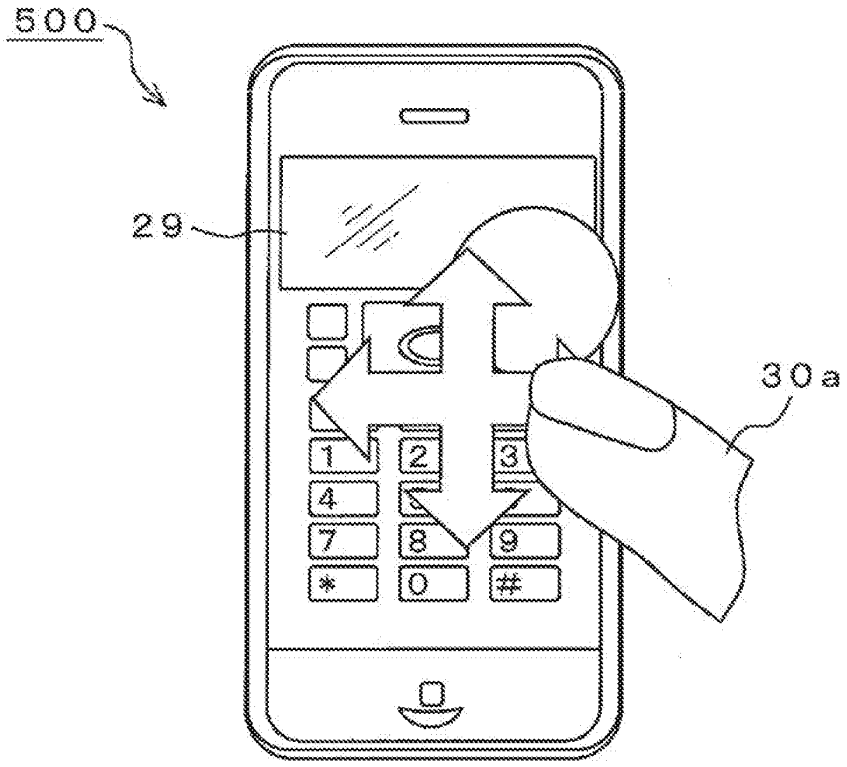


FIG. 36

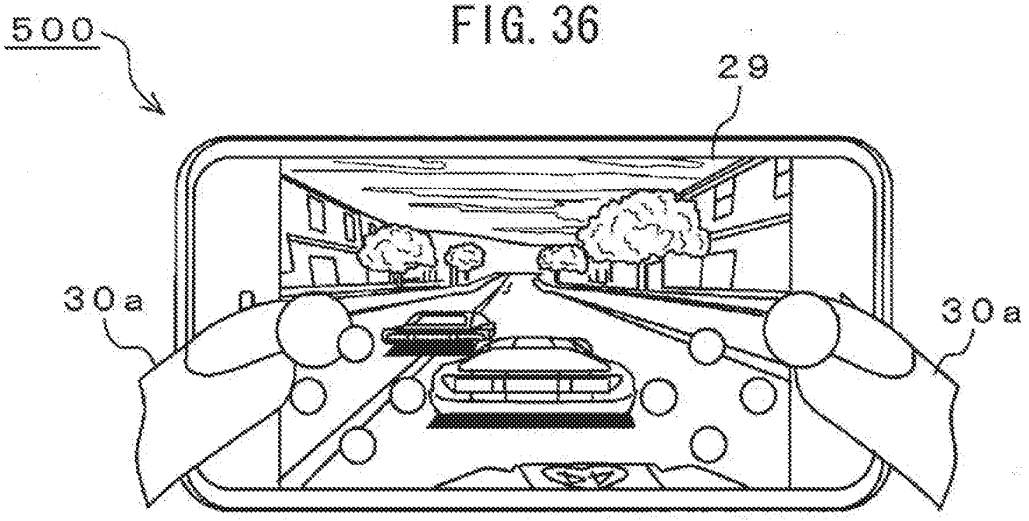


FIG. 37

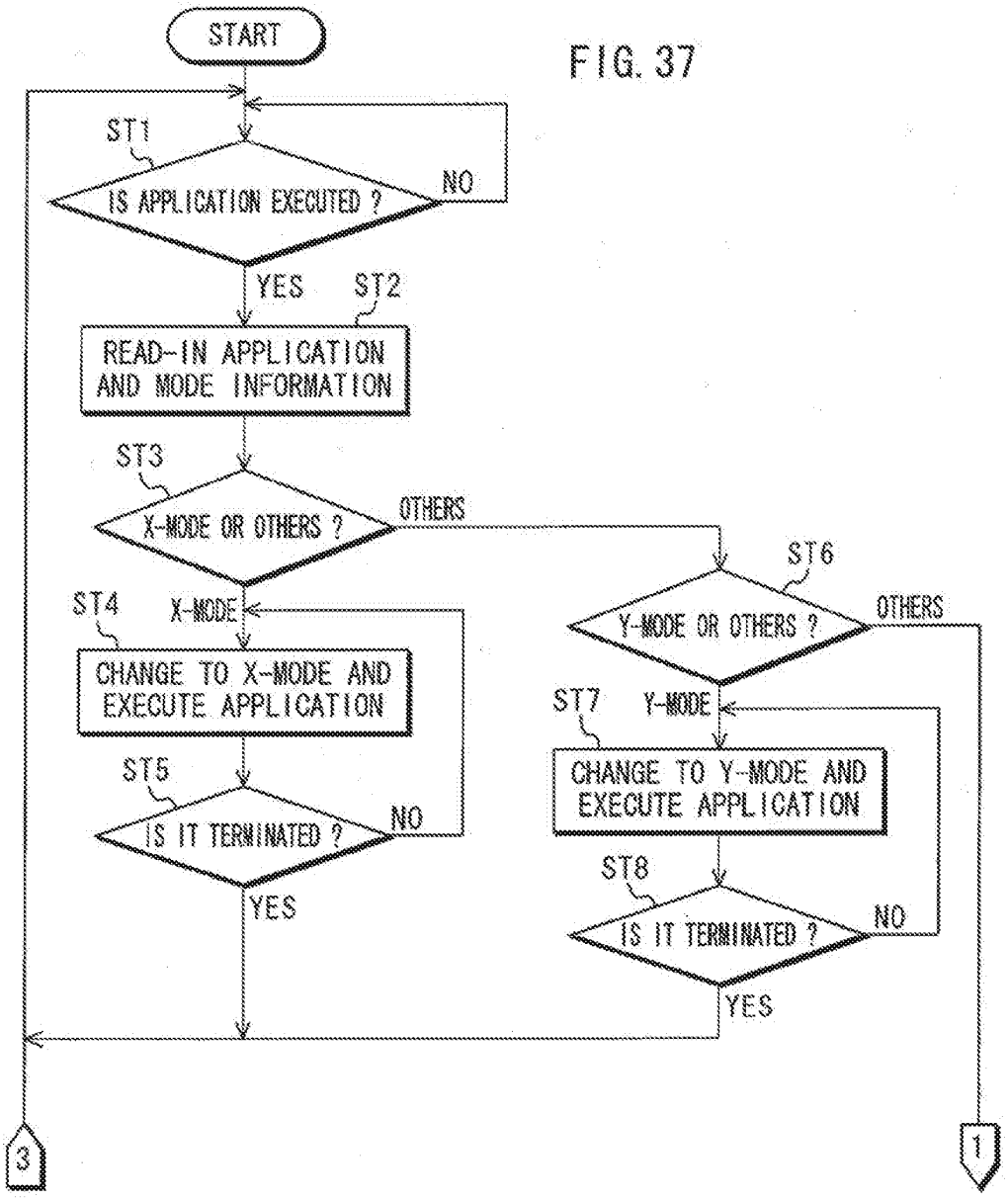

START
ST1
IS APPLICATION EXECUTED ?
NO
YES
ST2
READ-IN APPLICATION AND MODE INFORMATION
ST3
X-MODE OR OTHERS ?
OTHERS
ST4
X-MODE
CHANGE TO X-MODE AND EXECUTE APPLICATION
ST5
IS IT TERMINATED ?
NO
YES
ST6
Y-MODE OR OTHERS ?
OTHERS
ST7
Y-MODE
CHANGE TO Y-MODE AND EXECUTE APPLICATION
ST8
IS IT TERMINATED ?
NO
YES
3
1

FIG. 38

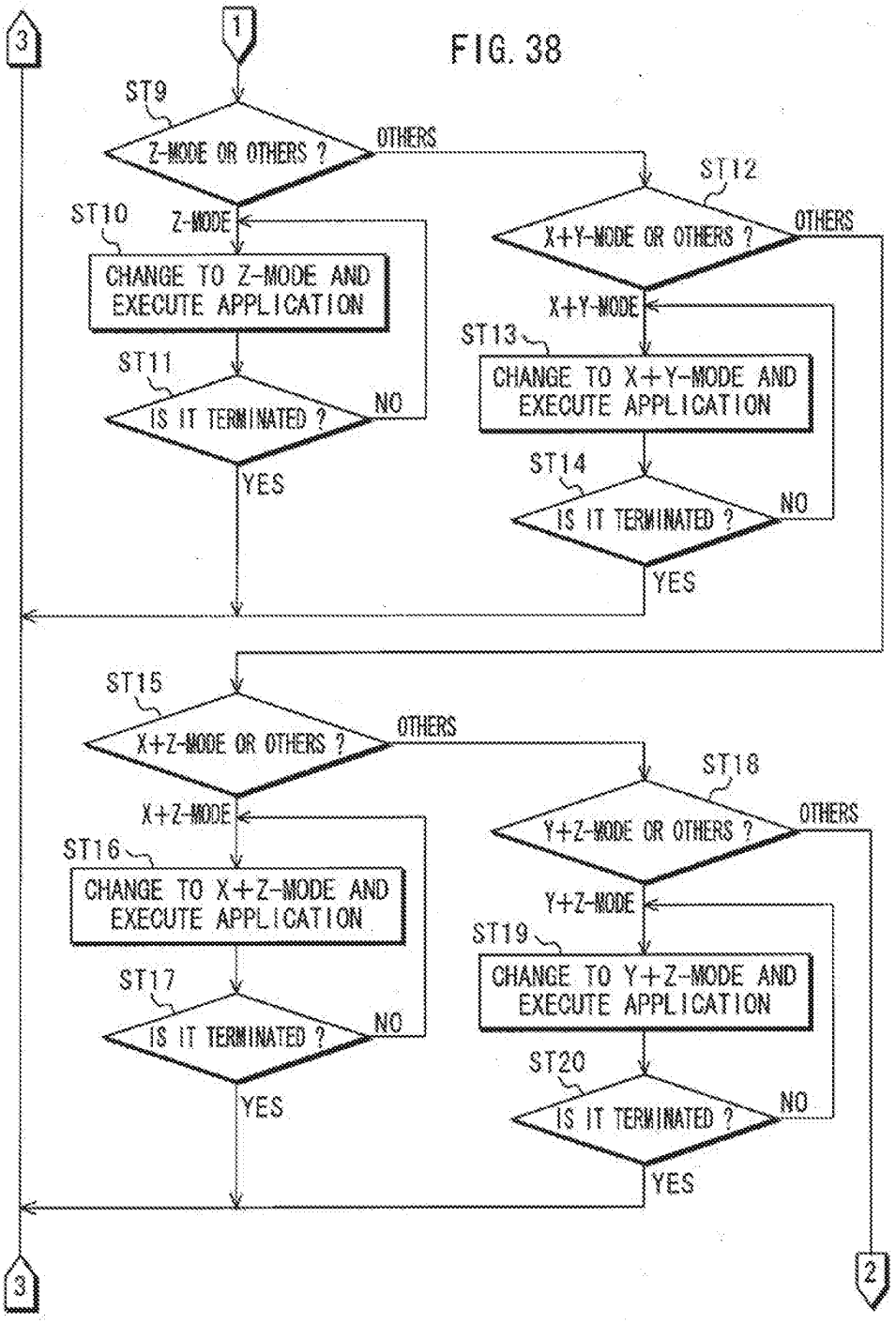
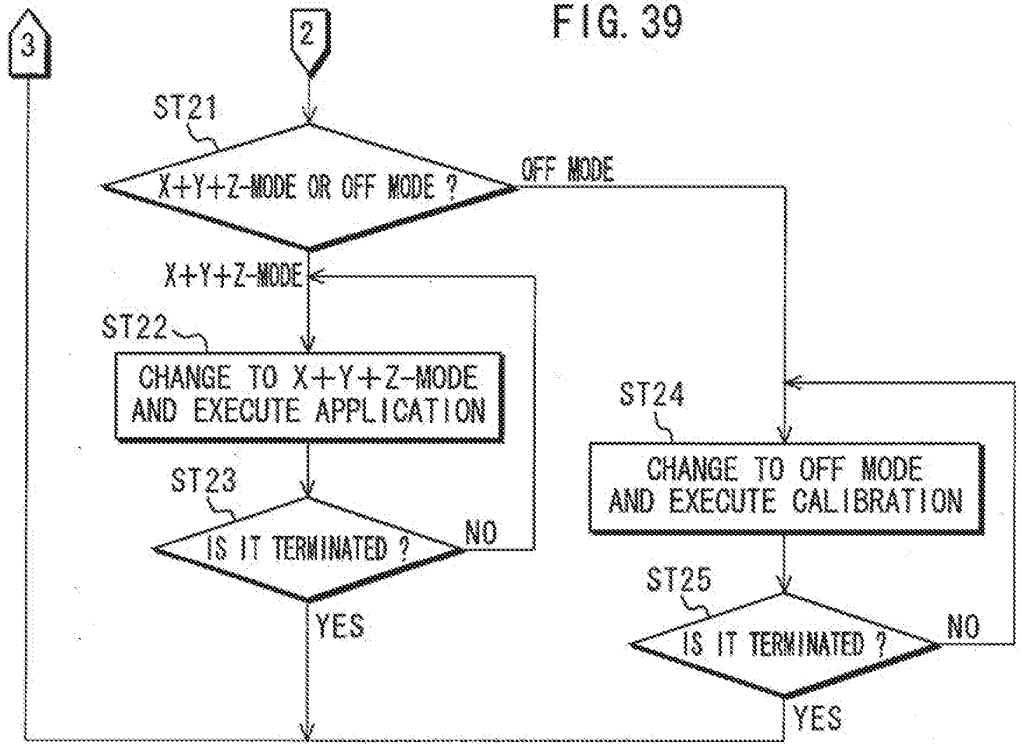

1
3
ST9
Z-MODE OR OTHERS ?
OTHERS
ST10
Z-MODE
CHANGE TO Z-MODE AND EXECUTE APPLICATION
ST11
IS IT TERMINATED ?
NO
YES
ST12
X+Y-MODE OR OTHERS ?
OTHERS
X+Y-MODE
ST13
CHANGE TO X+Y-MODE AND EXECUTE APPLICATION
ST14
IS IT TERMINATED ?
NO
YES
ST15
X+Z-MODE OR OTHERS ?
OTHERS
X+Z-MODE
ST16
CHANGE TO X+Z-MODE 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 DC1 and DC2 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 DC1. 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 DC2. 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 DC1. 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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G06F 3/043	(2006.01)
G08B 6/00	(2006.01)

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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.

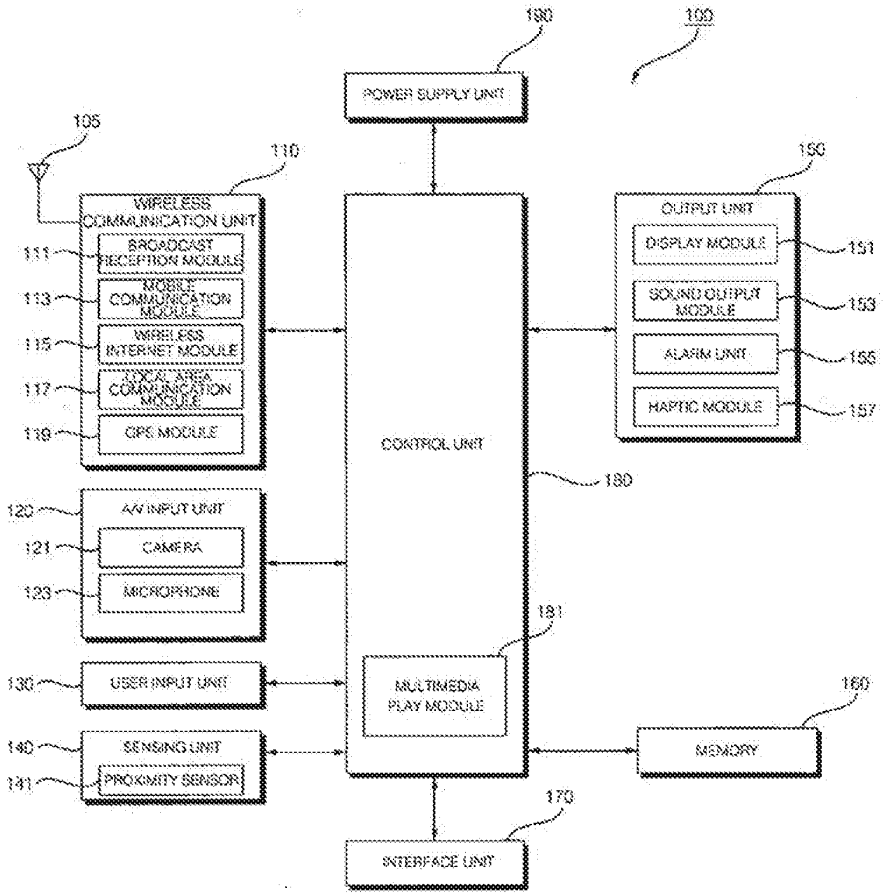


FIG. 1

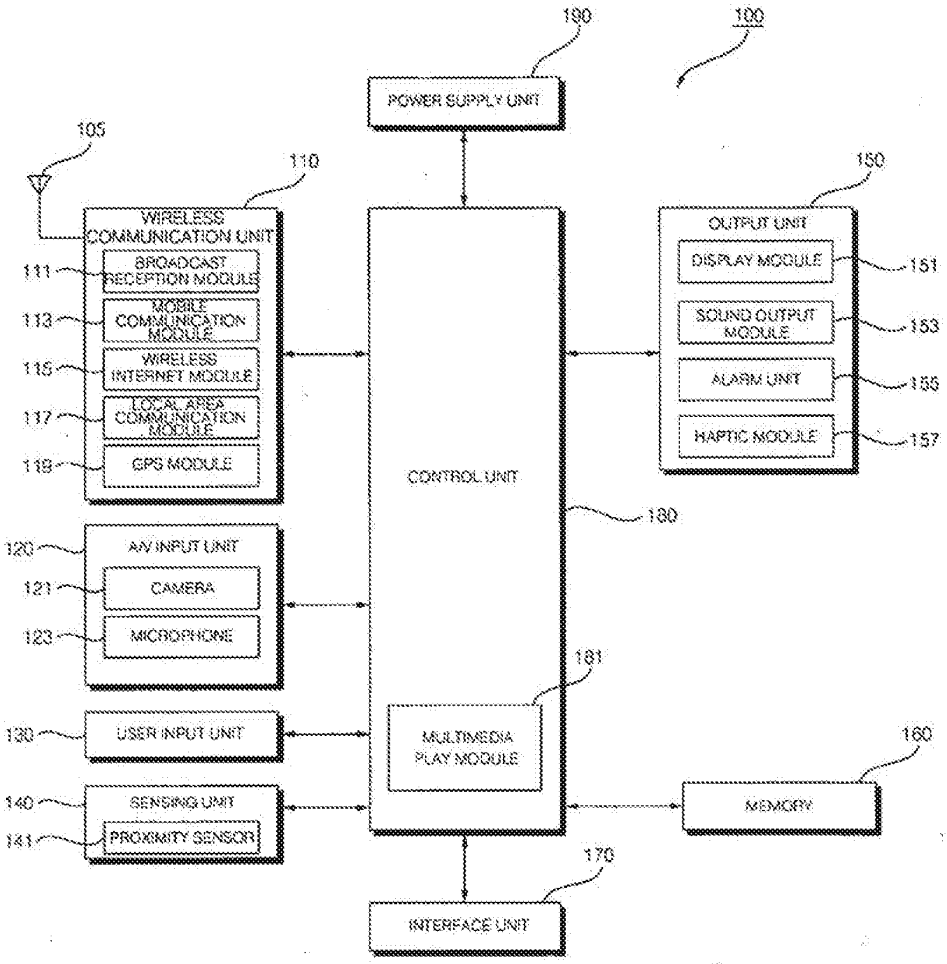

190
100
POWER SUPPLY UNIT
105
110
150
WIRELESS COMMUNICATION UNIT
OUTPUT UNIT
111
BROADCAST RECEPTION MODULE
DISPLAY MODULE
151
113
MOBILE COMMUNICATION MODULE
SOUND OUTPUT MODULE
153
115
WIRELESS INTERNET MODULE
ALARM UNIT
155
117
LOCAL AREA COMMUNICATION MODULE
HAPTIC MODULE
157
119
GPS MODULE
CONTROL 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

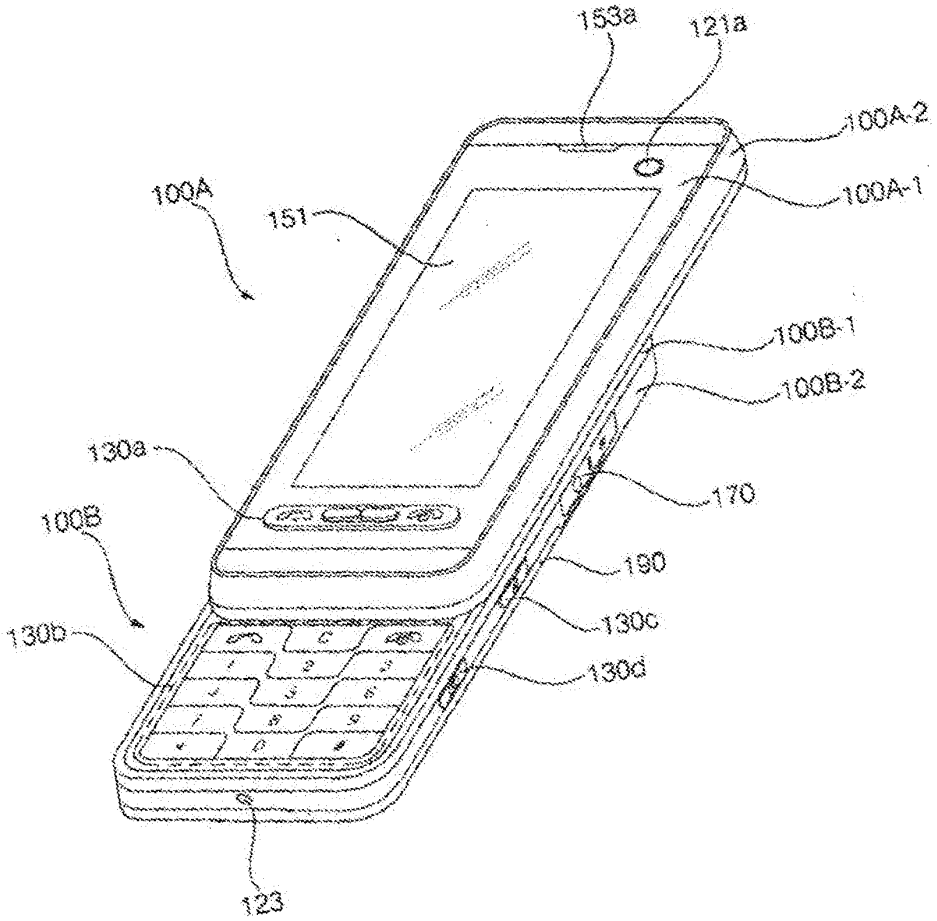

153a
121a
100A-2
100A-1
100A
151
100B-1
100B-2
130a
170
100B
150
130c
130b
130d
123

FIG. 3

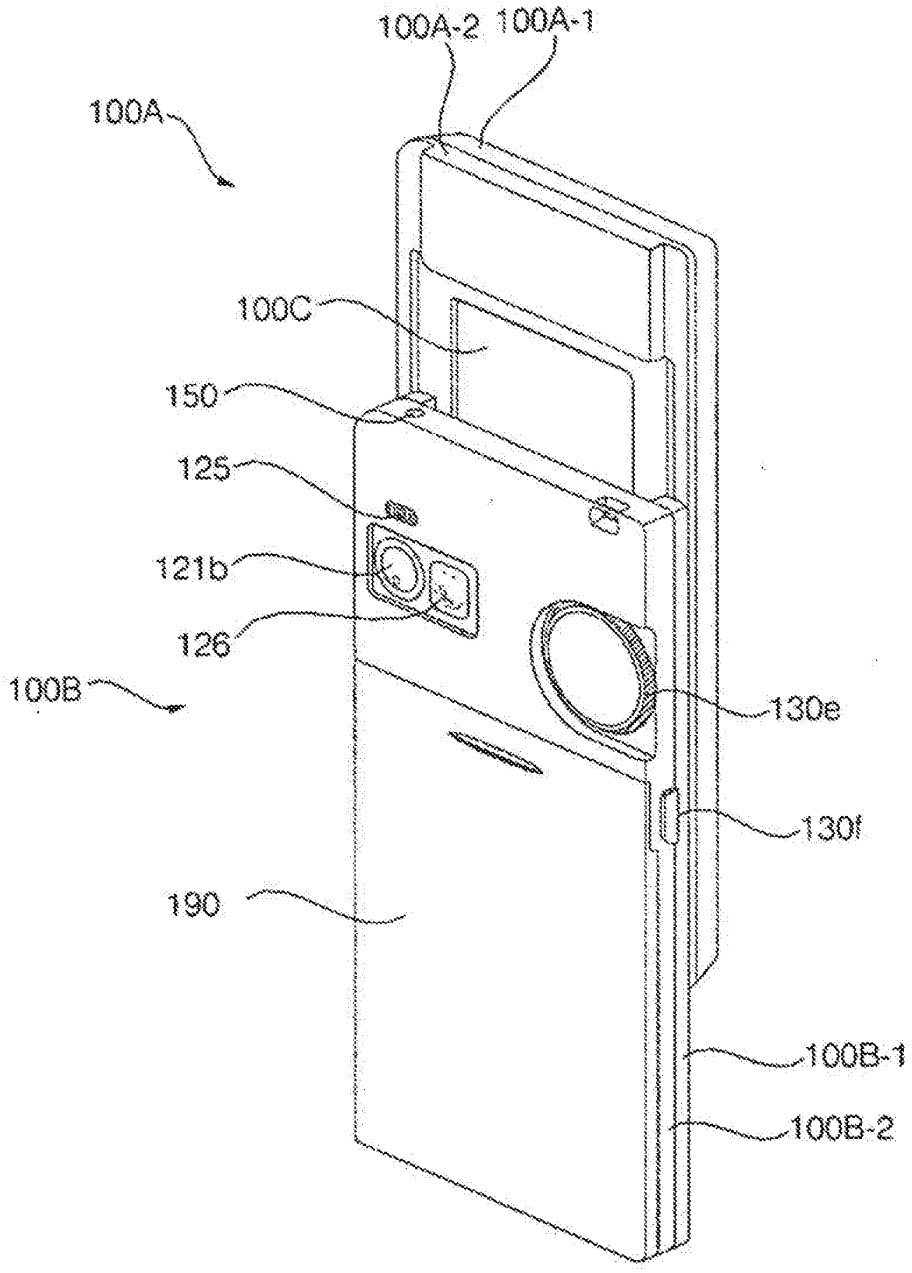

100A-2
100A-1
100A
100C
150
125
121b
126
100B
130e
130f
190
100B-1
100B-2

FIG. 4

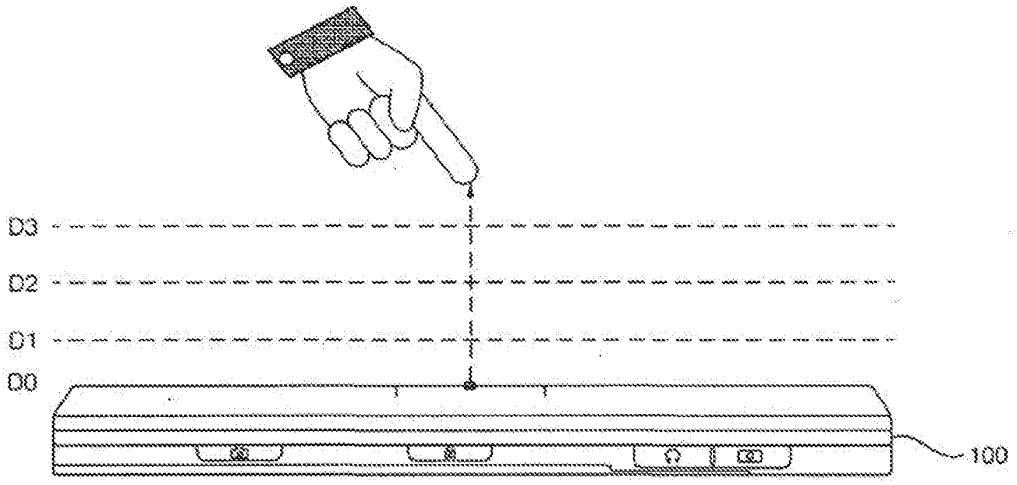


FIG. 5a

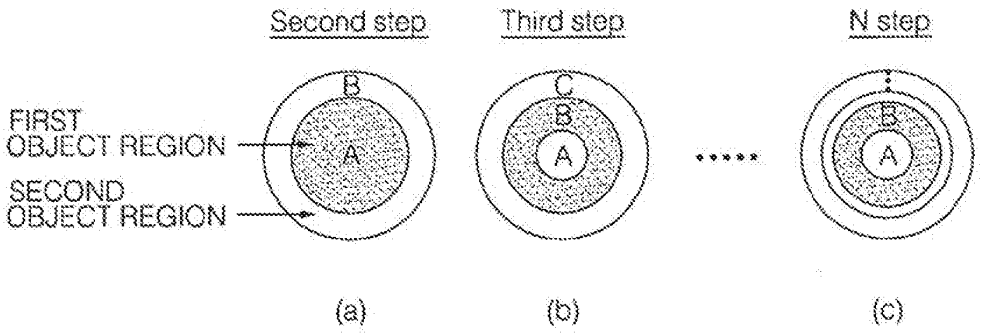

Second step
Third step
N step
FIRST OBJECT REGION
SECOND OBJECT REGION
B
A
C
B
A
B
A
(a)
(b)
(c)

FIG. 5b

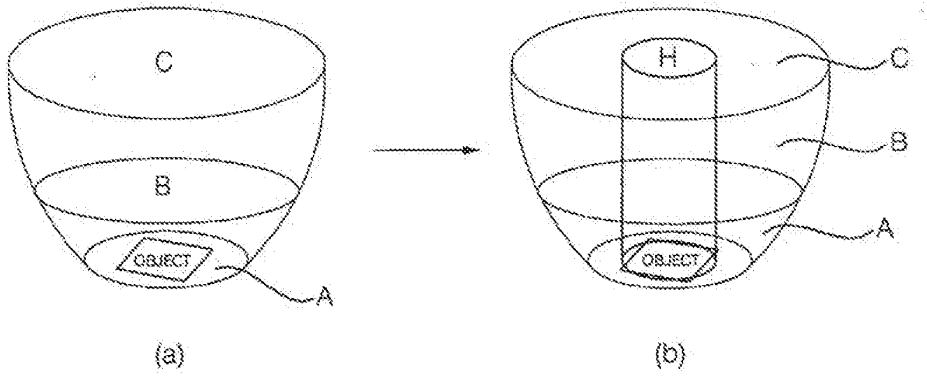

C
B
OBJECT
A
H
C
B
A
OBJECT
(a)
(b)

FIG. 6

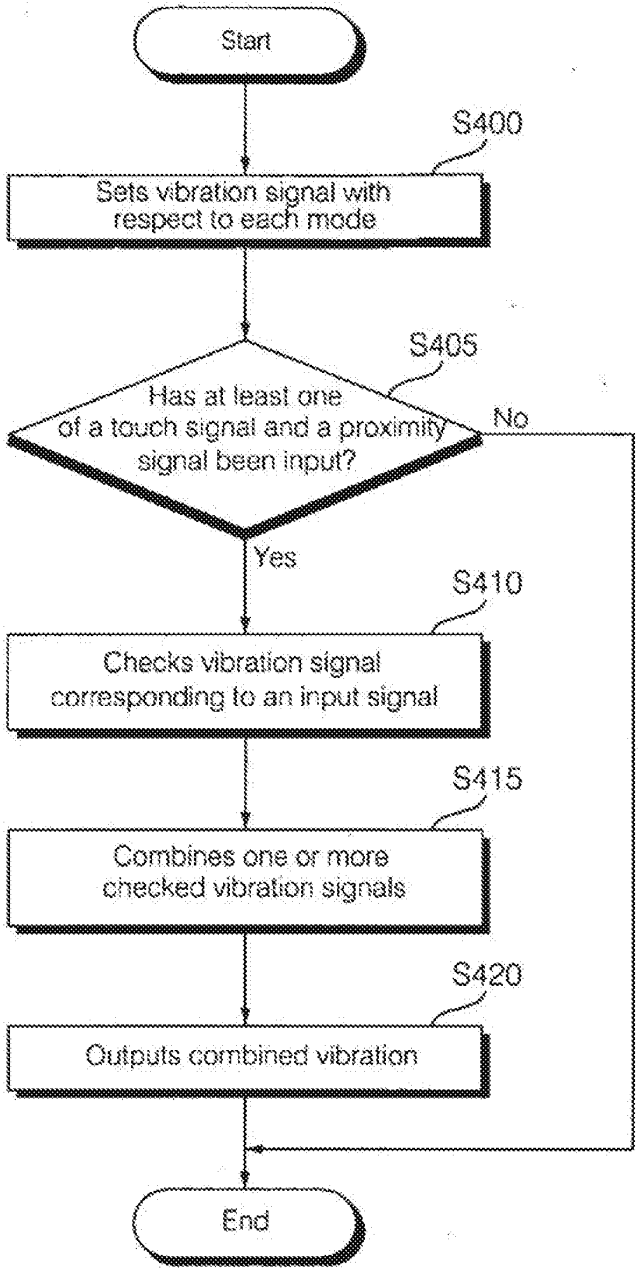

Start
S400
Sets vibration signal with respect to each mode
S405
Has at least one of a touch signal and a proximity signal been input?
No
Yes
S410
Checks vibration signal corresponding to an input signal
S415
Combines one or more checked vibration signals
S420
Outputs combined vibration
End

FIG. 7

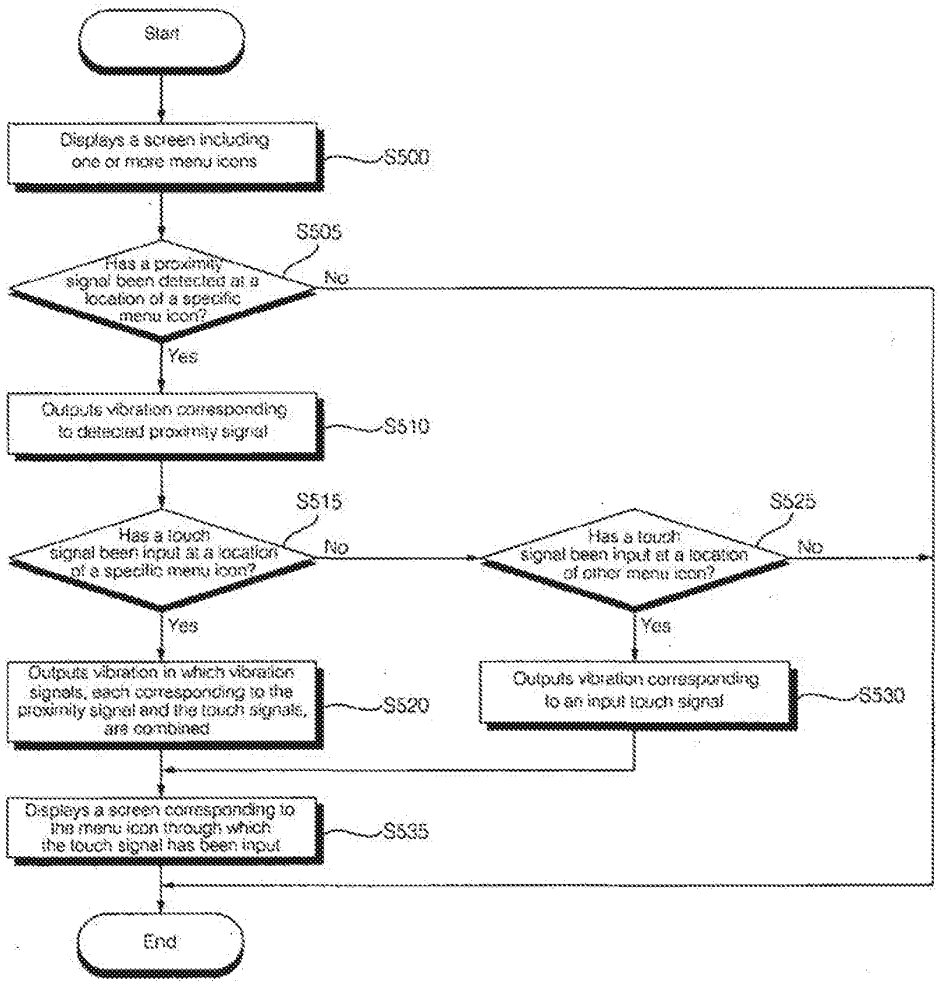

Start
Displays a screen including one or more menu icons
S500
Has a proximity signal been detected at a location of a specific menu icon?
S505
No
Yes
Outputs vibration corresponding to detected proximity signal
S510
Has a touch signal been input at a location of a specific menu icon?
S515
No
Yes
Has 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

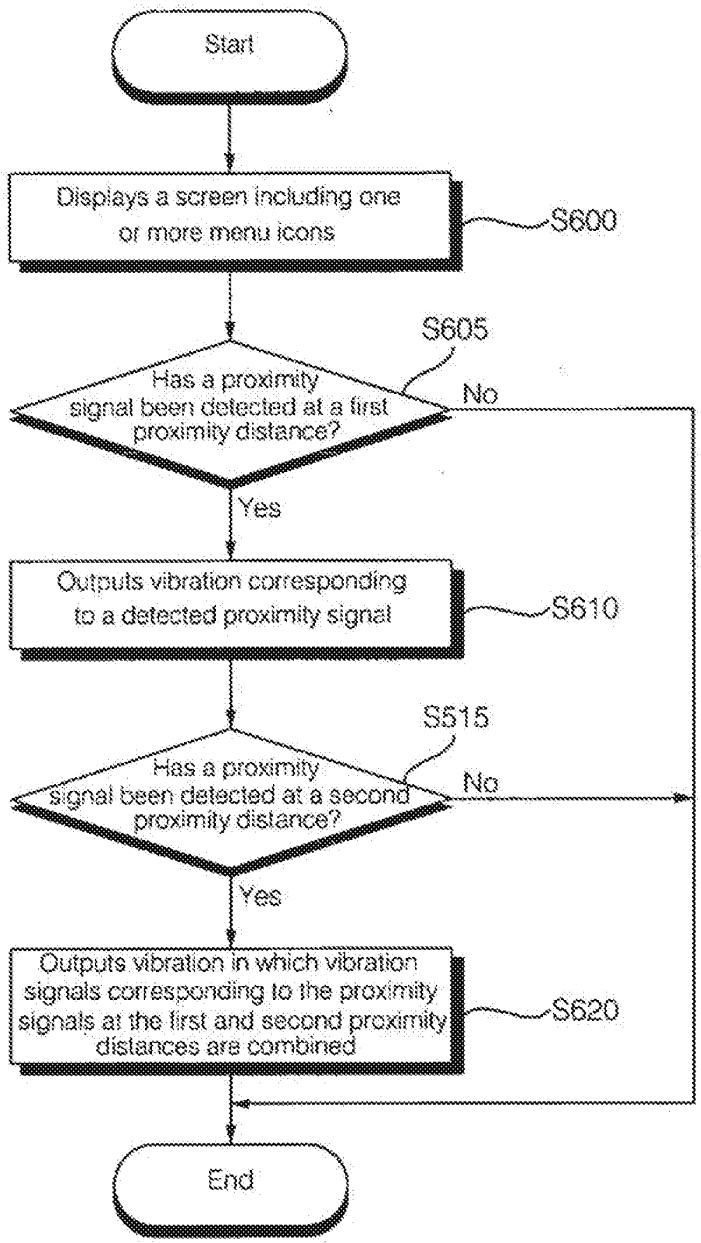

Start
Displays a screen including one or more menu icons
S600
S605
Has a proximity signal been detected at a first proximity distance?
No
Yes
Outputs vibration corresponding to a detected proximity signal
S610
S515
Has a proximity signal been detected at a second proximity distance?
No
Yes
Outputs vibration in which vibration signals corresponding to the proximity signals at the first and second proximity distances are combined
S620
End

FIG. 9

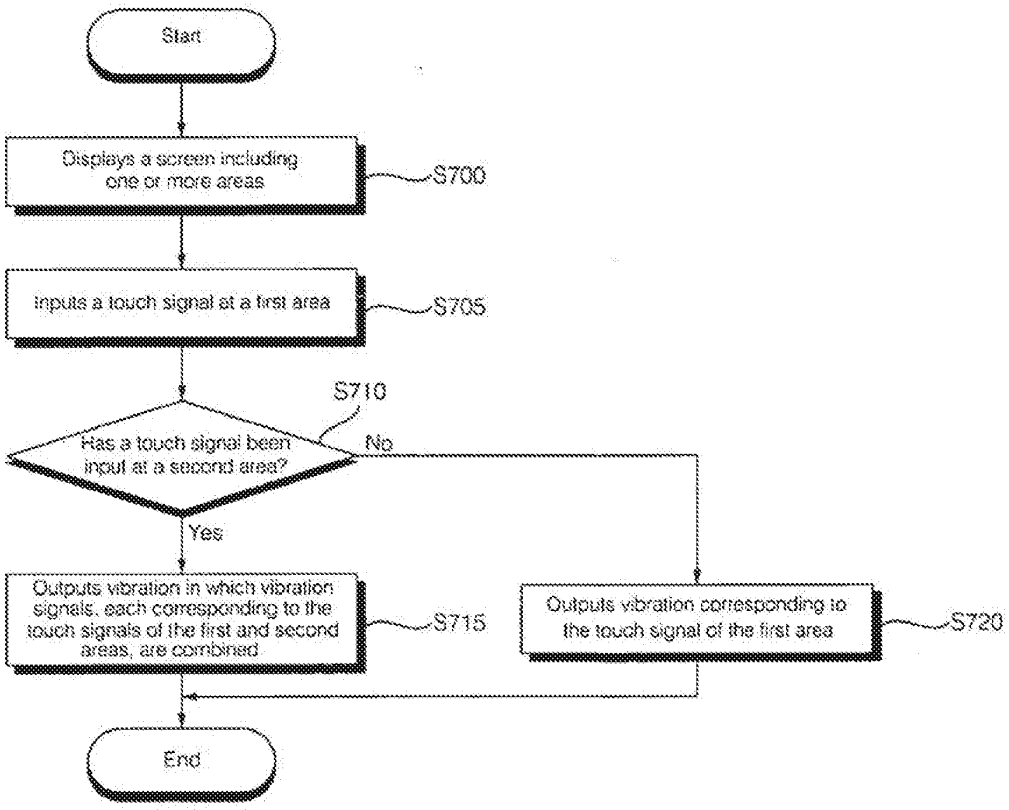

Start
Displays a screen including one or more areas
S700
Inputs a touch signal at a first area
S705
S710
Has a touch signal been input at a second area?
No
Yes
Outputs vibration in which vibration signals, each corresponding to the touch signals of the first and second areas, are combined
S715
Outputs vibration corresponding to the touch signal of the first area
S720
End

FIG. 10

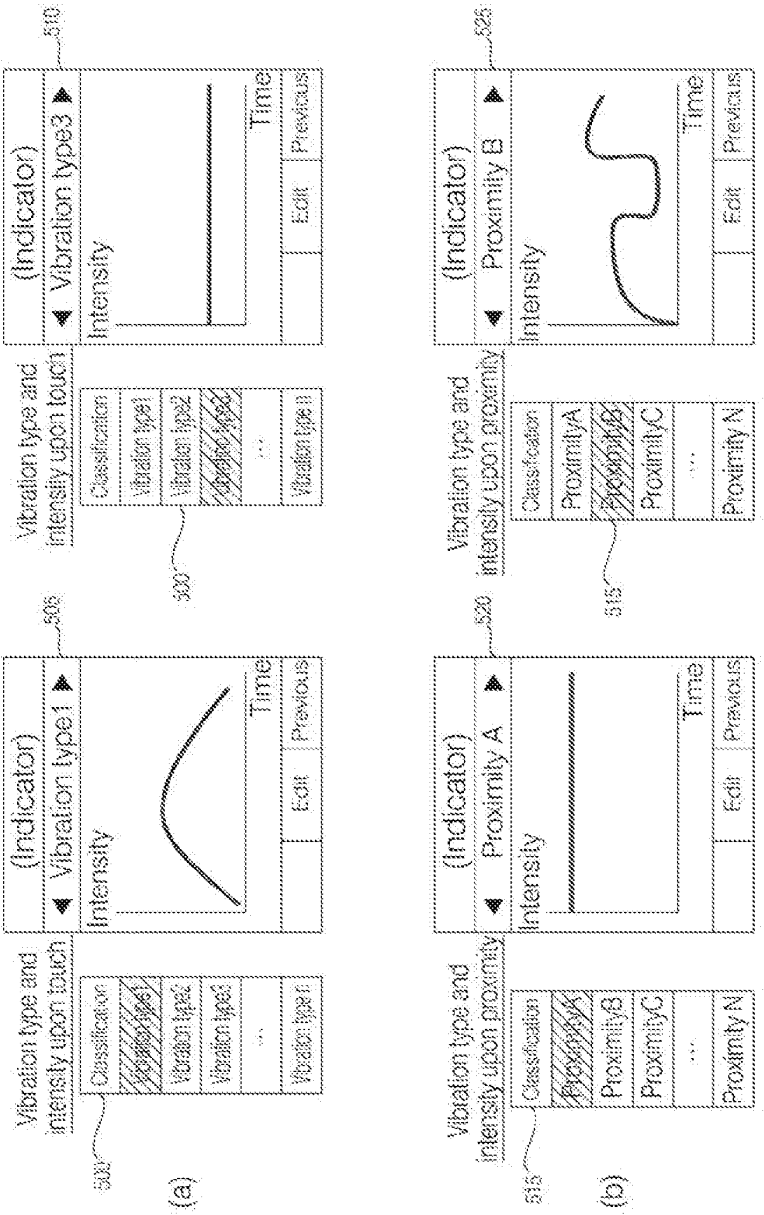

(a)
Vibration type and intensity upon touch
Classification
Vibration type1
Vibration type2
Vibration type3
...
Vibration type n
500
(Indicator)
Vibration type1
Intensity
Time
Edit
Previous
505
(Indicator)
Vibration type3
Intensity
Time
Edit
Previous
510
(b)
Vibration type and intensity upon proximity
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

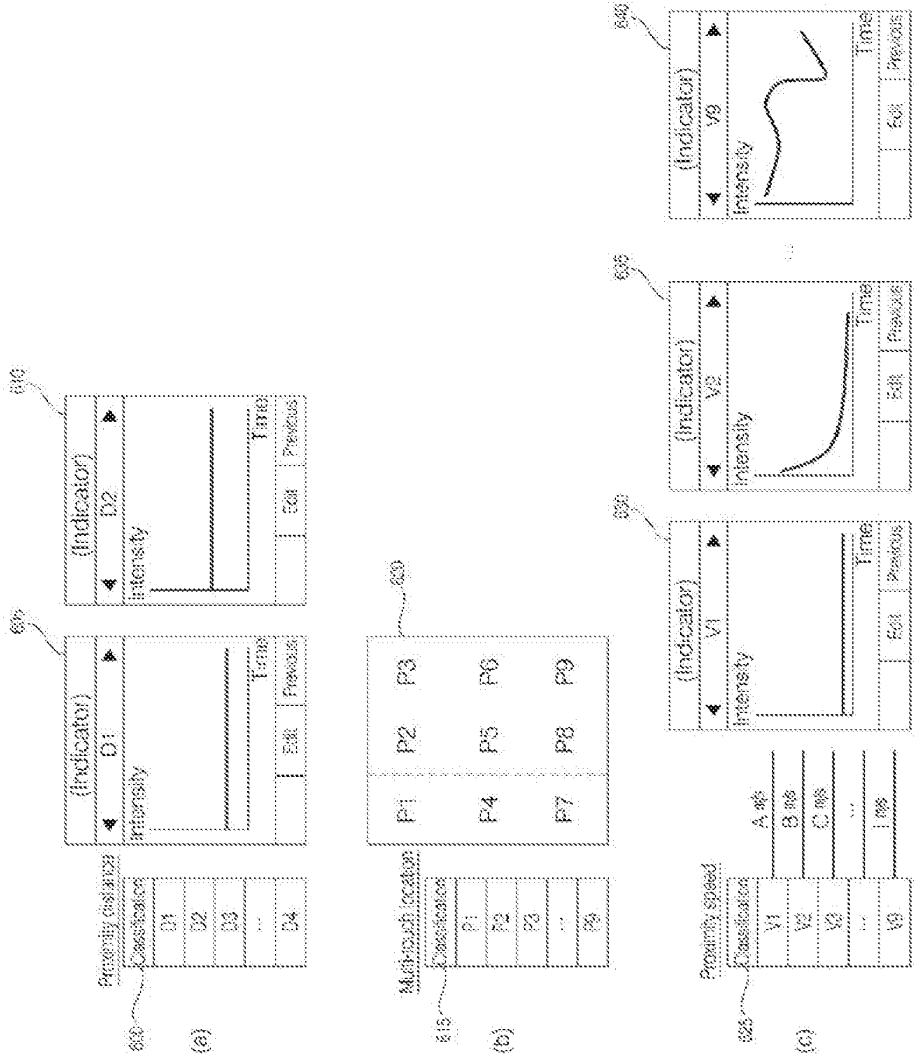

(Indicator)
D1
D2
Intensity
Time
Edit
Previous
Proximity distance
Classification
D1
D2
D3
D4
610
(a)
(Indicator)
D2
Intensity
Time
Edit
Previous
615
P1
P2
P3
P4
P5
P6
P7
P8
P9
Multi-touch location
Classification
P1
P2
P3
P9
620
(b)
(Indicator)
V1
V2
V9
Intensity
Time
Edit
Previous
625
Proximity speed
Classification
V1
V2
V9
A ms
B ms
C ms
ms
630
635
640
(c)

FIG.12

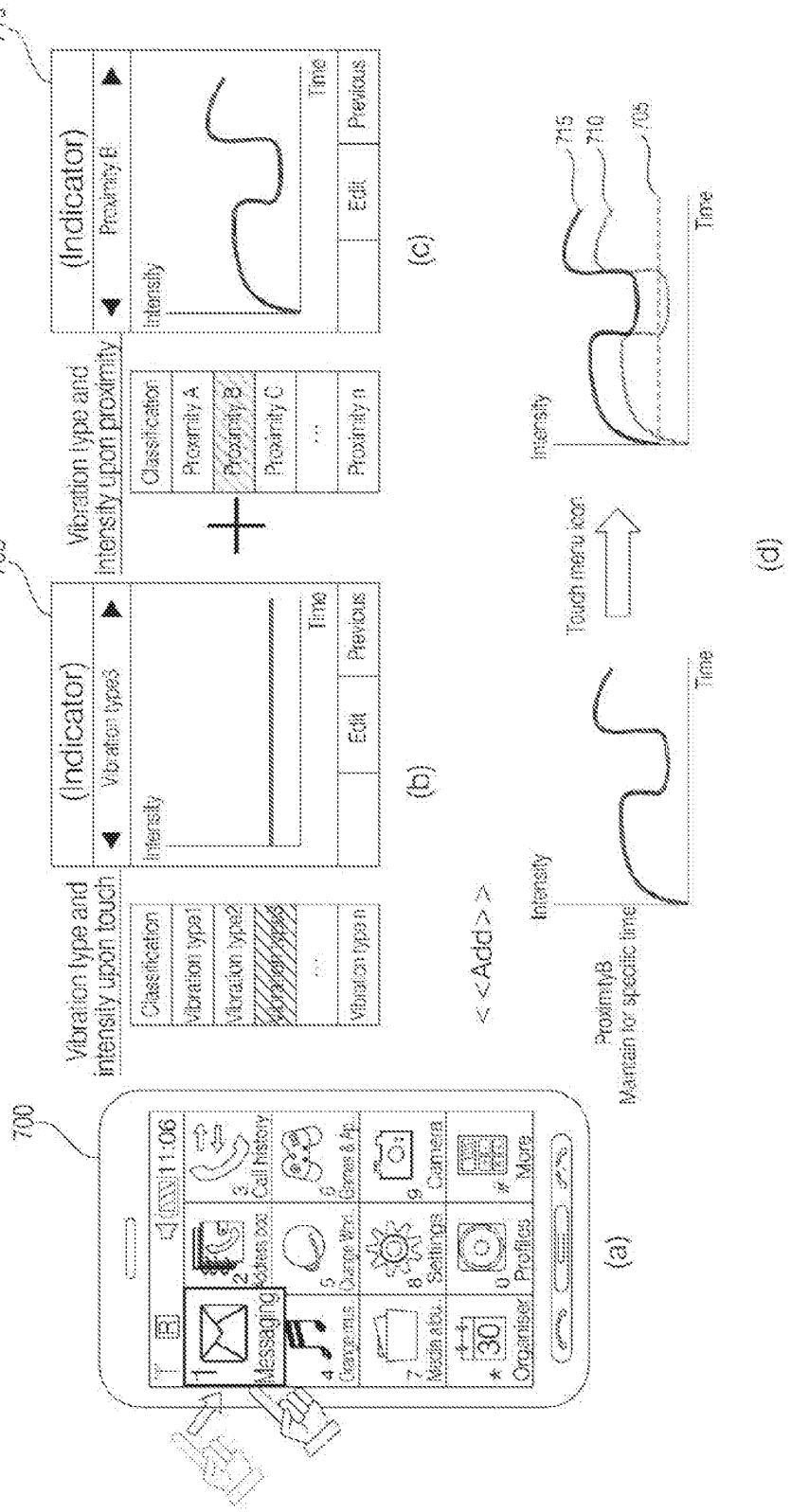

700
705
710
(Indicator)
Vibration types
Intensity
Time
Edit
Previous
Vibration type and intensity upon touch
Classification
Vibration type1
Vibration type2
Vibration type n
Vibration type and intensity upon proximity
Proximity A
Proximity B
Proximity C
Proximity n
(a)
(b)
(c)
(d)
< <Add > >
Proximity B
Maintain for specific time
Touch menu icon
715

FIG. 13

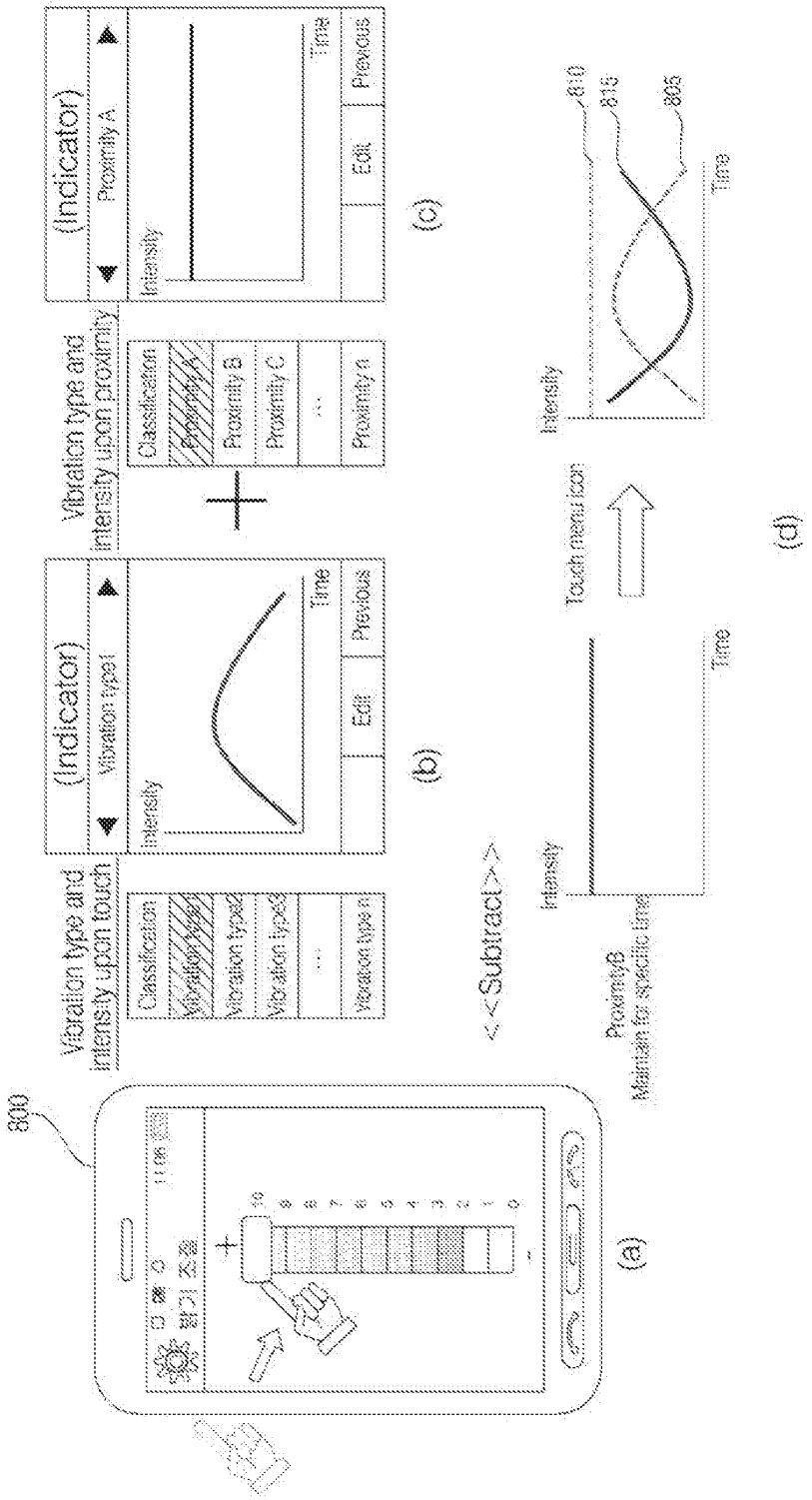

800
(a)
Proximity B
Maintain for specific time
Intensity
Time
<<Subtract>>
Touch menu icon
(b)
(Indicator)
Vibration type1
Intensity
Time
Edit
Previous
Vibration type and intensity upon touch
Classification
Vibration type1
Vibration type2
Vibration type3
Vibration type n
Vibration type and intensity upon proximity
Proximity A
Proximity B
Proximity C
Proximity n
(c)
(d)
810
815
805

FIG.14

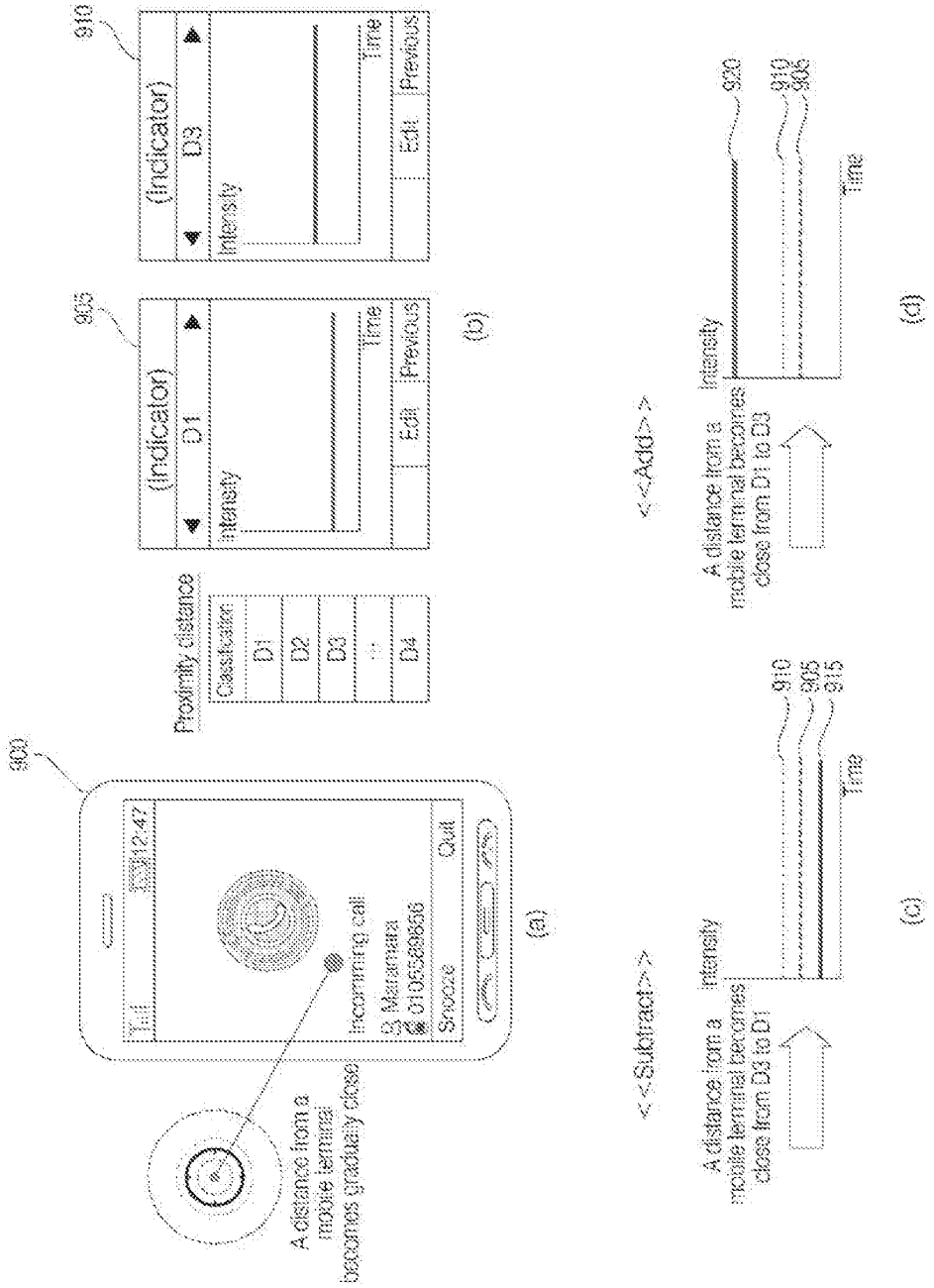
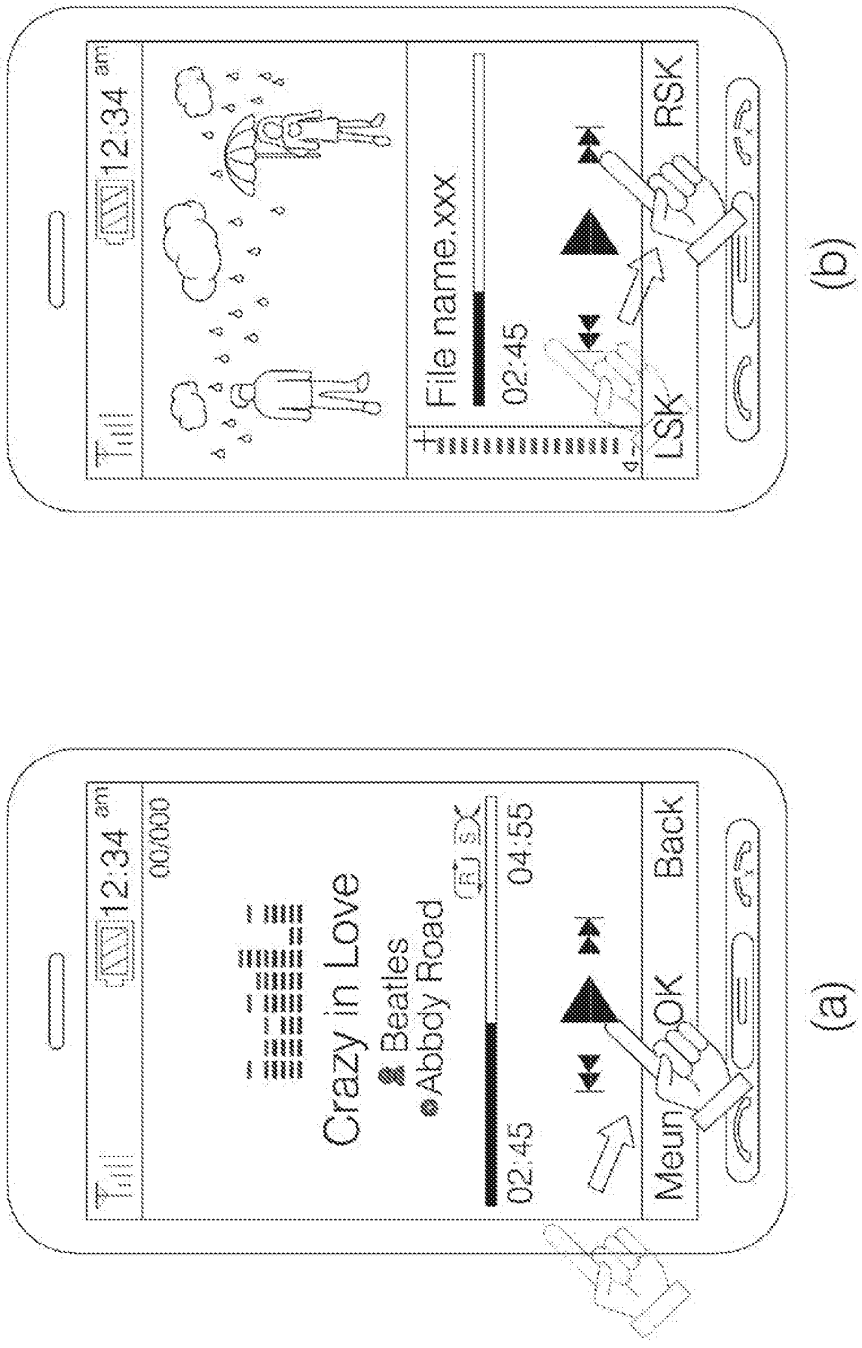

900
Tuf
12:47
Incoming call
Snooze
Quit
A distance from a mobile terminal becomes gradually close
(a)
Proximity distance
Classification
D1
D2
D3
D4
905
(Indicator)
D1
Intensity
Time
Edit
Previous
910
(Indicator)
D3
Intensity
Time
Edit
Previous
(b)
<<Subtract>>
A distance from a mobile terminal becomes 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



EX1002 - Page 805

FIG. 16

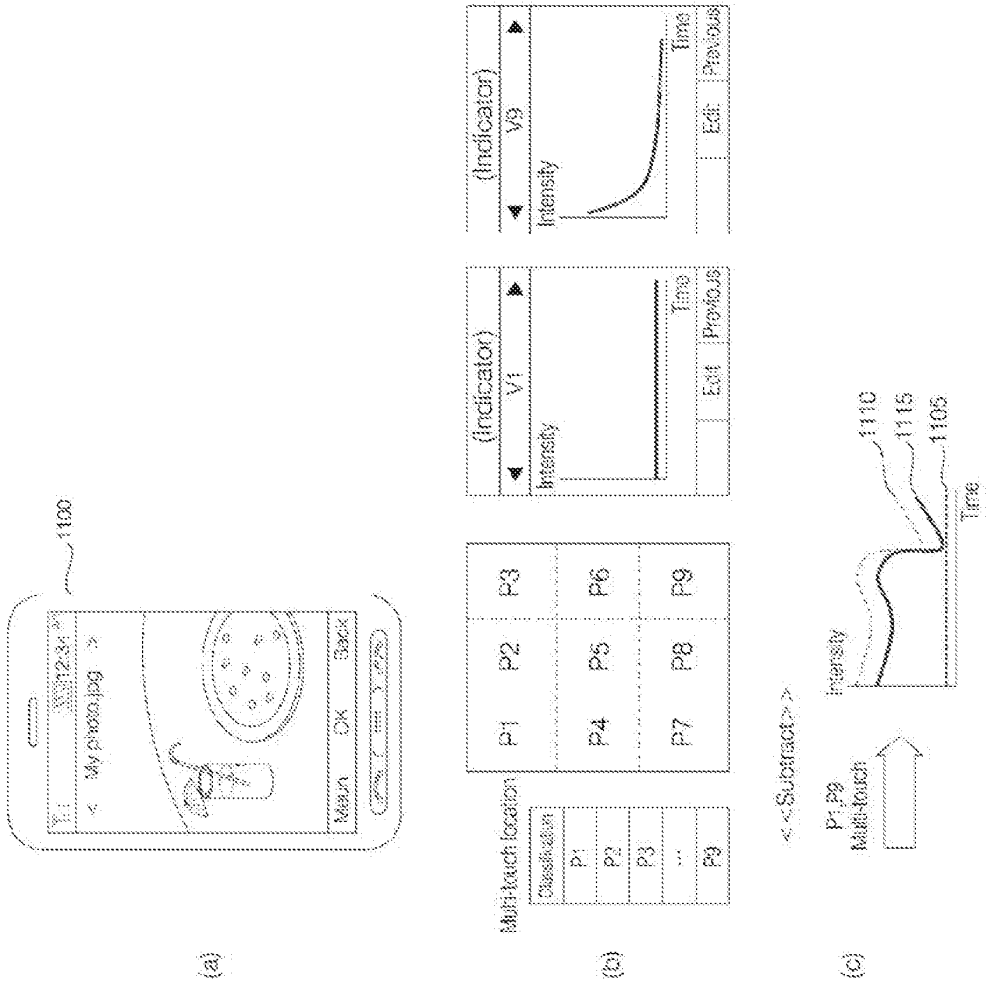

(a)
1100
My photo.jpg
Mean
OK
Back
(b)
Multi-touch location
Classification
P1
P2
P3
P9
P1
P2
P3
P4
P5
P6
P7
P8
P9
(Indicator)
V1
Intensity
Time
Edit
Previous
(Indicator)
V9
Intensity
Time
Edit
Previous
(c)
< <Subtract> >
P1,P9
Multi-touch
Intensity
1110
1115
1105
Time

FIG.17

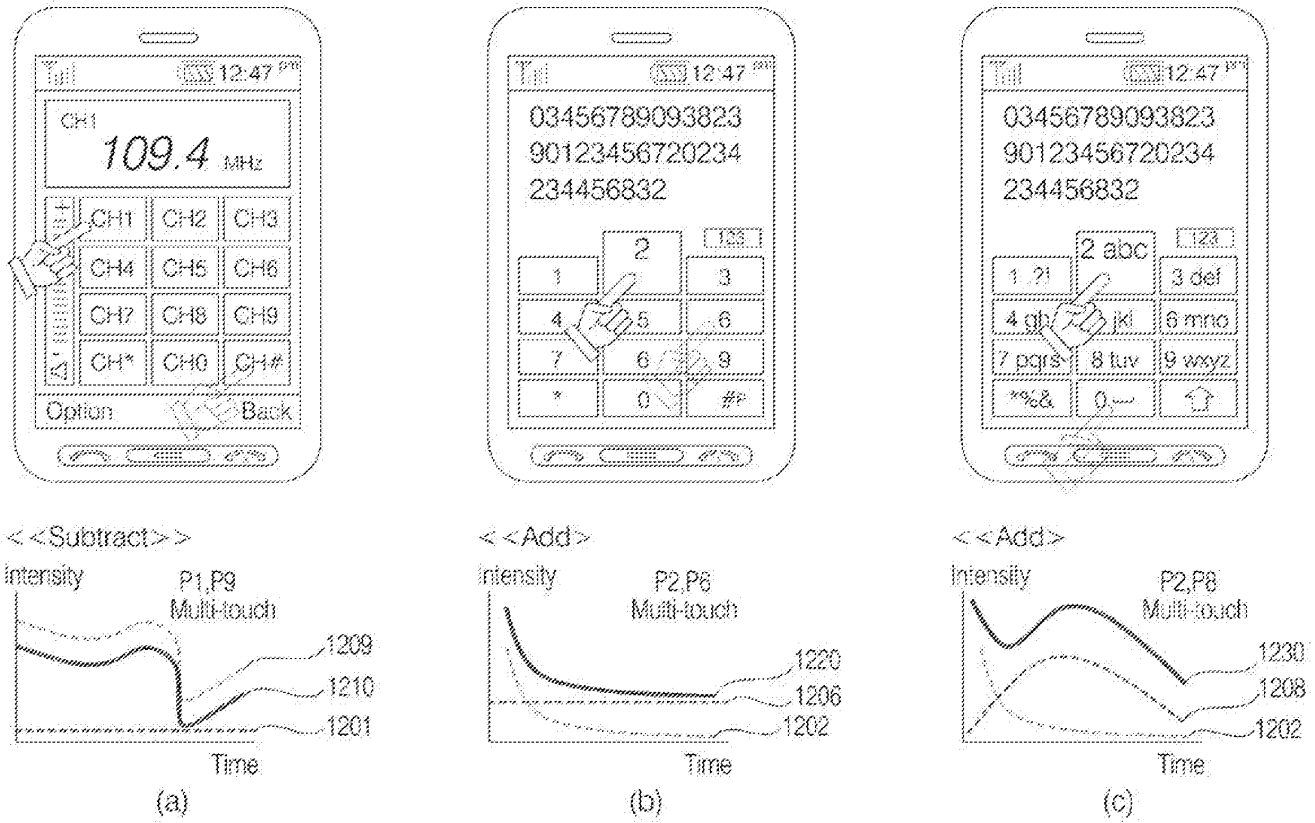
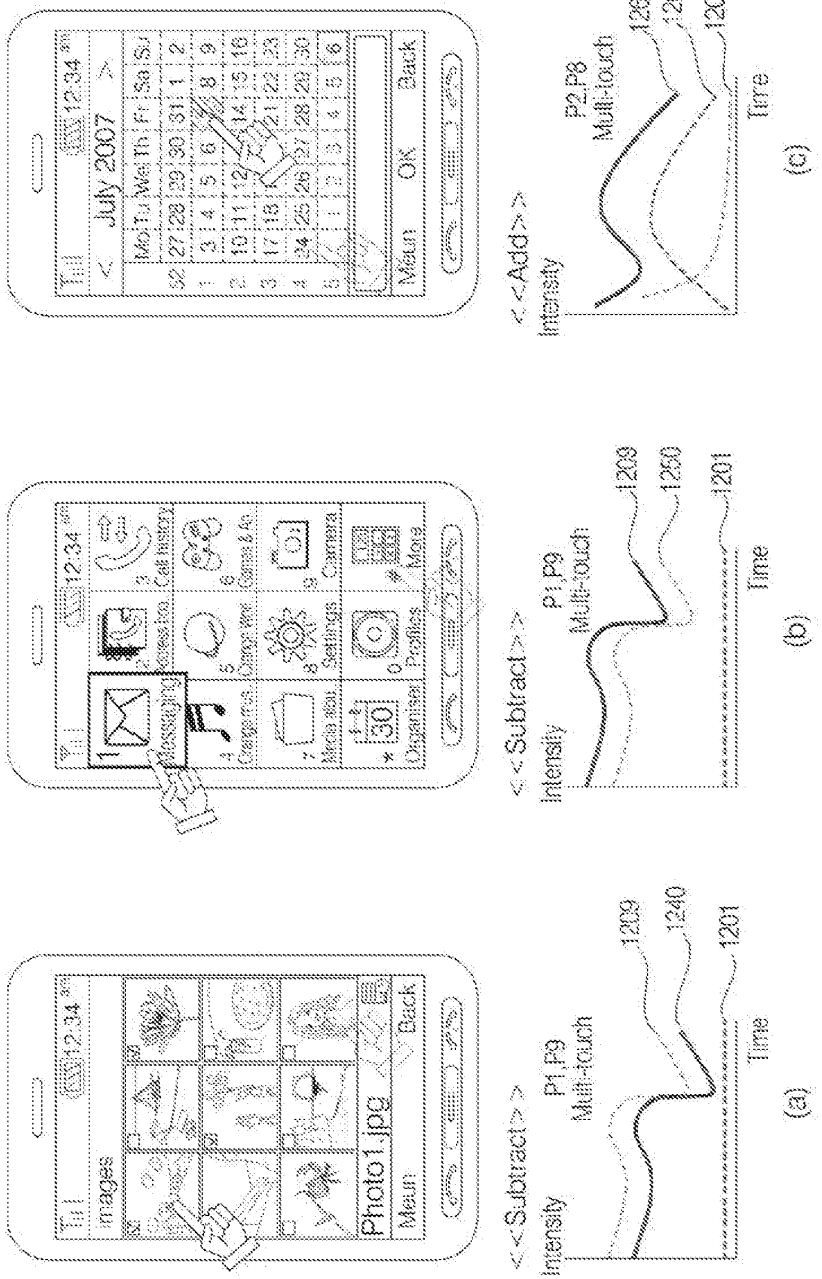

12:47 PM
CH1
109.4 MHz
CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH*
CH0
CH#
Option
Back
03456789093823
90123456720234
234456832
2 abc
3 def
4 ghi
jkl
6 mno
7 pqrs
8 tuv
9 wxyz
<<Subtract>>
Intensity
P1,P9
Multi-touch
1209
1210
1201
Time
(a)
<<Add>>
Intensity
P2,P6
Multi-touch
1220
1206
1202
Time
(b)
<<Add>>
Intensity
P2,P8
Multi-touch
1230
1208
1202
Time
(c)

FIG. 18



EX1002 - Page 808

FIG. 19

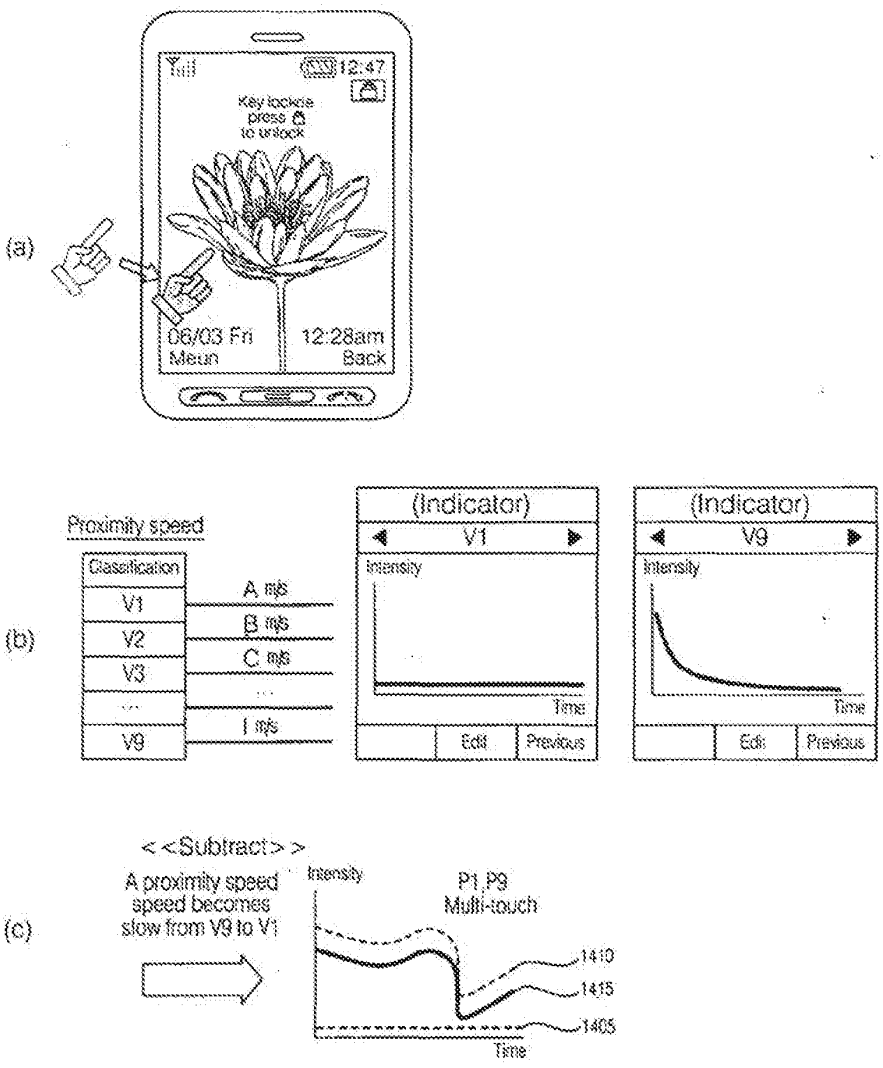

(a)
12:47
Key lockde
press
to unlock
06/03 Fri
Menu
12:28am
Back
(b)
Proximity speed
Classification
V1
V2
V3
...
V9
A m/s
B m/s
C m/s
...
I m/s
(Indicator)
V1
Intensity
Time
Edit
Previous
(Indicator)
V9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
A proximity speed
speed becomes
slow from V9 to V1
Intensity
P1,P9
Multi-touch
1410
1415
1405
Time

FIG. 20

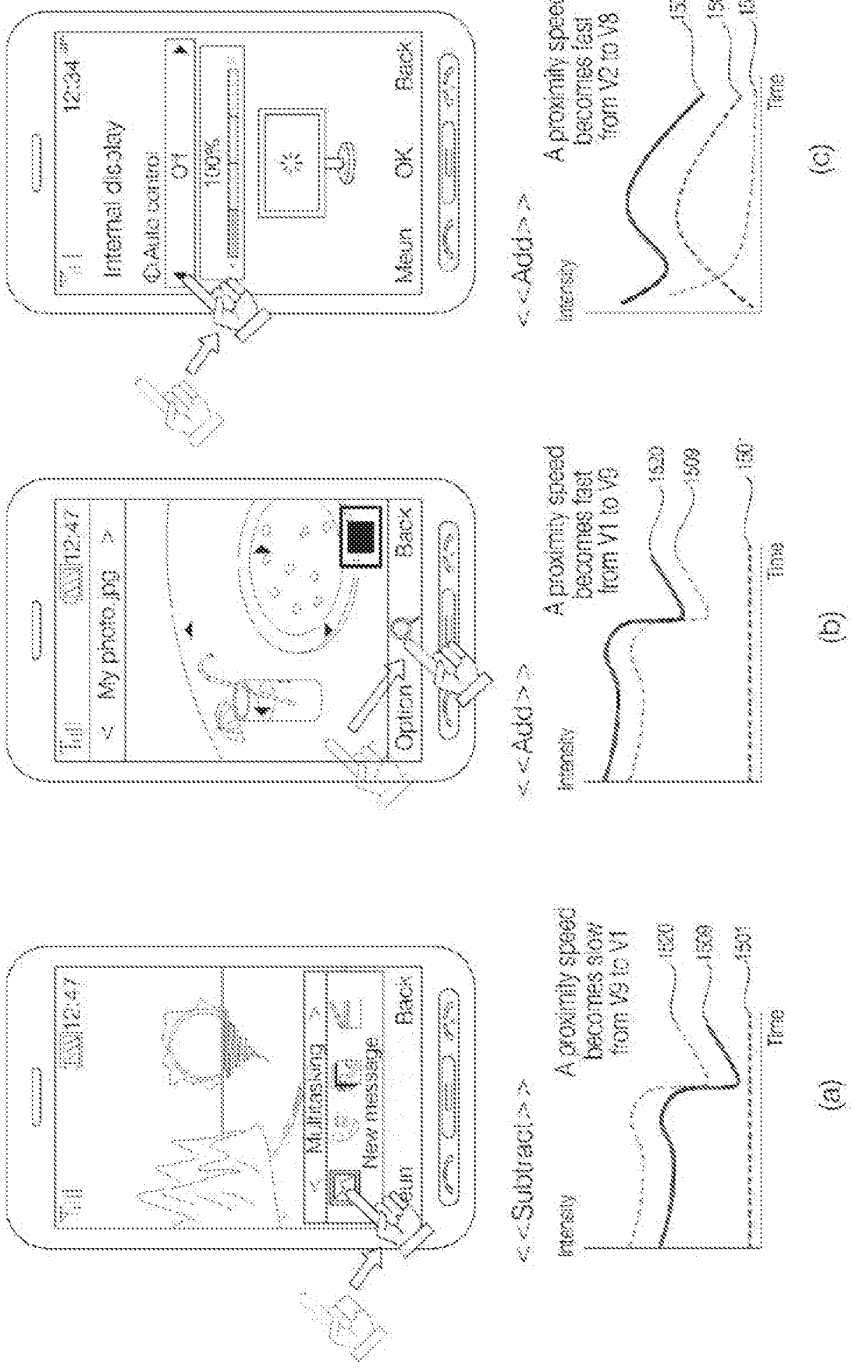

12:47
Multitasking
New message
Back
Menu
<<Subtract>>
Intensity
A proximity speed becomes slow from V9 to V1
1520
1509
1501
Time
(a)
12:47
My photo.jpg
Option
Back
<<Add>>
Intensity
A proximity speed becomes fast from V1 to V9
1520
1509
1501
Time
(b)
12:34
Internal display
Auto control
0%
100%
Menu
OK
Back
<<Add>>
Intensity
A proximity speed becomes fast from V2 to V8
1530
1506
1502
Time
(c)

FIG. 21

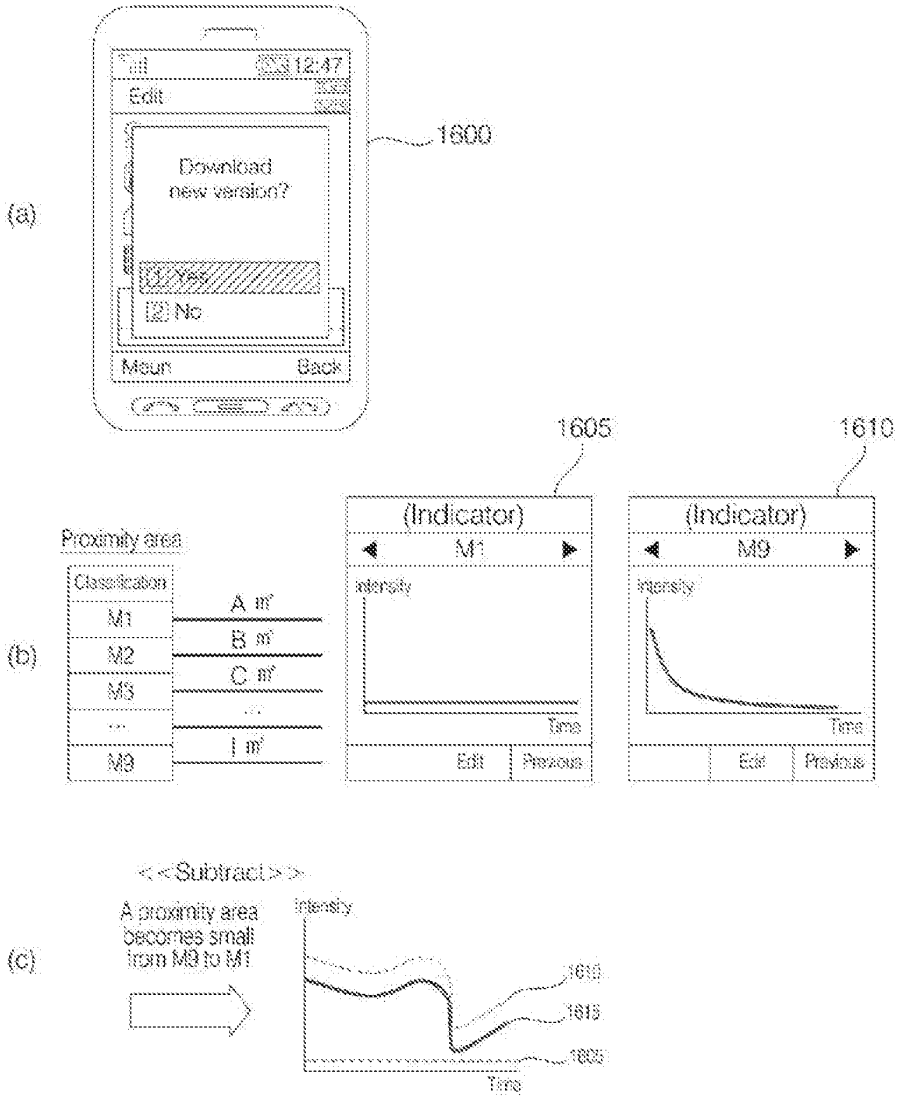
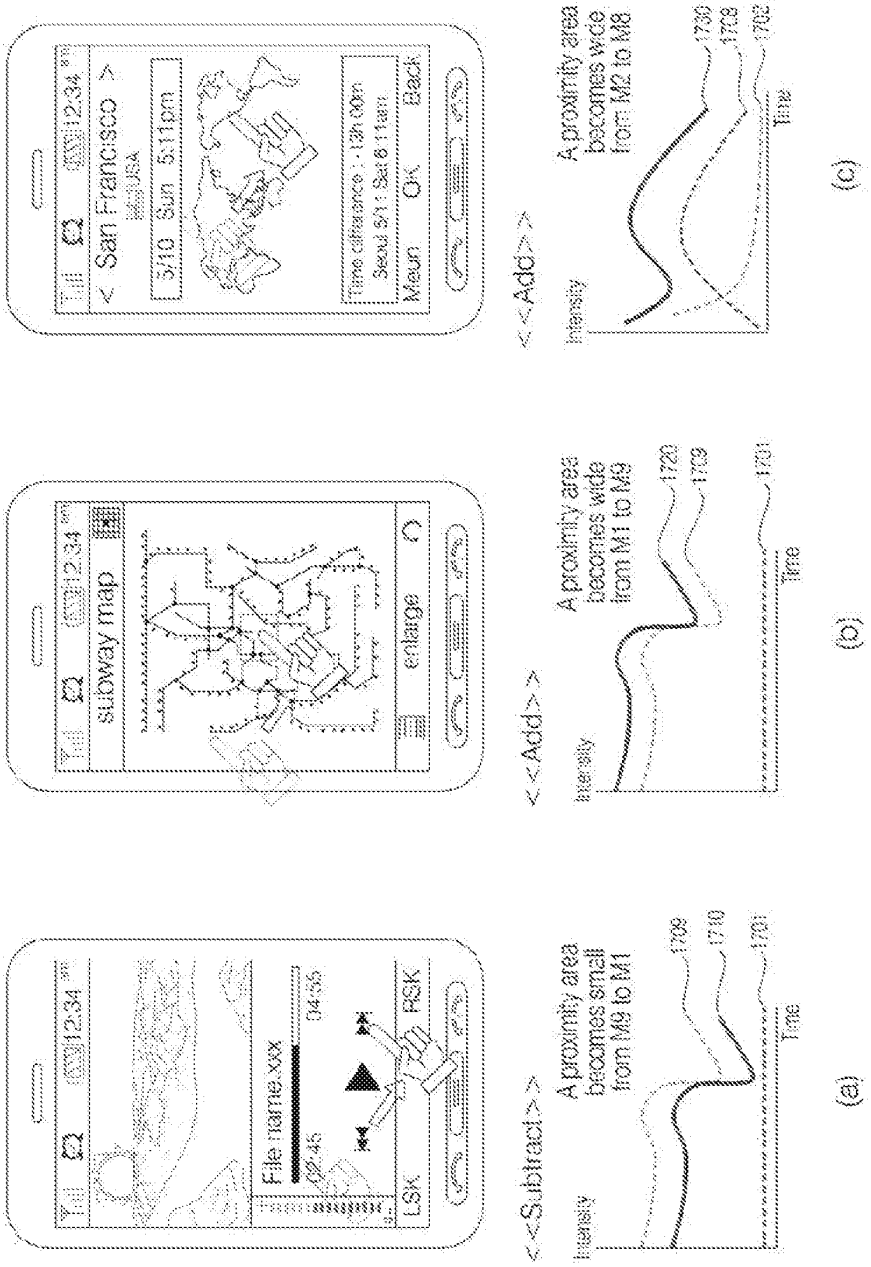

(a)
12:47
Edit
1600
Download new version?
[1] Yes
[2] No
Menu
Back
(b)
1605
1610
(Indicator)
(Indicator)
Proximity area
Classification
M1
M2
M3
...
M9
A m
B m
C m
...
I m
M1
M9
Intensity
Time
Edit
Previous
(c)
<<Subtract>>
A proximity area becomes small from M9 to M1
Intensity
1610
1615
1620
Time

FIG. 22



12:34
File name.xxx
02:45
04:55
LSK
RSK
<<Subtract>>
A proximity area becomes small from M9 to M1
Intensity
Time
1709
1710
1701
(a)
subway map
enlarge
<<Add>>
A proximity area becomes wide from M1 to M9
1720
1709
1701
(b)
< San Francisco >
USA
5/10 Sun 5:11pm
Time difference : -13h 00m
Seoul 5/11 Sat 6:11am
Meun
OK
Back
<<Add>>
A proximity area becomes wide from M2 to M8
1730
1708
1702
(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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Publication Classification

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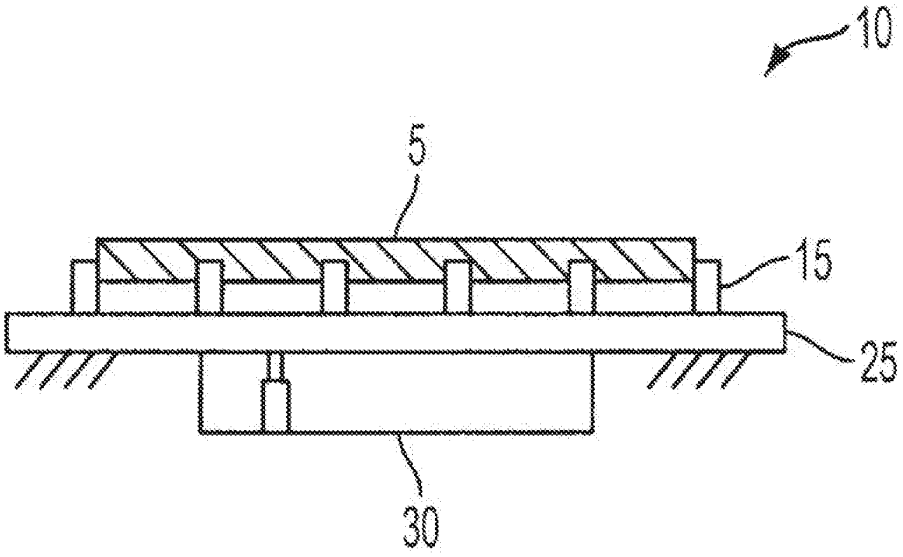
G08B 6/00 (2006.01)

(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.



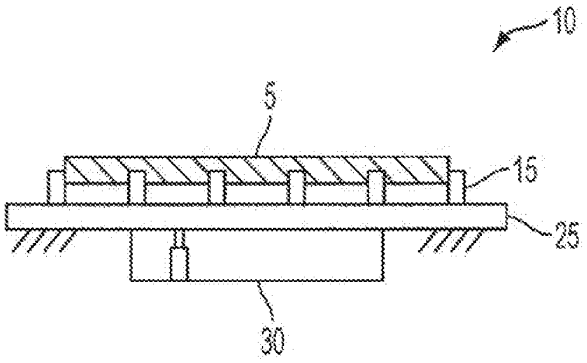


FIG. 1A

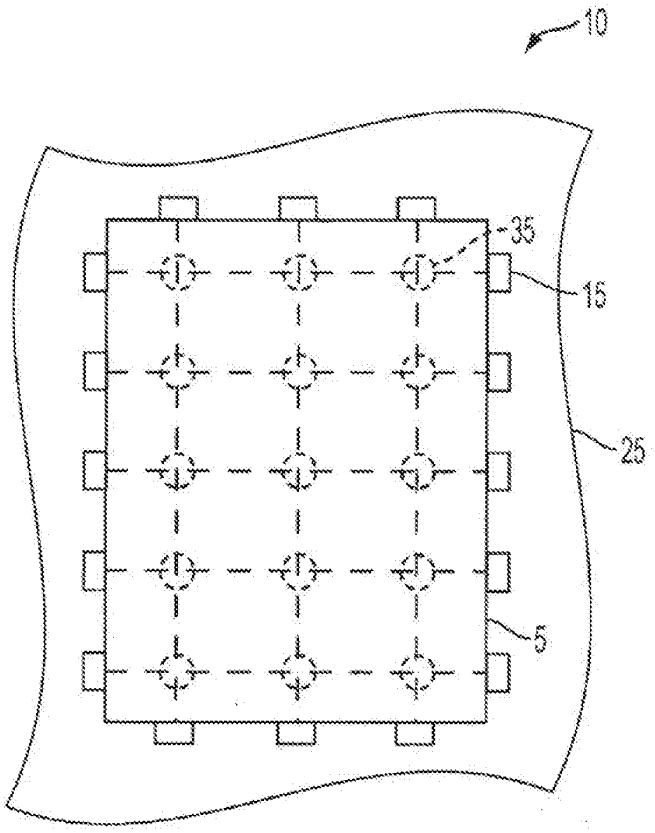


FIG. 1B

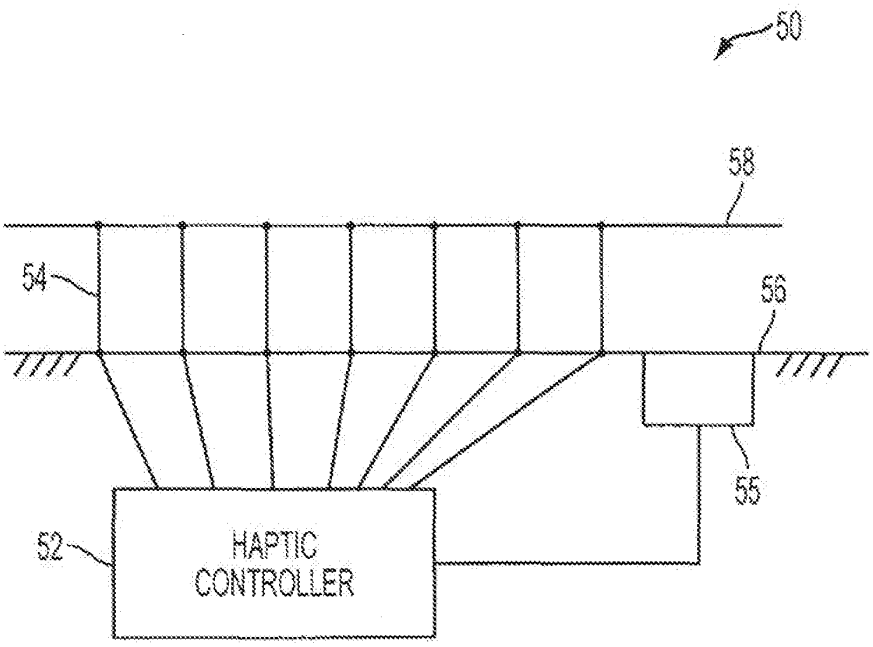


FIG. 2

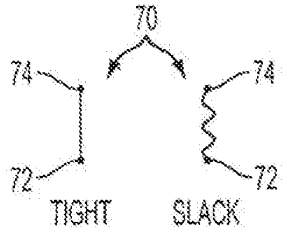


FIG. 3A

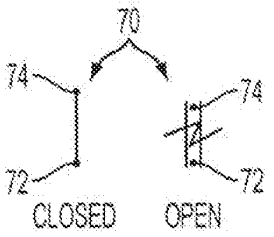


FIG. 3B

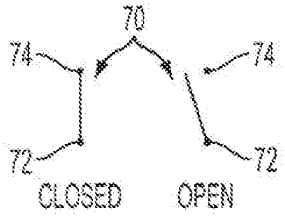


FIG. 3C

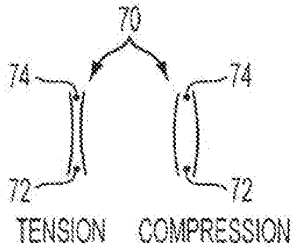


FIG. 3D

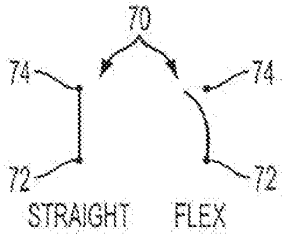


FIG. 3E

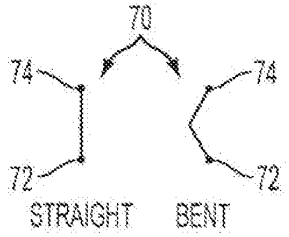


FIG. 3F

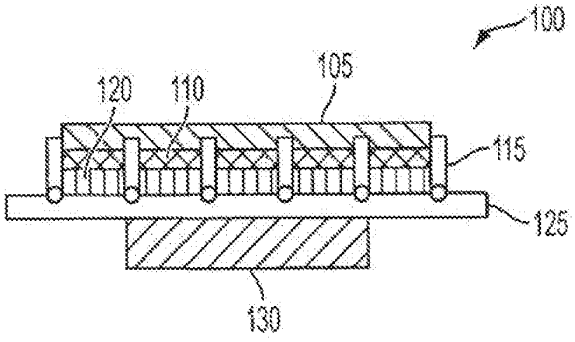


FIG. 4A

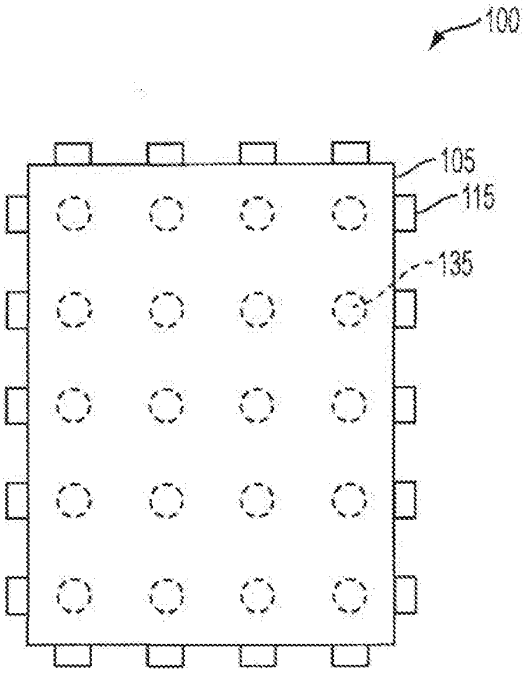


FIG. 4B

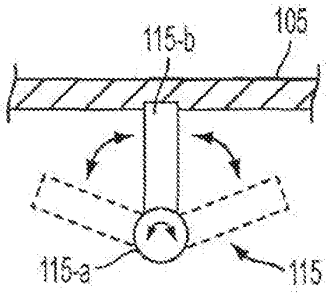


FIG. 5A

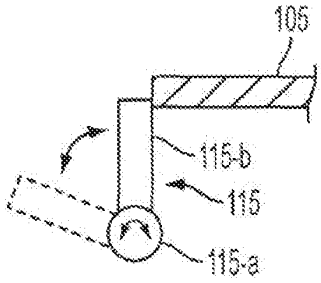


FIG. 5B

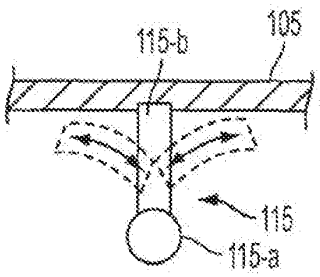


FIG. 5C

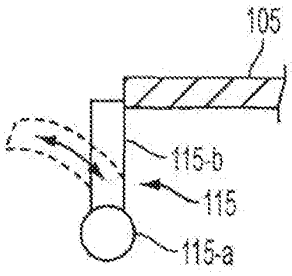


FIG. 5D

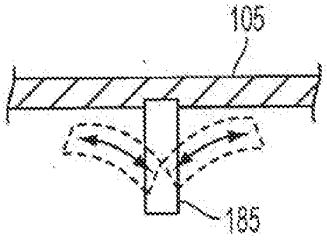


FIG. 5E

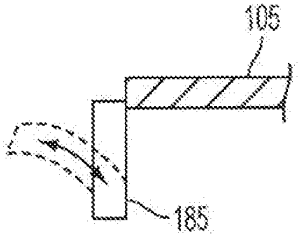


FIG. 5F

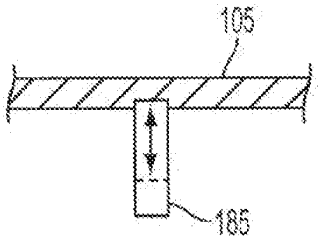


FIG. 5G

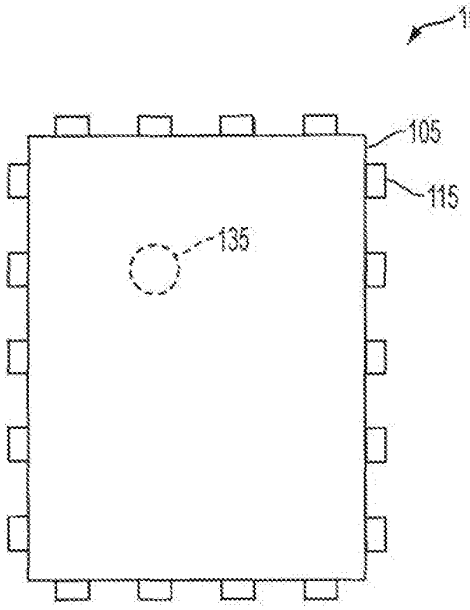


FIG. 6A

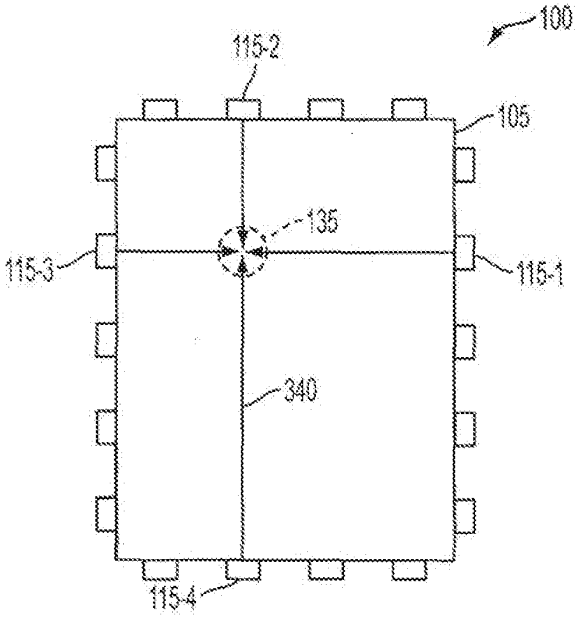


FIG. 6B

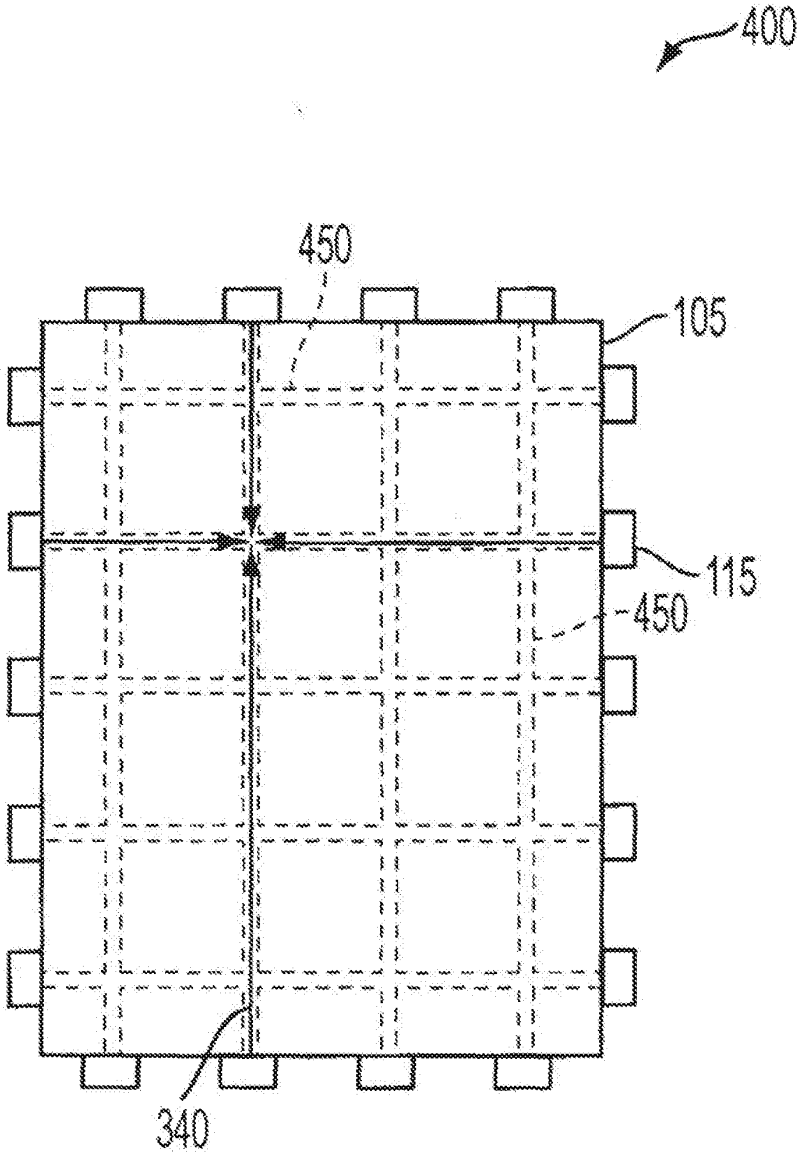


FIG. 7

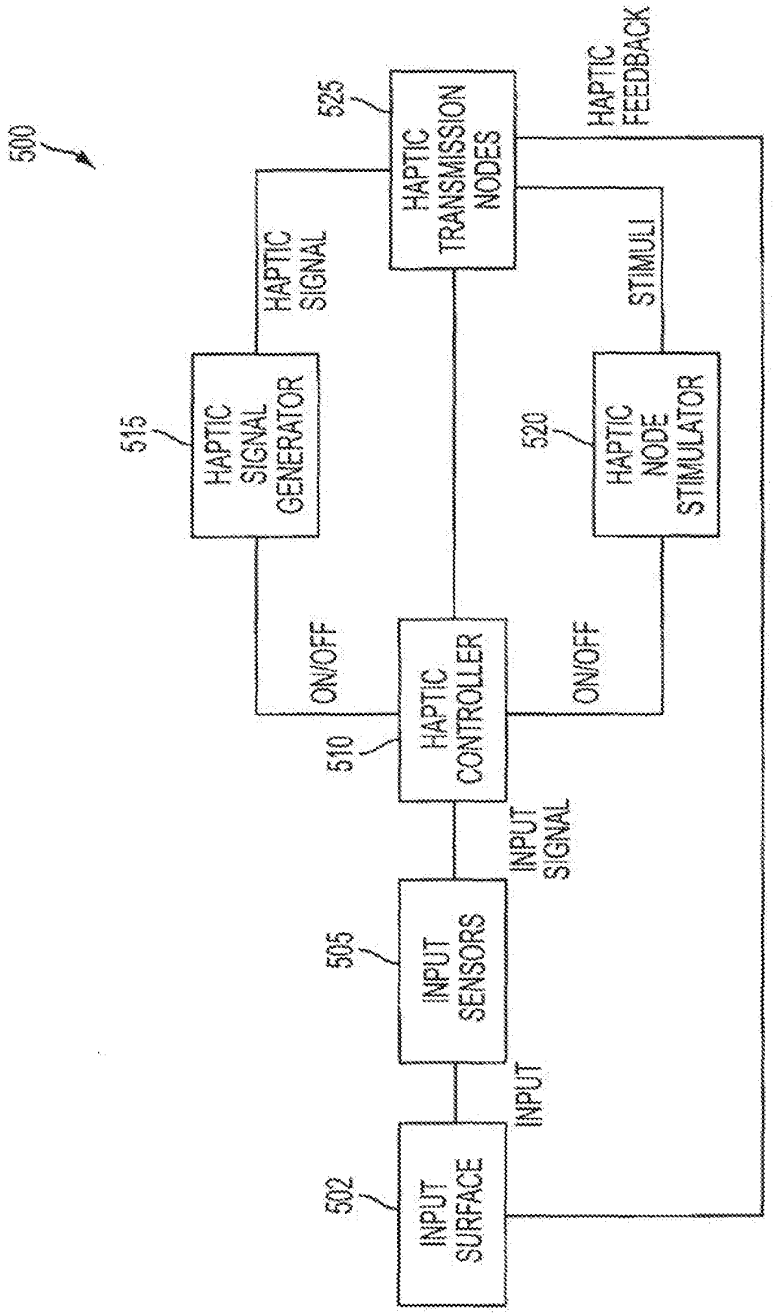


FIG. 8

EX1002 - Page 834

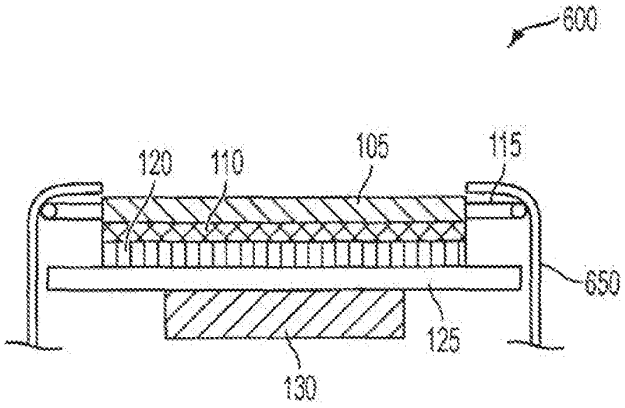


FIG. 9A

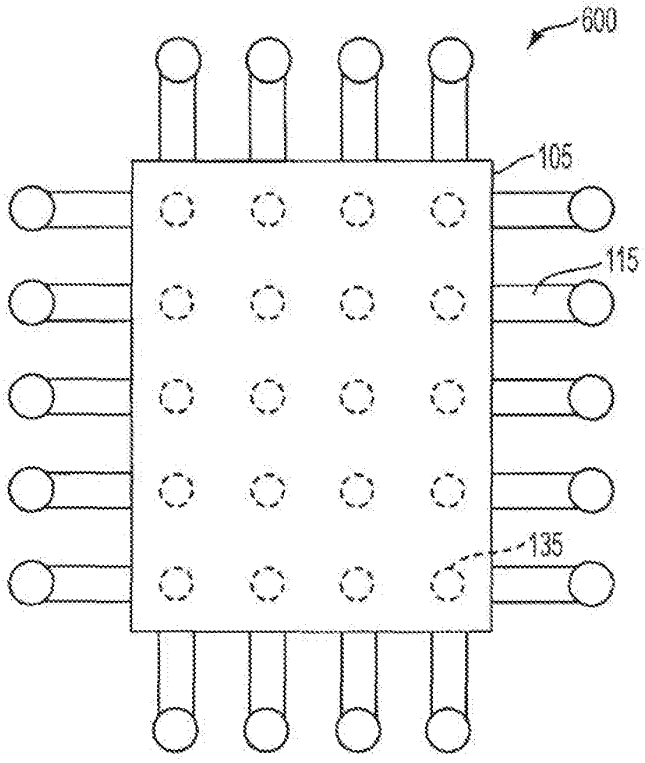


FIG. 9B

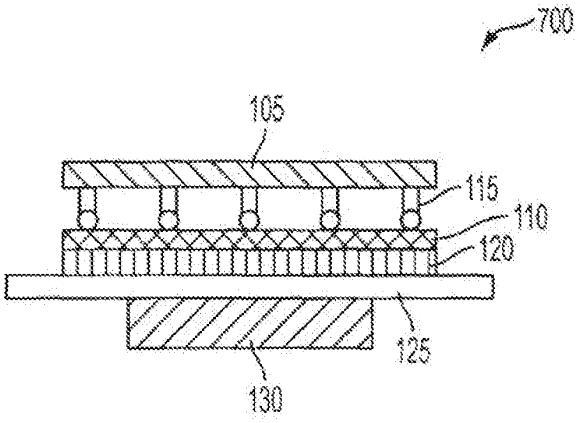


FIG. 10A

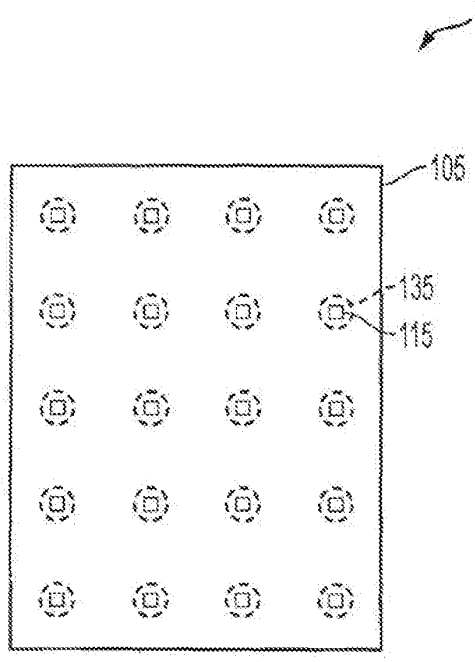


FIG. 10B

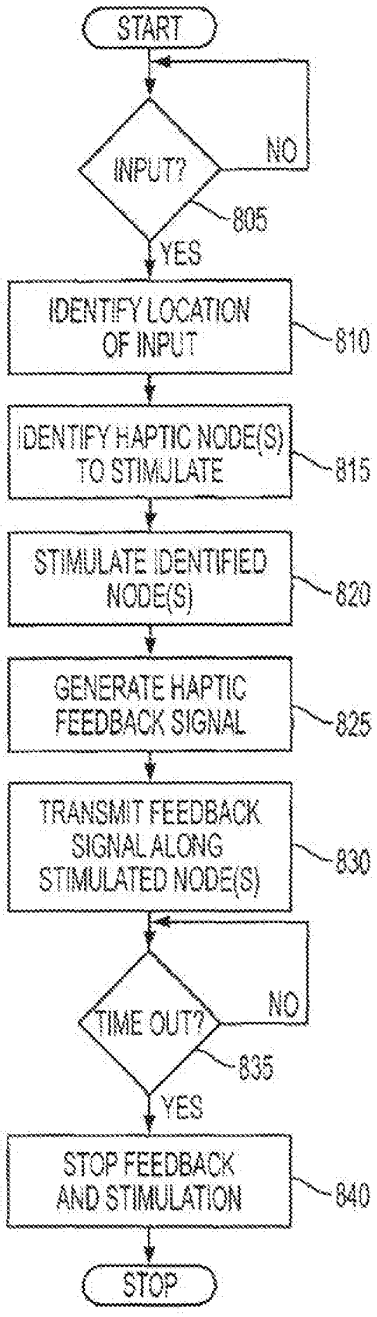

START
INPUT?
NO
805
YES
IDENTIFY LOCATION OF INPUT
810
IDENTIFY HAPTIC NODE(S) TO STIMULATE
815
STIMULATE IDENTIFIED NODE(S)
820
GENERATE HAPTIC FEEDBACK SIGNAL
825
TRANSMIT FEEDBACK SIGNAL ALONG STIMULATED NODE(S)
830
TIME OUT?
NO
835
YES
STOP FEEDBACK AND STIMULATION
840
STOP

FIG. 11

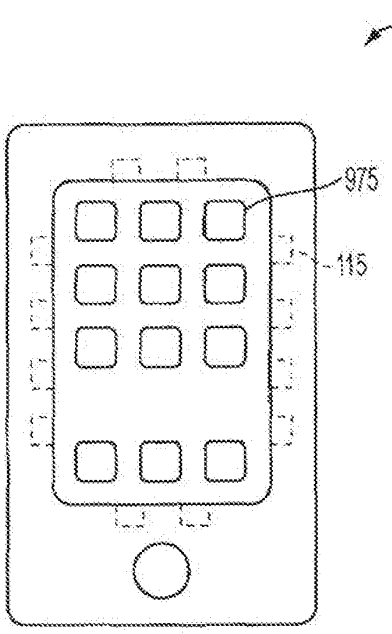


FIG. 12A

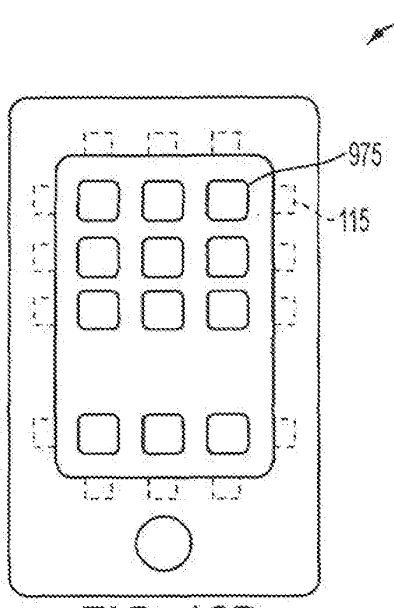


FIG. 12B

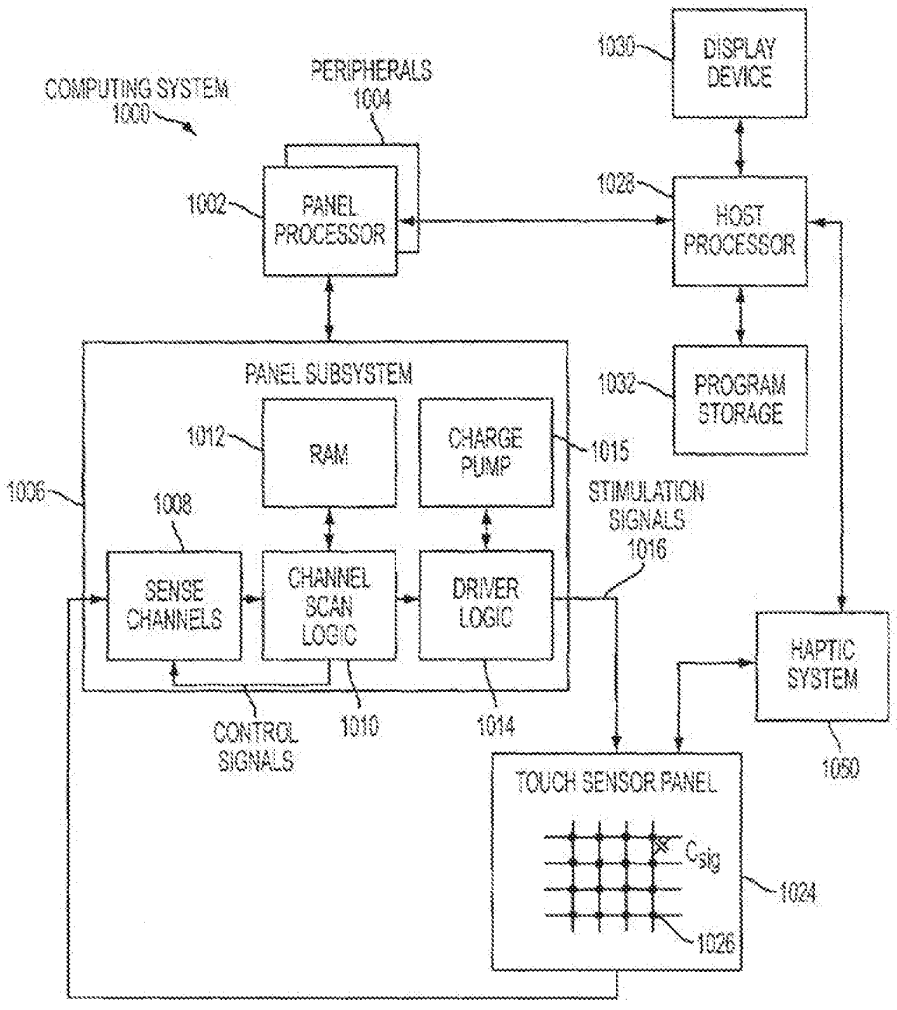

COMPUTING SYSTEM
1000
PERIPHERALS
1004
1030
DISPLAY DEVICE
1002
PANEL PROCESSOR
1028
HOST PROCESSOR
PANEL SUBSYSTEM
1032
PROGRAM STORAGE
1012
RAM
CHARGE PUMP
1015
1006
1008
STIMULATION SIGNALS
1016
SENSE CHANNELS
CHANNEL SCAN LOGIC
DRIVER LOGIC
HAPTIC SYSTEM
CONTROL SIGNALS
1010
1014
1050
TOUCH SENSOR PANEL
C_{sig}
1024
1026

FIG. 13

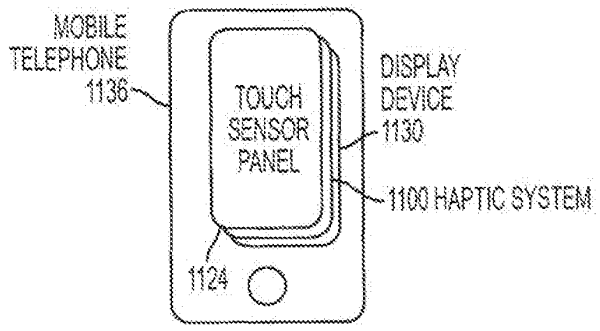


FIG. 14A

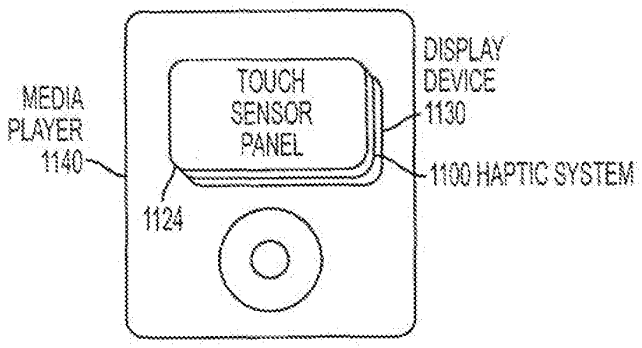


FIG. 14B

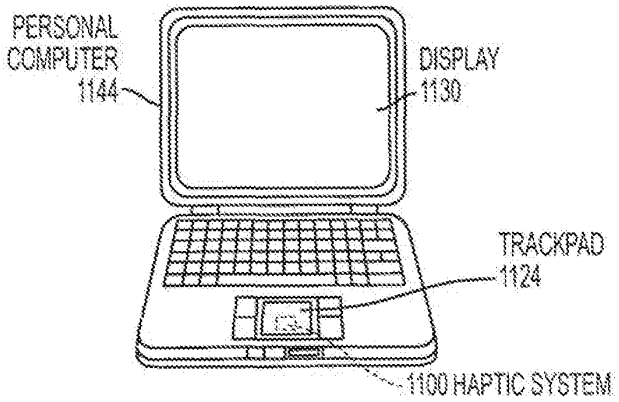


FIG. 14C

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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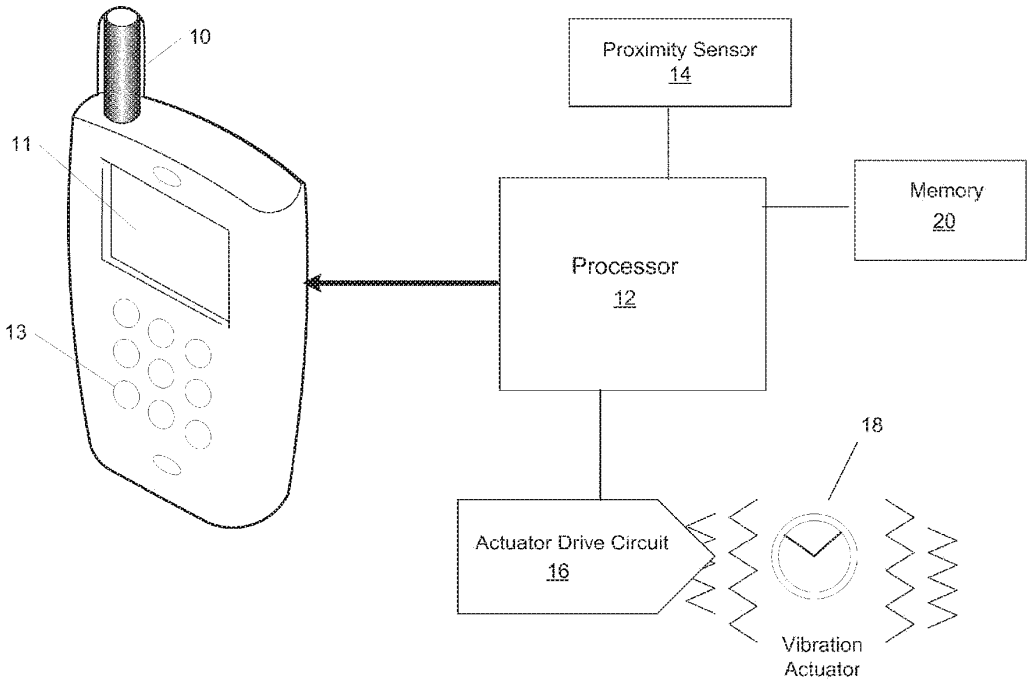
(52) **U.S. Cl.** **715/702**

(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.



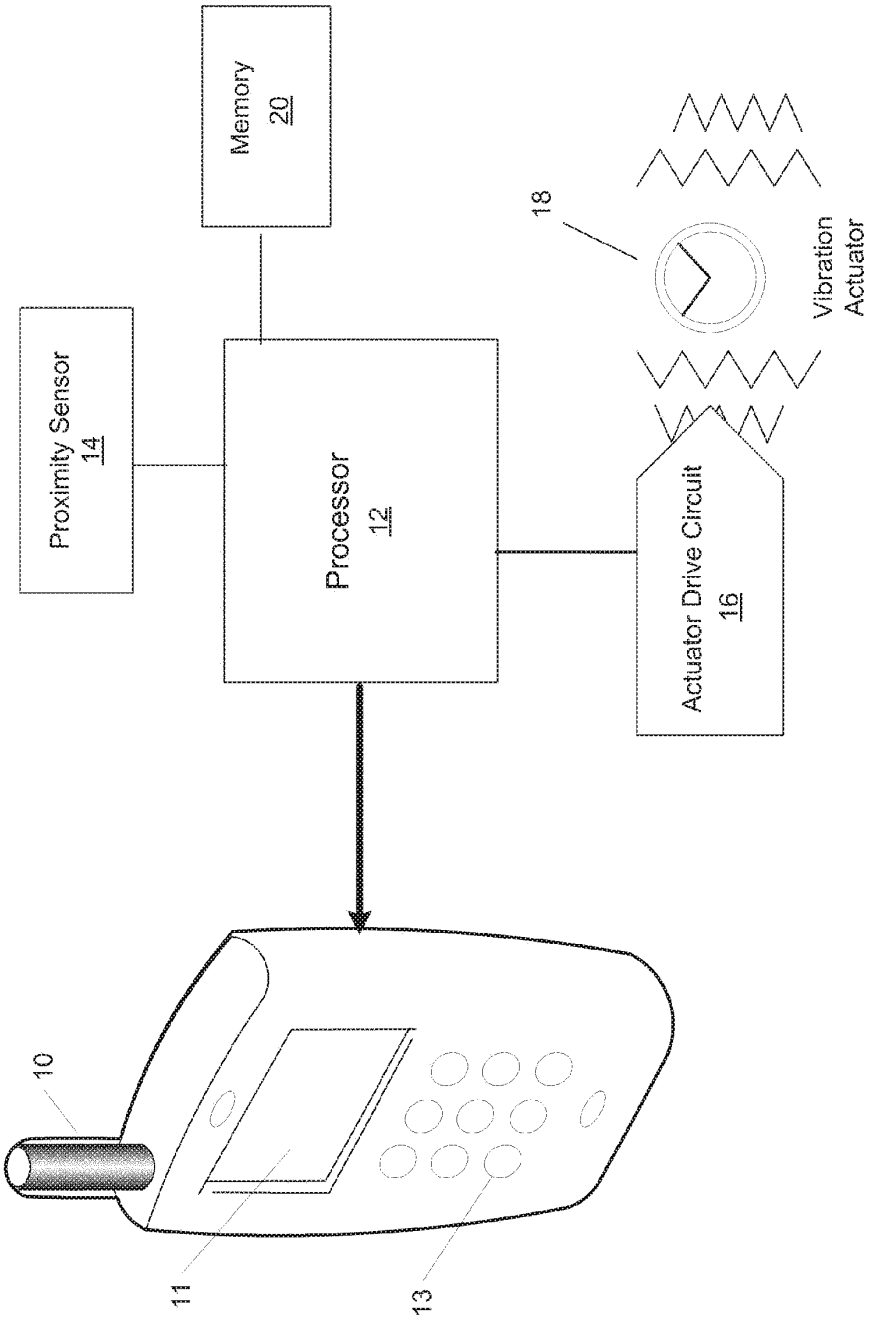

Memory
20
18
Vibration
Actuator
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
10
11
13

Fig. 1

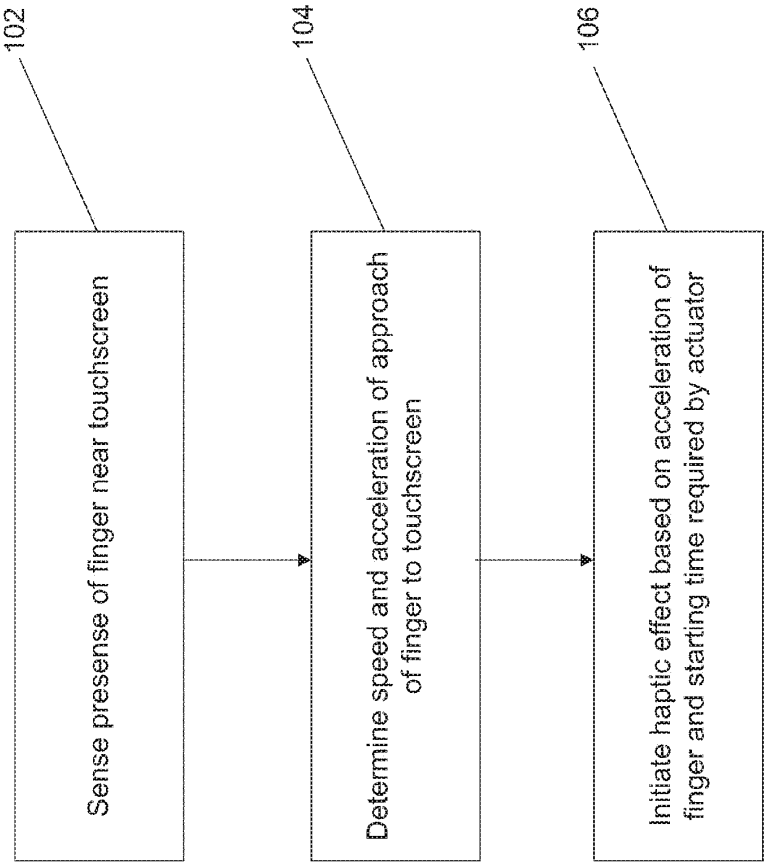


Fig. 2

EX1002 - Page 855

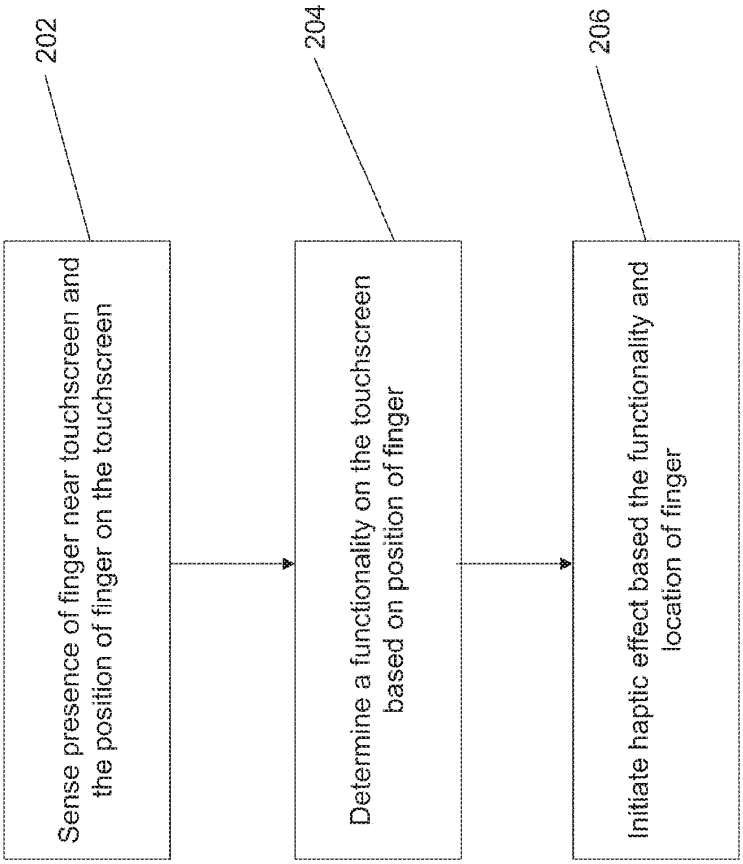

202
Sense presence of finger near touchscreen and the position of finger on the touchscreen
204
Determine a functionality on the touchscreen based on position of finger
206
Initiate haptic effect based the functionality and location of finger

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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(43) **Pub. Date: Jul. 7, 2011**

(54) **DISPLAY INPUT DEVICE**

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(21) Appl. No.: **13/062,713**

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G06F 3/041 (2006.01)

(52) **U.S. Cl.** **345/661**; 345/676

(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.

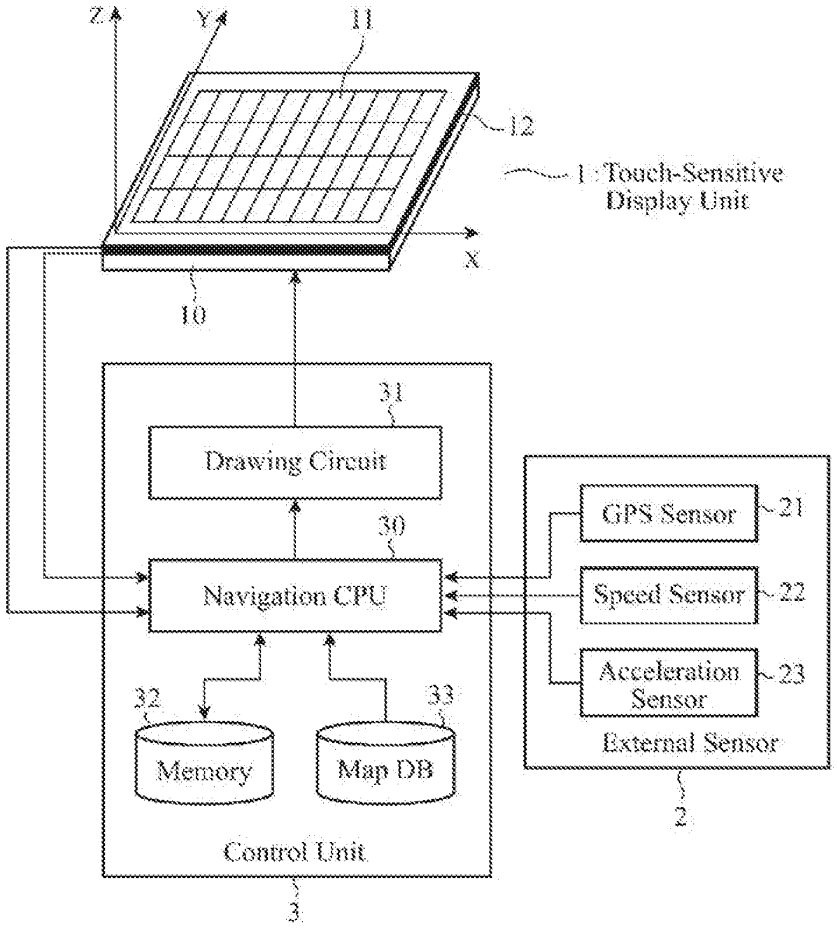


FIG.1

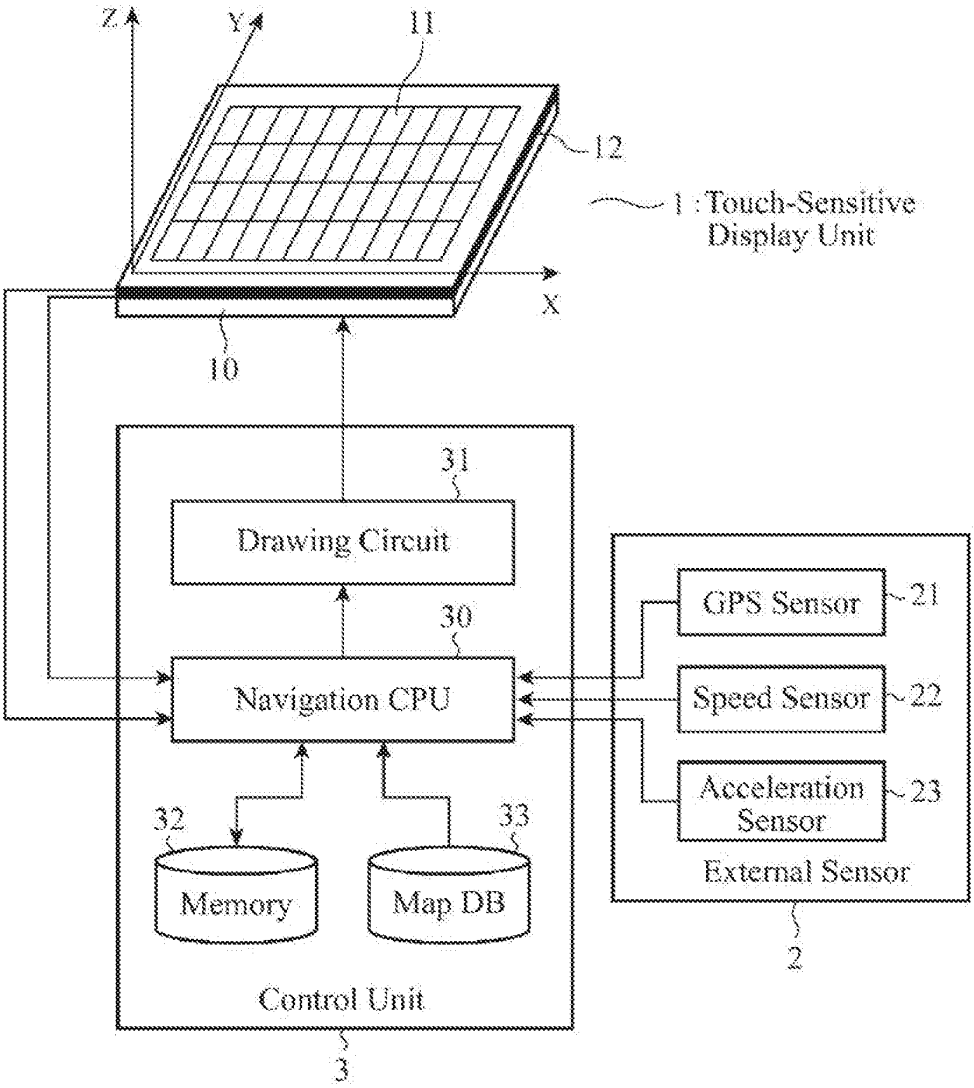
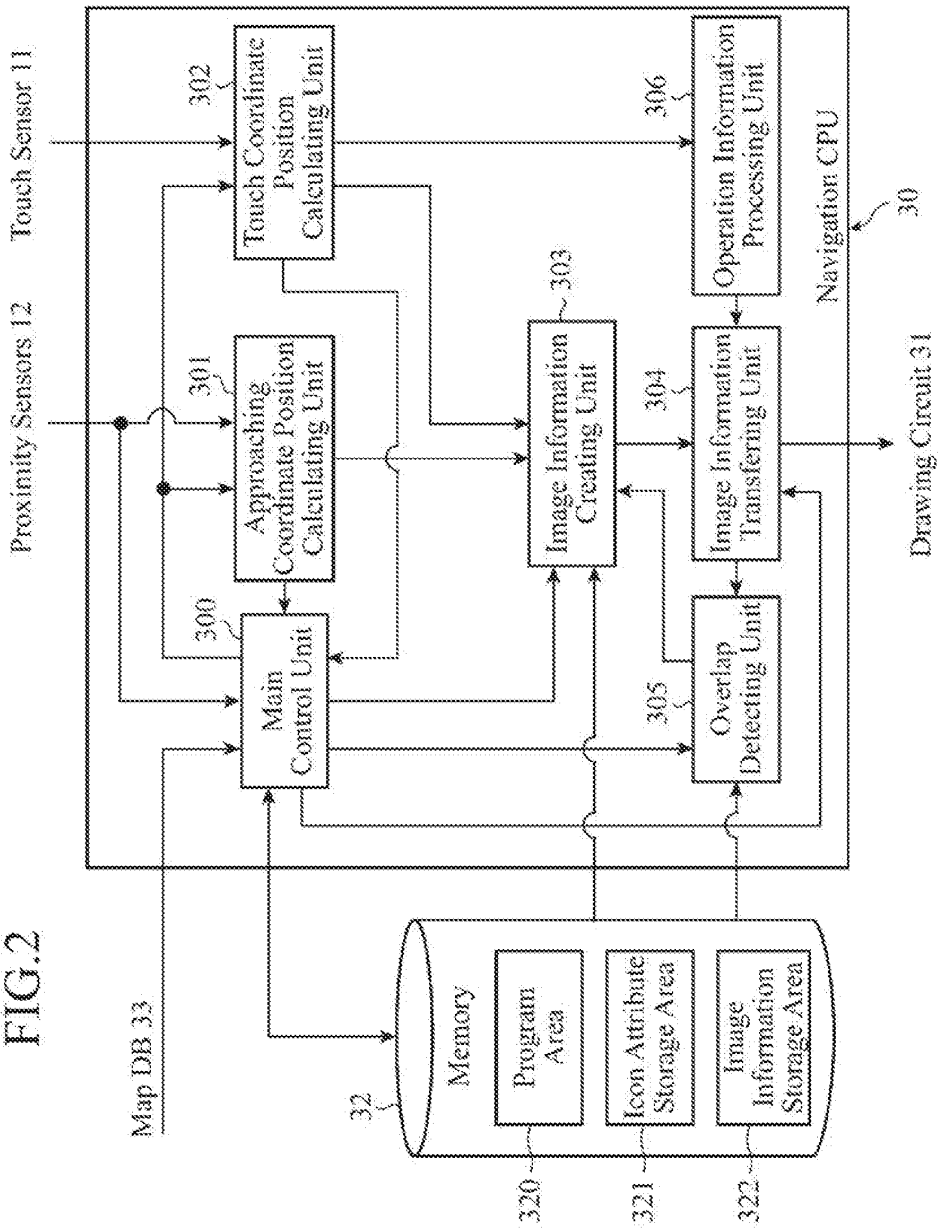

Z
Y
11
12
1 : Touch-Sensitive Display Unit
X
10
31
Drawing Circuit
30
Navigation CPU
32
33
Memory
Map DB
Control Unit
3
GPS Sensor
21
Speed Sensor
22
Acceleration Sensor
23
External Sensor
2

FIG.2



EX1002 - Page 863

FIG.3

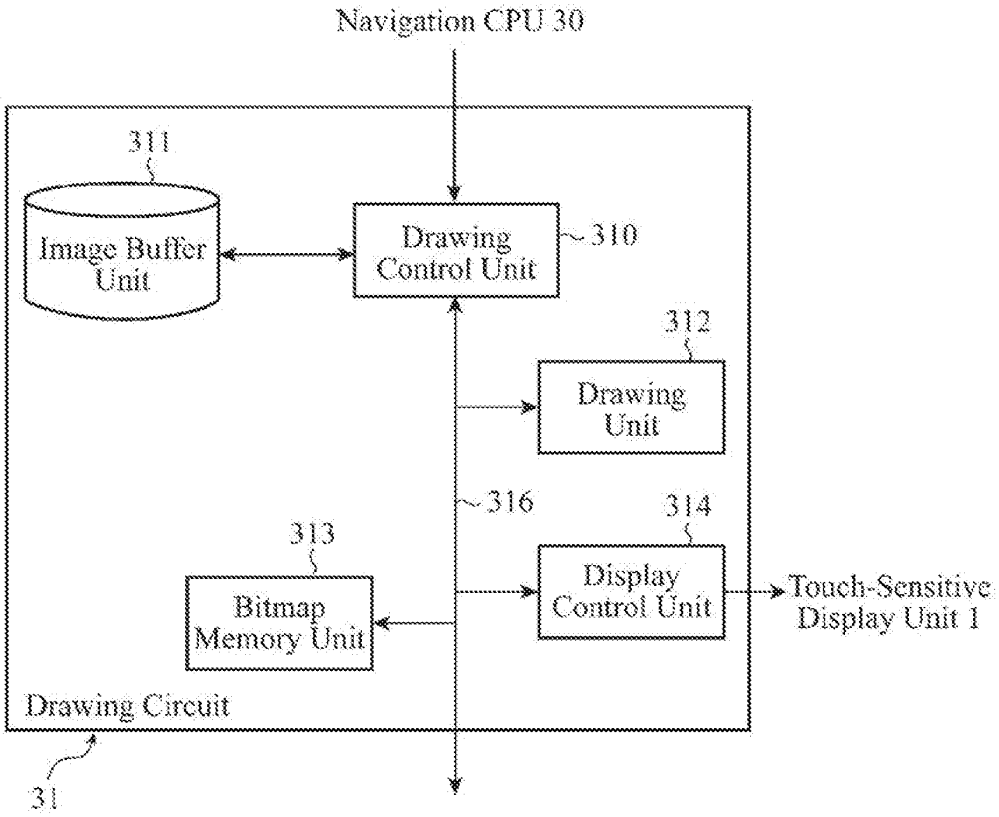

Navigation CPU 30
311
Image Buffer Unit
Drawing Control Unit
310
312
Drawing Unit
316
314
313
Display Control Unit
Touch-Sensitive Display Unit 1
Bitmap Memory Unit
Drawing Circuit
31

FIG.4

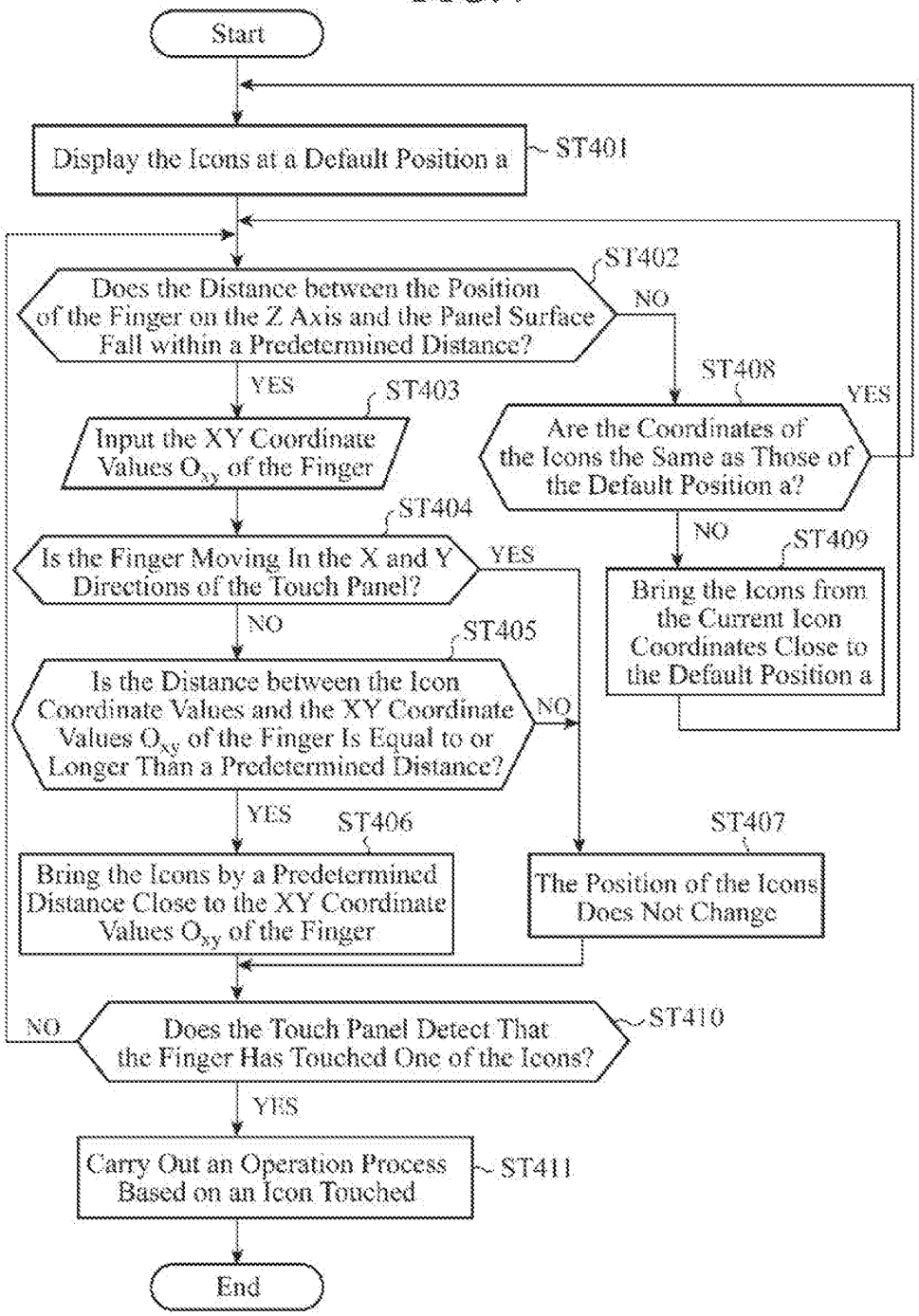

Start
Display the Icons at a Default Position a
ST401
ST402
Does the Distance between the Position of the Finger on the Z Axis and the Panel Surface Fall within a Predetermined Distance?
NO
YES
ST403
Input the XY Coordinate Values O_{xy} of the Finger
ST404
Is the Finger Moving In the X and Y Directions 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

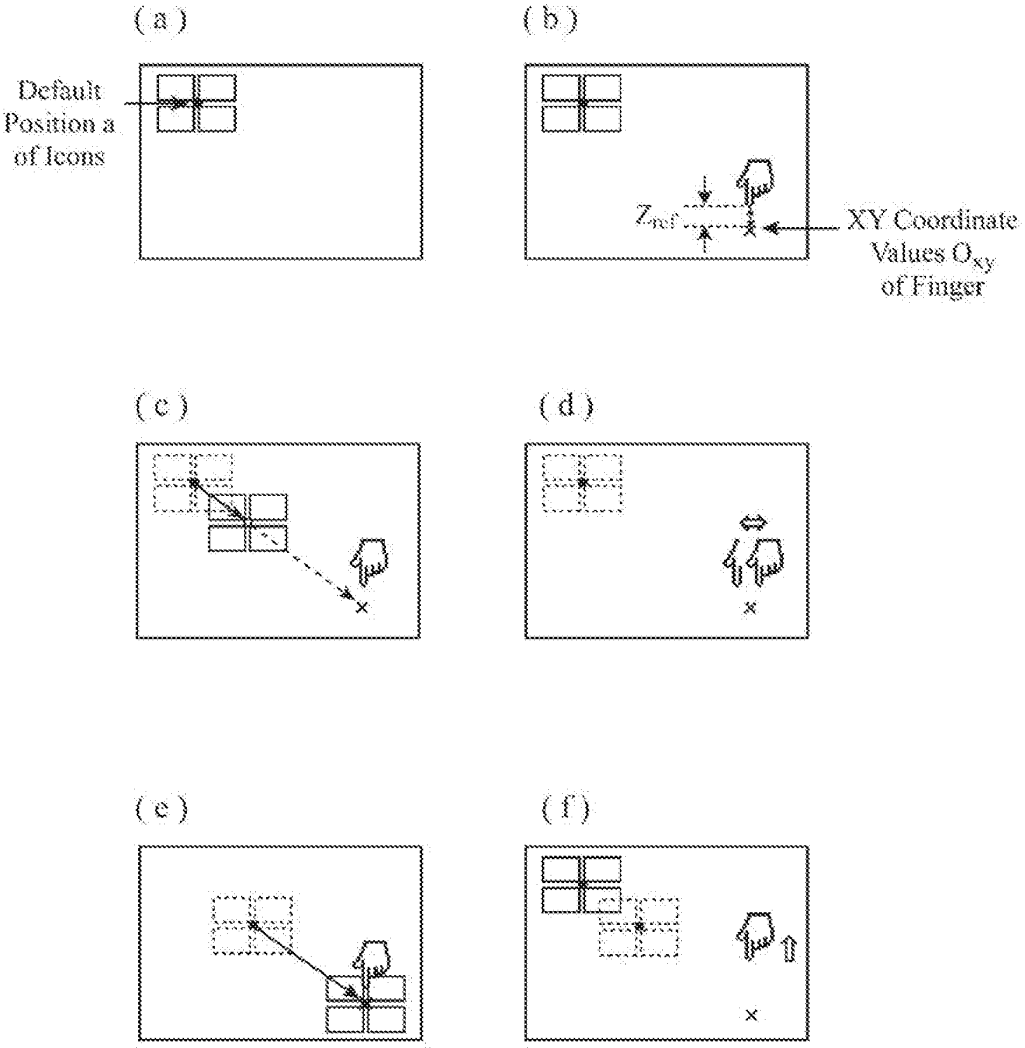

(a)
Default Position a of Icons
(b)
Z_{ref}
XY Coordinate Values O_{xy} of Finger
(c)
(d)
(e)
(f)

FIG.6

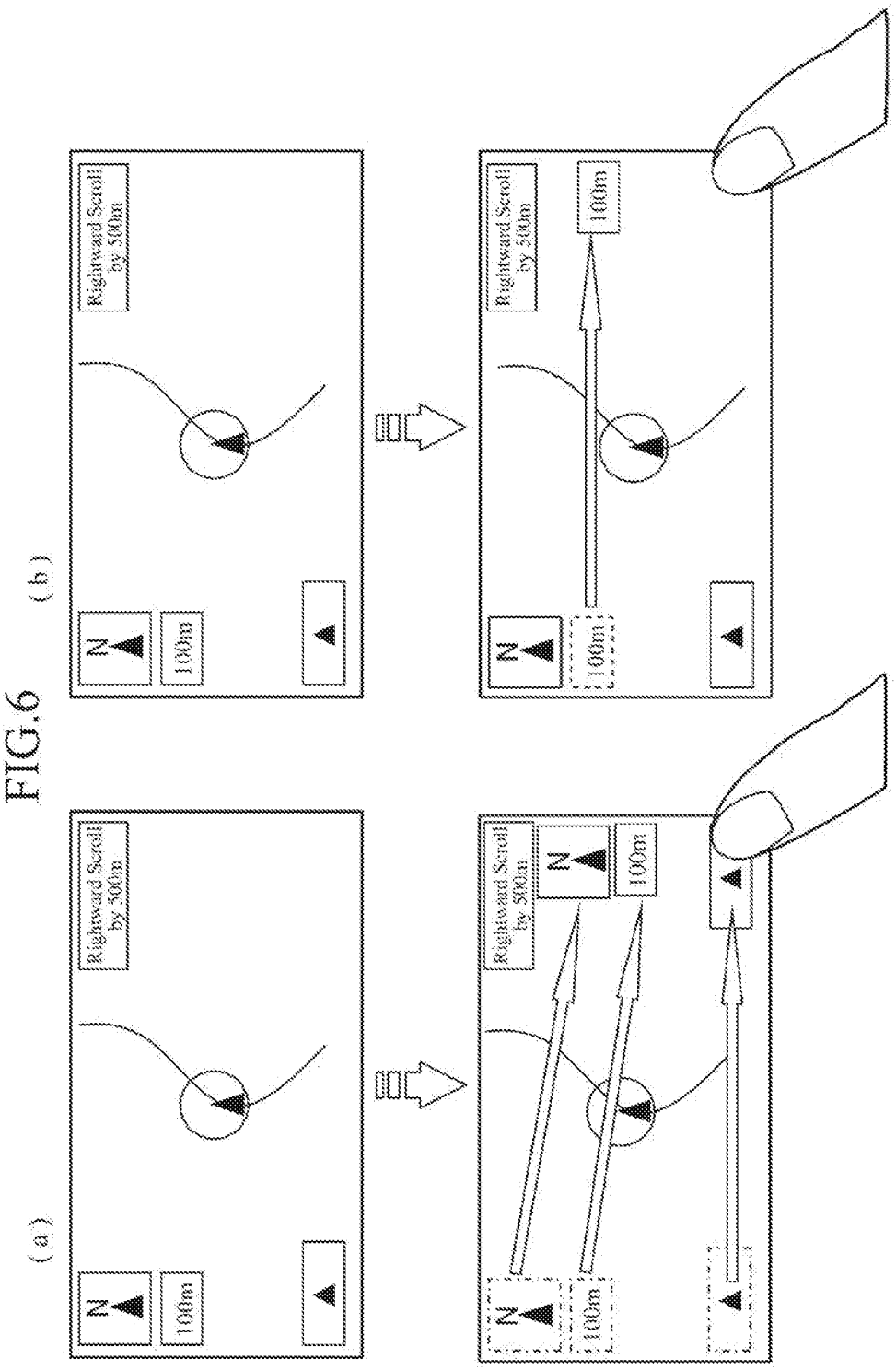

(a)
Rightward Scroll by 500m
N
100m
(b)
Rightward Scroll by 500m
N
100m

FIG.7

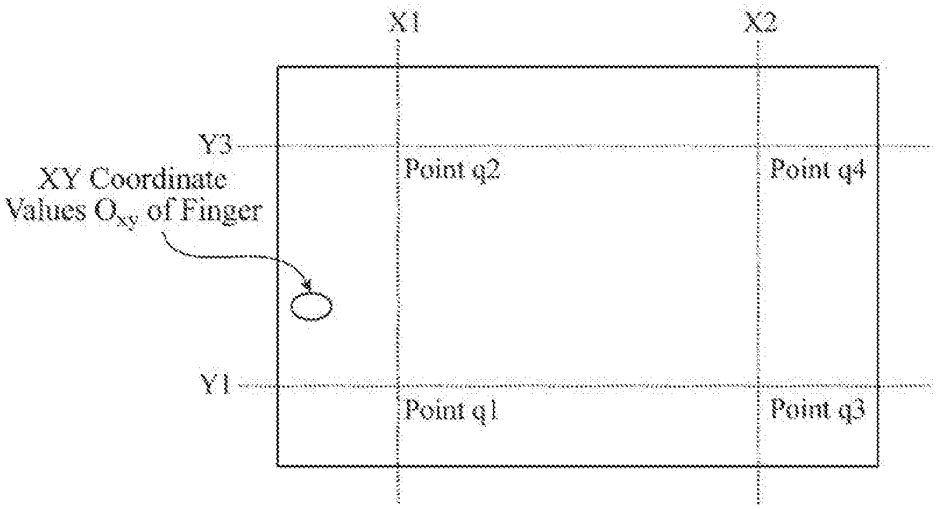

X1
X2
Y3
Point q2
Point q4
XY Coordinate
Values O_{xy} of Finger
Y1
Point q1
Point q3

FIG.8

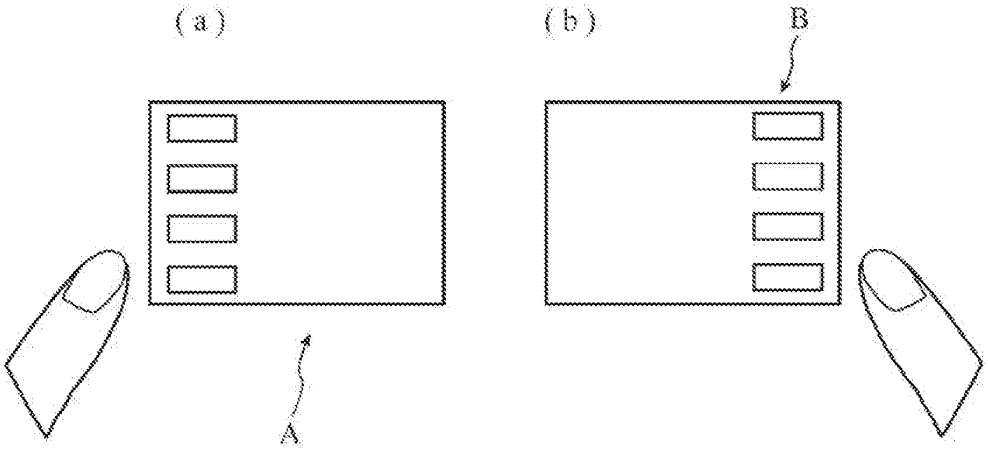
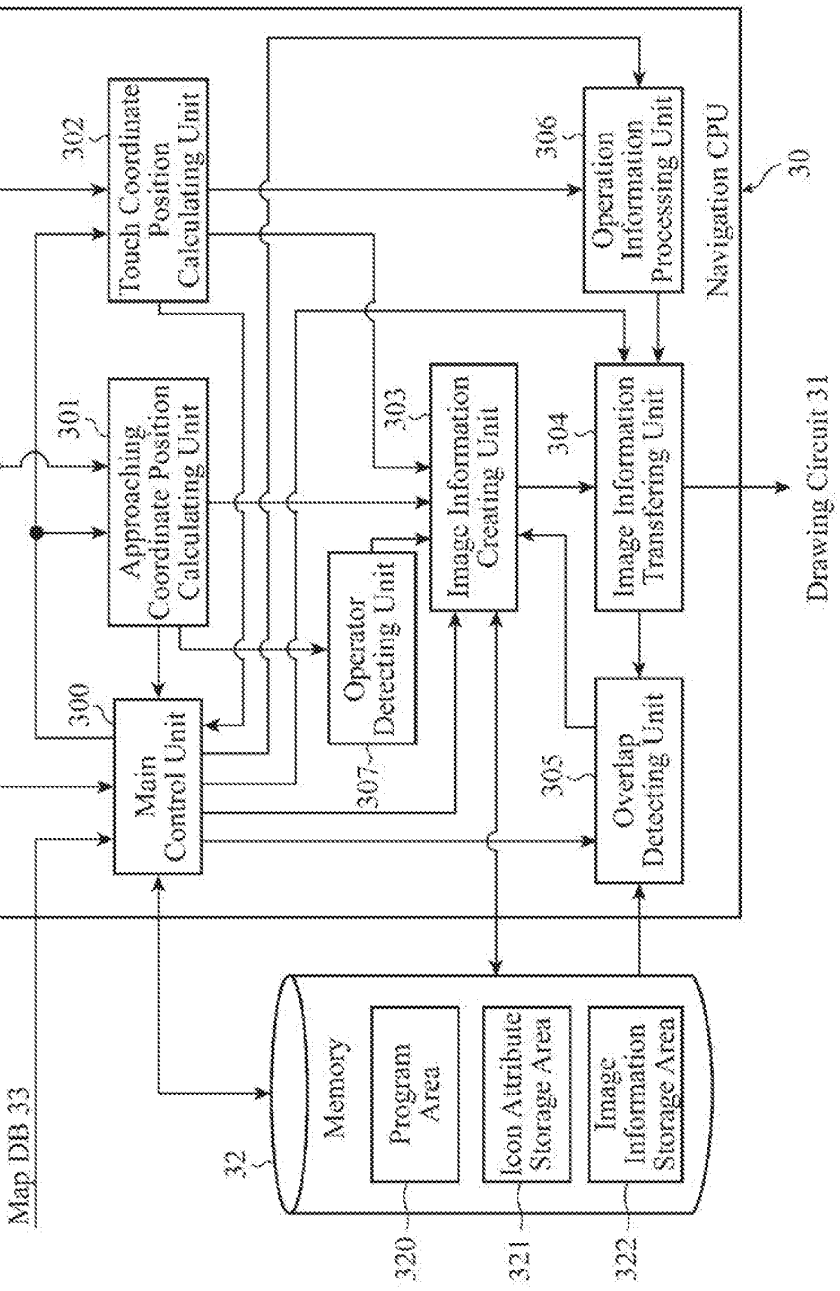

(a)
(b)
B
A

FIG.9



EX1002 - Page 869

FIG.10

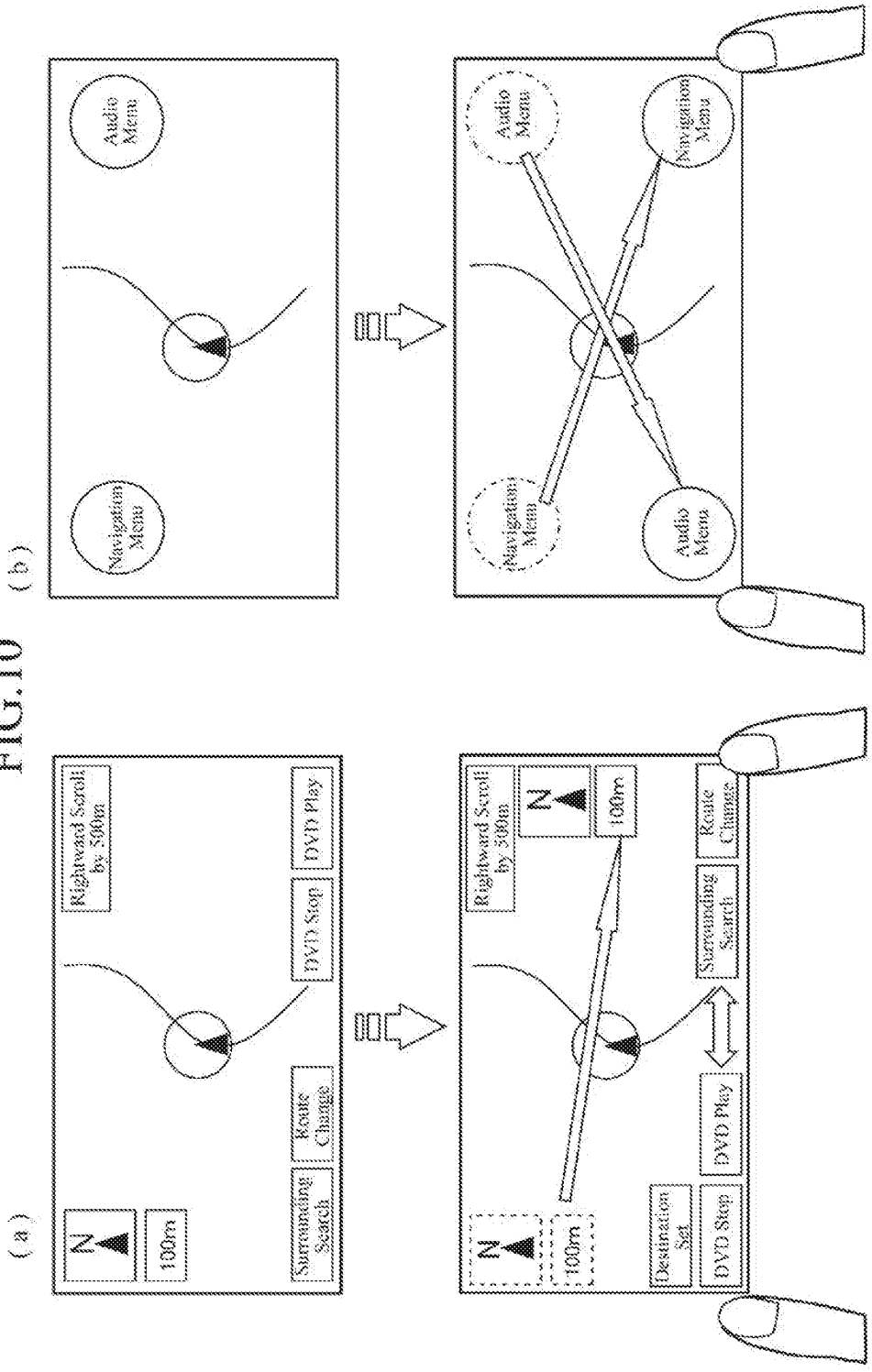
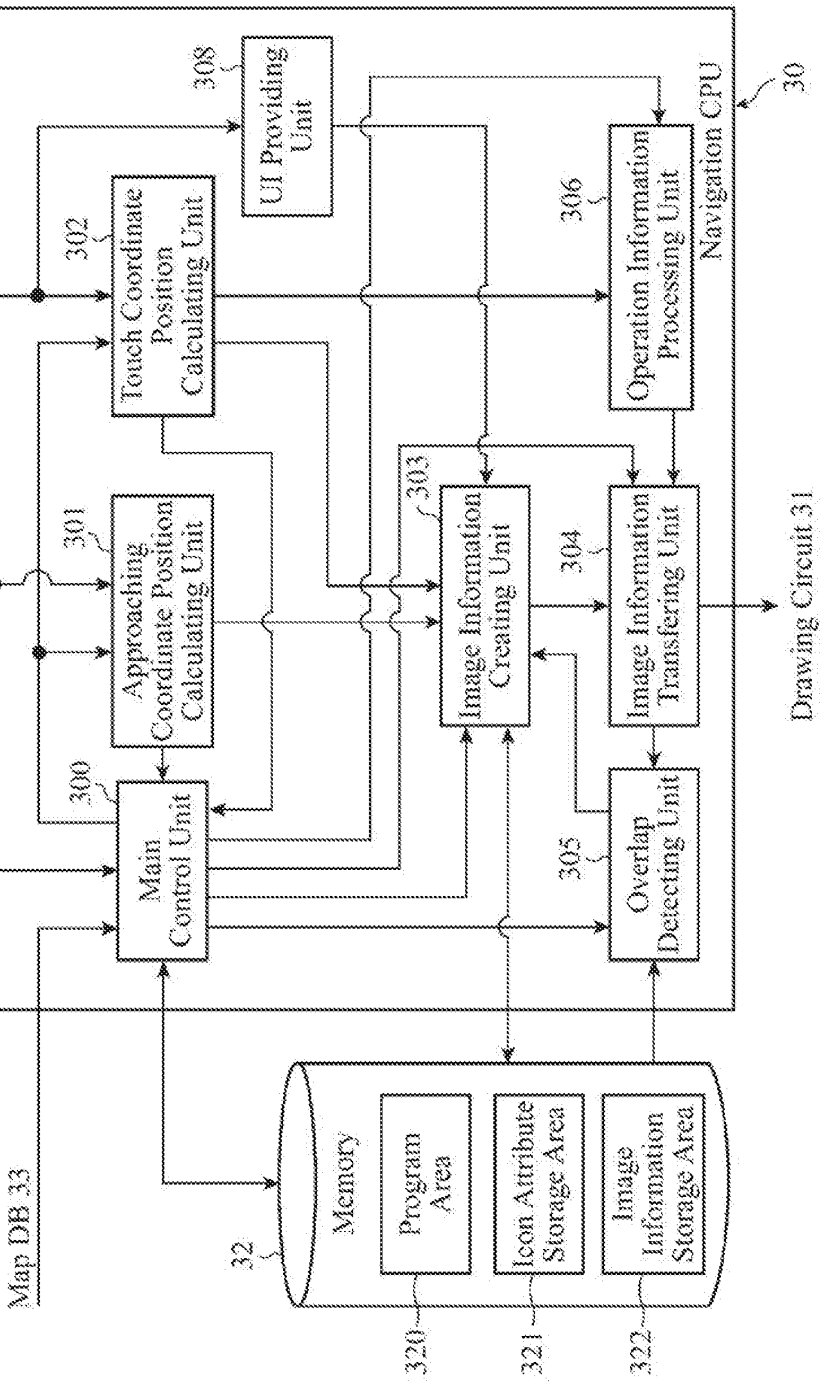

(a)
N
100m
Surrounding Search
Route Change
DVD Stop
DVD Play
Rightward Scroll by 500m
Destination Set
(b)
Audio Menu
Navigation Menu

FIG. 11



EX1002 - Page 871

FIG.12

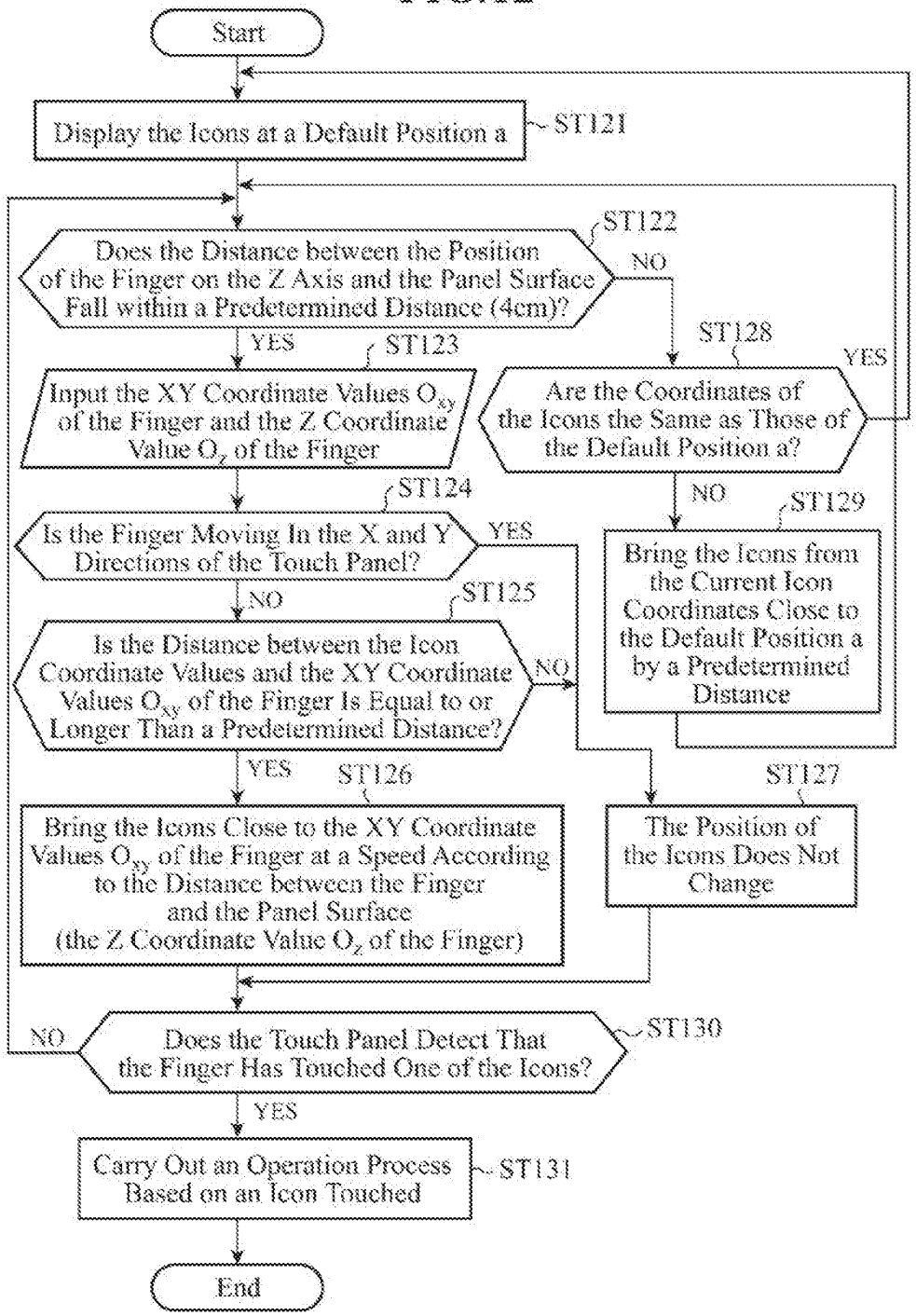

Start
Display the Icons at a Default Position a
ST121
Does the Distance between the Position of the Finger on the Z Axis and the Panel Surface Fall within a Predetermined Distance (4cm)?
ST122
NO
YES
Input the XY Coordinate Values O_{xy} of the Finger and the Z Coordinate Value O_z of the Finger
ST123
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

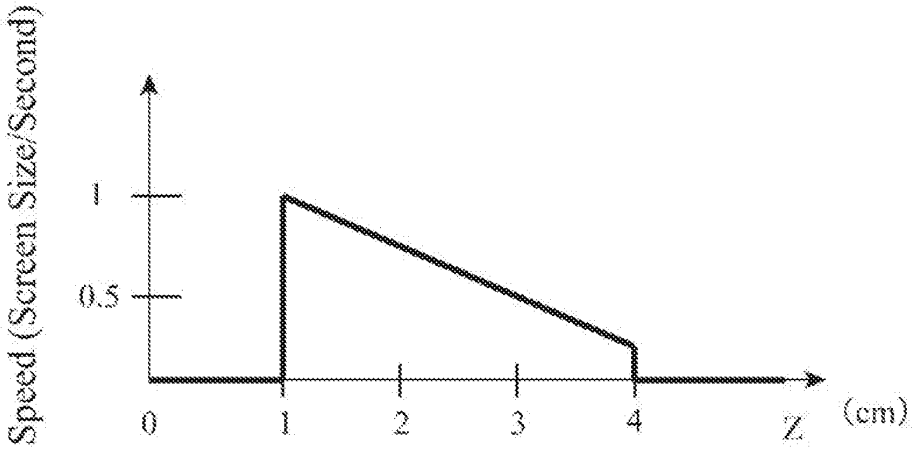
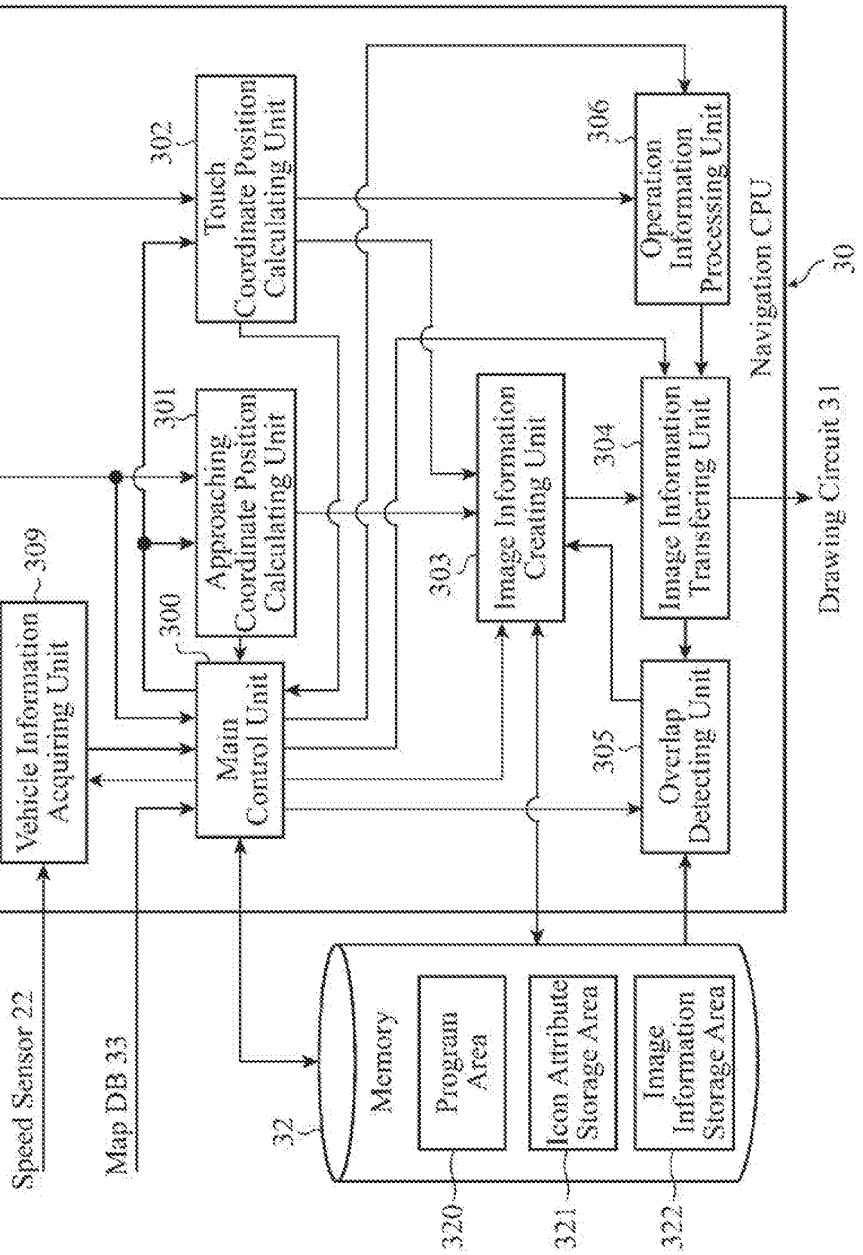
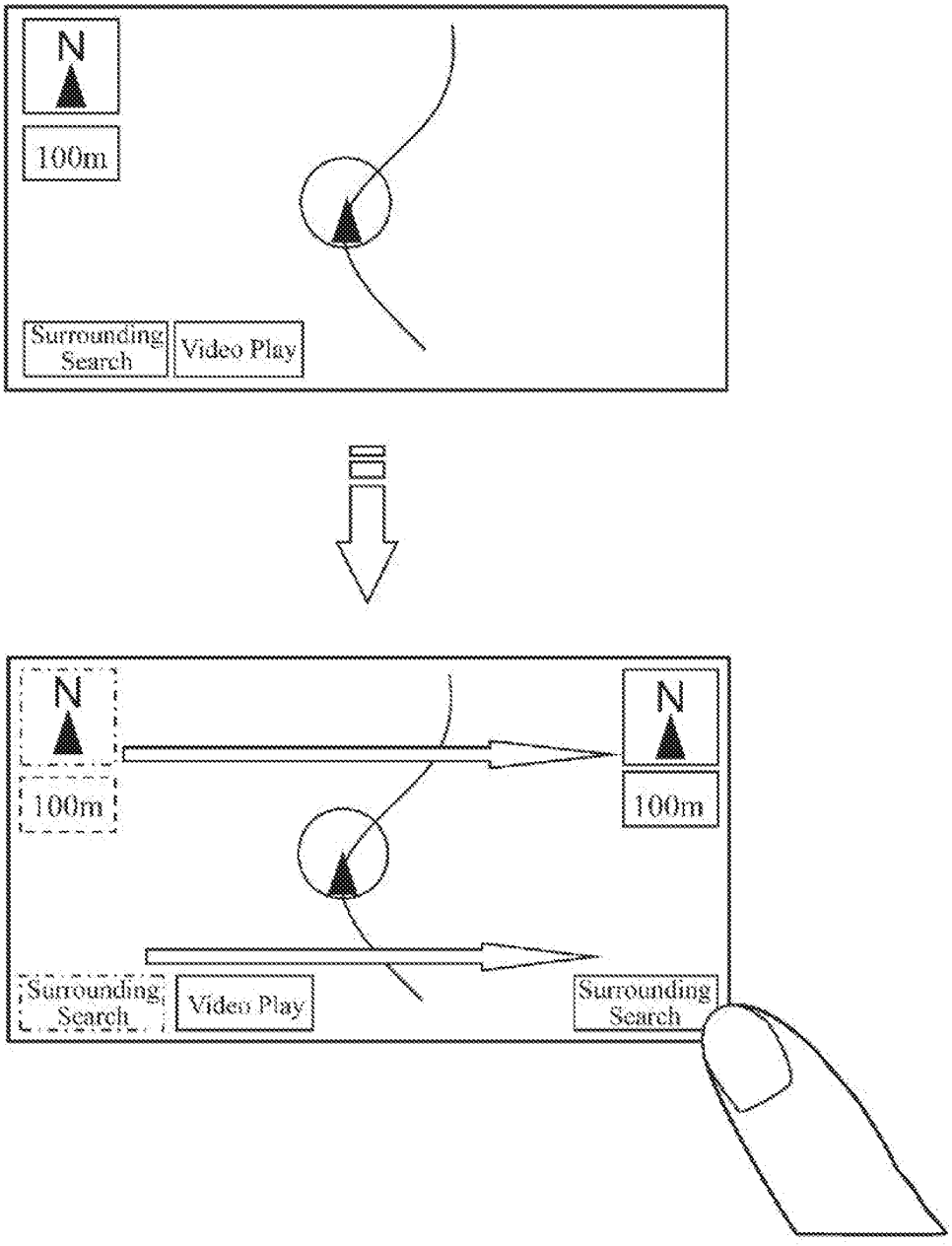


FIG. 14



EX1002 - Page 874

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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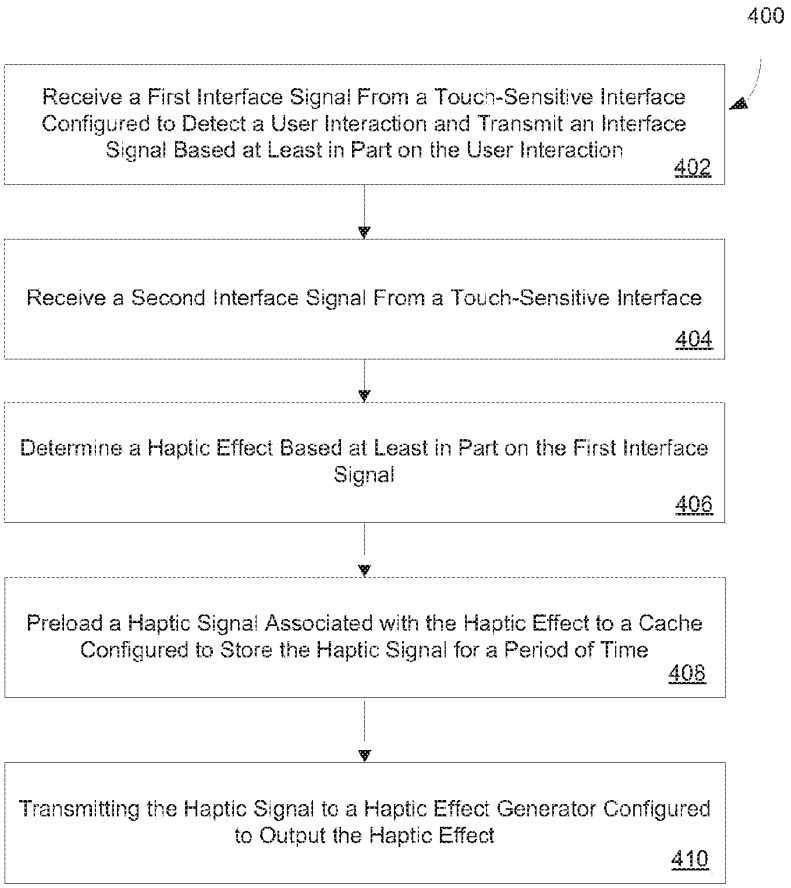
(52) **U.S. Cl.** **345/173**

(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.



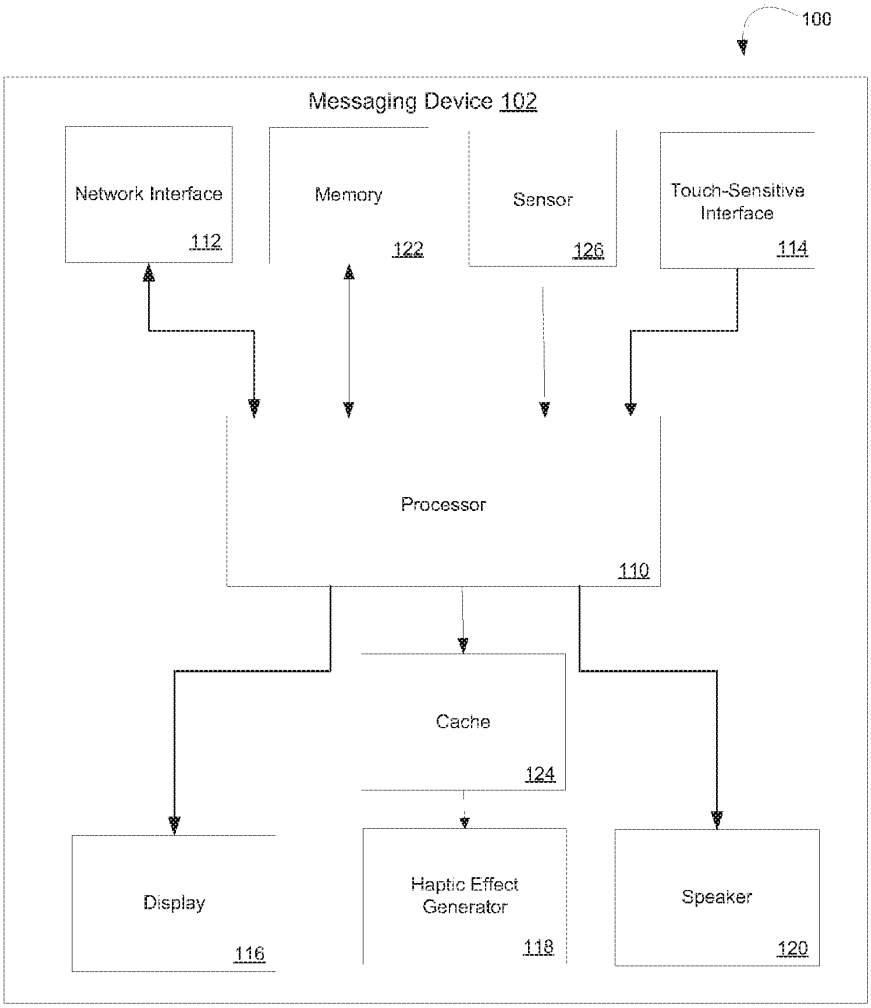

100
Messaging Device 102
Network Interface
112
Memory
122
Sensor
126
Touch-Sensitive Interface
114
Processor
110
Cache
124
Display
116
Haptic Effect Generator
118
Speaker
120

Figure 1

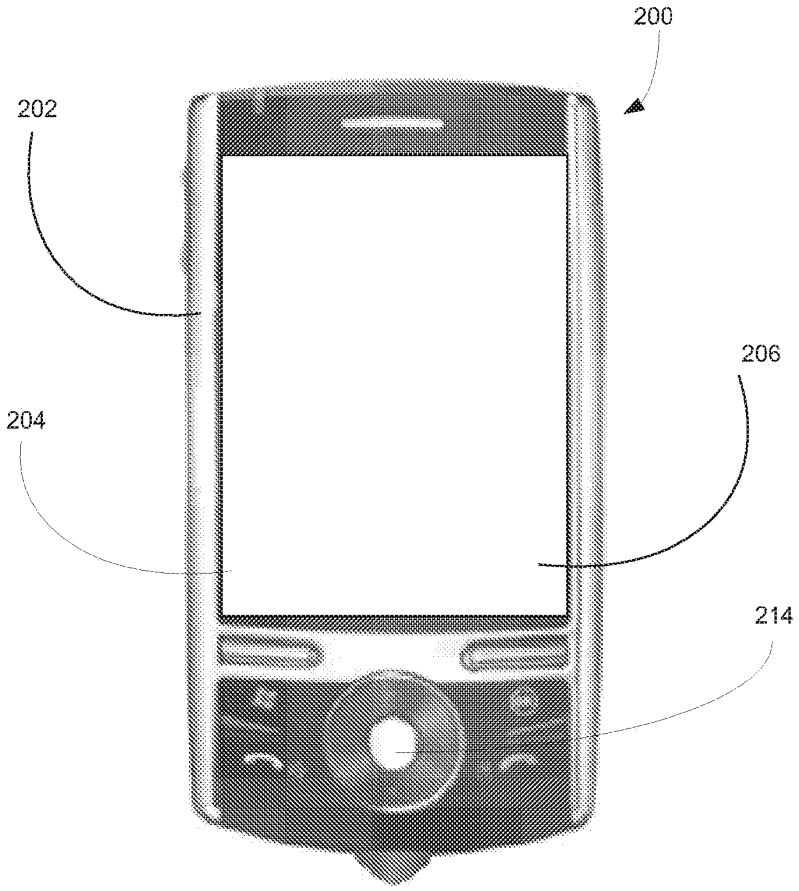


Figure 2

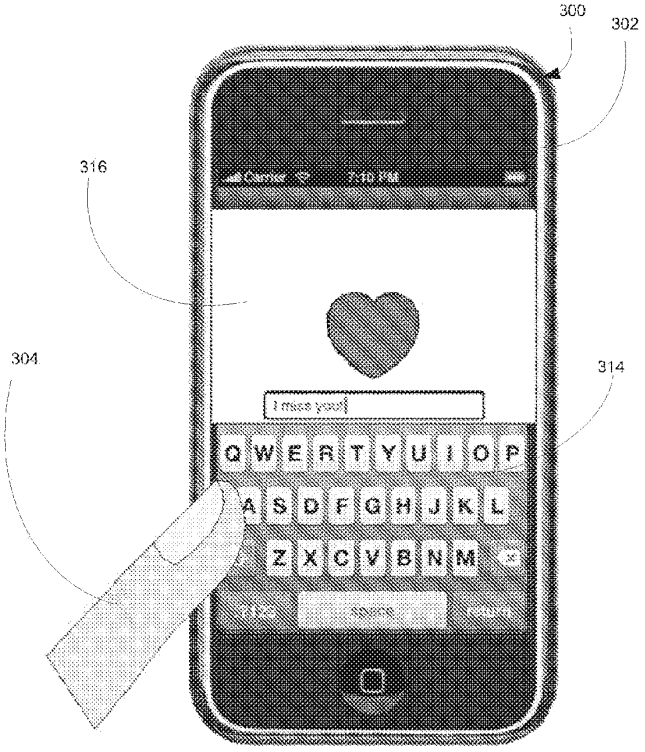


Figure 3A

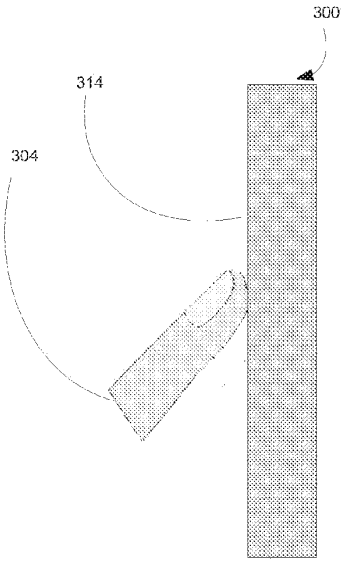


Figure 3B

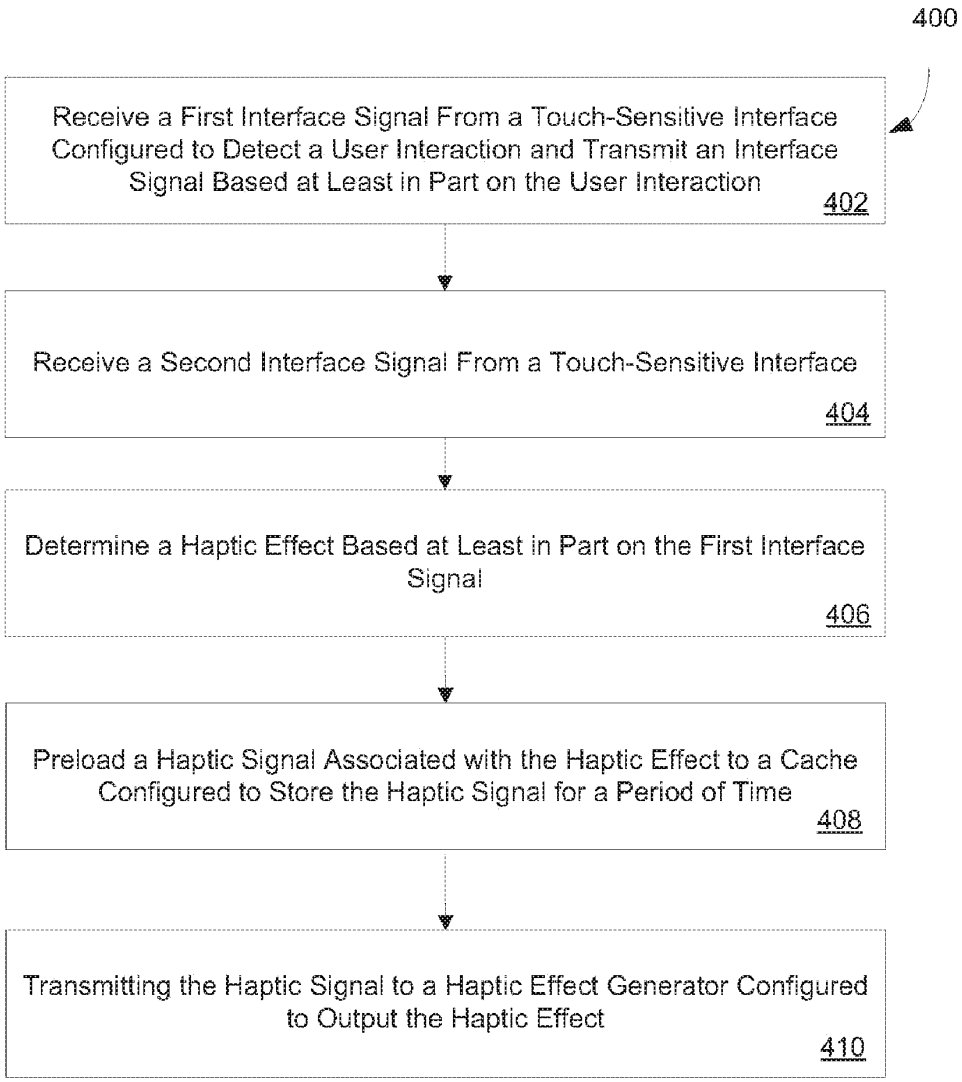

400
Receive a First Interface Signal From a Touch-Sensitive Interface Configured to Detect a User Interaction and Transmit an Interface Signal Based at Least in Part on the User Interaction
402
Receive a Second Interface Signal From a Touch-Sensitive Interface
404
Determine a Haptic Effect Based at Least 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

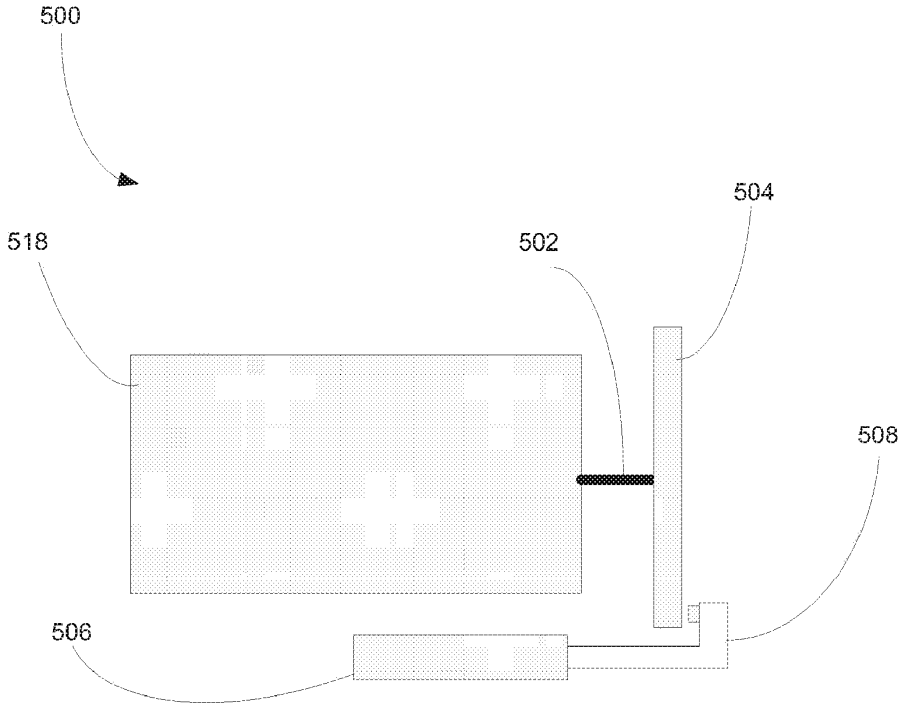


Figure 5

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 electroactive 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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【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〔ダンシャー(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〕によっ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11
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一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。ブ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.

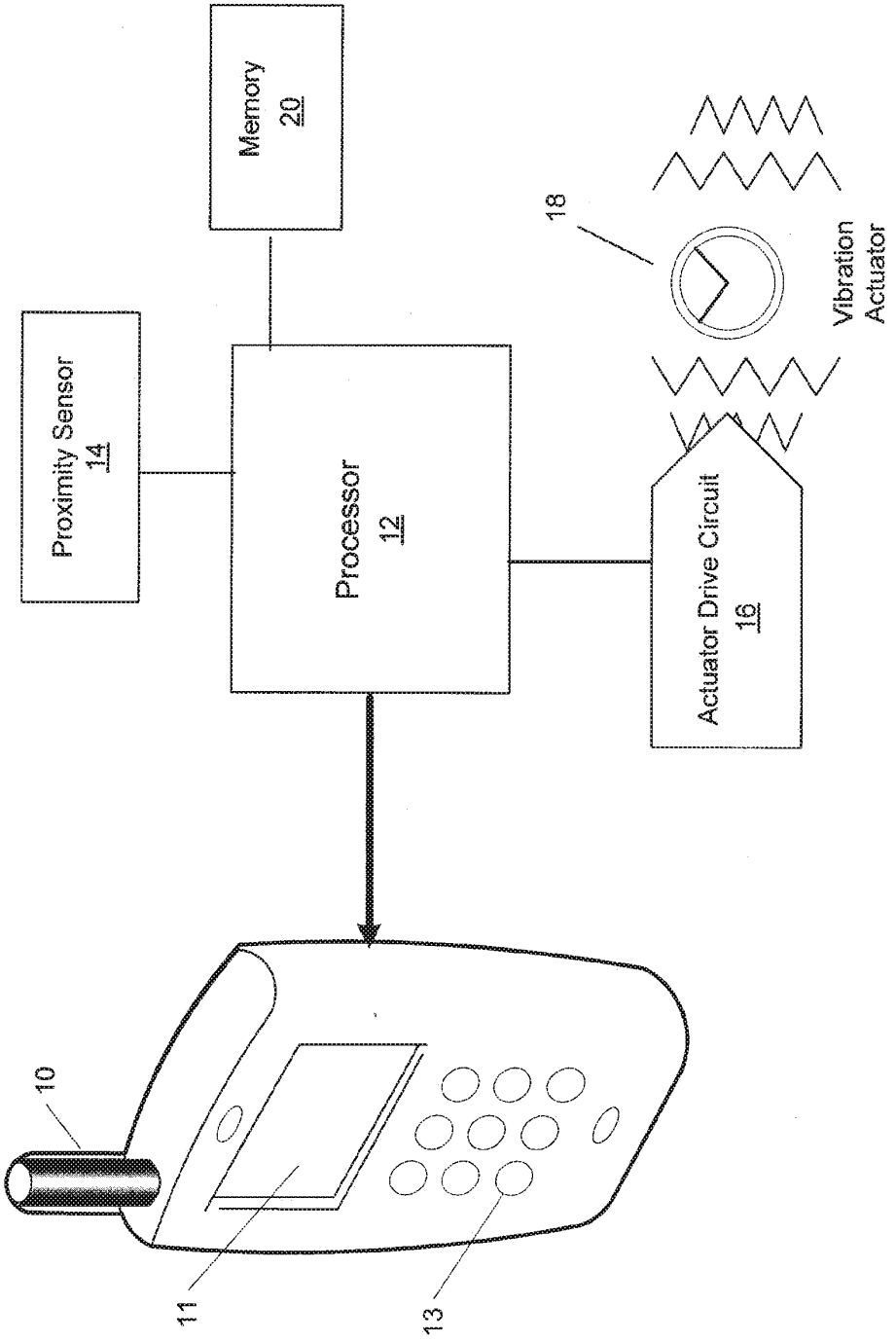
Memory
20
Proximity Sensor
14
Processor
12
Actuator Drive Circuit
16
18
Vibration
Actuator
10
11
13

Fig. 1

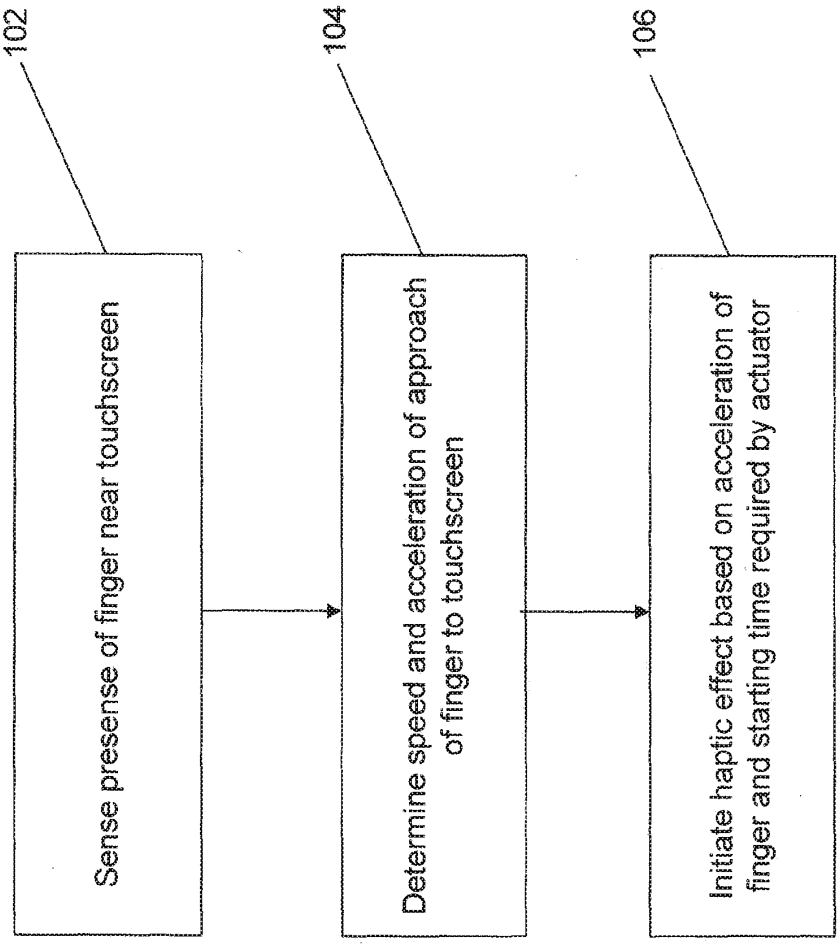

Fig. 2

EX1002 - Page 929

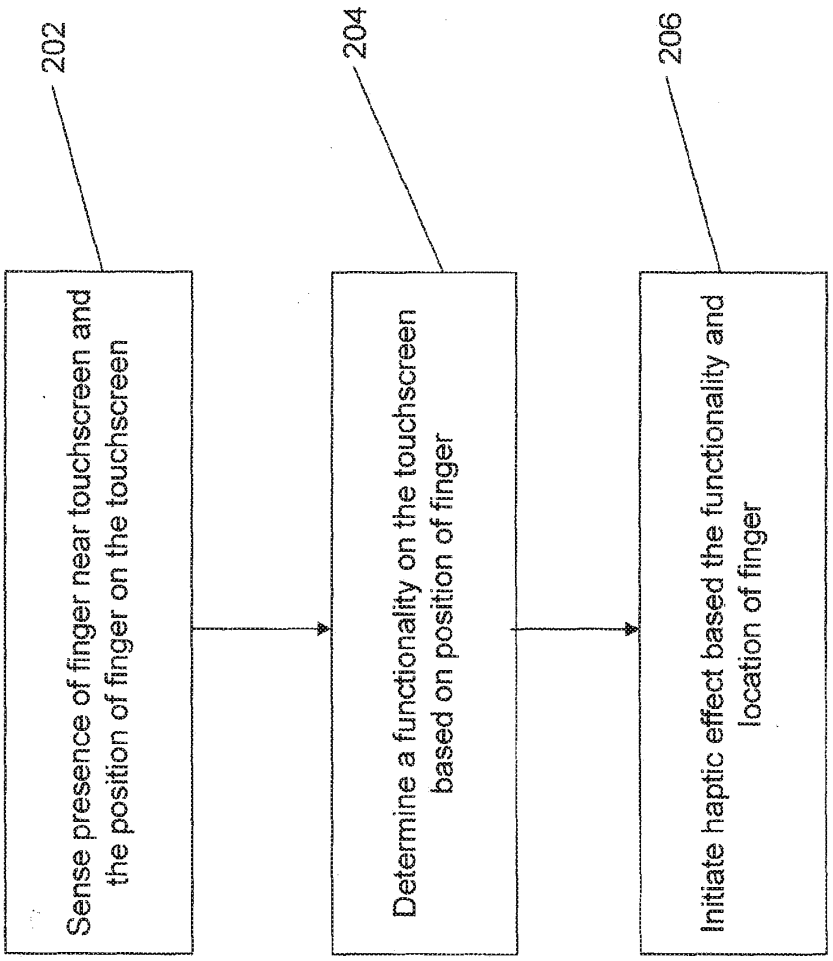

Fig. 3

EX1002 - Page 930

Espacenet

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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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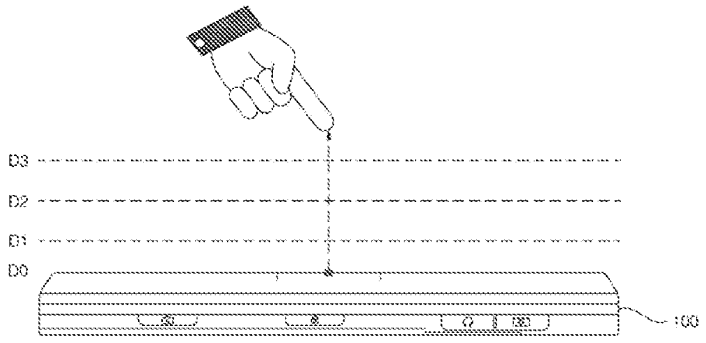
전체 청구항 수 : 총 47 항

(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 본작 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 특정으로 하는 휴대 단말기 동작 제어방법.

청구항 6

제1항에 있어서,

상기 진동신호는 사용자에 의해 생성된 진동신호인 것을 특정으로 하는 휴대 단말기 동작 제어방법.

청구항 7

근접센서를 포함하는 휴대 단말기 본작 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

EX1002 - Page 936

진동신호인 것을 특징으로 하는 휴대 단말기 동작 제어방법.

청구항 26

제19항에 있어서,

상기 제2진동신호는 일정한 압력 및 면적 `중 어느 하나를 특징으로 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 조합한 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 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 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 근접면적으로 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 접촉물체가 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, 접촉영역이 서로 다른 근접센서를 복수로 배치하여 이들 근접센서 중에서 어느 근접센서로부터 근접신호가 출력되는지를 파악하여, 접촉물체가 디스플레이부(151)의 어느 영역으로 접근하는지 여부와, 접촉물체가 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 측각 효과를 발생하는 햅팁영역에 대한 설명에 참조되는 도면이다. 먼저, 도 5a의 (a)에 도시된 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 도시된 바와 같이, 오브젝트가 표시된 영역을 3개의 영역(A, B, C)으로 구분하거나, 혹은 도 5a의 (c)에 도시된 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 도시된 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 도시된 '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 동대 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 터치신호가 일정한 면적을 갖고 입력되는 경우, 터치신호가 일정한 압력을 갖고 입력되는 경우, 터치신호들이, 터치신호가 멀티터치로 입력되는 경우에 따라 진동신호가 각각 설정될 수 있다. 또한, 근접신호가 일정한 근접면적을 갖거나 일정한 근접속도를 갖고 입력되는 경우, 근접신호가 멀티터치로 입력되는 경우도 각각 진동신호가 설정될 수 있다. 또한, 단순하게 터치신호가 입력된 경우, 근접신호가 입력되는 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 접촉된 값을 기초로 판단할 수 있으며, 근접신호는 근접센서(141)로부터 접촉된 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 경보를 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 접점

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 진동(910)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 조합방법은 서로 바뀔 수 있다.

<114> 제1 근접거리에서 입력되는 근접신호 및 제2 근접거리에서 입력되는 근접신호를 포함하는 신호가 입력되어, 각 근접거리에 대한 진동신호을 조합하여 진동을 출력하는 휴대 단말기 동작 제어방법은 도 15의 (a)에 도시된 바와 같이, 음악 재생시 디스플레이부(151)를 통해 동작 버튼이 선택되는 경우 적용 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 여러영역을 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 여러영역을 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 입력된 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 입력의 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. 복수의 메뉴가 표시된 디스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정하여, P1영역 및 P9영역을 통해 터치신호가 입력된 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 디스플레이부(151)의 영역을 9개의 멀티터치 영역으로 설정하여, P2영역 및 P8영역을 통해 터치신호가 입력된 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,

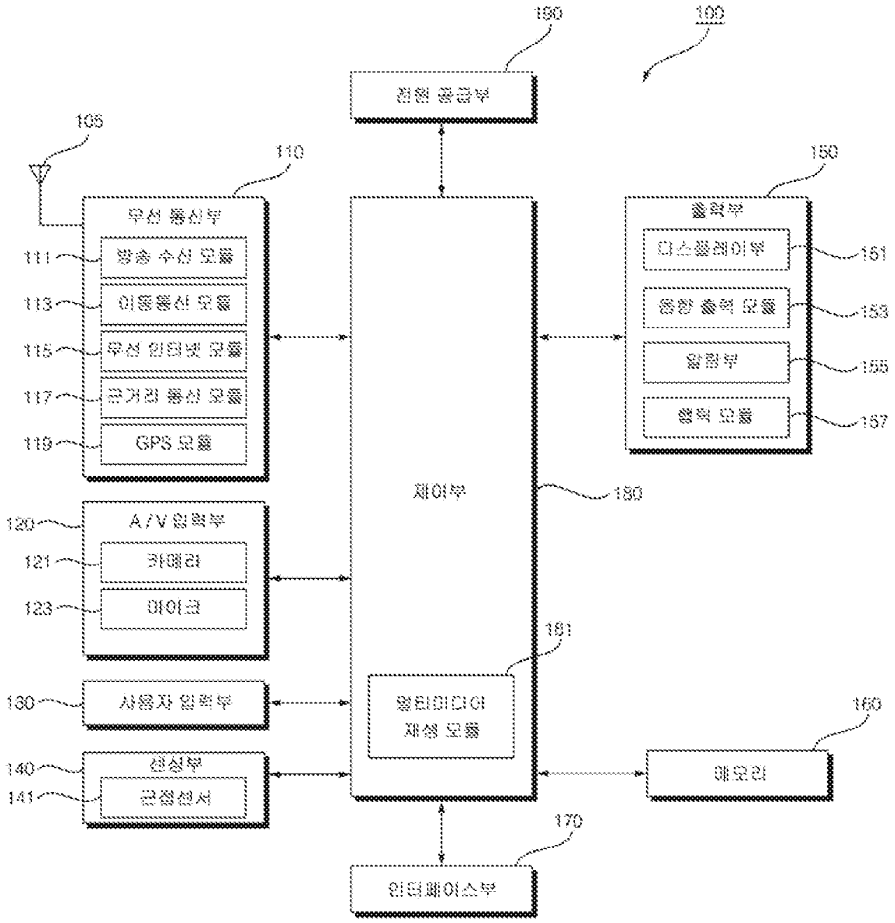
<141> 도 14 내지 도 15는 본 발명의 제3 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면,

<142> 도 16 내지 도 18은 본 발명의 제4 실시예에 따른 휴대 단말기의 동작 제어방법에 따른 진동신호를 나타내는 도면,

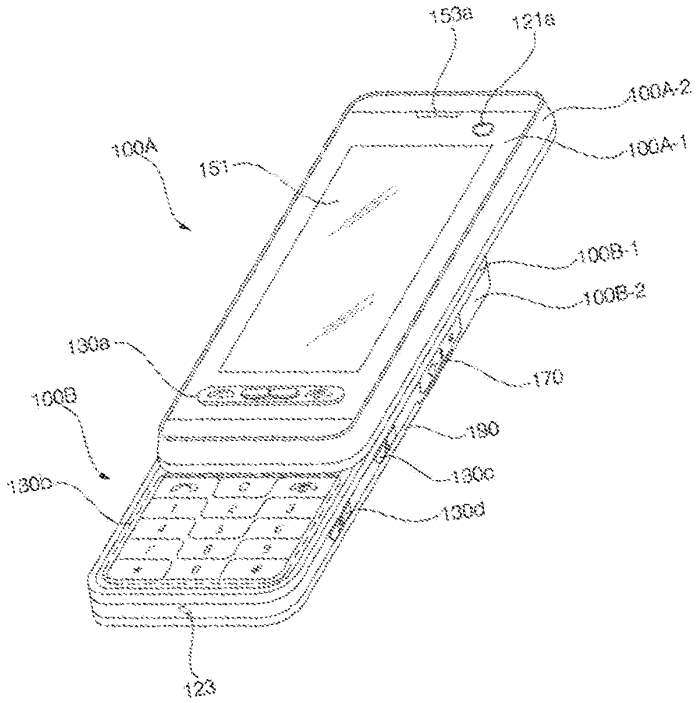
<143> 도 19 내지 도 22는 본 발명에 따른 휴대 단말기의 동작 제어방법을 다양한 일실시예와 함께 설명하기 위해 참고되는 도면이다.

도면

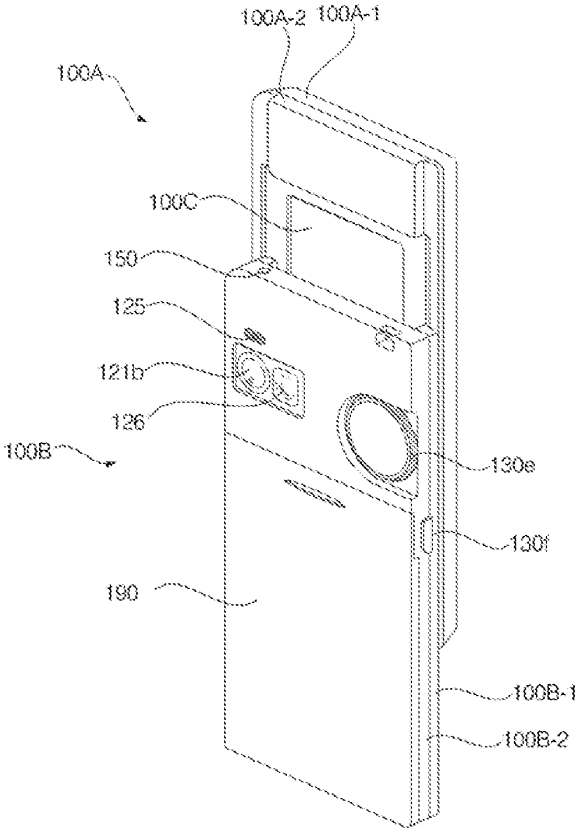
도면1


100
190
전원 공급부
105
110
무선 통신부
111
방송 수신 모듈
113
이동통신 모듈
115
무선 인터넷 모듈
117
근거리 통신 모듈
119
GPS 모듈
150
출력부
151
디스플레이부
153
음향 출력 모듈
155
알림부
157
햅틱 모듈
제어부
180
120
A/V 입력부
121
카메라
123
마이크
161
멀티미디어 재생 모듈
130
사용자 입력부
160
메모리
140
센싱부
141
근접센서
170
인터페이스부

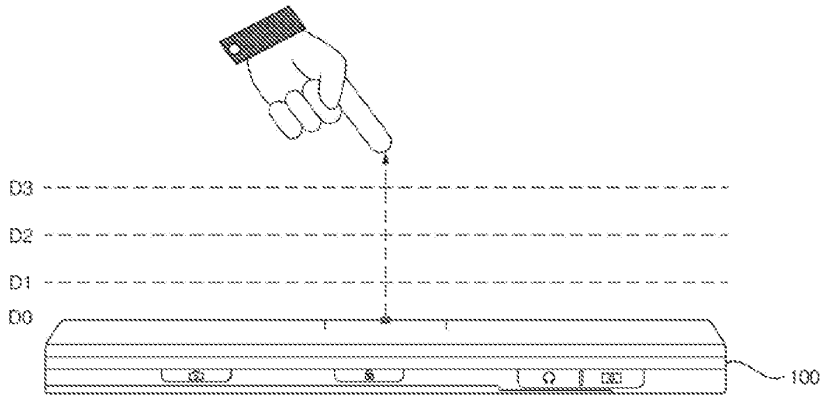
도면2


153a
121a
100A-2
100A-1
100A
151
100B-1
100B-2
130a
170
100B
190
130c
130b
130d
123

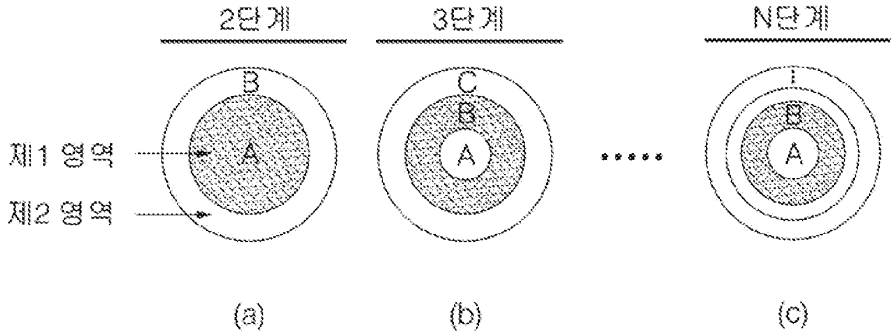
도면3


100A-2
100A-1
100A
100C
150
125
121b
126
100B
130e
130f
190
100B-1
100B-2

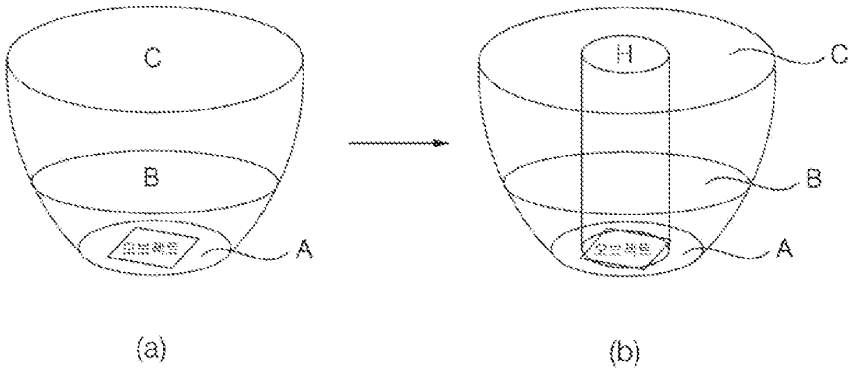
도면4


D3
D2
D1
D0
100

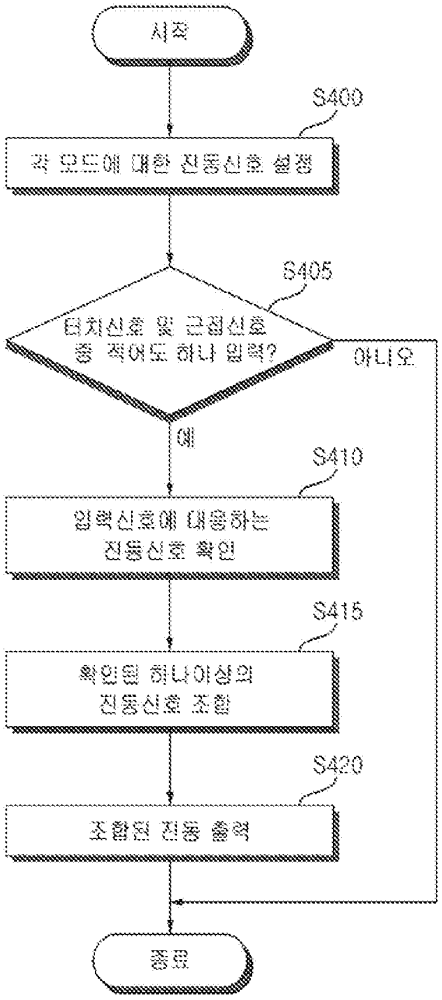
도면5a



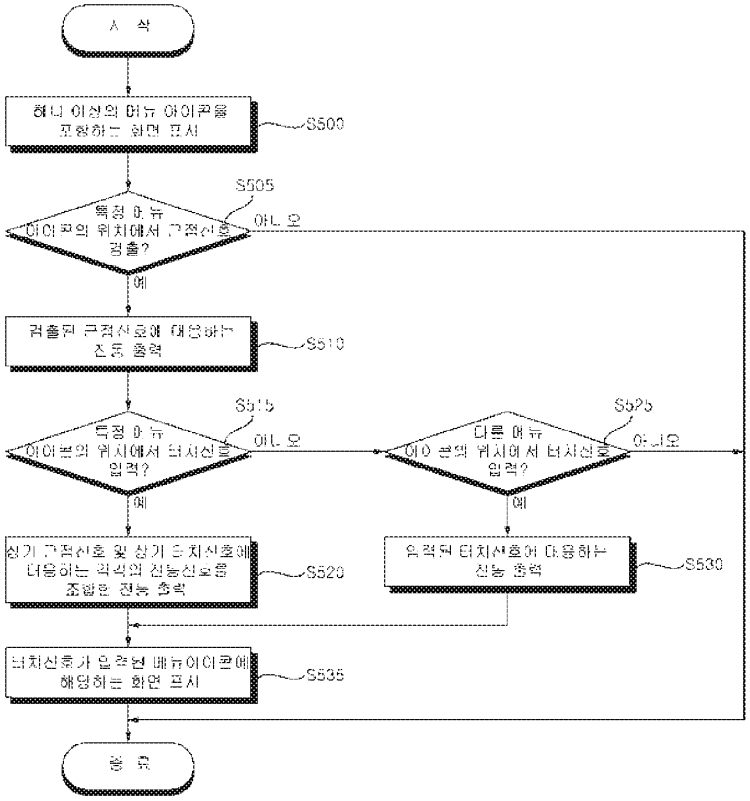
도면5b



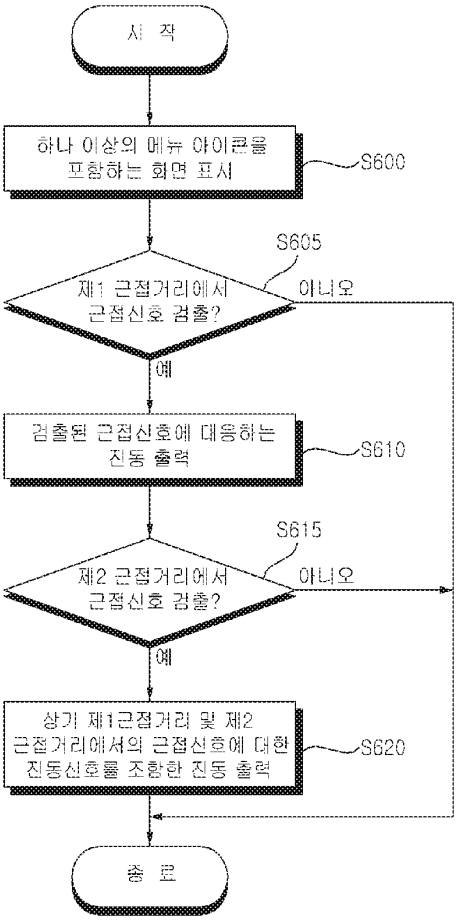
도면6


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

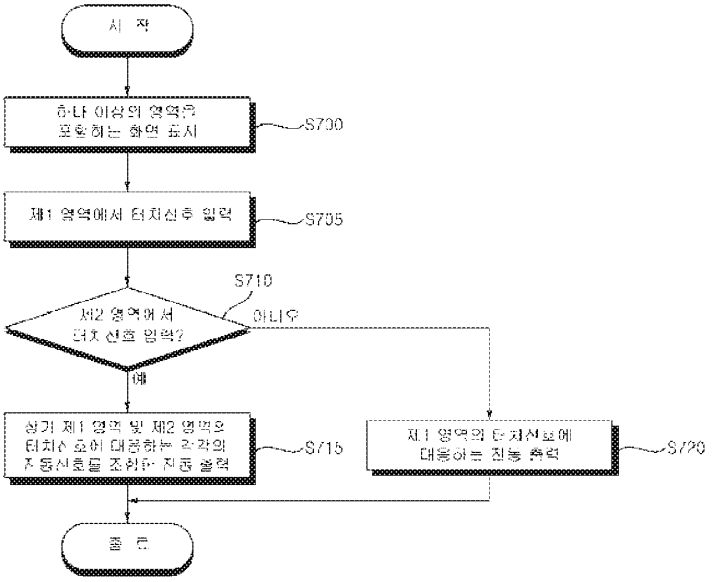
도면7


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

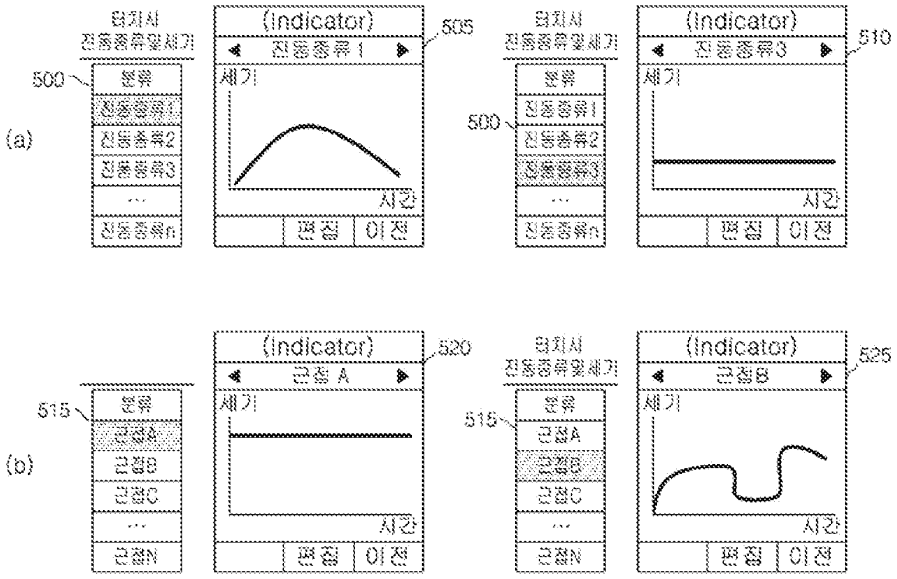
도면8


시 작
하나 이상의 메뉴 아이콘을 포함하는 화면 표시
S600
제1 근접거리에서 근접신호 검출?
S605
아니오
예
검출된 근접신호에 대응하는 진동 출력
S610
제2 근접거리에서 근접신호 검출?
S615
아니오
예
상기 제1근접거리 및 제2 근접거리에서의 근접신호에 대한 진동신호를 조합한 진동 출력
S620
종 료

도면9

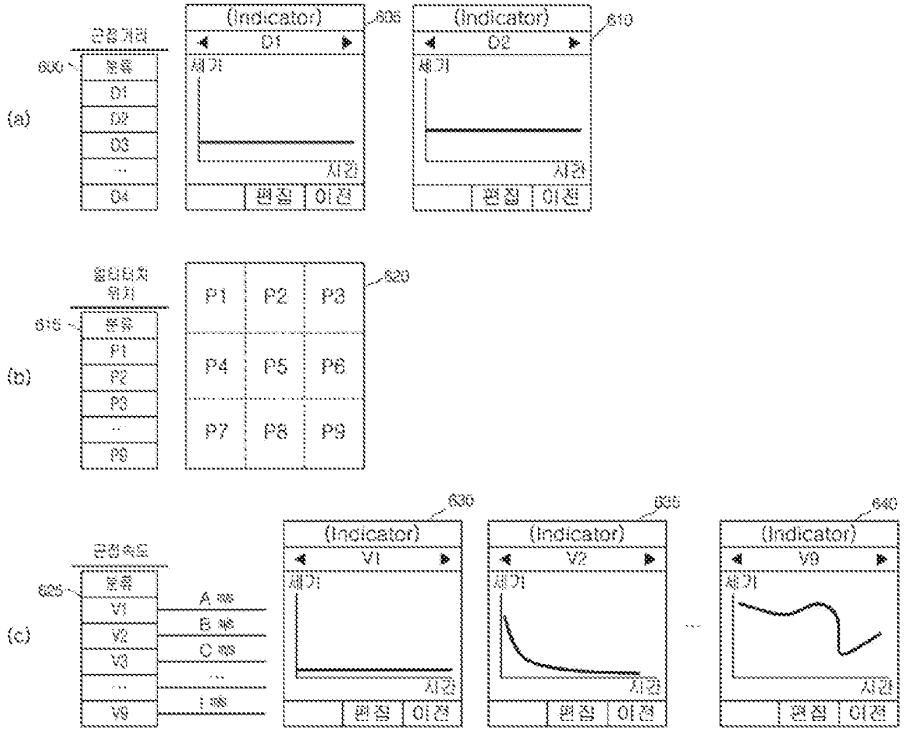


도면10

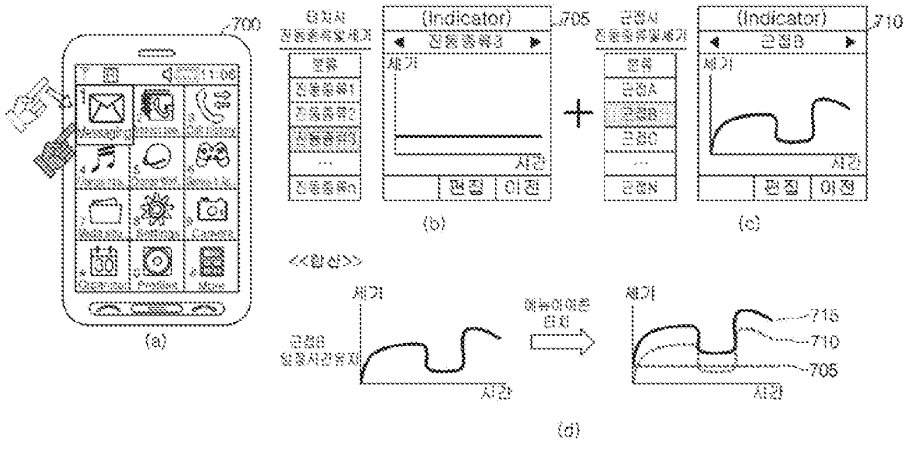


EX1002 - Page 959

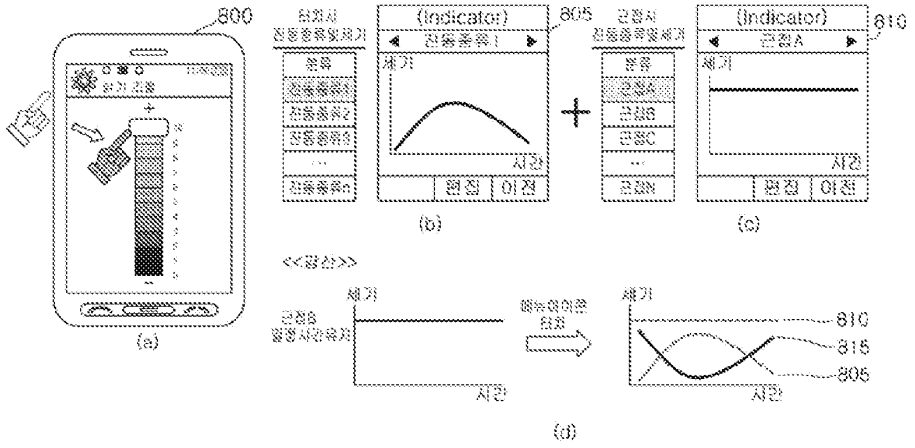
도면11



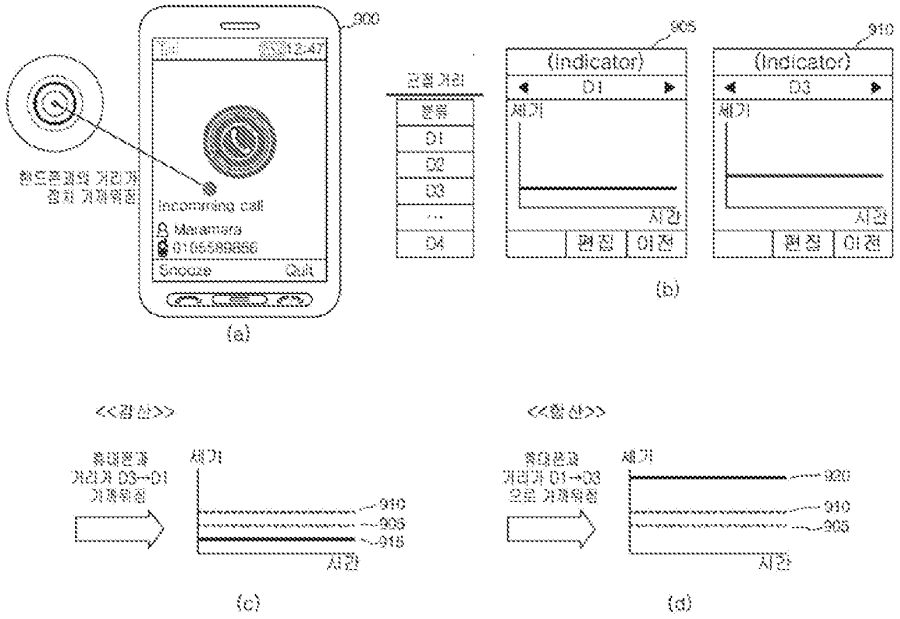
도면12



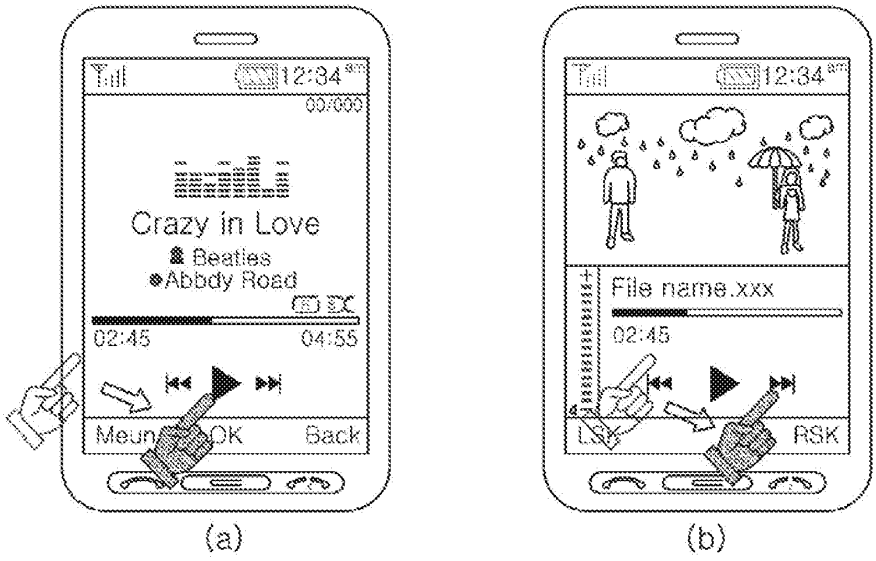
도면13


800
(Indicator)
805
(Indicator)
810
(a)
(b)
(c)
<<참조>>
(d)

도면14

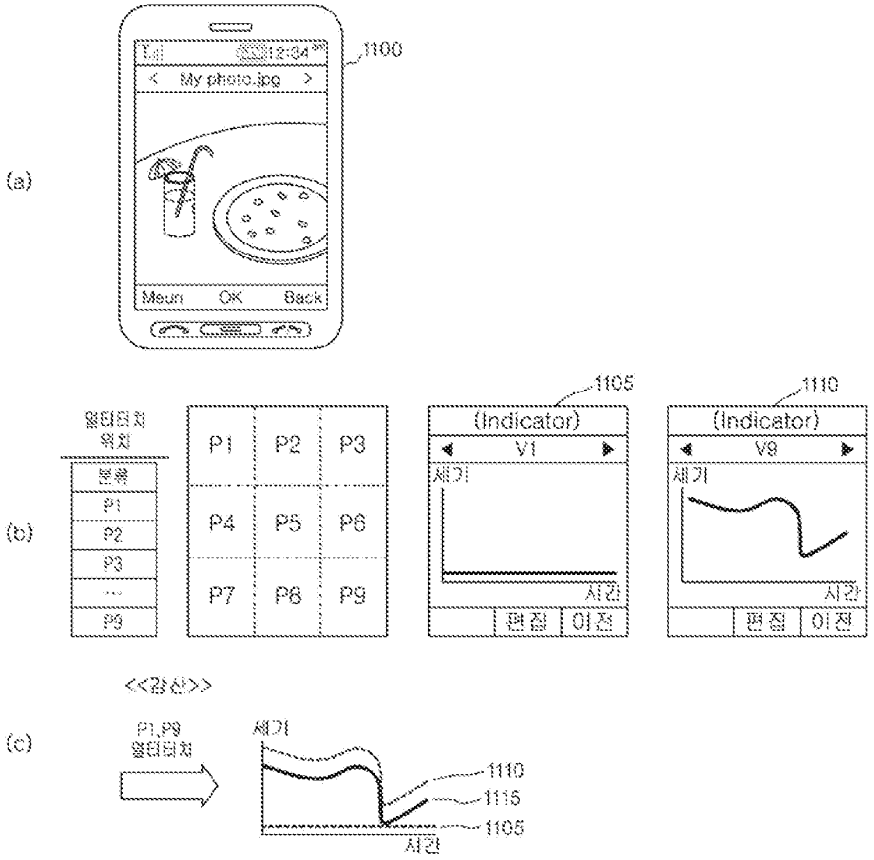

900
905
910
(Indicator)
(Indicator)
(a)
(b)
<<참조>>
<<참조>>
(c)
(d)

도면15

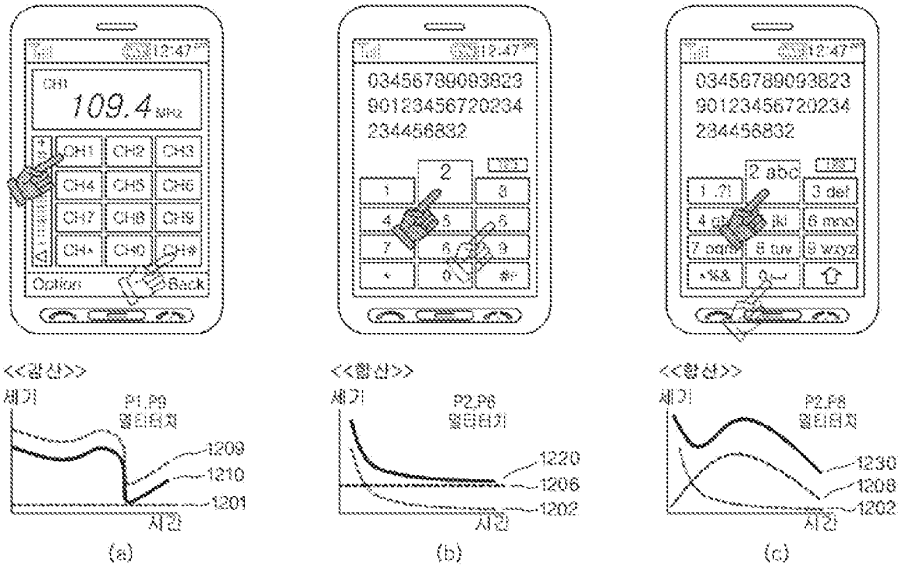

12:34
00/000
Crazy in Love
Beatles
Abbdy Road
02:45
04:55
Back
12:34
File name.xxx
02:45
RSK

(a) (b)

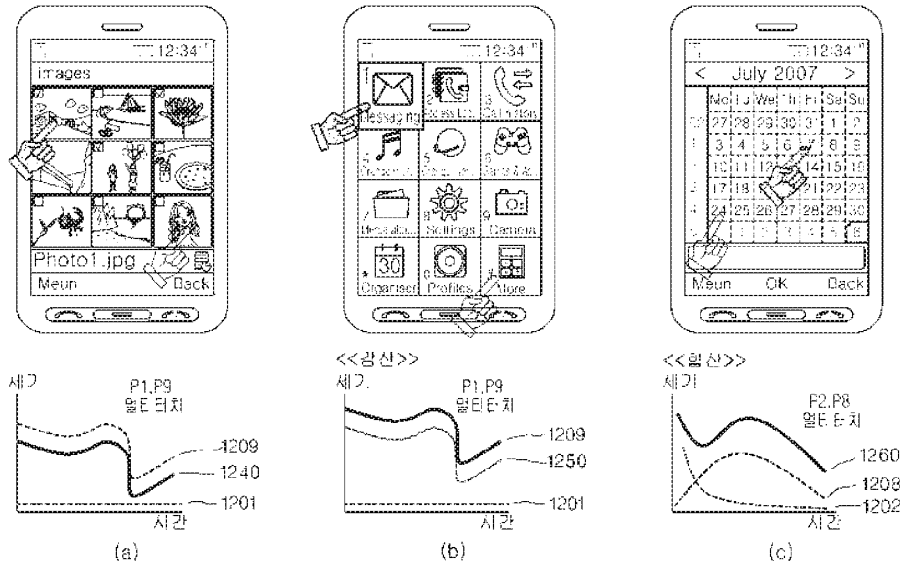
도면16


(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

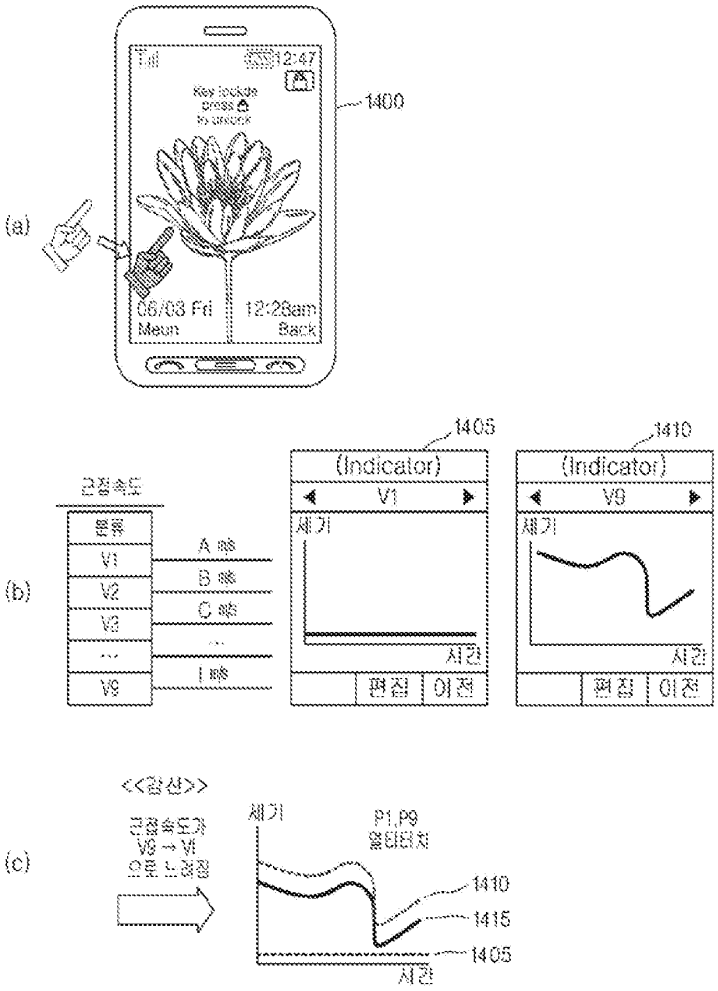
도면17


12:47
CH1
109.4 MHz
CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH*
CH0
CH#
Option
Back
03456789093823
90123456720234
234456832
2 abc
3 def
6 mno
8 tuv
9 wxyz
<<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)

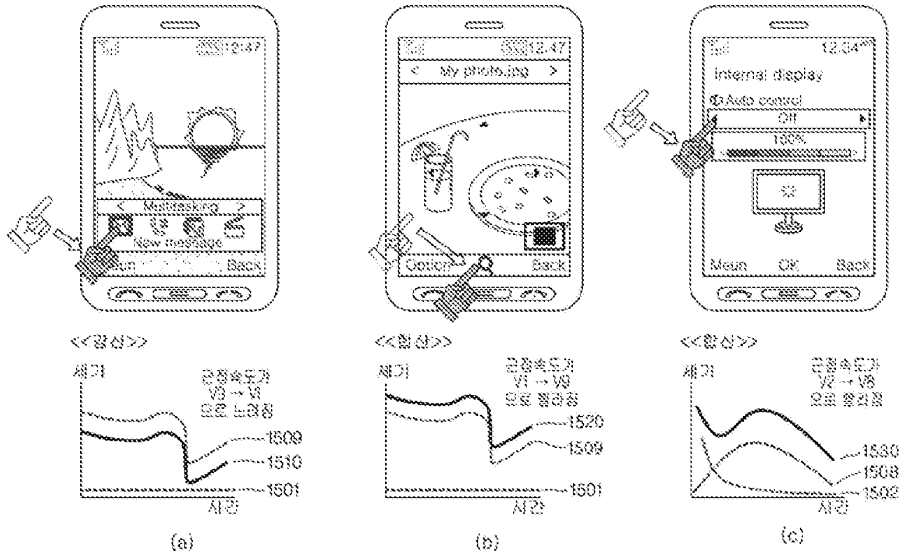
도면18


12:34
Images
Photo1.jpg
Meun
Back
Settings
Organiser
Profiles
More
July 2007
Mo
Tu
We
Th
Fr
Sa
Su
Meun
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)

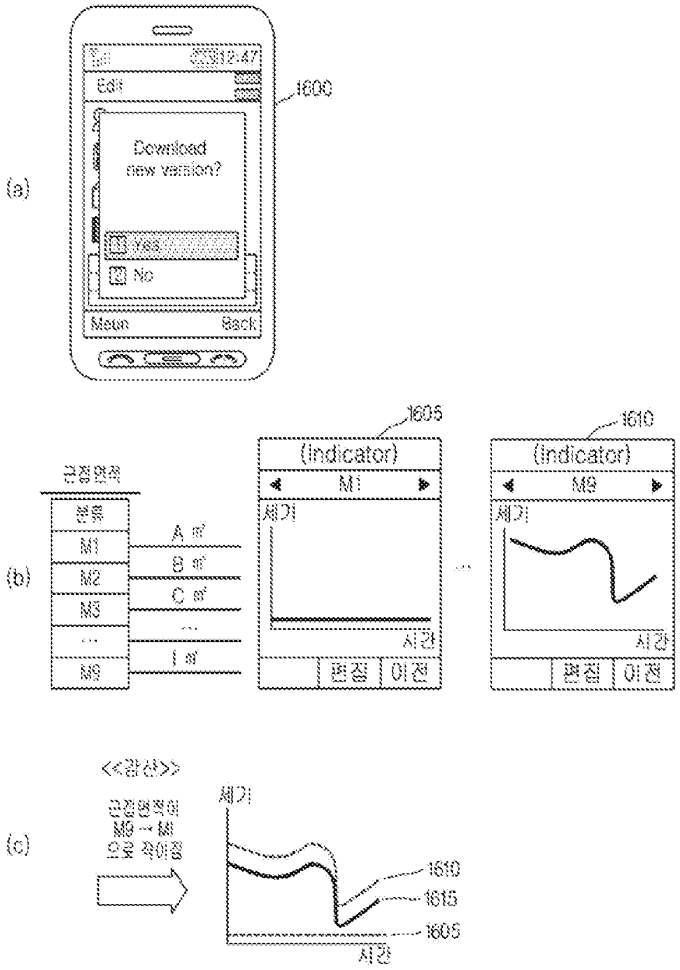
도면19


(a)
12:47
1400
06/03 Fri
Menu
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

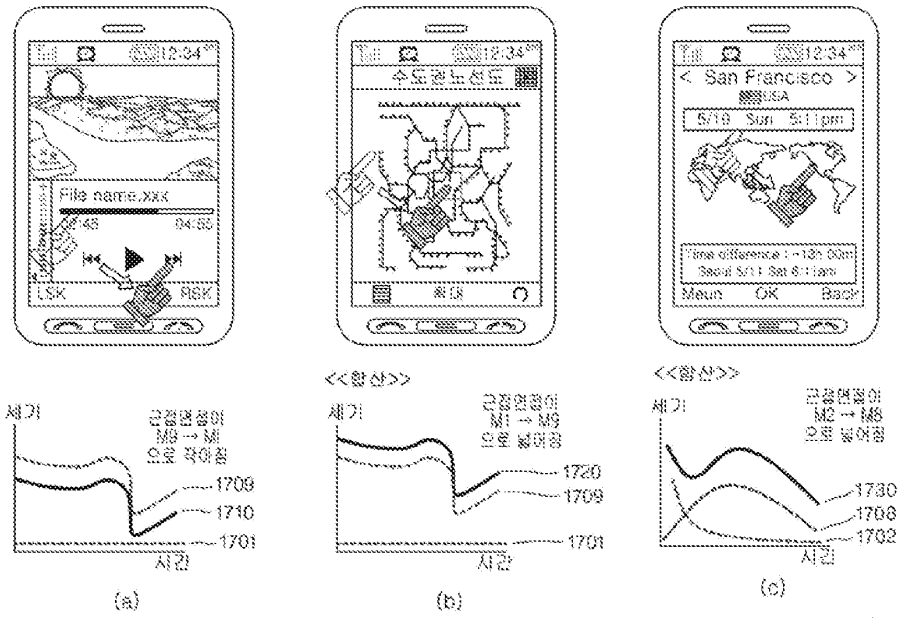
도면20


12:47
Multitasking
New message
Back
My photo.jpg
Option
Back
12:34
Internal display
Auto control
Off
100%
Menu
OK
Back
<<감산>>
세기
근접속도가
V3 → V1
으로 느려짐
1509
1510
1501
시간
(a)
<<합산>>
세기
근접속도가
V1 → V9
으로 빨라짐
1520
1509
1501
시간
(b)
<<합산>>
세기
근접속도가
V2 → V8
으로 빨라짐
1530
1508
1502
시간
(c)

도면21


(a)
12:47
Edit
1600
Download
new version?
Yes
No
Menu
Back
(b)
근접면적
분류
M1
M2
M3
...
M9
A ㎡
B ㎡
C ㎡
...
I ㎡
1605
(indicator)
M1
세기
시간
편집
이전
1610
(indicator)
M9
세기
시간
편집
이전
(c)
<<감산>>
근접면적이
M9 → M1
으로 작아짐
세기
1610
1615
1605
시간

도면22


File name.xxx
LSK
RSK
수도권노선도
< San Francisco >
USA
5/19 Sun 5:11pm
Meun
OK
Back
<<항산>>
세기
근접면접이
M9 → M1
으로 작아짐
1709
1710
1701
시간
(a)
<<항산>>
세기
근접면접이
M1 → M9
으로 넓어짐
1720
1709
1701
시간
(b)
<<항산>>
세기
근접면접이
M2 → M8
으로 넓어짐
1730
1708
1702
시간
(c)

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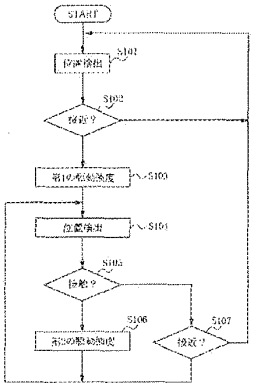
(54)【発明の名称】接触提示装置及び方法

(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。

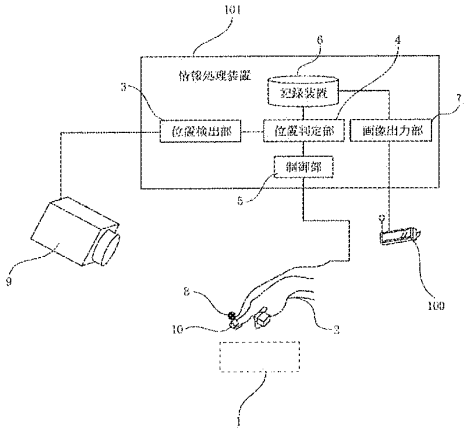
【図７】第二の実施例を説明するための接触提示装置である。

【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。

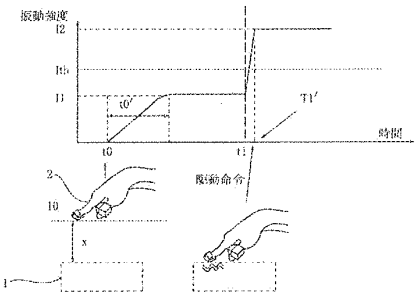
【図９】本実施形態の処理を示すフローチャートである。

【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

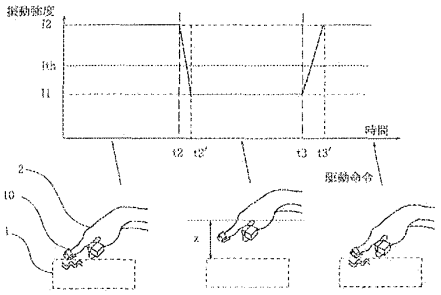
【図１】



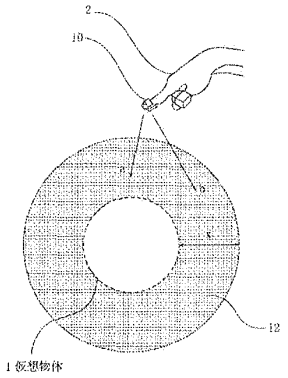
【図２】



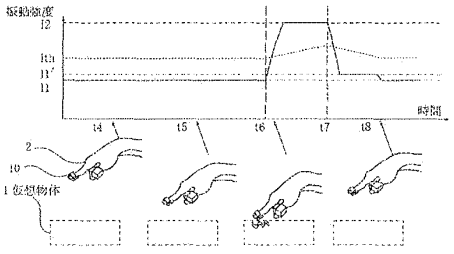
【図３】


振動強度
I2
I1h
I1
時間
t2 t2' t3 t3'
駆動命令
2
10
1
x

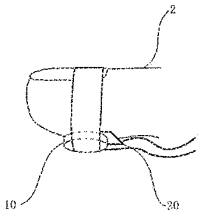
【図４】


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】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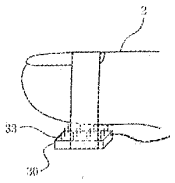
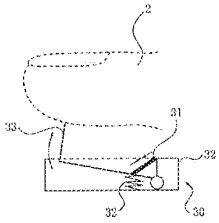
10
20

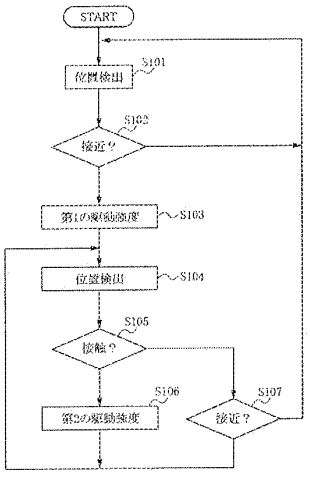
【図７】


2
33
30

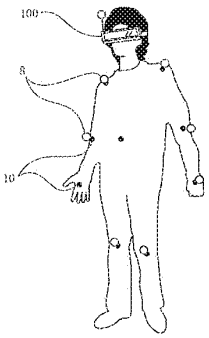
【図８】


2
31
33
32
32
30

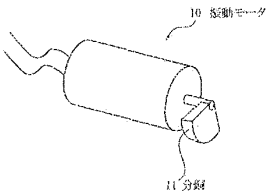
【図９】


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

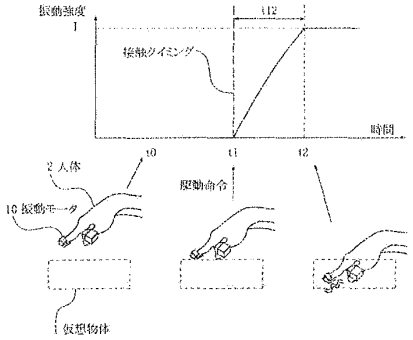
【図１０】


100
8
10

【図１１】


10 振動モータ
11 分銅

【図１２】


振動強度
I
I12
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

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:	34874133
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:	15:34:13
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	IMM637Transmittal0971162.pdf	91722 2a3c573b3b242500ee4280126ec5d9b4523d420d	no	2

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IMM63708a0971162.pdf	122765 1fbdee615a06f9f75dea3540da47ad6feee8ce79	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Other Reference-Patent/App/Search documents	US5311175A.pdf	25908331 080de645719d490abd49468c72644c6f51342b57	no	18
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	US6715045B2.pdf	13469214 1c04c61efeeb2196b6f77fb8cad400cb02aa29a4	no	29
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	US7890863B2.pdf	9514037 bd79c83419c4f53bf0f4fe2875a563e1ce31727d	no	8
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	US20040257339A1.pdf	17130393 6f74ba064723ea53429f005d6caea9ade91d8c3d	no	14
Warnings:					
Information:					
7	Other Reference-Patent/App/Search documents	US20060152497A1.pdf	16164756 c0b7d20ac6e3dd1ded297fdf83120a9d4ad8a450	no	46
Warnings:					
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8	Other Reference-Patent/App/Search documents	US20070070044A1.pdf	8205131 a59bc150c844426059ed77a6737cf0d5a4dd8853	no	14
Warnings:					
Information:					

9	Other Reference-Patent/App/Search documents	US20080238886A1.pdf	11796102 b2b6bd87d1d8380f54d3109d8803d79f025e1085	no	11
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	US20090140996A1.pdf	19742257 01d837b62b2021bd44587310977946acadf11a9d	no	55
Warnings:					
Information:					
11	Other Reference-Patent/App/Search documents	US20090322497A1.pdf	11337972 37ea28994a19f7b67d373307ffbc91ae1c870e43	no	35
Warnings:					
Information:					
12	Other Reference-Patent/App/Search documents	US20100079264A1.pdf	9469127 93be9e304f2f2a42fd3865e70aa38009afbc8503	no	28
Warnings:					
Information:					
13	Other Reference-Patent/App/Search documents	US20110138277A1.pdf	8464684 58e327810da82f6b07811e0b051e320d05ad0afd	no	8
Warnings:					
Information:					
14	Other Reference-Patent/App/Search documents	US20110164063A1.pdf	9519863 78a1d69c30a2c98454e1abc9ee3f6656d877ceb9	no	26
Warnings:					
Information:					
15	Other Reference-Patent/App/Search documents	US20120056825A1.pdf	22049571 940212e457548fadef6c2fa53be50d4bb8b0dada	no	15
Warnings:					
Information:					

16	Foreign Reference	JPH0643998B2.pdf	9408687 2570fa1a33049b3702996fe59bd15eb3e1dc174f	no	9
Warnings:					
Information:					
17	Foreign Reference	WO2008042745A2.pdf	14116626 21d4498fc6505aaf4a1505051838335053ef2e8f	no	20
Warnings:					
Information:					
18	Foreign Reference	KR20100002776A.pdf	1419771 2013a5e82cafeaab740af1486a8ad26255739137	no	38
Warnings:					
Information:					
19	Foreign Reference	JP2008123431A.pdf	15271589 4d785710c8bfe4e807af8028a4cc0f027436ea54	no	15
Warnings:					
Information:					
20	Fee Worksheet (SB06)	fee-info.pdf	31027 2cb0eb097d3f6b8567eb38a404b1fe580d361cab	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	223233625		

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 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

representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

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/
Michael T. Morlock
Registration No. 62,245

Kilpatrick Townsend & Stockton LLP
1100 Peachtree Street NE, Suite 2800
Atlanta, GA 30309-4528
(404) 815-6003
mmorlock@kilpatricktownsend.com

Attachment(s):

- ☒ PTO/SB/08
- ☒ Documents
- ☒ Fee
- ☐ Other

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. 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 displays a valid OMB control number.

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	01/16/2019	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	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/VINCENT S BUTLER/
*** 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 number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. 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 12 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: 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.

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 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 01/24/2019

Kilpatrick Townsend and Stockton/Immersion
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

NOTIFICATION DATE	DELIVERY MODE
01/24/2019	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
ipefiling@kilpatricktownsend.com
kts_imm_docketing@kilpatricktownsend.com

Advisory Action Before the Filing of an Appeal Brief	**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 --

THE REPLY FILED 16 January 2019 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☑ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires ____ months from the mailing date of the final rejection.
   b) ☑ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection.The current period for reply expires ____ months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.
   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANTS FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☐ They raise the issue of new matter (see NOTE below);
   c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: _____ (See 37CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicants reply has overcome the following rejection(s): _____
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☐ For purposes of appeal, the proposed amendment(s):(a)☐ will not be entered, or (b)☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☑ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.
13. ☑ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☐ Other: _____.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
    Claim(s) allowed:_____.
    Claim(s) objected to:_____.
    Claim(s) rejected:1-19.
    Claim(s) withdrawn from consideration:_____.

/BRYAN EARLES/ Primary Examiner, Art Unit 2625	

Continuation of REQUEST FOR RECONSIDERATION/OTHER 12. The request for reconsideration has been considered but does NOT place the application in condition for allowance because:

Applicant's request for consideration in the response After Final Action dated 16 January 2019 is acknowledged and granted.

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,” and further argues, “at best these paragraphs describe determining a first haptic effect 225 based on proximity and a second haptic effect 226 based on contact.”

While the Office agrees with Applicant in that the first haptic effect 225 is based on a proximity input and the second haptic effect 226 is based on a contact input. However, different haptic effects can be combined as disclosed in paragraph [0052] and suggested in figures 16-17 of Choe. A signal from the proximity sensor 141 and a signal from the touchscreen 130 are supplied to the haptic module 157 which synthesizes different vibration effects and outputs a result of the synthetization (paragraph [0052]). As the user’s finger approaches the touchscreen a first haptic effect 225 is scaled based on a distance determined by the proximity sensor 141. Then, once contact is detected at a location corresponding to the user interface element 224 displayed on the touchscreen 130 a second haptic effect 226 is output in order to provide the user confirmation that the touch command was issued. The result is a haptic profile dependent upon both the touchscreen signal and the proximity sensor signal. As such, Choe’s disclosure fully meets the BRI of the argued 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.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Field

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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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.	

U.S. PATENT APPLICATION PUBLICATIONS

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.	
	7	20080238886	A1	Oct 2, 2008	Bengtsson et al.	
	8	20090140996	A1	Jun 4, 2009	Takashima et al.	
	9	20090322497	A1	Dec 31, 2009	Ku et al.	
	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.	

FOREIGN PATENT DOCUMENTS

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]

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	Attorney Docket Number	051851-0971162 (IMM637)

EXAMINER SIGNATURE			
Examiner Signature	/BRYAN EARLES/	Date Considered	01/18/2019

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[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.

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EXAMINER SIGNATURE			
Examiner Signature	/BRYAN EARLES/	Date Considered	01/18/2019

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U.S. PATENT APPLICATION PUBLICATIONS

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	1	2013/0249859	A1	Sep 26, 2013	Park et al.	

FOREIGN PATENT DOCUMENTS

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]
	2	2 141 580	EP	A2	Jan 6, 2010	Lg Electronics Inc.		
	3	2 209 060	EP	A2	Jul 21, 2010	Immersion Corporation		
	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	/BRYAN EARLES/	Date Considered	01/18/2019

*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.

US2008 14166347 1

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Attorney Docket IMM637 (051851-0971162)
Application No. 15/377,096

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.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on March 25, 2019.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Catherine A. Anderson/
Catherine A. Anderson

Attorney Docket IMM637 (051851-0971162)
Application No. 15/377,096

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

PRE-APPEAL BRIEF AND CONFERENCE REQUEST

Appellant requests review of this application prior to submission of an Appeal Brief. The Final Office Action mailed on mailed November 21, 2018 (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. Appellant traverses each of these rejections for the reasons below.

I. 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

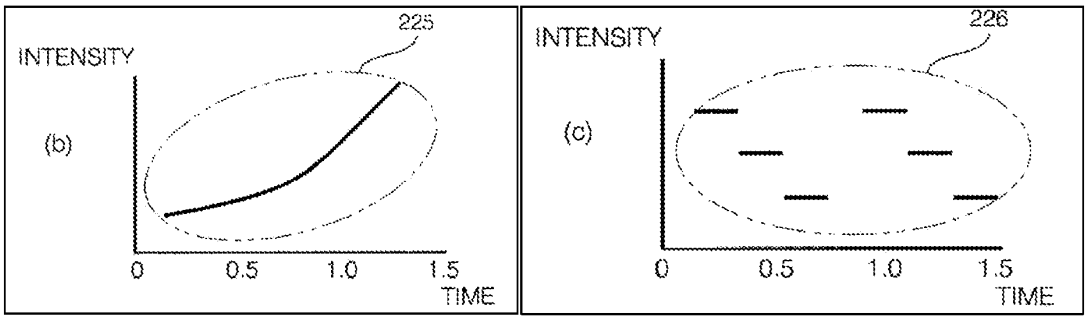
The claim requires "generat[ing] a haptic output signal based at least in part on the *first and second sensor signals*." Thus, the claim requires determining a haptic effect based on signals from two sensors (the claimed "proximity sensor" and the claimed "touch sensor"). The cited paragraphs of Choe 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)).

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."

> 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

Office Action at 2.

These 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). That effects 225 and 226 are different is emphasized by Figures 16(b) and 16(c), which are pasted below for reference:



Therefore these paragraphs do 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 they describe 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 clear as a matter of law. 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, haptic effect 225 and 226 are different.

In the Advisory Action mailed January 24, 2019 ("the Advisory Action") the Examiner urges that though these two haptic effects are different, they can be combined. *See* Advisory Action (citing Choe at [0052] and Figures 16-17). *First*, this is an anticipation rejection, not an

obviousness rejection, and thus it is improper to combine multiple embodiments in the reference as the Office Action proposes. As the Court of Customs and Patent Appeals explained,

> [s]uch picking and choosing may be entirely proper in the making of a 103, obviousness rejection, where the applicant must be afforded an opportunity to rebut with objective evidence any inference of obviousness which may arise from the similarity of the subject matter which he claims to the prior art, but it has no place in the making of a 102, anticipation rejection.[1]

Second, even if it were proper to combine embodiments (it is not), the cited paragraph simply describes that the "haptic module 157 may synthesize different vibration effects and may output the result of the synthesization." Choe at [0052]. At most this is synthetizing vibrations, which does not anticipate the claimed "haptic output signal based at least in part on the *first and second sensor signals*," as is required by claim 1. Appellant respectfully requests reversal of this rejection.

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. Appellant requests reversal of these rejections.

II. 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. 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

[1] *Application of Arkley*, 455 F.2d. 586, 587-88 (CCPA 1972); *see also Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1371 (2008) ("Thus, it is not enough that the prior art reference . . . includes multiple, distinct teachings hat the artisan might somehow combine to achieve the claimed invention." (citation omitted))

obvious over the combination of Choe and Rosenberg, and does not establish that claims 5 and 7-10 are obvious. Appellant requests reversal of these rejections.

III. 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. Appellant requests reversal of this rejection.

IV. 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. Appellant requests reversal of this rejection.

Respectfully submitted,

Date: 3/25/2019

/Michael Morlock/

Michael Morlock
Reg. No. 62,245

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1100 Peachtree St NE #2800,
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 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	$
☐	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	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.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 201430.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 62,245.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Michael Morlock/	3/25/2019
Signature	Date
Michael Morlock	(404) 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*.

☐ * Total of _____ forms are submitted.

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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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 Cooperation Treaty.
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 inspection 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.

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:				
NOTICE OF APPEAL	1401	1	800	800
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
		Total in USD ($)		**1000**

Electronic Acknowledgement Receipt

EFS ID:	35520976
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:	25-MAR-2019
Filing Date:	13-DEC-2016
Time Stamp:	16:39:39
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1000
RAM confirmation Number	032619INTEFSW16402100
Deposit Account	201430
Authorized User	Catherine Anderson
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 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	Notice of Appeal Filed	0971162noticeofappeal.pdf	241505 38c5baecf200c889c7b54439beadbaac149b2573	no	2
Warnings:					
Information:					
2	Pre-Brief Conference request	0971162preappealbrief.pdf	263969 1c85fbdf302e8bb5177c44eee02789b2c7b3ddcd	no	5
Warnings:					
Information:					
3	Extension of Time	0971162EOT.pdf	140882 1b5ef58e641b03b1f2874e09149f5532defb7da6	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32520 72e68a6a8336df7c5a4d11a43b202a876215a462	no	2
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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.

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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.

PTO/AIA/31 (03-14)
Approved for use through 11/30/2020. OMB 0651-0031
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

Docket Number (Optional): 051851-0971162

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, EFS-Web transmitted to the USPTO, or deposited with the United States Postal Service with sufficient postage in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, on Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on March 25, 2019.

Signature /Catherine A. Anderson/

Typed or printed name Catherine A. Anderson

In re Application of: Vahid Khoshkava

Application Number	Filed
15/377,096	December 13, 2016

For: Systems and Methods for Proximity-Based Haptic Feedback

Art Unit	Examiner
2625	Bryan E. Earles

Applicant hereby **appeals** to the Patent Trial and Appeal Board from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 800

☐ Applicant asserts small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by 50%, and the resulting fee is: $ _____

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Therefore, the fee shown above is reduced by 75%, and the resulting fee is: $ _____
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 is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 201430.

☑ Payment made via EFS-Web.

☑ A petition for an extension of time under 37 CFR 1.136(a) (PTO/AIA/22 or equivalent) is enclosed.
For extensions of time in reexamination proceedings, see 37 CFR 1.550.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant

☑ attorney or agent of record
Registration number 62245

☐ attorney or agent acting under 37 CFR 1.34
Registration number _____

Signature /Michael Morlock/

Typed or printed name Michael Morlock

Telephone Number (404) 815-6500

Date March 25, 2019

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*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 41.20(b)(1) and 41.31. 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, 1.14 and 41.6. This collection is estimated to take 12 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: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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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 disclosure of these records is required by the Freedom of Information Act.
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.
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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 Cooperation Treaty.
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.
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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.

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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 04/09/2019

Kilpatrick Townsend and Stockton/Immersion
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
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EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

NOTIFICATION DATE	DELIVERY MODE
04/09/2019	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
ipefiling@kilpatricktownsend.com
kts_imm_docketing@kilpatricktownsend.com

Notice of Panel Decision from Pre-Appeal Brief Review

Application No.	Applicant(s)	
15/377,096	Khoshkava et al.	
Examiner	**Art Unit**	**AIA (FITF) Status**
BRYAN EARLES	2625	Yes

This is in response to the Pre-Appeal Brief Request for Review filed 25 March 2019 .

1. ☐ **Improper Request** - The Request is improper and a conference will not be held for the following reason(s):

☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
☐ The request does not include reasons why a review is appropriate.
☐ A proposed amendment is included with the Pre-Appeal Brief request.
☐ Other: _____ .

The time period for filing a response continues to run from the receipt date of the Notice of Appeal or from the mail date of the last Office communication, if no Notice of Appeal has been received.

2. ☑ **Proceed to Board of Patent Appeals and Interferences** - A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

☑ The panel has determined the status of the claim(s) is as follows:
Claim(s) allowed: _____ .
Claim(s) objected to: _____ .
Claim(s) rejected: 1-19 .
Claim(s) withdrawn from consideration: _____ .

3. ☐ **Allowable application** - A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** - A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) BRYAN EARLES .	(3) Amr Awad .
(2) Will Boddie .	(4) _____ .

/BRYAN EARLES/ Primary Examiner, Art Unit 2625	/WILLIAM BODDIE/ Supervisory Patent Examiner, Art Unit 2625	/AMR A AWAD/ Supervisory Patent Examiner, Art Unit 2621

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 Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

This is an Appeal Brief filed under 37 C.F.R. § 41.37 in connection with the final rejection of claims 1-19 in the Final Office Action mailed November 21, 2018 (hereinafter the "Office Action"). Each of the topics required by 37 C.F.R. § 41.37 is presented herewith and labeled appropriately.

Real Party in Interest

The real party in interest in the present application is the assignee, Immersion Corporation, 50 Rio Robles, San Jose, CA 95134 (hereinafter "Appellant").

Related Appeals and Interferences

Appellant and Appellant's legal representative know of no appeals or interferences that will directly affect, will be directly affected by, or have a bearing on the Board's decision in this appeal.

Status of Claims

Claims 1-19 stand rejected and are the subject of this appeal. The rejection of claims 1-19 is appealed.

Summary of the Claimed Subject Matter

The following summary is intended to provide examples of embodiments disclosed within the present specification and is not intended to limit the full scope of the disclosure within the specification or to otherwise replace or modify the disclosure of the present application. Discussion below of step numberings or orderings, such as by use of the word "next" or "last," is only for the convenience of discussing each of the claim elements; no ordering of steps or processing should be inferred from such numberings or orderings. The present application recites three independent claims, claims 1, 15, and 19.

Claim 1 recites a device, the device comprising "a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device and outputting a first sensor signal." Support may be found throughout the specification, which describes "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."[1] The specification further describes that "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."[2]

[1] Application as-filed at [0031].
[2] *Id.* at [0061].

Claim 1 further recites "a touch sensor capable of detecting a touch with the touch-sensitive device and outputting a second sensor signal." Support may be found throughout the specification, which describes "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."[3] The specification further describes that "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."[4]

Claim 1 further recites "a haptic output device configured to receive a haptic output signal and output a haptic effect in response to the haptic output signal." Support may be found throughout the specification, which describes "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."[5]

Claim 1 further recites "a processor." Support may be found throughout the specification, which describes "a computer may comprise a processor or processors. The processor comprises or has access to a computer-readable medium, such as a random access

[3] *Id.* at [0027].
[4] *Id.* at [0066].
[5] *Id.* at [0033].

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."[6] The specification further describes "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."[7]

Claim 1 further recites that the processor is configured to "receive the first sensor signal and the second sensor signal." Support may be found throughout the specification, which describes "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."[8] The specification further describes "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."[9]

Claim 1 further recites that the processor is configured to "generate a haptic output signal based at least in part on the first and second sensor signals." Support may be found throughout

[6] *Id.* at [0077].
[7] *Id.* at [0078].
[8] *Id.* at [0046].
[9] *Id.* at [0043].

the specification, which describes "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."[10] The specification further describes "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."[11]

Claim 1 further recites that the processor is configured to "transmit the haptic output signal to the haptic output device." Support may be found throughout the specification, which describes "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."[12]

Claim 15 recites a method. The method recites "detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device." Support may be found throughout the specification, which describes "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

[10] *Id.* at [0067].
[11] *Id.* at [0046].
[12] *Id.* at [0068].

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."[13] The specification further describes that "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."[14]

The method of claim 15 further recites "detecting, by a touch sensor, a touch on the touch-sensitive device." Support may be found throughout the specification, which describes "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."[15] The specification further describes that "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."[16]

The method of claim 15 further recites "transmitting a first sensor signal associated with the non-contact interaction to a processor." Support may be found throughout the specification, which describes "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

[13] *Id.* at [0031].
[14] *Id.* at [0061].
[15] *Id.* at [0027].
[16] *Id.* at [0066].

when approaching the surface such that the system can detect the user's finger."[17] The specification further describes that "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."[18]

The method of claim 15 further recites "transmitting a second sensor signal associated with the touch to a processor." Support may be found throughout the specification, which describes "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."[19] The specification further describes that "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."[20]

The method of claim 15 further recites "receiving, by the processor, the first and second sensor signals." Support may be found throughout the specification, which describes "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."[21] The specification further describes "the proximity sensor 132 and touch sensor 108 are shown as separate elements, in some embodiments, they may be

[17] *Id.* at [0031].
[18] *Id.* at [0061].
[19] *Id.* at [0027].
[20] *Id.* at [0066].
[21] *Id.* at [0046].

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."[22]

The method of claim 15 further recites "generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals." Support may be found throughout the specification, which describes "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."[23] The specification further describes "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."[24]

The method of claim 15 further recites "transmitting, by the processor, the haptic output signal to a haptic output device." Support may be found throughout the specification, which describes "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

[22] *Id.* at [0043].
[23] *Id.* at [0067].
[24] *Id.* at [0046].

module 128 causes the processor 102 to generate and transmit the haptic signal to the haptic output device 118."[25]

The method of claim 15 further recites "outputting, by the haptic output device, a haptic effect in response to the haptic output signal." Support may be found throughout the specification, which describes "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."[26]

Claim 19 recites a "computer-readable non-transitory medium encoded with executable program code, the computer-readable medium." Support may be found throughout the specification, which describes "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."[27] The specification further describes "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."[28]

Claim 19 further recites "program code for detecting, by a proximity sensor, a non-contact interaction with a touch-sensitive device." Support may be found throughout the specification, which describes "the computing device 101 comprises one or more proximity sensors 132. In some embodiments, the sensor 132 may comprise a capacitance based sensor.

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[25] *Id.* at [0068].
[26] *Id.* at [0069].
[27] *Id.* at [0077].
[28] *Id.* at [0078].

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."[29] The specification further describes that "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."[30]

Claim 19 further recites "program code for detecting, by a touch sensor, a touch on the touch-sensitive device." Support may be found throughout the specification, which describes "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."[31] The specification further describes that "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."[32]

Claim 19 further recites "program code for transmitting a first sensor signal associated with the non-contact interaction to a processor." Support may be found throughout the specification, which describes "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

[29] *Id.* at [0031].
[30] *Id.* at [0061].
[31] *Id.* at [0027].
[32] *Id.* at [0066].

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."[33] The specification further describes that "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."[34]

Claim 19 further recites "program code for transmitting a second sensor signal associated with the touch to a processor." Support may be found throughout the specification, which describes "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."[35] The specification further describes that "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."[36]

Claim 19 further recites "program code for receiving, by the processor, the first and second sensor signals." Support may be found throughout the specification, which describes "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

[33] *Id.* at [0031].
[34] *Id.* at [0061].
[35] *Id.* at [0027].
[36] *Id.* at [0066].

determination module 126 may then determine a haptic effect based at least in part on the sensor signal from the proximity sensor."[37] The specification further describes "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."[38]

Claim 19 further recites "program code for generating, by the processor, a haptic output signal based at least in part on the first and second sensor signals." Support may be found throughout the specification, which describes "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."[39] The specification further describes "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."[40]

Claim 19 further recites "program code for transmitting the haptic output signal to a haptic output device." Support may be found throughout the specification, which describes

[37] *Id.* at [0046].
[38] *Id.* at [0043].
[39] *Id.* at [0067].
[40] *Id.* at [0046].

"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."[41]

[41] *Id.* at [0069].

Grounds of Rejection to be Reviewed on Appeal

Four issues are presented for appeal:

(1) Did the Examiner err in rejecting 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")?

(2) Did the Examiner err in rejecting 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")?

(3) Did the Examiner err in rejecting 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")?

(4) Did the Examiner err in rejecting claim 14 as allegedly obvious under 35 U.S.C. § 103 over the combination of Choe and Rosenberg848?

Argument

Issue 1: Did the Examiner err in rejecting claims 1-4, 11-13, and 15-19 under 35 U.S.C. § 102 as allegedly anticipated by Choe.

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. *See* MPEP § 2131; *see also 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. In particular the Office Action never establishes that Choe determines the haptic effect based on signals received from ***both*** "a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device" ***and*** "a touch sensor capable of detecting a touch with the touch-sensitive device," as is required by claim 1.

I. The Office Action's Initial Citation Describes Determining Haptic Effects Based on Proximity, Choe does not Disclose Determining Haptic Effects Based on Both Proximity and Contact.

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 claimed "proximity sensor" and the claimed "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)). This at most describes determining an effect based on proximity, and thus does not meet the claim element.

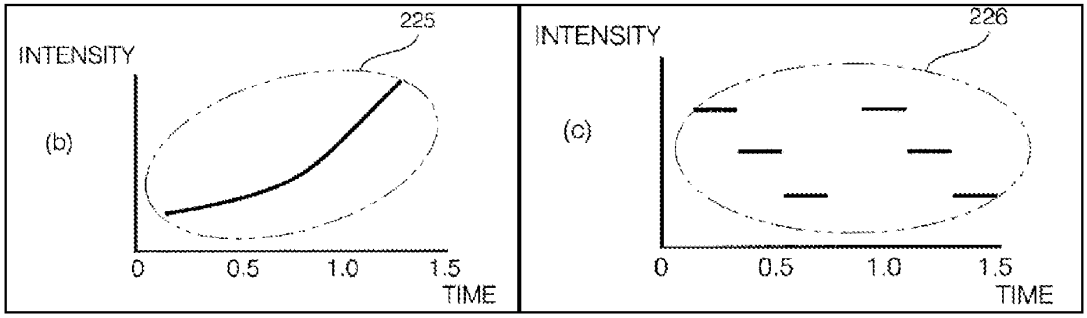
II. The New Citations Describe at most Determining Two Distinct Effects: a First Effect 225 Based on Proximity and a Second Effect 226 Based on Contact, this does not Disclose Determining an Effect Based on Both Contact and Proximity.

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."

> 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

Office Action at 2.

These 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). That effects 225 and 226 are different is emphasized by Figures 16(b) and 16(c), which are pasted below for reference:



Therefore these paragraphs do 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 they describe 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 clear as a matter of law. 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, haptic effect 225 and 226 are different. And indeed, the Examiner appears to acknowledge as much in the Advisory Action mailed January 24, 2019 (the "Advisory Action") which states: "the Office agrees with Applicant in that the first haptic effect 225 is based on a proximity input and the second haptic effect 226 is based on a contact input." Thus, these two separate effects do not meet the claim element.

III. As a Matter of Law it is Improper to Combine Two Separate Effects in an Anticipation Rejection Under 35 U.S.C. § 102.

The Advisory Action urges that, though haptic effects 225 and 226 are different, "different haptic effects can be combined." Advisory Action. This is an anticipation rejection under 35 U.S.C. § 102. It is thus improper to attempt to combine these two separate effects.

As the Court of Customs and Patent Appeals explained, "picking and choosing may be entirely proper in the making of a 103, obviousness rejection, where the applicant must be afforded an opportunity to rebut with objective evidence any inference of obviousness which may arise from the similarity of the subject matter which he claims to the prior art, ***but it has no place in the making of a 102, anticipation rejection***. *Application of Arkley*, 455 F.2d. 586, 587-88 (CCPA 1972) (emphasis added). The Federal Circuit has also explained that in an anticipation rejection "it is not enough that the prior art reference discloses part of the claimed invention, which an ordinary artisan might supplement to make the whole, or that it includes multiple, distinct teachings that the artisan might somehow combine to achieve the claimed invention." *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1371 (2008).

There is simply no basis to maintain this anticipation rejection, in particular where the Examiner ***agrees*** that the prior art does not disclose this claim element. Advisory Action ("the Office agrees with Applicant in that the first haptic effect 225 is based on a proximity input and the second haptic effect 226 is based on a contact input.")

IV. Even if it were Proper to Consider Other Embodiments in Choe (it is not) there is no Suggestion that the Claimed Effect Could be Generated.

Further, there is no disclosure in Choe that multiple effects can be combined. The Advisory Action states "different haptic effects can be combined as disclosed in paragraph [0052] and suggested in figures 16-17 of Choe." This is incorrect. Rather, paragraph [0052] simply describes synthesizing different vibration effects or outputting effects sequentially.

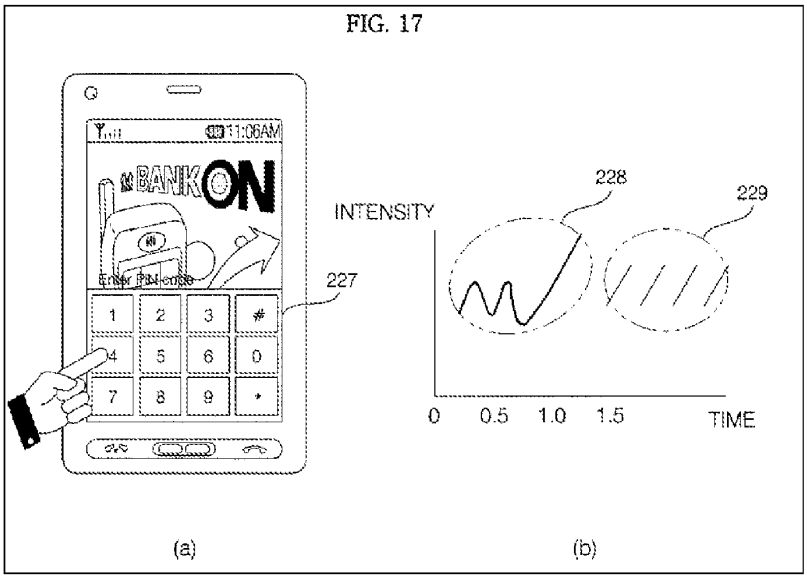
> **[0052]** The haptic module **157** may provide various haptic effects (such as vibration) that can be perceived by the user. If the haptic module **157** generates vibration as a haptic effect, the intensity and the pattern of vibration generated by the haptic module **157** may be altered in various manners. The haptic module **157** may synthesize different vibration effects and may output the result of the synthesization. Alternatively, the haptic module **157** may sequentially output different vibration effects.

Choe at [0052].

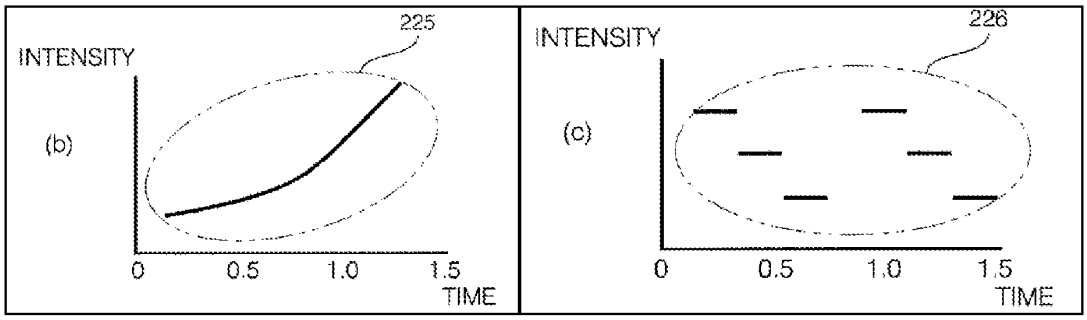
At most this is synthetizing vibrations. This says nothing of determining a haptic effect based on ***both*** "a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device" ***and*** "a touch sensor capable of detecting a touch with the touch-sensitive device," as is required by claim 1.

And there is no suggestion whatsoever in Figures 16-17 that effects can somehow be combined. To the contrary, these figures show ***distinct*** haptic effects, to the extent they show effects at all. For example, with regard to Figure 17, this shows to separated and distinct effects 228 and 229.

FIG. 17



Similarly, effects 225 and 226 in figures 16(a) and 16(b) are shown to be distinct from each other.



It is well settled law that "[a] prior art reference can only anticipate a claim if it discloses all the claimed limitations 'arranged or combined in the same way as in the claim.'" *Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1381 (Fed. Cir. 2015) (quoting *Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1361 (Fed. Cir. 2012). The limited disclosure discussed above cannot anticipate the claim element because "synthesiz[ing] different vibration effects" is not arranged in the same way as the claim or described in the same detail as in the claim, both of which are required. For example, with respect to arranged as in the claim, the description in paragraph [0052] simply states that different vibration effects may be synthesized. This is not arranged in the same way as claim 1's requirement that the haptic effect is determined based on signals received from ***both*** "a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device" ***and*** "a touch sensor capable of detecting a touch with the touch-sensitive device." Further, with respect to detail, there are no details in this description other than that "different vibration effects" may be synthesized. Again, this does not have the detail required by the claim.

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. Appellant requests reversal of these rejections.

V. Dependent Claim 11 the Office Action Fails to Establish that Choe Anticipates "wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor."

Further, with respect to claim 11 the Office Action fails to establish that Choe anticipates "wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor." With regard to this claim element the Office Action cites to Choe at [0045], without further

citation. This paragraph includes no disclosure whatsoever of an optical sensor, much less "a laser, an infra-red emitter, or a photo-resistor." This is clear from a simple review of the paragraph, which is pasted below, and at best discusses that the proximity sensor may detect "a change in an alternating magnetic field or the rate of change of static capacitance."

> **[0045]** The sensing unit **140** may include a proximity sensor **141**. The proximity sensor **141** may determine whether there is an object nearby and approaching the mobile terminal **100** without any mechanical contact with the entity. More specifically, the proximity sensor **141** may detect an object that is nearby and approaching by detecting a change in an alternating magnetic field or the rate of change of static capacitance. The sensing unit **140** may include two or more proximity sensors **141**.

Thus, Appellants request reversal of the rejection of claim 11 for this additional reason.

Issue 2: Did the Examiner err in rejecting claims 5 and 7-10 as allegedly obvious under 35 U.S.C. § 103 over the combination of Choe and to Rosenberg?

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. 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. These rejections should be reversed.

Issue 3: Did the Examiner err in rejecting claim 6 as allegedly obvious under 35 U.S.C. § 103 over the combination of Choe, Rosenberg, and Rosenberg848?

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. These rejections should be reversed.

Issue 4: Did the Examiner err in rejecting claim 14 as allegedly obvious under 35 U.S.C. § 103 over the combination of Choe and Rosenberg848?

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. These rejections should be reversed.

Conclusion

In view of the foregoing arguments, Appellant respectfully requests that the Board reverse each of the Examiner's bases for rejection.

Respectfully submitted,

Date: 5/23/2019

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Appendix A – Claims

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 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 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 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 second network electrode pattern 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 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 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.

Appendix B – Evidence

None.

Appendix C – Related Proceedings

None.

Electronic Acknowledgement Receipt

EFS ID:	36093530
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/John Mulhern
Filer Authorized By:	Michael T. Morlock
Attorney Docket Number:	IMM637 (051851-0971162)
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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 10/03/2019

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EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

NOTIFICATION DATE	DELIVERY MODE
10/03/2019	ELECTRONIC

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Application Number: 15/377,096
Filing Date: 13 December 2016
Appellants: Vahid Khoshkava, Abdelwahab Hamam

Michael Morlock

For Appellant

EXAMINER'S ANSWER

This is in response to the Appeal Brief filed 23 May 2019 appealing to the Final Rejection mailed 21 November 2018.

(1) Grounds of Rejection to be Reviewed on Appeal

Every ground of rejection set forth in the Office Action dated 30 April 2018 from which the appeal is taken is being maintained by the examiner.

The following grounds of rejection are applicable to the appealed claims.

Claims **1-19** are pending.

Claims **3, 4, 6-8, 10-14 and 16-18** are original.

Claims **1, 2, 5, 9, 15 and 19** are previously presented.

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** (Previously Presented), 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** (Previously Presented), 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** (Previously Presented), 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** (Previously Presented), 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, 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]).

(2) Response to Argument

Appellant's arguments with respect to claims 1-19 have been fully considered but are not persuasive for at least the following reason(s):

With respect to the Argument section of the Appeal Brief, on pages 15-17, Appellant asserts:

> "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," and further argues, "at best these paragraphs describe determining a first haptic effect 225 based on proximity and a second haptic effect 226 based on contact."

The Office agrees with Applicant in that the first haptic effect 225 is based on a proximity input and the second haptic effect 226 is based on a contact input. However, haptic effects are combinable as disclosed in paragraph [0052] and at Figures 16-17 of Choe. A first signal output from the proximity sensor 141 and a second signal output from the touchscreen 130 are supplied as input to the haptic module 157 which synthesizes different vibration effects and outputs a result of the synthetization (paragraph [0052]). As the user's finger approaches the touchscreen a first haptic effect 225 is scaled based on a distance determined by the proximity sensor 141. When contact is detected at a location corresponding to the user interface element 224 displayed on the touchscreen 130 a second haptic effect 226 is output in order to provide the user confirmation that the touch command was issued. The result is a haptic

effect profile and signal that is dependent on both the touchscreen signal and the proximity sensor signal.

With respect to the Argument section of the Appeal Brief, on pages 19-20, Appellant asserts:

> "with respect to claim 11 the Office fails to establish that Choe anticipates "wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor," and further argues, paragraph [0045] "includes no disclosure whatsoever of an optical sensor, much less "a laser, an infra-red emitter, or a photo-resistor."

The Office emphasizes that claim 11 is dependent upon claim 3 which requires "the proximity sensor comprises one of a capacitive sensor or an optical sensor." Claim 3, as currently worded, only requires one of the two different types of proximity sensors (capacitive sensor *or* optical sensor). As such citation to either a capacitive sensor or an optical sensor would meet the limitations of claim 3. The Office has cited the paragraph [0045] of Choe, which expressly discloses the use of a capacitive sensor, not an optical sensor, to detect proximity inputs. Claim 11 merely requires that any optical sensor comprises a laser, IR emitter, or photo-resistor. Importantly, claim 11 does not state that the proximity sensor definitively requires an optical sensor. The Office's interpretation is that claim 11 merely states that *should* the proximity sensor include an optical sensor it must also comprise the elements claimed therein. Should Appellant want to mandate that the proximity sensor is an optical sensor then the claims must be worded such that that becomes the broadest reasonable interpretation. Such a rewording of claim 11 could be something as simple as, 'wherein the proximity sensor

comprises the optical sensor, and wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor.' The current version of the claims simply does not require the interpretation of a purely optical sensor. In short, were the current limitations of claim 11 incorporated into claim 3, there would seem to be little doubt that a proper claim interpretation of claim 3 would not somehow require an optical sensor. Mere separation of the limitations into an additional dependent claim should not alter this interpretation. Accordingly, Choe meets the claim limitations of claim 11 as no additional limitations have been placed on the mapped capacitive sensor in claim 3.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/BRYAN EARLES/
Primary Examiner, Art Unit 2625

Conferees:

/WILLIAM BODDIE/
Supervisory Patent Examiner, Art Unit 2625

/AMR A AWAD/
Supervisory Patent Examiner, Art Unit 2621

Requirement to pay appeal forwarding fee. In order to avoid dismissal of the instant appeal in any application or ex parte reexamination proceeding, 37 CFR 41.45 requires payment of an appeal forwarding fee within the time permitted by 37 CFR 41.45(a),

unless appellant had timely paid the fee for filing a brief required by 37 CFR 41.20(b) in effect on March 18, 2013.

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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 10/17/2019

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EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Application Number: 15/377,096
Filing Date: 13 Dec 2016
Appellant(s): Khoshkava et al.

Michael Morlock
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 23 May 2019 appealing to the Final Rejection mailed 21 November 2018.

(1) Grounds of Rejection to be Reviewed on Appeal

Every ground of rejection set forth in the Office Action dated 21 November 2018 from which the appeal is taken is being maintained by the examiner.

The following grounds of rejection are applicable to the appealed claims.

Claims **1-19** are pending.

Claims **3, 4, 6-8, 10-14 and 16-18** are original.

Claims **1, 2, 5, 9, 15 and 19** are previously presented.

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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:

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> (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** (Previously Presented), 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]);

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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** (Previously Presented), 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** (Previously Presented), 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** (Previously Presented), 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.

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However, Rosenberg848 teaches:

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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]).

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(2) Response to Argument

Appellant's arguments with respect to claims 1-19 have been fully considered but are not persuasive for at least the following reason(s):

With respect to the Argument section of the Appeal Brief, on pages 15-17, Appellant asserts:

> "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," and further argues, "at best these paragraphs describe determining a first haptic effect 225 based on proximity and a second haptic effect 226 based on contact."

The Office agrees with Appellant in that the first haptic effect 225 is based on a proximity input and the second haptic effect 226 is based on a contact input. However, haptic effects are combinable as disclosed in paragraph [0052] and at Figures 16-17 of Choe. A first signal output from the proximity sensor 141 and a second signal output from the touchscreen 130 are supplied as input to the haptic module 157 which synthesizes different vibration effects and outputs a result of the synthetization (paragraph [0052]). As the user's finger approaches the touchscreen a first haptic effect 225 is scaled based on a distance determined by the proximity sensor 141. When contact is detected at a location corresponding to the user interface element 224 displayed on the touchscreen 130 a second haptic effect 226 is output in order to provide the user confirmation that the touch command was issued. The result is a haptic

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> "with respect to claim 11 the Office fails to establish that Choe anticipates "wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor," and further argues, paragraph [0045] "includes no disclosure whatsoever of an optical sensor, much less "a laser, an infra-red emitter, or a photo-resistor."

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comprises the optical sensor, and wherein the optical sensor comprises one of a laser, an infra-red emitter, or a photo-resistor.' The current version of the claims simply does not require the interpretation of a purely optical sensor. In short, were the current limitations of claim 11 incorporated into claim 3, there would seem to be little doubt that a proper claim interpretation of claim 3 would not somehow require an optical sensor. Mere separation of the limitations into an additional dependent claim should not alter this interpretation. Accordingly, Choe meets the claim limitations of claim 11 as no additional limitations have been placed on the mapped capacitive sensor in claim 3.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/BRYAN EARLES/
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Supervisory Patent Examiner, Art Unit 2625

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Supervisory Patent Examiner, Art Unit 2621

Requirement to pay appeal forwarding fee. In order to avoid dismissal of the instant appeal in any application or ex parte reexamination proceeding, 37 CFR 41.45 requires payment of an appeal forwarding fee within the time permitted by 37 CFR 41.45(a),

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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 Appeal Brief – Patents
Commissioner for Patents
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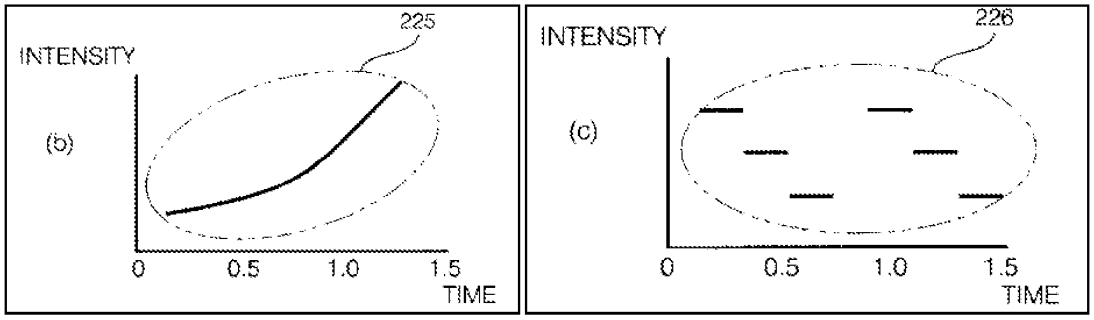
REPLY BRIEF

This is a Reply Brief filed under 37 C.F.R. § 41.41 in response to the Examiner's Answer mailed October 3, 2019 (the "Answer"). This Reply Brief is in connection with the final rejection of claims 1-19 in the Final Office Action mailed November 21, 2018 (hereinafter the "Office Action"). In the present Reply Brief Appellant addresses a portion of the issues raised in the Answer. Appellant hereby incorporates Appellant's arguments as presented in Appellant's Appeal Brief filed May 23, 2019 (the "Appeal Brief"), and Appellant's failure to address any issue in this Reply Brief should not be taken as an indication that Appellant agrees with the Examiner. The Board should instead consider Appellant's arguments in the record as a whole.

The Answer agrees that Choe discloses only two distinct haptic effects. However, the Answer urges that this disclosure is irrelevant because "haptic effects are combinable as disclosed in paragraph [0052] and Figures 16-17 of Choe." Answer at 10. The Answer goes on to provide an example of what it alleges is "a haptic effect profile and signal that is dependent on both the touchscreen signal and the proximity signal." Answer at page 11. This is incorrect. As an initial matter, the Answer's proposed example is presented without any citation to the actual disclosure of Choe. This is because, as detailed below, Choe does not disclose such an embodiment, rather the cited effects 225 and 226 are shown as being different. *See* Choe, FIGS.

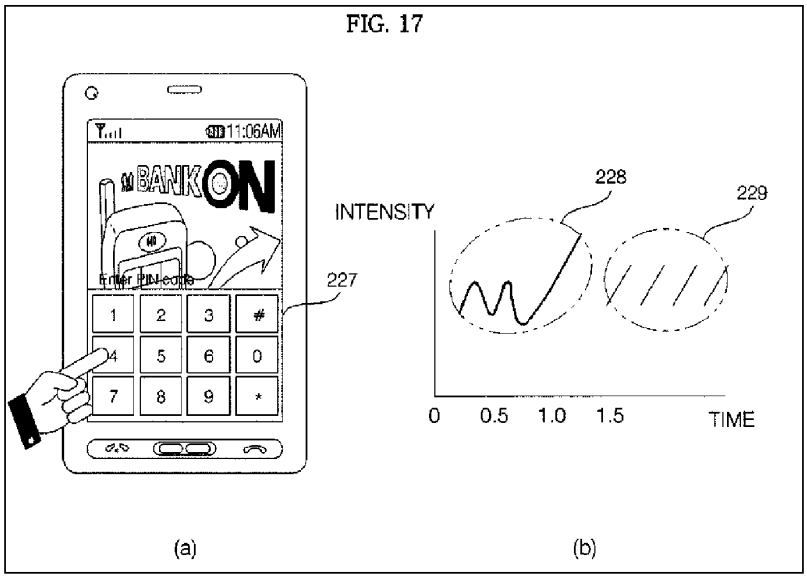
16(b) and 16(c).



Further, even assuming the analysis were supported by citation to Choe, the claim does not recite "a haptic effect profile," but rather requires "generate ***a haptic output signal*** based at least in part on ***the first and second sensor signals***." This is not disclosed by Choe.

As explained in detail in the Appeal Brief, neither paragraph [0052] nor Figures 16-17 suggest that haptic effects are combinable. To the contrary each of these citations in fact describes distinct haptic effects. Choe paragraph [0052] simply describes synthesizing different vibration effects or outputting effects sequentially. This says nothing of determining a haptic effect based on ***both*** "a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device" ***and*** "a touch sensor capable of detecting a touch with the touch-sensitive device," as is required by claim 1. Second, effects 225 and 226 are shown as distinct effects in figures 16(b) and 16(c) (both pasted above). And the specification is explicit that these are different effects that are not output at overlapping times. Choe [0137]-[0138] ("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 in order to alert the user to the approach of the user's finger to the key 224. Referring to FIG.16(c), 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 in order to alert the user to the payment of charges."). Indeed, the Answer agrees as much stating "the first haptic effect 225 is based on a proximity input and the second haptic effect 226 is based on a contact input." Answer at 10. Similarly, Choe Figure 17 shows two separate and distinct effects 228 and 229.

FIG. 17



Further, as explained in detail in the Appeal Brief, it is improper to make this type of combination in an anticipation rejection. As the Court of Customs and Patent Appeals explained, "picking and choosing may be entirely proper in the making of a 103, obviousness rejection, where the applicant must be afforded an opportunity to rebut with objective evidence any inference of obviousness which may arise from the similarity of the subject matter which he claims to the prior art, ***but it has no place in the making of a 102, anticipation rejection***. *Application of Arkley*, 455 F.2d. 586, 587-88 (CCPA 1972) (emphasis added). The Federal Circuit has also explained that in an anticipation rejection "it is not enough that the prior art reference discloses part of the claimed invention, which an ordinary artisan might supplement to make the whole, or that it includes multiple, distinct teachings that the artisan might somehow combine to achieve the claimed invention." *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1371 (2008).

In view of the Appellant's arguments in the Appeal Brief and this Reply Brief, Appellant respectfully requests the Board reverse the rejection of the pending claims.

Respectfully submitted,

Date: 12/3/2019

/Michael Morlock/

Michael T. Morlock
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KILPATRICK TOWNSEND & STOCKTON LLP
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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/John Mulhern
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:				
APPEAL FORWARDING FEE	1413	1	2240	2240
Post-Allowance-and-Post-Issuance:				

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Electronic Acknowledgement Receipt	
EFS ID:	37915548
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/John Mulhern
Filer Authorized By:	Michael T. Morlock
Attorney Docket Number:	IMM637 (051851-0971162)
Receipt Date:	03-DEC-2019
Filing Date:	13-DEC-2016
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Application Type:	Utility under 35 USC 111(a)

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15/377,096	12/13/2016	Vahid Khoshkava	IMM637 (051851-0971162)	4030

34300 7590 12/09/2019

Kilpatrick Townsend and Stockton/Immersion
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EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte VAHID KHOSHKAVA et al.

Appeal 2020-001249
Application 15/377,096
Technology Center 2600

APPEAL DOCKETING NOTICE

The Patent Trial and Appeal Board received the appeal in the above-identified application from the Technology Center on December 05, 2019, and has assigned it the appeal number indicated above.

The recipient of this notice is reminded of its ongoing duty, within 20 days of any change during the proceeding, to update its mandatory notices to identify the real party-in-interest and each judicial or administrative proceeding that could affect, or be affected by, the Board proceeding. 37 C.F.R. § 41.8. For example, another docketed appeal in a related application may have the potential to affect, or be affected by, the Board proceeding.

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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 06/28/2021

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EXAMINER	
EARLES, BRYAN E	

ART UNIT	PAPER NUMBER
2625	

NOTIFICATION DATE	DELIVERY MODE
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte VAHID KHOSHKAVA and ABDELWAHAB HAMAM

Appeal 2020-001249
Application 15/377,096
Technology Center 2600

Before JEAN R. HOMERE, ADAM J. PYONIN, and
PHILLIP A. BENNETT, *Administrative Patent Judges.*

BENNETT, *Administrative Patent Judge.*

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant[1] appeals from the Examiner's decision to reject claims 1–19. Appeal Br. 2. We have jurisdiction under 35 U.S.C. § 6(b).

We reverse.

---

[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42(a). Appellant identifies the real party in interest as Immersion Corporation. Appeal Br. 1.

CLAIMED SUBJECT MATTER

The claims are directed to a systems and methods for proximity-based haptic feedback. Claim 1, reproduced below, is illustrative of the claimed subject matter:

> 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 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.

Appeal Br. 23 (Claims Appendix).

REFERENCES[2]

The Examiner relies on the following as prior art:

Name	Reference	Date
Choe	US 2010/0004033 A1	Jan. 7, 2010
Rosenberg '848	US 2017/0285848 A1	Oct. 5, 2017
Rosenberg	US 2017/0300166 A1	Oct. 19, 2017

[2] All citations herein to the references are by reference to the first named inventor/author only.

REJECTIONS

Claims 1–4, 11–13 and 15–19 stand rejected under 35 U.S.C. § 102(a)(1) as being anticipated by Choe. Final Act. 3.

Claims 5 and 7–10 stand rejected under 35 U.S.C. § 103 as being unpatentable over Choe and Rosenberg. Final Act. 6.

Claim 6 stands rejected under 35 U.S.C. § 103 as being unpatentable over Choe, Rosenberg, and Rosenberg '848. Final Act. 8.

Claim 14 stands rejected under 35 U.S.C. § 103 as being unpatentable over Choe and Rosenberg '848. Final Act. 9.

ISSUE

Has the Examiner erred in finding Choe teaches or suggests "a processor configured to: generate a haptic output signal based at least in part on the first and second sensor signals," as recited in claim 1?

ANALYSIS

The Examiner's Findings

Claim 1 recites a device that includes both a proximity sensor and a touch sensor, and uses signals from each sensor to generate a haptic output. The proximity sensor detects non-contact interaction with the device and generates a first sensor signal, and the touch sensor detects a touch interaction and outputs a second sensor signal. *See, e.g.*, Spec. ¶ 43. Relevant to the issue before us, claim 1 recites the limitation "generate a haptic output signal based at least in part of the first and second sensor signals." Appeal. Br. 23 (Claims Appendix). In rejecting claim 1, the Examiner finds that Choe discloses this limitation. Final Act. 2 (citing Choe ¶¶ 136–138), 4 (citing Choe ¶¶ 76–78). The Examiner explains that Choe's

disclosure of generating haptic effects 225 and 226, as depicted in Figures 16(b) and 16(c), meets the argued limitation because effect 225 is generated based on a proximity signal, and 226 is based on a touch signal. The Examiner further explains that the argued limitation encompasses Choe's two separate effects because Choe discloses that haptic effects are combinable. Ans. 10 (citing Choe ¶ 52).

Appellant's Arguments

Appellant argues the rejection is in error because "the claim requires determining a haptic effect based on signals from two sensors," and that "Choe . . . makes clear that the haptic effect is determined based *only on proximity*." Appeal Br. 15. Appellant further argues that the Examiner's reliance on haptic effects 225 and 226, as described in paragraphs 136–138, is misplaced. Appeal Br. 16–17; Reply Br. 1–2. Specifically, Appellant argues that the claim requires that a single haptic effect be generated based on the first and second signals, but that the haptic effects 225 and 226 are separate and distinct haptic effects, as emphasized in Figures 16(b) and 16(c) of Choe.

Appellant further asserts that the Examiner's finding that haptic effects are combinable is not supported by the evidence. Specifically, Appellant argues:

> Choe paragraph [0052] simply describes synthesizing different vibration effects or outputting effects sequentially. This says nothing of determining a haptic effect based on both "a proximity sensor capable of detecting a non-contact interaction with a touch-sensitive device" and "a touch sensor capable of detecting a touch with the touch-sensitive device," as is required by claim 1.

Reply Br. 2.

Our Review

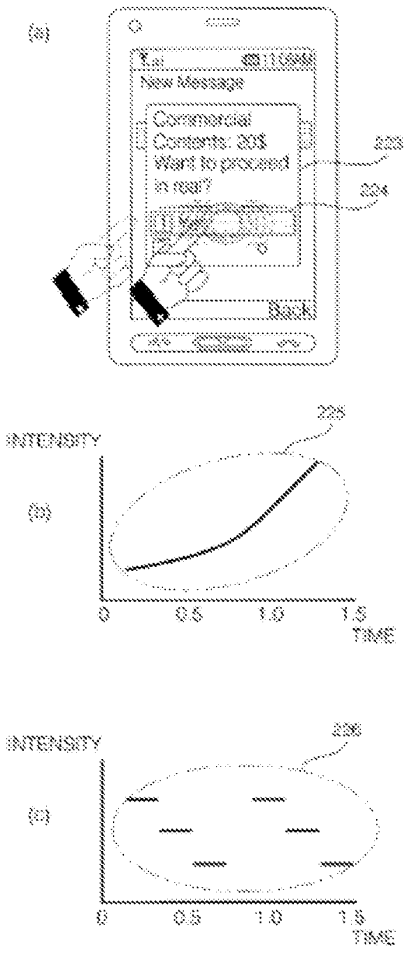
Neither the Examiner nor Appellant appears to dispute that the broadest reasonable interpretation in light of the Specification for the argued limitation requires generating a haptic effect based on both a proximity signal and a touch signal, and does not mean that one haptic effect may be based on proximity and another haptic effect may be based on touch. We agree with both the Examiner and Appellant that the broadest reasonable interpretation of the argued limitation requires that both touch and proximity signals be used to generate each haptic effect.

As noted above, the Examiner relies separately on two distinct passages in Choe as disclosing the argued limitation. We address each passage in turn.

First, the Examiner cites Choe's ¶¶ 76–78 as allegedly teaching the argued limitation. We agree with Appellant that Choe does not describe the using of touch sensing for generating the haptic signal in this embodiment, and we agree with Appellant that the Examiner's reliance on Choe's ¶¶ 76–78 is misplaced.

Second, the Examiner relies on ¶¶ 136–138 and Figures 16(a)–16(c) for support. We agree with Appellant, however, that the Examiner's finding that "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" is not supported by the evidence. Choe's Figure 16, reproduced below, shows two separate haptic effects.

FIG. 18



The proximity haptic effect is "a haptic effect 225 in order to alert the user to the approach of the user's finger to the key 224." Choe ¶ 137. The touch haptic effect is "haptic effect 226 in order to alert the user to the payment of charges." Choe ¶ 138. Although this disclosure in Choe describes two haptic effects, neither of these haptic effects is generated based on both proximity signals and touch signals. Rather, the first haptic effect is based only on a proximity signal, and the second is haptic effect is based only on a touch signal. Choe makes this configuration clear in

paragraph 138, stating that the haptic effect uses either touch or proximity in the alterative, but not both together: "[O]nce 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 in order to alert the user to the payment of charges." Choe ¶ 138. Thus, Choe discloses the haptic effect 226 is generated based on a touch of the user, *or* the approach of the user's finger, but not both.

Moreover, we agree with Appellant that the Examiner's determination that Choe discloses that haptic signals may be combined is insufficient to support a finding of anticipation. As Appellant correctly notes, "Choe paragraph [0052] simply describes synthesizing different vibration effects or outputting effects sequentially." Generally describing the use of synthesized vibration effects does not disclose that the specific signals 225 and 226 described by Choe in a separate embodiment are combined.

Because Appellant has persuaded us the Examiner erred in rejecting claim 1 as anticipated by Choe, we do not sustain the rejection under 35 U.S.C. § 102(a)(1). For the same reasons, we also do not sustain the § 102 rejection of claims 2–4, 11–13, and 15–19, which depend therefrom. The remaining claims 5–10 and 14 are rejected under § 103. However, the Examiner does not identify any subject matter in the additionally cited references which would remedy the deficiencies of Choe discussed above. As a result, we also do not sustain the rejections under 35 U.S.C. § 103.

CONCLUSION

We reverse the Examiner's decision to reject the claims.

DECISION SUMMARY

Claims Rejected	**35 U.S.C. §**	**Reference(s)/Basis**	**Affirmed**	**Reversed**
1–4, 11–13, 15–19	102(a)(1)	Choe		1–4, 11–13, 15–19
5, 7–10	103	Choe, Rosenberg		5, 7–10
6	103	Choe, Rosenberg, Rosenberg ’848		6
14	103	Choe, Rosenberg ’848		14
Overall Outcome				1–19

REVERSED

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EXAMINER	
EARLES, BRYAN E	
ART UNIT	PAPER NUMBER
2625	

DATE MAILED: 07/02/2021

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

TITLE OF INVENTION: Systems and Methods for Proximity-Based Haptic Feedback

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	10/04/2021

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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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nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	10/04/2021

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1_____
2_____
3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

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

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 07/02/2021

Immersion / Kilpatrick Townsend and Stockton
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
EARLES, BRYAN E	
ART UNIT	PAPER NUMBER
2625	

DATE MAILED: 07/02/2021

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 30 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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 disclosure of these records is required by the Freedom of Information Act.
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 Cooperation Treaty.
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 inspection 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.

Notice of Allowability	Application No. 15/377,096	Applicant(s) Khoshkava et al.	
	Examiner BRYAN EARLES	Art Unit 2625	AIA (FITF) Status Yes

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 28 June 2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ 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.

3. ☑ The allowed claim(s) is/are 1-19 . As a result of the allowed claim(s), 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.**

4. ☐ 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)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/BRYAN EARLES/
Primary Examiner, Art Unit 2625

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/377,096	Khoshkava et al.
	Examiner	**Art Unit**
	BRYAN EARLES	2625

CPC						
Symbol					**Type**	**Version**
G06F	/	3	/	016	F	2013-01-01
G06F	/	3	/	0421	I	2013-01-01
G06F	/	3	/	0416	I	2013-01-01
G06F	/	3	/	0488	I	2013-01-01
G06F	/	3	/	0446	I	2019-05-01
G06F	/	2203	/	04108	A	2013-01-01
G06F	/	2203	/	04101	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	19	
/BRYAN EARLES/ Primary Examiner, Art Unit 2625	25 June 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

U.S. Patent and Trademark Office — Part of Paper No.: 20210624

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/377,096	Khoshkava et al.
	Examiner	**Art Unit**
	BRYAN EARLES	2625

INTERNATIONAL CLASSIFICATION				
CLAIMED				
G06F	/	3	/	01

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	19	
/BRYAN EARLES/ Primary Examiner, Art Unit 2625	25 June 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

U.S. Patent and Trademark Office — Part of Paper No.: 20210624

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/377,096	Khoshkava et al.
	Examiner	**Art Unit**
	BRYAN EARLES	2625

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	19	
/BRYAN EARLES/ Primary Examiner, Art Unit 2625	25 June 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

U.S. Patent and Trademark Office — Part of Paper No.: 20210624

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/377,096	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

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

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	06/25/2021	BE

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
G06F	3/016, 3/0416, 3/044, 3/0421, 2203/04108	06/25/2021	BE

/BRYAN EARLES/ Primary Examiner.Art Unit 2625	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/377,096	Khoshkava et al.
	Examiner	Art Unit
	BRYAN EARLES	2625

/BRYAN EARLES/ Primary Examiner.Art Unit 2625	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S37	2	(propinquity and haptic).clm.	US-PGPUB; USPAT	OR	ON	2021/06/24 14:02
S36	583	(("IMMERSION") near3 ("CORPORATION")).AANM.	USPAT	OR	ON	2021/06/24 14:02
S35	61	(("HAMAM") near3 ("Abdelwahab")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/06/24 14:02
S34	188	(("KHOSHKAVA") near3 ("Vahid")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/06/24 14:02
S38	206	("20030095110" | "20030134256" | "4333092" | "4406998" | "5086287" | "5154614" | "5165897" | "5186629" | "5233333" | "5272470" | "5412189" | "5568536" | "5580254" | "5588839" | "5590373" | "5619684" | "5729394" | "5748177" | "5757361" | "5805138" | "5810597" | "5821881" | "5835080" | "5874955" | "5909211" | "5920303" | "5936614" | "5989099" | "6042383" | "6059575" | "6088805" | "6141754" | "6162059" | "6217338" | "6233576" | "6259043" | "6262718" | "6267598" | "6278944" | "6292713" | "6292904" | "6308173" | "6320496" | "6351748" | "6357940" | "6381602" | "6384743" | "6412070" | "6446206" | "6449633" | "6473103" | "6492978" | "6513721" | "6581099" | "6609199" | "6776546" | "7079119" | "7116313").PN. OR ("7403191").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2021/06/24 14:03
L1	1	"15377096"	US-PGPUB; USPAT	OR	ON	2021/06/25 07:03
L5	142	3 and 2	US-PGPUB; USPAT	OR	ON	2021/06/25 07:07
L4	142	3 and 2	US-PGPUB; USPAT	OR	ON	2021/06/25 07:07

L3	38,905	(G06F3/016 or G06F3/0416 or G06F3/044 or G06F3/0421 or G06F2203/04108).cpc.	US-PGPUB; USPAT	OR	ON	2021/06/25 07:07
L2	443	((propinquit$3 proximit$3 hover$3) near9 (haptic$3 tactile)).clm.	US-PGPUB; USPAT	OR	ON	2021/06/25 07:07

EAST Search History (Interference)

<This search history is empty>

6/25/2021 7:08:20 AM
C:\Users\bearles\Documents\EAST\Workspaces\15377096.wsp

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 **Issue Fees**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Amendment Under Rule 1.312

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. (Currently Amended) The method of claim 15, wherein the haptic output signal is 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

This paper submits the amendments above pursuant to Rule 312. These amendments are directed to formal matters and do not add any new matter to the claims. Applicants respectfully request that the Examiner enter these amendments prior to issuance of the application as a patent.

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: 10/1/2021

/Michael Morlock/

Michael Morlock
Reg. No. 62,245

KILPATRICK TOWNSEND & STOCKTON LLP
1100 Peachtree Street N.E.
Suite 2800
Atlanta, GA 30309
(404) 815-6003

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on October 1, 2021.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /John Mulhern/

PATENT
Attorney Docket No.: 051851-0971162
Client Ref. No.: IMM637

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 4030
Vahid Khoshkava	Examiner: Bryan E. Earles
Application No.: 15/377,096	Technology Center/Art Unit: 2625
Filed: December 13, 2016	
For: SYSTEMS AND METHODS FOR PROXIMITY-BASED HAPTIC FEEDBACK	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. Patents 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

representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information. This Information Disclosure Statement is being filed after an action closing prosecution, but before the payment of the Issue Fee.

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.

I hereby certify under 37 CFR §1.704(d)(1) that each item of information contained in this Information Disclosure Statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by an individual designated in §1.56(c) more than thirty days prior to the filing of the information disclosure statement; or is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in §1.56(c) more than thirty days prior to the filing of the information disclosure statement.

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,

/Michael Morlock/

Michael T. Morlock
Registration No. 62,245

KILPATRICK TOWNSEND & STOCKTON LLP

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	IMM637 (051851-0971162)

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

U.S. PATENT APPLICATION PUBLICATIONS

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
	1	20060274050		Dec 7, 2006	Lii	

FOREIGN PATENT DOCUMENTS

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]
	2	2011150964	JP		Aug 4, 2011	Yokogawa Electric Corp	English Abstract Attached	
	3	102308270	CN		Jan 4, 2012	Pressure Profile Systems Inc.	English Abstract Attached	
	4	103543874	CN		Jan 29, 2014	Atmel Corporation	English Abstract Attached	
	5	105388966	CN		Mar 9, 2016	Apple Inc.	English Abstract Attached	
	6	105556423	CN		May 4, 2016	Immersion Corporation	English Abstract Attached	
	7	105900045	CN		Aug 24, 2016	Sensel Inc	English Abstract Attached	
	8	205680056	CN		Nov 9, 2016	Apple Inc.	English Abstract Attached	

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]
	9	CN. Application No CN201711322141.5 , Office Action, Mailed On September 15, 2021, 12 pages.	

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[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.

Espacenet

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SWITCH

Inventor(s): ABE TAKESHI ± (ABE TAKESHI)

Applicant(s): YOKOGAWA ELECTRIC CORP ± (YOKOGAWA ELECTRIC CORP)

Classification: **- international:** ***H01H13/00; H01H13/64; H01H36/00***
- cooperative:

Application number: JP20100012942 20100125 Global Dossier

Priority number(s): JP20100012942 20100125

Also published as: JP5088383 (B2)

Abstract of JP2011150964 (A)

PROBLEM TO BE SOLVED: To realize a switch installed on a conductive film or a conductive part, which has a bending portion that bends and elastic deforms when a user presses a keytop, and in which the function of a touch sensor is not deteriorated and reliability is secured, even if the user repeats a reciprocating movement of the keytop. ;SOLUTION: The switch is provided with a touch sensor and a push-type switch element, and the touch sensor detects approach or contact of an object to the pressing portion of itself, and the push-type switch element makes a connection state according to the pressing condition of its own keytop part. The touch sensor has a conductive film in which a conductive pattern is formed in the vicinity of the pressing portion, and detects approach or contact of the object by the changes in electric characteristics generated in the conductive pattern when the object approaches or contacts the conductive pattern, and the conductive film has the bending portion capable of elastic deformation formed in the vicinity of the pressing portion. ;COPYRIGHT: (C)2011,JPO&INPIT

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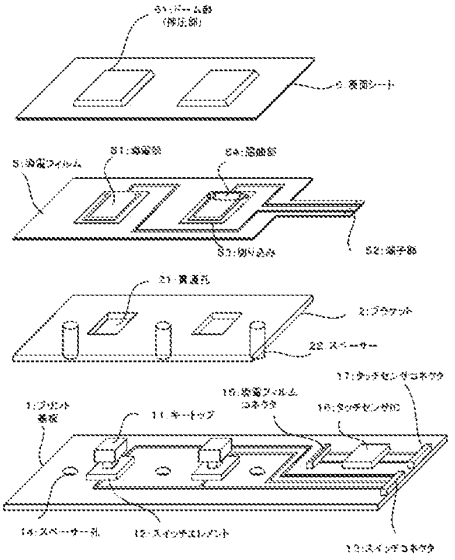
5G206 AS11K AS27K DS02H DS02K HS12 HS25 HU53 KS03 KS07 KS56 KS57 KU15 PS02

(54)【発明の名称】スイッチ

(57)【要約】
【課題】本発明の目的は、導電フィルムまたは導電部に、ユーザがキートップが押し下げられる際に曲げ弾性変形する屈曲部を設けることで、ユーザがキートップの往復動を繰り返しても、タッチセンサの機能が低下せず信頼性を確保できるスイッチを実現することにある。
【解決手段】本発明は、タッチセンサとプッシュ式スイッチエレメントとを備え、前記タッチセンサは自身の押圧部への物体の接近または接触を検知し，前記プッシュ式スイッチエレメントは自身のキートップ部の押圧状態に応じた接続状態をとるスイッチにおいて、前記タッチセンサは、前記押圧部付近に導電パターンが形成された導電フィルムを有し、前記導電パターンに物体が接近または接触したときに前記導電パターンに生じる電気的特性の変化により物体の接近または接触を検知し、前記導電フィルムは、前記押圧部近傍に弾性変形が可能な屈曲部が形成されていることを特徴とする。
【選択図】図１



【特許請求の範囲】
【請求項１】
タッチセンサとプッシュ式スイッチエレメントとを備え、前記タッチセンサは自身の押圧部への物体の接近または接触を検知し、前記プッシュ式スイッチエレメントは自身のキートップ部の押圧状態に応じた接続状態をとるスイッチにおいて、
前記タッチセンサは、前記押圧部付近に導電パターンが形成された導電フィルムを有し、前記導電パターンに物体が接近または接触したときに前記導電パターンに生じる電気的特性の変化により物体の接近または接触を検知し、
前記導電フィルムは、前記押圧部近傍に弾性変形が可能な屈曲部が形成されていることを特徴とするスイッチ。
【請求項２】
絶縁性を有する表面シートが，前記導電フィルムの一部または全部を覆うように配置されることを特徴とする請求項１記載のスイッチ。
【請求項３】
前記表面シートは、前記押圧部と対面する部分に凸状のドームが形成されることを特徴とする請求項２記載のスイッチ。
【請求項４】
前記押圧部は、前記キートップの上部対面部の外周に沿って、一端を残して切り込みが入れられ、この一端が片持ち支持端となり前記屈曲部を形成することを特徴とする請求項１～３のいずれかに記載のスイッチ。
【請求項５】
前記押圧部は、中心付近から周辺部に向かって放射状に切り込みが入れられ、前記周辺部の切り込みの末端間が片持ち支持端となり前記屈曲部を形成することを特徴とする請求項１～３のいずれかに記載のスイッチ。
【請求項６】
前記押圧部は、前記導電パターンの外周に位置する導電フィルムに，一端を残して切り込みを入れて形成され、この一端が片持ち支持端かつ前記屈曲部となることを特徴とする請求項１～３のいずれかに記載のスイッチ。
【請求項７】
前記押圧部は、その外周の一部または全部に渡り、弾性を有する弾性部材により前記導電フィルムと接合され，前記弾性部材が前記屈曲部を形成することを特徴とする請求項１～３のいずれかに記載のスイッチ。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、タッチセンサを備えたスイッチに関する。
【背景技術】
【０００２】
フィールド機器等を制御するコントローラの操作部等に用いられるスイッチは、タッチセンサとプッシュ式スイッチエレメントとを備えた装置で、タッチセンサが自身の押圧部への物体の接近または接触を検知し、プッシュ式スイッチエレメントがキートップ部の押圧状態に応じたＯＮ/ＯＦＦ状態を検知する。
【０００３】
このような従来のスイッチの例を、図面を用いて詳細に説明する。
図６は、従来のスイッチの構成例を示した図である。図６において、プリント基板１は、往復動を行うキートップ１１を備えたスイッチエレメント１２と、スイッチコネクタ１３と、スペーサ孔１４と、導電フィルムコネクタ１５と、タッチセンサＩＣ１６と、タッチセンサコネクタ１７が実装されている。スイッチエレメント１２は、可動部を備えた押しボタンスイッチ等で、可動部が押圧され一定の位置に達するとＯＮ状態となる。スイッチコネクタ１３とタッチセンサコネクタ１７は，図示しない制御部に接続されている。

スイッチエレメント１２とスイッチコネクタ１３との間と、導電フィルムコネクタ１５とタッチセンサＩＣ１６との間と、タッチセンサＩＣ１６とタッチセンサコネクタ１７との間は、導電性を有する部材によって配線されている。

【０００４】

ブラケット２は、プリント基板１の上方に設けられ、キートップ１１の往復動のガイドとなる貫通孔２１を有し、下面にはスペーサ２２が取り付けられている。このスペーサ２２はプリント基板１のスペーサ孔１４に嵌合され、ブラケット２とプリント基板１との間の一定距離を確保する。

【０００５】

導電フィルム３は、ブラケット２の上面に設けられ、弾性を有するプラスチック等で平板状に形成され、金属や導電性プラスチック等で形成された導電部３１と、プリント基板１の導電フィルムコネクタ１５と接続される端子部３２を備えている。導電部３１と端子部３２は導電性を有する部材によって配線されている。

導電部３１と、端子部３２および導電フィルムコネクタ１５を介して接続されたタッチセンサＩＣ１６とにより、導電部３１への物体の接近または接続を検知しその状態を出力するタッチセンサを形成する。ここでは、導電部３１がタッチセンサの押圧部となる。

【０００６】

ベゼル４は、下面部が開口した箱状に形成され、プリント基板１、ブラケット２、導電フィルム３の全体を取り囲むよう配置される。ベゼル４には、導電部３１に対面する位置に開口部４１を有している。

【０００７】

このような、スイッチの動作例を、図面を用いて説明する。

図６において、ユーザの指等がベゼル４の開口部４１を通して導電部３１に触れると、導電部３１やそれに接続された配線等の静電容量が変化し、タッチセンサＩＣ１６がこの変化を検出し、ユーザの指等が導電部３１に接触または接近を知らせる信号が、タッチセンサコネクタ１７を通じて図示しない制御部に出力される。制御部は、この出力に基づいて該当する処理を行う。

【０００８】

ユーザがベゼル４の導電部３１を、押し下げると、導電部３１はキートップ１１と接した状態で、スイッチエレメント１２の可動部とともに押し下げられる。そして可動部が一定の位置に達するとＯＮ状態と判断され、この情報がスイッチコネクタ１３を通じて図示しない制御部に伝達され、該当する処理が行われる。

【０００９】

特許文献１には、このようなタッチセンサを備えたスイッチの構成が記載されている。

【先行技術文献】

【特許文献】

【００１０】

【特許文献１】特開２００８－２７００２２号公報

【発明の概要】

【発明が解決しようとする課題】

【００１１】

しかしながらこのようなスイッチでは、ユーザがキートップ１１を押し下げる際に、平板状の導電フィルム３または導電部３１をブラケット２の貫通孔２１に押し込むことになる。したがって、導電フィルム３または導電部３１は、屈曲および伸張変形させられ、または、貫通孔２１の縁と接触による摩擦を受ける。導電フィルム３または導電部３１には、弾性変形しやすい素材を用いてはいるが、屈曲および伸張変形の回数が多くなり、また貫通孔２１の縁との摩擦を繰り返すと、疲労により導電フィルム３または導電部３１の破損等が起き、スイッチの機能も低下して信頼性が損なわれるという課題があった。

【００１２】

そこで本発明の目的は、導電フィルムまたは導電部に、ユーザがキートップを押し下げ

る際に曲げ弾性変形する屈曲部を設けることで、ユーザがキートップの往復動を繰り返しても、タッチセンサの機能が低下せず信頼性を確保できるスイッチを実現することにある。

【課題を解決するための手段】

【００１３】

このような課題を達成するために、本発明のうち請求項１記載の発明は、

タッチセンサとプッシュ式スイッチエレメントとを備え、前記タッチセンサは自身の押圧部への物体の接近または接触を検知し、前記プッシュ式スイッチエレメントは自身のキートップ部の押圧状態に応じた接続状態をとるスイッチにおいて、

前記タッチセンサは，前記押圧部付近に導電パターンが形成された導電フィルムを有し、前記導電パターンに物体が接近または接触したときに前記導電パターンに生じる電気的特性の変化により物体の接近または接触を検知し、

前記導電フィルムは、前記押圧部近傍に弾性変形が可能な屈曲部が形成されていることを特徴とするスイッチ。

【００１４】

請求項２記載の発明は，請求項１記載の発明であって、

絶縁性を有する表面シートが、前記導電フィルムの一部または全部を覆うように配置されることを特徴とする。

【００１５】

請求項３記載の発明は、請求項２記載の発明であって、

前記表面シートは、前記押圧部と対面する部分に凸状のドームが形成されることを特徴とする。

【００１６】

請求項４記載の発明は、請求項１～３のいずれかに記載の発明であって、

前記押圧部は、前記キートップの上部対面部の外周に沿って、一端を残して切り込みが入れられ、この一端が片持ち支持端となり前記屈曲部を形成することを特徴とする。

【００１７】

請求項５記載の発明は、請求項１～３のいずれかに記載の発明であって、

前記押圧部は、中心付近から周辺部に向かって放射状に切り込みが入れられ、前記周辺部の切り込みの末端間が片持ち支持端となり前記屈曲部を形成することを特徴とする。

【００１８】

請求項６記載の発明は、請求項１～３のいずれかに記載の発明であって、

前記押圧部は、前記導電パターンの外周に位置する導電フィルムに，一端を残して切り込みを入れて形成され、この一端が片持ち支持端かつ前記屈曲部となることを特徴とする。

【００１９】

請求項７記載の発明は，請求項１～３のいずれかに記載の発明であって，

前記押圧部は、その外周の一部または全部に渡り、弾性を有する弾性部材により前記導電フィルムと接合され、前記弾性部材が前記屈曲部を形成することを特徴とする。

【発明の効果】

【００２０】

本発明によれば、導電フィルムまたは導電部に、キートップの上部対面部の外周に沿って、一端を残して切込みを入れ、この一端が片持ち支持端となり屈曲部を形成する。そして、キートップの押下の際には、この屈曲部が曲げ弾性変形して、導電部のうち、切り込みで囲まれた部分がキートップの往復動とともに円滑に移動するので、導電フィルムまたは導電部の屈曲部以外の部分には応力が発生しにくくなる。このためキートップの往復動を繰り返しても導電フィルムまたは導電部の破損等起きにくいスイッチを実現することができる。

【図面の簡単な説明】

【００２１】

【図１】本発明の一実施例の構成を示した分解斜視図である。
【図２】図１のスイッチの完成斜視図である。
【図３】図２に示されるスイッチにおいて、Ａ－Ａ’部分での縦断面図である。
【図４】図１のスイッチエレメントおよび導電部付近を抽出した上面図および縦断面図である。
【図５】本発明の他の実施例の構成を示した図である。
【図６】従来のスイッチの構成例を示した図である。
【発明を実施するための形態】
【００２２】
以下本発明を、図面を用いて詳細に説明する。
図１は本発明の一実施例の構成を示した図である。図４は、スイッチエレメントおよび導電部付近の上面図および縦断面図である。
ここで、図６と同一のものは同一符号を付し、説明を省略する。
図１において、導電フィルム５は、ブラケット２の上面に設けられ、弾性を有するプラスチック等で形成され、導電部５１と、プリント基板１の導電フィルムコネクタ１５と接続される端子部５２を備えている。導電部５１には、キートップ１１の上部対面部の外周に沿って、一端を残して切り込み５３が入れられ、この一端が片持ち支持端となり屈曲部５４を形成している。
導電部５１と端子部５２は導電性を有する部材によって配線されている。
【００２３】
表面シート６は、導電フィルム５の上面に設けられる。表面シート６の、導電部５１に対応する位置には、エンボス加工により凸状のドーム部６１が形成される。
【００２４】
ここで、ドーム部６１と、導電部５１と、端子部５２および導電フィルムコネクタ１５を介して接続されたタッチセンサＩＣ１６と、により、ドーム部６１への物体の接近または接続を検知しその状態を出力するタッチセンサを形成する。ドーム部は、タッチセンサの押圧部６１となる。
【００２５】
図１のスイッチの組み立てを完成したものが、図２および図３に示されている。図２は、図１のスイッチの組み立て完成図、図３は、図２に示されるＡ－Ａ’部分における縦断面図である。
【００２６】
このようなスイッチの動作例を、図１を用いて説明する。
図１において、ユーザの指等が表面シート６のドーム部６１に触れると、導電部５１やそれに接続された配線等の静電容量等が変化し、タッチセンサＩＣ１６がこの変化を検出し、ユーザの指等が導電部５１に接触したという信号が、タッチセンサコネクタ１７を通じて図示しない制御部に伝達され、必要な処理が行われる。
【００２７】
ドーム部６１がさらに押し下げられると、導電部５１とキートップ１１と共にスイッチエレメント１２の可動部が押し下げられる。この際に、屈曲部５４が片持ち支持端となり、導電フィルム５の屈曲部５４には曲げが発生するが、この屈曲部５４が曲げ弾性変形して、導電部５１のうち切り込み５３で囲まれた部分がキートップ１１の往復動とともに円滑に移動する。このため、屈曲部５４以外の部分については、伸張変形したり、貫通孔２１の縁との摩擦で磨耗したりすることが少なくなる。
【００２８】
図４の（ａ）および（ｂ）はスイッチエレメント１２と導電部５１付近のそれぞれ上面図および縦断面図である。図４において、導電部５１に屈曲部５４が形成され、この屈曲部５４が片持ち支持端となり曲げ変形が加えられる様子が示されている。
【００２９】
スイッチエレメント１２の可動部が一定の位置に達するとＯＮ状態と判断され、この情

報がスイッチコネクタ１３を通じて図示しない制御部に伝達され、該当する処理が行われる。

【００３０】

このように、導電部５１に、キートップ１１の上部対面部の外周に沿って、一端を残して切込みを入れ、この一端が片持ち支持端となり屈曲部５４を形成する。そして，キートップの押下の際には、この屈曲部５４が曲げ弾性変形して、導電部５１のうち切り込み５３で囲まれた部分がキートップ１１の往復動とともに円滑に移動するので、導電部５１の屈曲部５４以外の部分には応力が発生しにくくなる。このためキートップ１１の往復動を繰り返しても導電フィルム５または導電部５１の破損等起きにくい、信頼性を向上させたスイッチを実現することができる。

【００３１】

なお，導電部５１の一端を残して切り込みが入れられ，この一端が片持ち支持端となって屈曲部５４が形成される構成を示したが，これに限定されるものではなく、切り込みは、図５に示すように、導電フィルム７の一端を残して、導電部７１を囲むように切り込み７２を入れて，この一端が片持ち支持端である屈曲部７３を形成される構成でもよい。

また、導電部の中心付近から周辺部に向かって放射状に切り込みが入れられ、前記周辺部の切り込みの末端間が片持ち支持端となり屈曲部を形成してもよい。

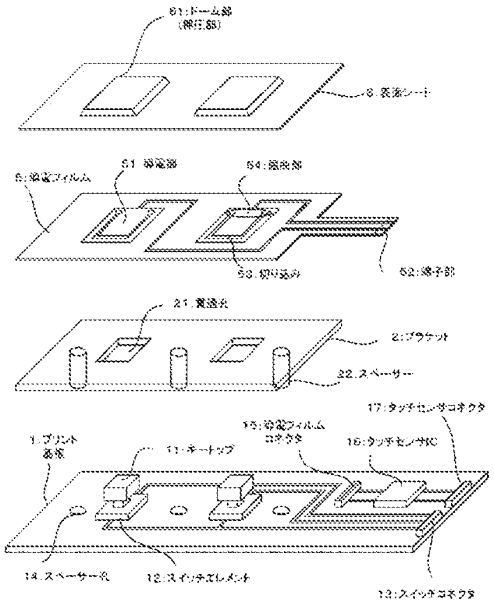
導電部が、その外周の一部または全部に渡り、弾性を有する例えばラバーなどの弾性部材により導電フィルムと接合され、この弾性部材が前記屈曲部を形成してもよい。

【符号の説明】

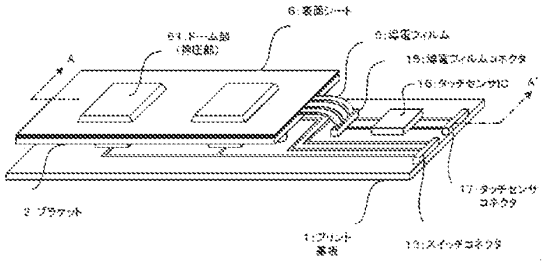
【００３２】

１２　スイッチエレメント
１５　導電フィルムコネクタ
１６　タッチセンサＩＣ
１７　タッチセンサコネクタ
５　導電フィルム
５１、７１　導電部
５３、７２　切り込み
５４、７３　屈曲部
６　表面シート
６１　ドーム部、押圧部

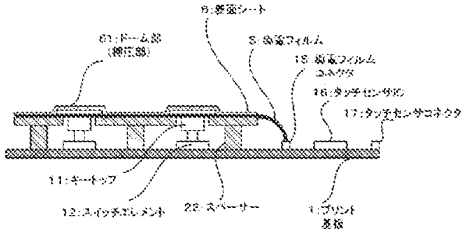
【図１】



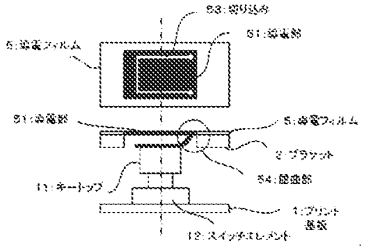
【図２】



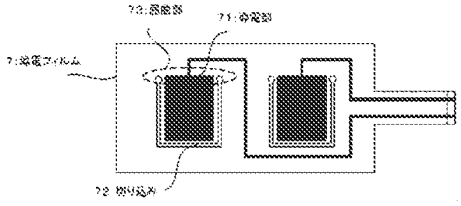
【図３】



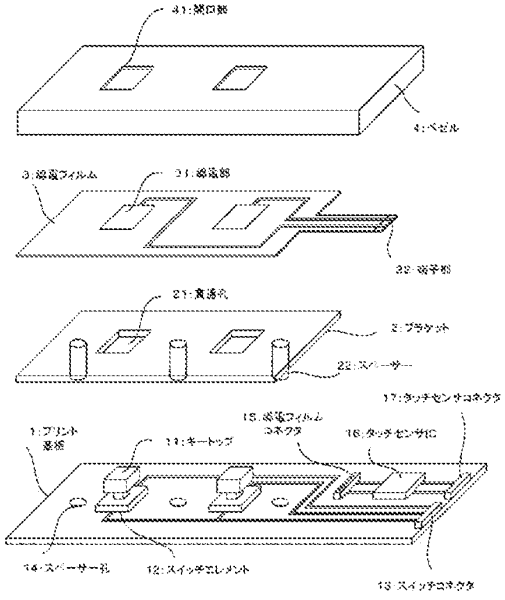
【図４】



【図５】



【図６】



Espacenet

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Capacitive proximity tactile sensor

Inventor(s): SON JAE S ± (SON JAE S)

Applicant(s): PRESSURE PROFILE SYSTEMS INC ± (PRESSURE PROFILE SYSTEMS INC)

Classification: **- international:** ***G06F3/044; H03K17/955***
- cooperative: **G06F3/0447 (EP, US)**

Application number: CN20108006914 20100205

Priority number(s): WO2010US23355 20100205 ; US20090150580P 20090206

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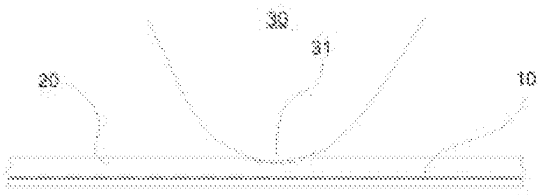
Abstract of CN102308270 (A)



A novel capacitive proximity tactile sensor is formed by an electrode layer 10 and a compressible non-conductive layer 20. Positioning a conductive object 30 in contact with the sensor and applying contact force onto the sensor surface 31 allows for both detecting the location of touch (as in traditional proximity sensors) as well as measuring contact force (as in tactile array sensors) due to a capacitance-measuring sensor formed between the electrode layer 10 and the object 30 with the compressible non-conductive layer 20 therebetween. Useful applications of the sensor include input device for consumer electronic item, flexible and thin weight scale, shoe insole for monitoring pressure distribution of a foot while walking, pressure-monitoring seat cushion and others.

(19)中华人民共和国国家知识产权局

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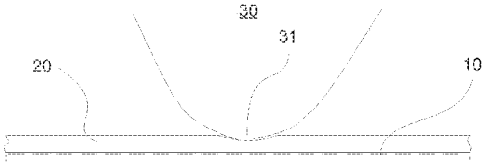
权利要求书 1 页 说明书 5 页 附图 6 页

(54)发明名称

电容式接近触觉传感器

(57)摘要

一种新颖的电容式接近触觉传感器由电极层10以及可压缩不传导层20所形成。放置传导对象30与传感器接触，在传感器表面31上应用接触力，由于通过电极层10和对象30之间的可压缩不传导层20，在电极层10以及对象30之间形成电容测量传感器，允许检测接触的位置（作为传统接近传感器）以及测量接触力（作为触觉阵列传感器）。该传感器的有利应用包括用于消费类电子产品的输入设备，柔韧的、及薄的重量秤，行走时用于监测脚的压力分布的鞋垫，压力监视坐垫以及其他。



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1. 一种电容式接近触觉传感器，其包含电极层和暴露于传导对象的可压缩不传导层，所述可压缩层限定了接触力的渐进可压缩范围，其中当通过所述传导对象作用于所述可压缩层上的接触力在所述渐进可压缩范围内时，通过所述电极层和所述传导对象之间的可压缩不传导层，在所述电极层和所述传导对象之间形成电容传感器，其中所述传感器产生接触信号以及代表所述接触力的力信号。

2. 如权利要求 1 所述的传感器，其中所述电极层包含电极阵列，每个电极都能检测通过所述传导对象的接触，以及测量其与所述对象之间的电容。

3. 如权利要求 1 所述的传感器，其中所述电极层和所述可压缩不传导层是柔韧的。

4. 权利要求 1 所述的传感器可适应于作为一个柔韧的重量秤。

5. 权利要求 1 所述的传感器可适应于作为用于监视人的脚下面的压力分布的鞋垫。

6. 权利要求 1 所述的传感器可适应于作为用于消费类电子产品的输入设备。

7. 权利要求 1 所述的传感器可适应于作为拳击力量监视器。

8. 权利要求 1 所述的传感器可适应于作为压力监视坐垫。

9. 权利要求 1 所述的传感器，其中所述可压缩不传导层由泡沫制成。

10. 权利要求 9 所述的传感器，其中所述泡沫选自由硅泡沫，聚亚安酯泡沫，以及热塑性弹性泡沫。

电容式接近触觉传感器

[0001] 与有关申请的对照

[0002] 本申请要求同一发明人的美国临时专利申请No. 61/150,580的优先权，于2009年2月6日以相同的题目提交。本申请将其全部以参考的方式并入。

[0003] 发明背景

[0004] 本发明总体上涉及电容式接近传感器。更特别地，本发明的传感器利用覆盖有一层可压缩的不传导材料的接近阵列传感器，允许其检测附近的传导对象、以及通过这种对象作用到传感器表面上的作用力。

[0005] 电容式接触传动器通常被用作消费类电子设备的输入设备。例如苹果公司的iPhone，就是一种使用接近接触传感器输入设备制作而成的具有改良的用户界面的广泛使用的设备。虽然这种电容式接触传感器的灵敏度在检测附近传导对象的存在或不存在的方面非常高，但是他们不能被用于有效地测量由对象作用到传感器表面上的渐进力。接近传感器被用于现有技术中的其他已知的应用中，例如，如图1所示的包含由行及列所形成的栅格式电极的电容式接触面板。其提供了非常灵敏的对象检测，因为在使用接地的或传导对象，如手指、裸露的脚或金属时，感应机构在传感器的电学性质中。尽管如此，这种接近效果不能测量由对象，如脚，所作用的压力或力。然而，通过整合所有的测量，其有效地提供了脚的尺寸，而不是人的体重－称重性能的研究显示出他们是不精确的。他们的读数也极其依靠人是否穿着袜子。

[0006] 触觉阵列传感器在另一方面，确实可测量实际接触压力并且能将它们合并到接触力中。然而，对于许多常见的应用，例如用于力－传感电阻(FSR)，他们的表现总是不够准确。触觉阵列传感器的另一个缺点是其制造的难度及复杂性。

[0007] 现有技术中触觉传感器阵列传感器(相同发明人的美国专利No. 7,609,178)的横断面视图如图2所示。它包括通过间隔105与第二电极103分开的第一电极101。通过对象104在区域110内对电极的压缩，导致两个电极之间电容量的变化，此变化随后被控制单元所检测。高度灵敏的触觉传感器的这种设计需要一个模塑的结构用来支撑接地电极(ground electrode)。通过结合所有压力测量结果，一个总的力或重量可以被推算出来。类似这种需要高灵敏度和对抗大的切变应力的应用，例如当一个人跨步及步行在传感器上，提出了一个巨大的挑战，因为接地电极可能由安装好的基板上脱层。

[0008] 因此，存在一个高度灵敏以及可靠的传感器的需求，其制造简单，且能提供作为触觉传感器的精确性以及接近传感器的灵敏度。

发明内容

[0009] 因此，本发明的目的在于通过提供一种新颖的电容式接近触觉传感器，可将接触检测以及力量测量功能融入一个单独的设备中，以克服现有技术中这些和其他的缺点。

[0010] 本发明的另一个目的在于提供一种通过接地的或用电的传导对象，其中包含人的身体的一部分，具有感应接触以及测量接触力的能力的电容式触觉传感器。

[0011] 本发明的进一步的目的在于提供一个可符合简单的制造过程的电容式接近触觉

EX1002 - Page 1125

传感器。

[0012] 本发明的另一个目的在于一个具有统一的灵敏度的电容接近触觉传感器。

[0013] 本发明的另一个目的在于提供一个柔韧的、且能围绕一个平面或曲面或在其上面弯曲或折叠的电容式接近触觉传感器。

[0014] 本发明的传感器包括一个电容感应电极层以及一个可压缩的不传导层。当传导对象被放置在附近时，接近传感器在电容感应电极和传导对象之间形成，允许检测接触位置。同时，对象所作用的力引起了不传导层的压缩。电容式触觉传感器在感应电极和传动对象之间形成，其中具有不传导层的。感应电极和传导对象之间的测量电容允许确定对象与电极之间的间隔。相应地，知道了间隔可从已知的不传导材料的可压缩参数计算在那个位置的作用力。结合材料被压缩和接触被检测的多个位置的力量数据可计算总的接触力或对象的重量。

附图说明

[0015] 通过参考下面对引用的附图的详细描述，可以了解本发明主旨的更加完整的理解及其各种优点，其中：

[0016] 图 1 是现有技术中接近传感器的整体描绘，

[0017] 图 2 是现有技术中电容式触觉传感器的整体图示，

[0018] 图 3 是传导对象放置在其上的本发明的传感器的整体图示，

[0019] 图 4 示出了本发明的传感器的一个作为压力映射垫的实际应用，

[0020] 图 5 示出了本发明的传感器的一个作为用于消费类电子产品的实际应用的力测量输入设备，

[0021] 图 6A 和 6B 示出了本发明的传感器的一个作为压力分布式测量鞋垫传感器的实际应用，

[0022] 图 7A 和 7B 示出了本发明传感器的一个作为柔韧浴室秤的实际应用，

[0023] 图 8 示出了本发明的传感器的一个作为用于与沙袋一块使用的冲击力测量传感器实际应用，及最后

[0024] 图 9 示出了本发明的传感器在坐垫里的一个实际应用。本发明优选实施例的详细描述

[0025] 本发明的详细描述参考附图如下，在附图中，相同的元件由相同的附图文字和数字表示。

[0026] 图 3 描绘了包含两个主要元件 - 至少一个电容感应电极层 10 以及可压缩不传导层 20 的本发明的传感器的整体图示。电容感应电极层 10 以类似传统接近传感器阵列的方式形成。它包括一些当传导对象 30 被放置在附近时，能够测量电学和电容特性的位置（像素）。像素的具体数量以及它们的设计很大程度上取决于特定的应用；它们中的一些实例在下面被更详细的描述。源自单个像素的信号通过电缆（未示出）被传输至控制单元（未示出）。在一些实际应用中，控制单元合并至传感器设备本身并安装在附近，可选地作为传感器本身安装在同一支撑基板的上面。通常为接触传感器建立的任何电容感应集成电路 (IC) 都能用于本发明。

[0027] 可压缩层的厚度以及传感器元件的尺寸都能被如此调整，当对象产生接触时，源

EX1002 - Page 1126

自接近效应的信号在集成电路的噪声水平内。在这种构造中，接近效应被最小化，且传感器表现为类似可测量接触压力和力的传统触觉传感器。

[0028] 可压缩不传导层 20 放置在电极层 10 的上方。它可像聚亚安酯 (polyurethane) 泡沫层一样简单。重要地，预先知道此层的可压缩参数。材料选择，厚度，以及可压缩性都基于特定实际应用的需要被选择 - 参见以下实例。除了聚亚安酯之外，硅或热塑性弹性泡沫也能够使用。重要的是正确地评估对于每一个实际应用的最小和最大接触力。在材料和厚度选择之后的指导原则是确保可压缩层在其弹性渐进变形范围内形变。应选择足够柔软的，在预期的最小接触力下至少部分形变以便提供用于特殊用途的充分的灵敏度。同时，最大预期接触力不应该使材料超出其渐进压缩范围。超出渐进压缩范围可能导致不好的传感器性能或至少引起传感器读数达到饱和状态，因此引起输出信号错误。将已知的力或压力应用到将与传感器接触的使用对象上的传统校准过程提供了一个校准曲线，在此以数字计数的传感器输出能够被转化为压力或力。将与传感器接触的对象是预先已知的对于正确使用这种传感器是很重要的。

[0029] 本发明的传感器有效地结合了接近传感器的功能以及电容测量触觉传感器的功能。当传导对象 30 被放置在可压缩层 20 上，一个特定的力被作用在传感器表面之上，可压缩层 20 在区域 31 之上、对象 30 之下变形。传感器的接近感应接触检测部分利用传导对象 30 的紧密存在，作为可用作第一输入信号的接触位置的传统已知的检测。

[0030] 同时，在电极层 10 和传导对象 30 之间的电容感应电路允许确定在被区域 31 所包围的许多点之上的其间的间隙。在通过测量电容所确定的间隙的每个点上，局部的力可能随后由已知的可压缩层 20 的压缩特征所计算出来。结合整个区域 31 上的力的数据点，可计算出对象 30 按压本发明的传感器的总的接触力，即使对象 30 可能具有不规则形状。接触力能够用作第二输入信号，独立于由传感器的接近检测部分所产生的第一输入信号。

[0031] 根据本发明的方法，接触位置以及接触力的检测可由以下步骤完成：

[0032] a. 提供包含电极层和暴露于传导对象的可压缩不传导层的电容式接近触觉传感器；可压缩层的特征在于具有由最小接触力和最大接触力所限定的渐进压缩范围，

[0033] b. 通过在最小接触力和最大接触力之间的一定范围内的传导对象的接触力的实际应用，利用传感器的电学性能以及基于传导对象的紧密接近，检测接触的位置，

[0034] c. 测量遍及在对象和传感器之间的接触区域的电容，

[0035] d. 由电容数据计算变形的可压缩层的厚度分布，

[0036] e. 由不传导层的厚度分布以及预定的压缩性能计算在接触区域上的力的分布，以及

[0037] f. 由力的分布数据计算接触力。

[0038] 可选择地，基于与已知的作用力相关的电容测量，校准曲线能够被创建以确定接触力。

[0039] 重要地，电极层和可压缩不传导层都是弹性的，使得整个传感器具有弹性。这有利于用在本发明的一些潜在的实际应用中，除了被说明的许多应用外。例如，用于测量口内的舌头所施加的力的传感器可以被创建，该传感器利用聚亚安酯的热成型层密封或在水溶性防护涂层中浸渍。

[0040] 下面的描述提供了本发明实施例。图 4 说明了本发明的传感器用于检测当一个人

EX1002 - Page 1127

走在传感器上时，人的脚下面的压力分布的一般应用。在此实例中，脚扮演了传导对象 30 的角色。可压缩层的厚度和刚度被选择适应在典型的人类重量范围下可压缩层的凹陷，人类重量的范围例如 20lbs 到 400lbs。脚 30 对层 20 的压缩被转化成在传感器变形区域 31 上的许多的电容测量结果。这些测量结果用于计算层 20 的厚度分布，然后利用层 20 材料的压缩性能，压力分布可通过控制单元被计算出来。这个实际应用最重要的优势在于有或者没有袜子都不会明显改变传感器的读数。

[0041] 重要地，可压缩层 20 的存在也允许有层 20 内部所固有发生的变形力的局部重新分布。这一点使得对比现有技术的传感器，本发明的传感器的更统一的灵敏度。

[0042] 知道在传感器表面之上人的脚的压力分布能被应用到许多应用实例中。本发明一个有用的实例是可记录一个行走中的人的脚的压力分布的鞋垫。这个传感器如图 6A（侧视图）和 6B（顶视图）所示。老人的灵活性的退化是摔跤和受伤的主要原因。研究表明，步法的变化常常先于摔跤的实际事件。许多设备已知被用于步法监视。如图 6 所示的简单且不显眼的鞋垫可被用于作为短期的或长期的步法监视工具。这种传感器也能被用作一种简单制作的鞋垫触觉传感器，其可利用压力分布信息来监视平衡，压疮，表现，动力，力量，以及重量。一个典型的鞋垫的设计包括至少一个或优选的多个感应区域 41 到 46，以监视脚下的多个点上的压力。鞋垫传感器可以通过要求人分别举起每一只脚，以及用两只脚平衡的站立，而用重量轻松的校准。通过将人的重量记入处理单元，在一只脚上的全部的重量，在一只脚上一半的重量以及没有重量都可被校准。

[0043] 本发明的传感器的另一个有用的实例在于制作有弹性的，耐用的以及薄的浴室体重秤。它可以像毯子一样被放置，允许人们在上面无绊跌的走。由于其薄的性质，它能被放置在更方便的位置用来测量某人的自身的重量，例如在浴室的中间，或可能甚至在一些不可避免的地方（在门的入口附近）。传感器的柔韧性使得它可以不平坦的表面操作，例如具有不平坦地面的老房子。当走在秤上时，泡沫的可压缩性将提供柔软及缓和的感觉。这种浴室秤的设计如作为顶视图的图 7A 所示，以及说明其柔韧性的透视图如图 7B 所示。

[0044] 本发明的电容式接近触觉传感器能够被用做类似于传统接近触觉输入设备，但是具有用于力量检测的额外好处。概念地，这种应用如图 5 所示。在这个例子中，用户的手指是传导对象 30。这种对常见接近接触传感器的简单的增强对于通过生成位置输入信号和渐进的力量信号的个人移动设备以及游戏控制器是非常有价值的。这种力量强度信号相应地能用于控制如滚动的速度或字符或车辆速度等参数。对于类似于吉他英雄 (Guitar Hero) 的游戏，当用户的手的位置被认为遵循一系列预设程序的动作时，通过要求人不只要遵循动作的顺序，而且要控制不同强度的作用的压力或力，一个更高级别的难度可被设定。这种依从的层的附加好处是自然的触觉反馈，用户可以获得与在操作传感器的过程中通过压缩泡沫的动作所获得的相同的更柔软的及更缓和的感觉。

[0045] 图 8 示出了使用更厚的可压缩层设计用于承受来自用拳猛击动作的冲击力的一个实例。这种应用允许创建一种力量及能量监视器用于训练运动员。对于拳击的应用，本发明的传感器可选择地并入拳击手套中（图中未示出）。

[0046] 图 9 示出了装备了压力分布监视器的座位。通过将电容电极插入到坐垫的底部作为依从的不传导层 20，人的臀部可充当传导对象 30，作为第二电极及然后形成电容式接近触觉传感器。这种构造能作为低廉及可靠的手段来检测车辆中的前面座位上乘客的存在以

EX1002 - Page 1128

启动或禁用各个安全气囊。用作这种实际应用的超出其他类型的传感器的一个重要优势在于其基于测量重量。当一个重物，而不是人，放置在座位上时，如一堆书或旅行包，本发明的传感器不会打开安全气囊。

[0047] 本发明的压力监视座位或仅仅坐垫也能用于轮椅或适合被用在医院病床上，来监视压力水平以防止压疮。

[0048] 尽管此处本发明采用特定的实施例进行了阐述，但是应理解为这些实施例仅仅用来说明本发明的原理及实际应用。因此应当理解，在不超出本发明的精神和范围的情况下，对说明性的实施例的修改以及其他装置的设计均用附加权利要求限定。

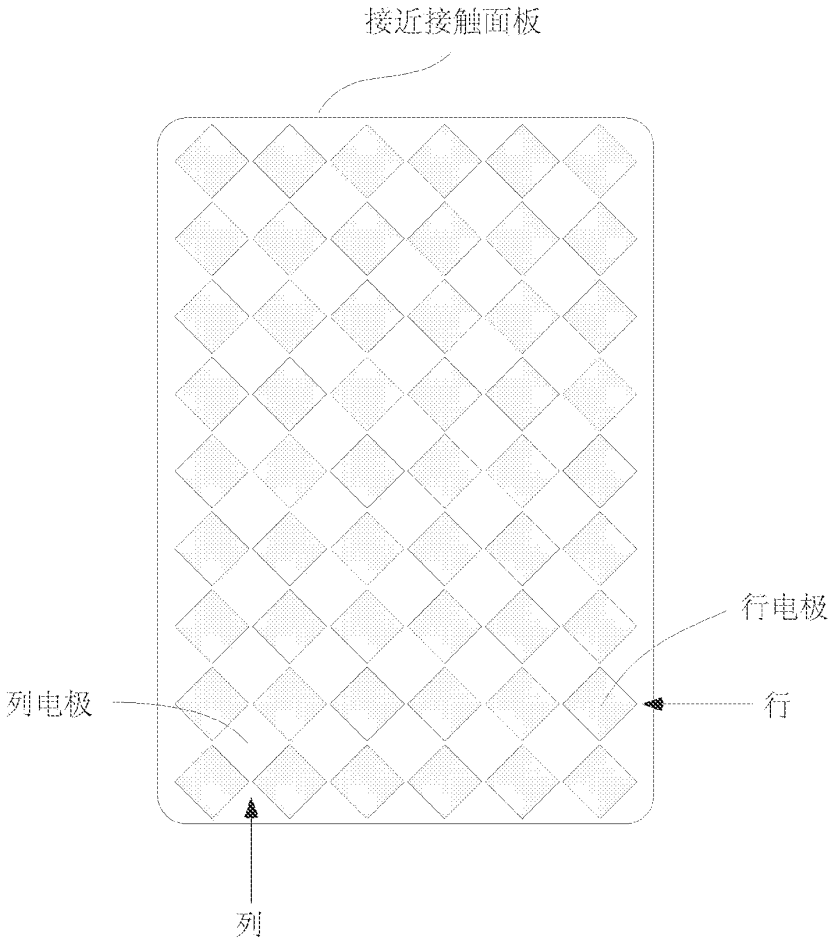

Fig.1(现有技术)

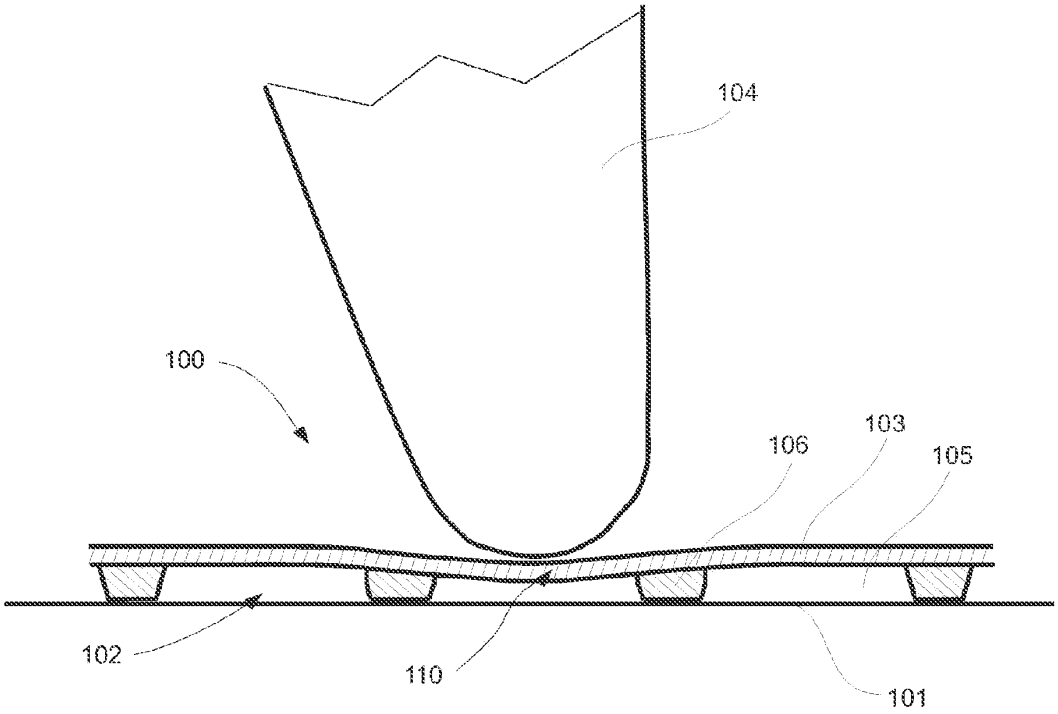

Fig.2(现有技术)

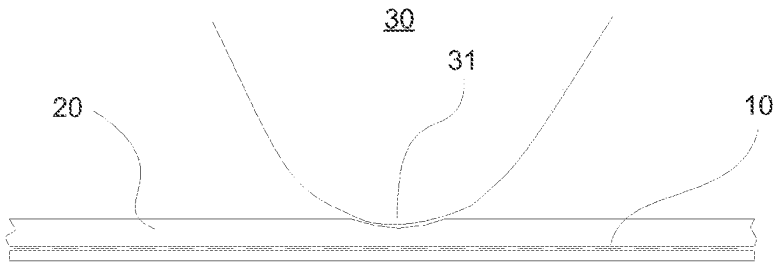

Fig.3

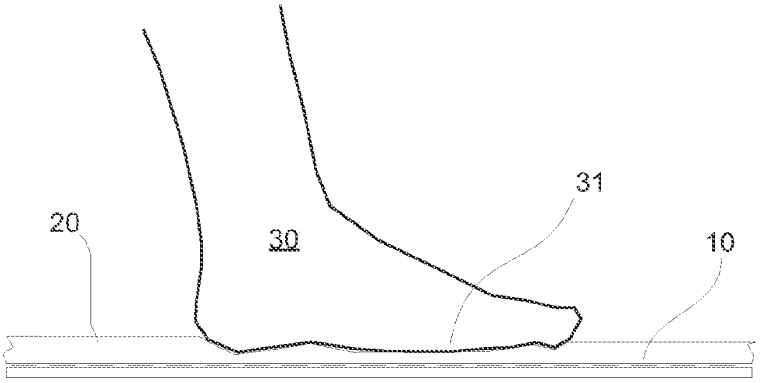

Fig. 4

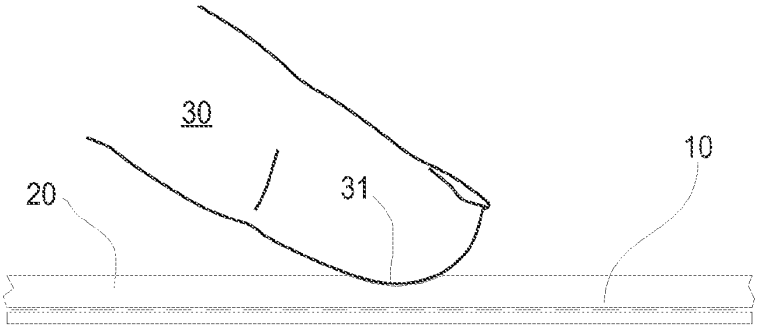

Fig. 5

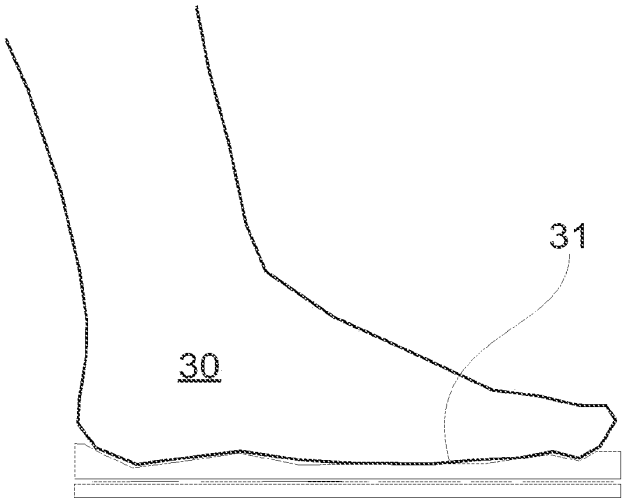

Fig. 6A

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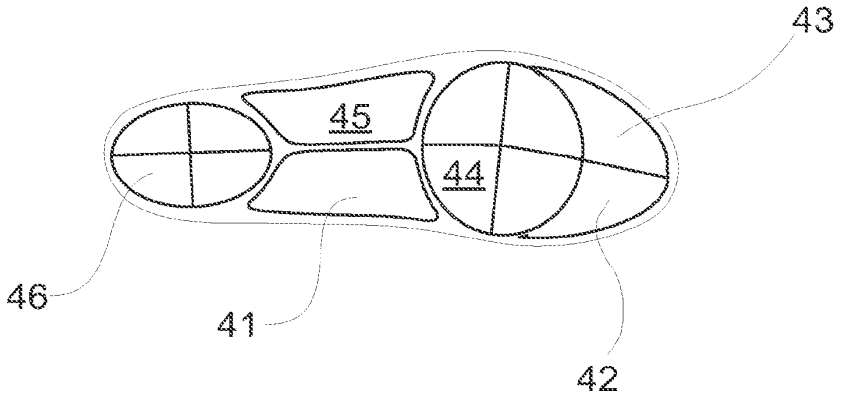

Fig. 6B

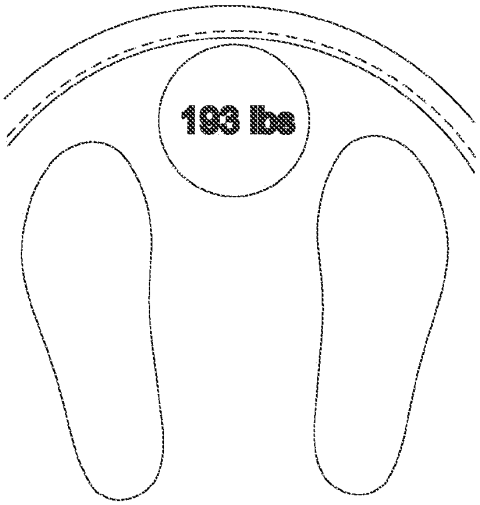

Fig. 7A

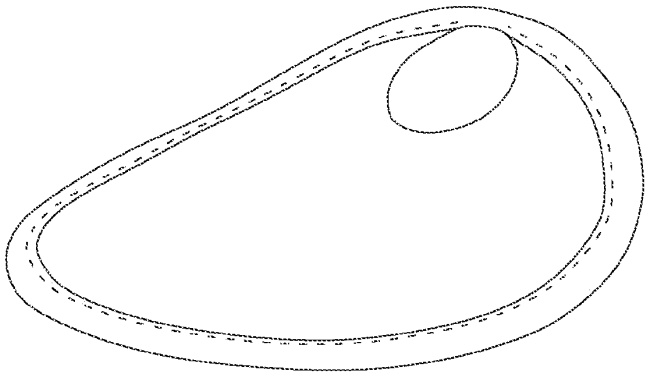

Fig. 7B

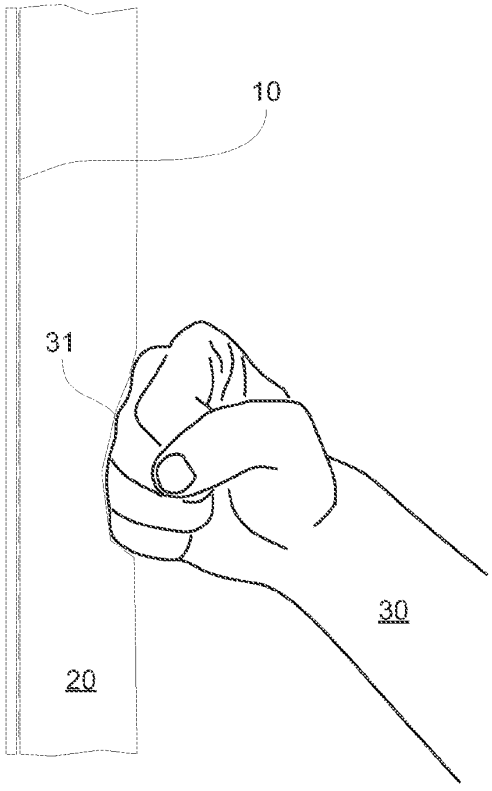

Fig. 8

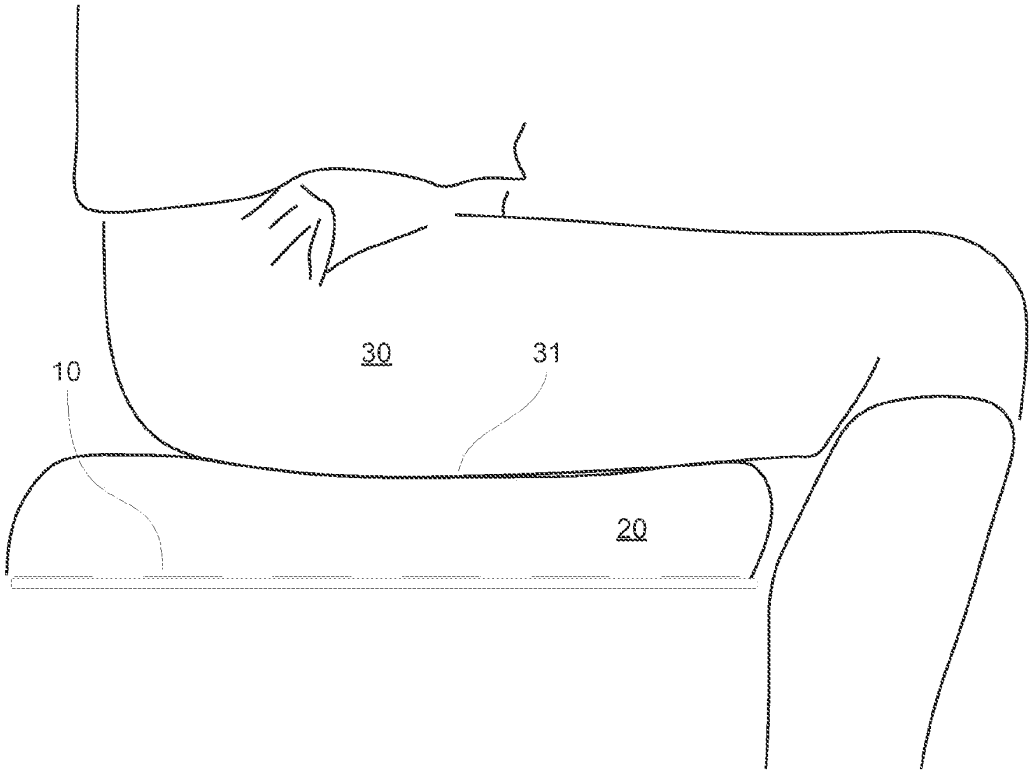

Fig. 9

Espacenet

Bibliographic data: CN103543874 (A) — 2014-01-29

Touch-sensor-controller sensor hub

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Applicant(s): ATMEL CORP ± (ATMEL CORPORATION)

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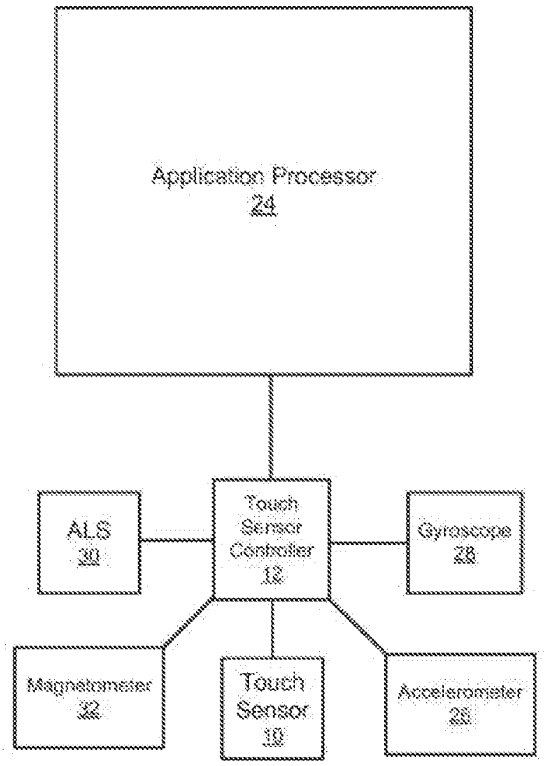
Abstract of CN103543874 (A)

In one embodiment, a method includes controlling a touch sensor of a device. The control of the touch sensor includes a first processing cycle executed by the controller that comprises acquisition of touch-sensor signals from the touch sensor; a second processing cycle executed by the controller that comprises pre-processing of the touch-sensor signals; and a third processing cycle executed by the controller that comprises processing of the touch-sensor signals to determine whether a touch or proximity input has occurred with respect to the touch sensor. If the touch or proximity input has occurred with respect to the touch sensor, a location of the touch or proximity input is determined. The method also includes controlling other sensors of the device. The control of the other sensors includes one or more fourth processing cycles executed by the controller concurrently with the first processing cycle or the second processing cycle.


Application Processor
24
ALS
30
Touch
Sensor
Controller
12
Gyroscope
28
Magnetometer
32
Touch
Sensor
10
Accelerometer
26

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代理人 章蕾

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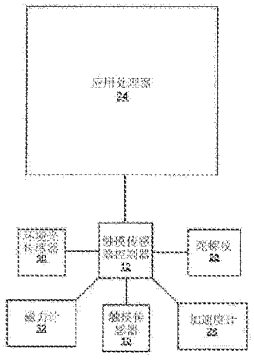
权利要求书3页 说明书10页 附图5页

(54)发明名称

触摸传感器控制器传感器集线器

(57)摘要

本申请案涉及触摸传感器控制器传感器集线器。在一个实施例中，一种方法包含控制装置的触摸传感器。所述触摸传感器的所述控制包含：由控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以确定是否已相对于所述触摸传感器发生触摸或接近输入。如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置。所述方法还包含控制所述装置的其它传感器。所述其它传感器的所述控制包含由所述控制器与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。



CN 103543874 A

1. 一种方法，其包括

由控制器来控制装置的触摸传感器，所述触摸传感器的所述控制包括：

由所述控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；

由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及

由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以：

确定是否已相对于所述触摸传感器发生触摸或接近输入；

如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置；及

由所述控制器来控制所述装置的一个或一个以上其它传感器，所述其它传感器的所述控制包括由所述控制器至少部分地与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。

2. 根据权利要求 1 所述的方法，其中所述预处理包括将一个或一个以上数字滤波器应用于所述触摸传感器信号。

3. 根据权利要求 1 所述的方法，其中所述其它传感器包括环境光传感器、磁力计、加速度计、陀螺仪或其组合。

4. 根据权利要求 1 所述的方法，其进一步包括至少部分地基于获取对应于一个或一个以上触摸或接近输入的触摸传感器信号来调整所述第一及第二处理循环中的每一者的持续时间。

5. 根据权利要求 4 所述的方法，其进一步包括基于所述第一、第二及第三处理循环的时间量来调整所述第四处理循环的持续时间。

6. 根据权利要求 1 所述的方法，其中所述第四处理循环包括：

从所述其它传感器获取传感器信号；及

处理来自所述其它传感器的所述传感器信号以至少部分地确定所述装置的环境的改变。

7. 根据权利要求 1 所述的方法，其中所述触摸传感器及所述其它传感器的所述控制大致使所述控制器的处理负载最大化。

8. 一种体现逻辑的计算机可读非暂时存储媒体，所述逻辑可操作以在执行时进行以下操作：

控制装置的触摸传感器，所述触摸传感器的所述控制包括：

由控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；

由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及

由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以：

确定是否已相对于所述触摸传感器发生触摸或接近输入；

如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置；及

控制所述装置的一个或一个以上其它传感器，所述其它传感器的所述控制包括由所述控制器至少部分地与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。

9. 根据权利要求 8 所述的媒体，其中所述逻辑进一步经配置以将一个或一个以上数字

EX1002 - Page 1139

滤波器应用于所述触摸传感器信号。

10. 根据权利要求 8 所述的媒体，其中所述其它传感器包括环境光传感器、磁力计、加速度计、陀螺仪或其组合。

11. 根据权利要求 8 所述的媒体，其中所述逻辑进一步经配置以至少部分地基于获取对应于一个或一个以上触摸或接近输入的触摸传感器信号来调整所述第一及第二处理循环中的每一者的持续时间。

12. 根据权利要求 11 所述的媒体，其中所述逻辑进一步经配置以基于所述第一、第二及第三处理循环的时间量来调整所述第四处理循环的持续时间。

13. 根据权利要求 8 所述的媒体，其中所述逻辑进一步经配置以：

从所述其它传感器获取传感器信号；及

处理来自所述其它传感器的所述传感器信号以至少部分地确定所述装置的环境的改变。

14. 根据权利要求 8 所述的媒体，其中所述触摸传感器及所述其它传感器的所述控制大致使所述控制器的处理负载最大化。

15. 一种装置，其包括：

控制器；

触摸传感器，其耦合到所述控制器；

一个或一个以上其它传感器，其耦合到所述控制器；及

体现逻辑的计算机可读非暂时存储媒体，所述逻辑可操作以在执行时进行以下操作：

控制所述装置的所述触摸传感器，所述触摸传感器的所述控制包括：

由所述控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；

由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及

由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以：

确定是否已相对于所述触摸传感器发生触摸或接近输入；及

如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置；及

控制所述装置的一个或一个以上其它传感器，所述其它传感器的所述控制包括由所述控制器至少部分地与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。

16. 根据权利要求 15 所述的装置，其中所述逻辑进一步经配置以将一个或一个以上数字滤波器应用于所述触摸传感器信号。

17. 根据权利要求 15 所述的装置，其中所述其它传感器包括环境光传感器、磁力计、加速度计、陀螺仪或其组合。

18. 根据权利要求 15 所述的装置，其中所述逻辑进一步经配置以至少部分地基于获取对应于一个或一个以上触摸或接近输入的触摸传感器信号来调整所述第一及第二处理循环中的每一者的持续时间。

19. 根据权利要求 18 所述的装置，其中所述逻辑进一步经配置以基于所述第一、第二及第三处理循环的时间量来调整所述第四处理循环的持续时间。

20. 根据权利要求 15 所述的装置，其中所述逻辑进一步经配置以：

从所述其它传感器获取传感器信号；及

处理来自所述其它传感器的所述传感器信号以至少部分地确定所述装置的环境的改变。

触摸传感器控制器传感器集线器

技术领域

[0001] 本发明一般来说涉及控制器。

背景技术

[0002] 举例来说，触摸传感器可在覆盖在显示器屏幕上的触摸传感器的触敏区域内检测物件（例如用户的手指或手写笔）的触摸或接近的存在及位置。在触敏显示器应用中，触摸传感器可使得用户能够与显示在屏幕上的内容直接交互作用而非借助鼠标或触摸垫间接交互作用。触摸传感器可附接到以下各项或作为以下各项的一部分而提供：桌上型计算机、膝上型计算机、平板计算机、个人数字助理 (PDA)、智能电话、卫星导航装置、便携式媒体播放器、便携式游戏控制台、信息亭计算机、销售点装置或其它适合装置。家用电器或其它电器上的控制面板可包含触摸传感器。

[0003] 存在若干种不同类型的触摸传感器，例如（举例来说）电阻性触摸屏、表面声波触摸屏及电容性触摸屏。本文中，在适当的情况下，对触摸传感器的提及可囊括触摸屏且反之亦然。当物件触摸或靠近到电容性触摸屏的表面时，可在触摸屏内所述触摸或接近的位置处发生电容的改变。触摸传感器控制器可处理所述电容的改变以确定其在触摸屏上的位置。

发明内容

[0004] 本申请案的一个方面用以提供一种方法，其包括：由控制器来控制装置的触摸传感器，所述触摸传感器的所述控制包括：由所述控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以：确定是否已相对于所述触摸传感器发生触摸或接近输入；如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置；及由所述控制器来控制所述装置的一个或一个以上其它传感器，所述其它传感器的所述控制包括由所述控制器至少部分地与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。

[0005] 本申请案的另一方面用以提供一种体现逻辑的计算机可读非暂时存储媒体，所述逻辑可操作以在执行时进行以下操作：控制装置的触摸传感器，所述触摸传感器的所述控制包括：由控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以：确定是否已相对于所述触摸传感器发生触摸或接近输入；如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置；及控制所述装置的一个或一个以上其它传感器，所述其它传感器的所述控制包括由所述控制器至少部分地与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。

EX1002 - Page 1142

[0006] 本申请案的又一方面用以提供一种装置，其包括：控制器；触摸传感器，其耦合到所述控制器；一个或一个以上其它传感器，其耦合到所述控制器；及体现逻辑的计算机可读非暂时存储媒体，所述逻辑可操作以在执行时进行以下操作：控制所述装置的所述触摸传感器，所述触摸传感器的所述控制包括：由所述控制器执行的第一处理循环，其包括从所述触摸传感器获取触摸传感器信号；由所述控制器执行的第二处理循环，其包括预处理所述触摸传感器信号；及由所述控制器执行的第三处理循环，其包括处理所述触摸传感器信号以：确定是否已相对于所述触摸传感器发生触摸或接近输入；及如果已相对于所述触摸传感器发生所述触摸或接近输入，那么确定所述触摸或接近输入的位置；及控制所述装置的一个或一个以上其它传感器，所述其它传感器的所述控制包括由所述控制器至少部分地与所述第一处理循环或所述第二处理循环同时执行的一个或一个以上第四处理循环。

附图说明

[0007] 图 1 图解说明实例触摸传感器控制器传感器集线器。

[0008] 图 2 图解说明实例触摸传感器控制器传感器集线器的实例时序图。

[0009] 图 3 图解说明用于控制传感器的实例方法。

[0010] 图 4 图解说明实例移动装置。

[0011] 图 5 图解说明具有实例触摸传感器控制器传感器集线器的实例触摸传感器。

[0012] 图 6 图解说明实例计算机系统。

具体实施方式

[0013] 图 1 图解说明实例基于触摸控制器的传感器集线器。在特定实施例中，装置可包含应用处理器 24、触摸传感器 10、触摸传感器控制器 12 及一个或一个以上其它传感器 26 到 32。应用处理器 24 为装置的主中央处理单元 (CPU) 且可执行装置的相对高百分比的数据处理。触摸传感器控制器 12 耦合到应用处理器 24 以及触摸传感器 10 及其它传感器 26 到 32。本文中，对其它传感器的提及囊括除触摸传感器以外的任何适合传感器，例如，惯性传感器，如下文所描述。在图 1 的实例中，触摸传感器控制器 12 可充当控制触摸传感器 10 及耦合到其的其它传感器 26 到 32 的传感器集线器。在特定实施例中，装置可包含检测或测量关于装置操作的环境的数据的一个或一个以上传感器 26 到 32。传感器 26 到 32 可检测及测量装置的环境的一个或一个以上特性，例如，加速度、移动、定向、接触、压力、力、振动、温度、湿度、接近或任何其它适合特性。作为一实例且不以限制方式，传感器 26 到 32 可包含加速度计 26、陀螺仪 28、环境光传感器 (ALS) 30 或磁力计 32 中的一者或一者以上。在特定实施例中，可机械地、电子地或电容性地实施传感器 26 到 32。虽然本发明描述及图解说明具有呈特定布置的特定数目个特定组件及传感器的特定装置，但本发明涵盖具有呈任何适合布置的任何适合数目个任何适合组件及传感器的任何适合装置。

[0014] 如下文所描述，触摸传感器控制器 12 经由由触摸传感器控制器 12 产生的且传输到触摸传感器 10 的特定信号而获取触摸传感器信号。触摸传感器控制器 12 接收并处理由触摸传感器 10 检测到的因所传输信号而产生的触摸传感器信号。在特定实施例中，触摸传感器控制器 12 可从其它传感器 26 到 32 获取或处理对应于装置的环境的改变的传感器信号。作为一实例且不以限制方式，触摸传感器控制器 12 可针对传感器信号周期性地轮询加

EX1002 - Page 1143

速度计 26 或陀螺仪 28 以确定是否已发生装置的移动。作为另一实例，触摸传感器控制器 12 可针对传感器信号轮询 ALS30 或磁力计 32 以确定是否已发生装置的环境的改变，例如，将装置移动到封闭区域或金属携带箱。在特定实施例中，触摸传感器控制器 12 可连续地控制每一传感器 26 到 32 或其任何并联组合。

[0015] 在特定实施例中，触摸传感器控制器 12 可响应于由一个或一个以上传感器 10 及 26 到 32 检测或测量的且由触摸传感器控制器 12 处理的数据而与应用处理器 24 通信。作为一实例且不以限制方式，触摸传感器控制器 12 可响应于高于指示装置的环境的改变的预定阈值的来自一个或一个以上其它传感器 26 到 32 的传感器信号而将信号传输到应用处理器 24。在特定实施例中，应用处理器 24 在不存在待处理的数据时可呈休眠模式。应用处理器 24 可响应于接收来自触摸传感器控制器 12 的信号而从休眠模式唤醒。在特定实施例中，应用处理器 24 可响应于所接收信号经由触摸传感器 12 与其它传感器 26 到 32 通信。在其它特定实施例中，应用处理器 24 可响应于来自触摸传感器控制器 12 的信号而起始将由装置执行的预定功能。作为一实例且不以限制方式，应用处理器 24 可响应于接收装置在封闭区域（例如，用户的口袋）中的信号而去激活装置的显示器。

[0016] 图 2 图解说明实例触摸传感器控制器传感器集线器的实例时序图。在图 2 的实例中，依据时间来图解说明触摸传感器控制器的处理负载。在特定实施例中，触摸传感器控制器可以三个处理循环 34 到 38 来控制触摸传感器。作为一实例且不以限制方式，第一处理循环 34 可从触摸传感器获取触摸传感器信号；第二处理循环 36 可预处理触摸传感器信号；及第三处理循环 38 可处理触摸传感器信号以确定是否已相对于触摸传感器发生触摸或接近输入。如果已发生触摸或接近输入，那么触摸传感器控制器可确定触摸或接近输入的位置。在特定实施例中，在第一处理循环 34 期间，触摸传感器控制器的处理器负载可为相对低的以用于获取触摸传感器信号，而在第三处理循环 38 期间，可大致将触摸传感器控制器的处理器负载最大化以用于处理触摸传感器信号。用于在第二处理循环 36 期间预处理触摸传感器信号的触摸传感器控制器的处理器负载可相对高于获取触摸传感器信号，但相对低于处理触摸传感器信号。

[0017] 在图 2 的实例中，可在由控制器与由触摸传感器控制器执行的第一处理循环 34 或第二处理循环 36 同时执行的第四处理循环 40 期间控制其它传感器。在特定实施例中，与控制触摸传感器同时地，触摸传感器控制器可控制一个或一个以上其它传感器。作为一实例且不以限制方式，在第四处理循环 40 期间，触摸传感器控制器可控制并处理来自一个或一个以上其它传感器（例如，加速度计、陀螺仪等）的信号以确定装置的环境的改变。虽然本发明描述及图解说明具有以特定顺序执行的特定数目个处理循环且每一处理循环具有特定功能的触摸传感器控制器的特定时序，但本发明涵盖具有以任何适合顺序执行的任何适合数目个处理循环且每一处理循环具有任何适合功能的触摸传感器控制器的任何适合时序。在特定实施例中，在控制触摸传感器及其它传感器期间，大致将触摸传感器控制器的处理器负载最大化。

[0018] 可至少部分地基于是否相对于触摸传感器发生一个或一个以上触摸或接近输入来调整处理循环 34 到 38 中的每一者的持续时间。作为一实例且不以限制方式，当触摸传感器的触敏区域内发生多个触摸或接近输入时，第三处理循环 38 的持续时间可增加。在特定实施例中，第四处理循环 40 的持续时间及在其期间执行的功能可至少部分地基于第一

EX1002 - Page 1144

处理循环 34 或第二处理循环 36 的持续时间。作为一实例且不以限制方式，对于相对长第一处理循环 34 或第二处理循环 36，可在第四处理循环 40 期间执行其它传感器的校准及来自其它传感器的传感器信号的获取。作为另一实例，对于相对短第一处理循环 34 或第二处理循环 36，可在第四处理循环 40 期间执行来自其它传感器的传感器信号的获取而不执行其它传感器的校准。在特定实施例中，可至少部分地基于第一处理循环 34、第二处理循环 36、第三处理循环 38 或其组合的持续时间按比例调整与其它传感器相关联的处理量。在其它特定实施例中，可至少部分地基于第四处理循环 40 的持续时间排定由其它传感器执行的功能的优先级。虽然本发明描述对其它传感器执行的特定功能，但本发明涵盖对其它传感器执行的任何适合功能。

[0019] 图 3 图解说明用于控制传感器的实例方法。方法可在步骤 100 处开始，其中由控制器控制装置的触摸传感器。在特定实施例中，由控制器执行的第一处理循环包含从触摸传感器获取触摸传感器信号；第二处理循环包含预处理触摸传感器信号，及第三处理循环包含处理触摸传感器信号以确定是否已相对于触摸传感器发生触摸或接近输入。在特定实施例中，如果已相对于触摸传感器发生触摸或接近输入，那么可确定触摸或接近输入的位置。在步骤 102 处，由控制器控制装置的一个或一个以上其它传感器，在此点处，所述方法可结束。在特定实施例中，由控制器与第一处理循环或第二处理循环同时执行的第四处理循环包含控制其它传感器。控制其它传感器可包含获取并处理来自其它传感器的信号。虽然本发明将图 3 的方法的特定步骤描述及图解说明为以特定次序发生，但本发明涵盖以任何适合次序发生的图 3 的方法的任何适合步骤。此外，虽然本发明描述及图解说明实施图 3 的方法的特定步骤的特定组件，但本发明涵盖实施图 3 的方法的任何适合步骤的任何适合组件的任何适合组合。

[0020] 图 4 图解说明具有图 1 的实例触摸传感器控制器传感器集线器及触摸传感器的实例装置。作为一实例且不以限制方式，实例装置 20 可包含智能电话、个人数字助理 (PDA)、平板计算机、膝上型计算机、桌上型计算机、信息亭计算机、卫星导航装置、便携式媒体播放器、便携式游戏控制台、销售点装置、游戏控制器、遥控器、另一适合装置、这些装置中的两者或两者以上的适合组合或这些装置中的一者或一者以上的适合部分。实例装置 20 可包含下文所描述的触摸传感器，所述触摸传感器具有接近于装置 20 的表面的触敏区域 22 及触摸传感器控制器传感器集线器。如上文所描述，触摸传感器控制器传感器集线器可处理测量信号以在触敏区域 22 内检测一个或一个以上触摸或接近输入的存在及位置。在特定实施例中，实例装置 20 可为计算系统，如下文所描述。

[0021] 图 5 图解说明具有实例触摸传感器控制器的实例触摸传感器。触摸传感器 10 及触摸传感器控制器 12 可在触摸传感器 10 的触敏区域内检测物件的触摸或接近的存在及位置。本文中，在适当的情况下，对触摸传感器的提及可囊括触摸传感器及其触摸传感器控制器两者。类似地，在适当的情况下，对触摸传感器控制器的提及可囊括触摸传感器控制器及其触摸传感器两者。在适当的情况下，触摸传感器 10 可包含一个或一个以上触敏区域。触摸传感器 10 可包含安置于可由电介质材料制成的一个或一个以上衬底上的驱动与感测电极的阵列（或单个类型的电极的阵列）。本文中，在适当的情况下，对触摸传感器的提及可囊括触摸传感器的电极及所述电极所安置于其上的衬底两者。或者，在适当的情况下，对触摸传感器的提及可囊括触摸传感器的电极但不囊括所述电极所安置于其上的衬底。

EX1002 - Page 1145

[0022] 电极（无论是接地电极、保护电极、驱动电极还是感测电极）可为形成一形状（例如碟形、正方形、矩形、细线形、其它适合形状或这些形状的适合组合）的导电材料区域。一个或一个以上导电材料层中的一个或一个以上切口可（至少部分地）形成电极的形状，且所述形状的区域可（至少部分地）由那些切口定边界。在特定实施例中，电极的导电材料可占据其形状的区域的约100%。作为一实例且不以限制方式，在适当的情况下，电极可由氧化铟锡（ITO）制成，且所述电极的ITO可占据其形状的区域的约100%（有时称为100%填充物）。在特定实施例中，电极的导电材料可大致占据小于其形状的区域的100%。作为一实例且不以限制方式，电极可由金属细线（FLM）或其它导电材料（例如铜、银或者基于铜或基于银的材料）细线制成，且导电材料细线可以阴影线、网格或其它适合图案占据其形状的区域的约5%。本文中，在适当的情况下，对FLM的提及囊括此材料。虽然本发明描述或图解说明由形成具有特定填充物百分比（具有特定图案）的特定形状的特定导电材料制成的特定电极，但本发明涵盖由形成具有任何适合填充物百分比（具有任何适合图案）的任何适合形状的任何适合导电材料制成的任何适合电极。

[0023] 在适当的情况下，触摸传感器的电极（或其它元件）的形状可全部地或部分地构成所述触摸传感器的一个或一个以上大型特征。那些形状的实施方案的一个或一个以上特性（例如，所述形状内的导电材料、填充物或图案）可全部地或部分地构成所述触摸传感器的一个或一个以上小型特征。触摸传感器的一个或一个以上大型特征可确定其功能性的一个或一个以上特性，且触摸传感器的一个或一个以上小型特征可确定触摸传感器的一个或一个以上光学特征，例如透射比、折射性或反射性。

[0024] 机械堆叠可含有衬底（或多个衬底）及形成触摸传感器10的驱动或感测电极的导电材料。作为一实例且不以限制方式，所述机械堆叠包含在覆盖面板下方的第一光学透明粘合剂（OCA）层。所述覆盖面板可为透明的且由适合于重复的触摸的弹性材料（例如玻璃、聚碳酸酯或聚（甲基丙烯酸甲酯）(PMMA)）制成。本发明涵盖由任何适合材料制成的任何适合覆盖面板。第一OCA层可安置于覆盖面板与具有形成驱动或感测电极的导电材料的衬底之间。所述机械堆叠还可包含第二OCA层及电介质层（其可由PET或另一适合材料制成，类似于具有形成驱动或感测电极的导电材料的衬底）。作为替代方案，在适当的情况下，可代替第二OCA层及电介质层而施加电介质材料的薄涂层。第二OCA层可安置于具有构成驱动或感测电极的导电材料的衬底与电介质层之间，且所述电介质层可安置于第二OCA层与到包含触摸传感器10及触摸传感器控制器12的装置的显示器的气隙之间。仅作为一实例且不以限制方式，所述覆盖面板可具有约1mm的厚度；第一OCA层可具有约0.05mm的厚度；具有形成驱动或感测电极的导电材料的衬底可具有约0.05mm的厚度；第二OCA层可具有约0.05mm的厚度；且所述电介质层可具有约0.05mm的厚度。虽然本发明描述具有由特定材料制成且具有特定厚度的特定数目个特定层的特定机械堆叠，但本发明涵盖具有由任何适合材料制成且具有任何适合厚度的任何适合数目个任何适合层的任何适合机械堆叠。作为一实例且不以限制方式，在特定实施例中，粘合剂或电介质层可替换上文所描述的电介质层、第二OCA层及气隙，其中不存在到显示器的气隙。

[0025] 触摸传感器10的衬底的一个或一个以上部分可由聚对苯二甲酸乙二酯（PET）或另一适合材料制成。本发明涵盖具有由任何适合材料制成的任何适合部分的任何适合衬底。在特定实施例中，触摸传感器10中的驱动或感测电极可全部地或部分地由ITO制成。

EX1002 - Page 1146

在特定实施例中，触摸传感器 10 中的驱动或感测电极可由金属或其它导电材料细线制成。作为一实例且不以限制方式，所述导电材料的一个或一个以上部分可为铜或基于铜的且具有约 5 μm 或小于 5 μm 的厚度及约 10 μm 或小于 10 μm 的宽度。作为另一实例，所述导电材料的一个或一个以上部分可为银或基于银的且类似地具有约 5 μm 或小于 5 μm 的厚度及约 10 μm 或小于 10 μm 的宽度。本发明涵盖由任何适合材料制成的任何适合电极。

[0026] 触摸传感器 10 可实施电容性形式的触摸感测。在互电容实施方案中，触摸传感器 10 可包含形成电容性节点阵列的驱动与感测电极阵列。驱动电极与感测电极可形成电容性节点。形成电容性节点的驱动与感测电极可彼此靠近但并不彼此进行电接触。而是，所述驱动与感测电极可跨越其之间的间隔而彼此电容性地耦合。（通过触摸传感器控制器 12）向驱动电极施加的脉冲或交变电压可在感测电极上诱发电荷，且所诱发的电荷量可易受外部影响（例如物件的触摸或接近）。当物件触摸或靠近到电容性节点时，可在电容性节点处发生电容改变，且触摸传感器控制器 12 可测量所述电容改变。通过测量整个阵列中的电容改变，触摸传感器控制器 12 可在触摸传感器 10 的触敏区域内确定所述触摸或接近的位置。

[0027] 在自电容实施方案中，触摸传感器 10 可包含可各自形成电容性节点的单个类型的电极的阵列。当物件触摸或靠近到电容性节点时，可在所述电容性节点处发生自电容改变，且触摸传感器控制器 12 可将所述电容改变测量为（举例来说）将所述电容性节点处的电压提升预定量所需的电荷量改变。与互电容实施方案一样，通过测量整个阵列中的电容改变，触摸传感器控制器 12 可在触摸传感器 10 的触敏区域内确定所述触摸或接近的位置。在适当的情况下，本发明涵盖任何适合形式的电容性触摸感测。

[0028] 在特定实施例中，一个或一个以上驱动电极可共同形成水平地或垂直地或以任何适合定向延续的驱动线。类似地，一个或一个以上感测电极可共同形成水平地或垂直地或以任何适合定向延续的感测线。在特定实施例中，驱动线可大致垂直于感测线而延续。本文中，在适当的情况下，对驱动线的提及可囊括构成所述驱动线的一个或一个以上驱动电极，且反之亦然。类似地，在适当的情况下，对感测线的提及可囊括构成所述感测线的一个或一个以上感测电极，且反之亦然。

[0029] 触摸传感器 10 可使驱动与感测电极以一图案安置于单个衬底的一侧上。在此配置中，跨越一对驱动与感测电极之间的空间而彼此电容性耦合的所述对驱动与感测电极可形成电容性节点。对于自电容实施方案，仅单个类型的电极可以一图案安置于单个衬底上。除使驱动与感测电极以一图案安置于单个衬底的一侧上以外或作为此情形的替代方案，触摸传感器 10 还可使驱动电极以一图案安置于衬底的一侧上且使感测电极以一图案安置于所述衬底的另一侧上。此外，触摸传感器 10 可使驱动电极以一图案安置于一个衬底的一侧上且使感测电极以一图案安置于另一衬底的一侧上。在此些配置中，驱动电极与感测电极的相交点可形成电容性节点。此相交点可为其中驱动电极与感测电极在其相应平面中“交叉”或彼此最靠近的位置。驱动与感测电极并不彼此进行电接触—而是其跨越电介质在相交点处彼此电容性地耦合。虽然本发明描述形成特定节点的特定电极的特定配置，但本发明涵盖形成任何适合节点的任何适合电极的任何适合配置。此外，本发明涵盖以任何适合图案安置于任何适合数目个任何适合衬底上的任何适合电极。

[0030] 如上文所描述，触摸传感器 10 的电容性节点处的电容改变可指示所述电容性节点的位置处的触摸或接近输入。触摸传感器控制器 12 可检测并处理所述电容改变以确定

EX1002 - Page 1147

触摸或接近输入的存在及位置。触摸传感器控制器 12 可接着将关于触摸或接近输入的信息传递到包含触摸传感器 10 及触摸传感器控制器 12 的装置的一个或一个以上其它组件（例如一个或一个以上中央处理单元 (CPU)），所述一个或一个以上其它组件可通过起始所述装置的功能（或在所述装置上运行的应用程序）来对所述触摸或接近输入做出响应。虽然本发明描述关于特定装置及特定触摸传感器具有特定功能性的特定触摸传感器控制器，但本发明涵盖关于任何适合装置及任何适合触摸传感器具有任何适合功能性的任何适合触摸传感器控制器。

[0031] 触摸传感器控制器 12 可为一个或一个以上集成电路 (IC)，例如通用微处理器、微控制器、可编程逻辑装置或阵列、专用 IC(ASIC)。在特定实施例中，触摸传感器控制器 12 包括模拟电路、数字逻辑及数字非易失性存储器。在特定实施例中，触摸传感器控制器 12 安置于接合到触摸传感器 10 的衬底的柔性印刷电路 (FPC) 上，如下文所描述。在适当的情况下，所述 FPC 可为有源或无源的。在特定实施例中，多个触摸传感器控制器 12 安置于所述 FPC 上。触摸传感器控制器 12 可包含处理器单元、驱动单元、感测单元及存储单元。所述驱动单元可向触摸传感器 10 的驱动电极供应驱动信号。所述感测单元可感测触摸传感器 10 的电容性节点处的电荷并将表示所述电容性节点处的电容的测量信号提供到处理器单元。所述处理器单元可控制由驱动单元向驱动电极的驱动信号供应并处理来自感测单元的测量信号以检测且处理触摸传感器 10 的触敏区域内的触摸或接近输入的存在及位置。所述处理器单元还可追踪触摸传感器 10 的触敏区域内的触摸或接近输入的位置改变。所述存储单元可存储用于由处理器单元执行的编程，包含用于控制驱动单元以向驱动电极供应驱动信号的编程、用于处理来自感测单元的测量信号的编程及在适当的情况下其它适合编程。虽然本发明描述具有拥有特定组件的特定实施方案的特定触摸传感器控制器，但本发明涵盖具有拥有任何适合组件的任何适合实施方案的任何适合触摸传感器控制器。

[0032] 安置于触摸传感器 10 的衬底上的导电材料迹线 14 可将触摸传感器 10 的驱动或感测电极耦合到也安置于触摸传感器 10 的衬底上的连接垫 16。如下文所描述，连接垫 16 促进将迹线 14 耦合到触摸传感器控制器 12。迹线 14 可延伸到触摸传感器 10 的触敏区域中或围绕触摸传感器 10 的触敏区域（例如，在其边缘处）延伸。特定迹线 14 可提供用于将触摸传感器控制器 12 耦合到触摸传感器 10 的驱动电极的驱动连接，触摸传感器控制器 12 的驱动单元可经由所述驱动连接向所述驱动电极供应驱动信号。其它迹线 14 可提供用于将触摸传感器控制器 12 耦合到触摸传感器 10 的感测电极的感测连接，触摸传感器控制器 12 的感测单元可经由所述感测连接感测触摸传感器 10 的电容性节点处的电荷。迹线 14 可由金属或其它导电材料细线制成。作为一实例且不以限制方式，迹线 14 的导电材料可为铜或基于铜的且具有约 100 μm 或小于 100 μm 的宽度。作为另一实例，迹线 14 的导电材料可为银或基于银的且具有约 100 μm 或小于 100 μm 的宽度。在特定实施例中，除金属或其它导电材料细线以外或者作为金属或其它导电材料细线的替代方案，迹线 14 还可全部地或部分地由 ITO 制成。虽然本发明描述由具有特定宽度的特定材料制成的特定迹线，但本发明涵盖由具有任何适合宽度的任何适合材料制成的任何适合迹线。除迹线 14 以外，触摸传感器 10 还可包含端接于触摸传感器 10 的衬底的边缘处的接地连接器（其可为连接垫 16）处的一个或一个以上接地线（类似于迹线 14）。

[0033] 连接垫 16 可沿着衬底的一个或一个以上边缘定位在触摸传感器 10 的触敏区域外

EX1002 - Page 1148

部。如上文所描述，触摸传感器控制器 12 可在 FPC 上。连接垫 16 可由与迹线 14 相同的材料制成且可使用各向异性导电膜 (ACF) 接合到所述 FPC。连接 18 可包含 FPC 上的将触摸传感器控制器 12 耦合到连接垫 16，又将触摸传感器控制器 12 耦合到迹线 14 及触摸传感器 10 的驱动或感测电极的导电线。在另一实施例中，连接垫 16 可连接到机电连接器（例如零插入力线到板连接器）；在此实施例中，连接 18 可不必包含 FPC。本发明涵盖触摸传感器控制器 12 与触摸传感器 10 之间的任何适合连接 18。

[0034] 图 6 图解说明实例计算机系统。在特定实施例中，一个或一个以上计算机系统 50 执行本文中所描述或所图解说明的一个或一个以上方法的一个或一个以上步骤。在特定实施例中，一个或一个以上计算机系统 50 提供本文中所描述或所图解说明的功能性。在特定实施例中，在一个或一个以上计算机系统 50 上运行的软件执行本文中所描述或所图解说明的一个或一个以上方法的一个或一个以上步骤或提供本文中所描述或所图解说明的功能性。特定实施例包含一个或一个以上计算机系统 50 的一个或一个以上部分。

[0035] 本发明涵盖任何适合数目个计算机系统 50。本发明涵盖采取任何适合物理形式的计算机系统 50。作为实例且不以限制方式，计算机系统 50 可为嵌入式计算机系统、单芯片系统 (SOC)、单板计算机系统 (SBC)（例如，计算机模块 (COM) 或系统模块 (SOM)）、桌上型计算机系统、膝上型或笔记型计算机系统、交互式信息亭、大型计算机、计算机系统的网格、移动电话、个人数字助理 (PDA)、服务器、平板计算机系统或这些系统中的两者或两者以上的组合。在适当的情况下，计算机系统 50 可包含一个或一个以上计算机系统 50；为单一式或分散式；跨越多个位置；跨越多个机器；跨越多个数据中心；或存在于云中，所述云可包含一个或一个以上网络中的一个或一个以上云组件。在适当的情况下，一个或一个以上计算机系统 50 可在无实质空间或时间限制的情况下执行本文中所描述或所图解说明的一个或一个以上方法的一个或一个以上步骤。作为一实例且不以限制方式，一个或一个以上计算机系统 50 可即时或以批处理模式执行本文中所描述或所图解说明的一个或一个以上方法的一个或一个以上步骤。在适当的情况下，一个或一个以上计算机系统 50 可在不同时间或在不同位置处执行本文中所描述或所图解说明的一个或一个以上方法的一个或一个以上步骤。

[0036] 在特定实施例中，计算机系统 50 包含处理器 52、存储器 54、存储装置 56、输入 / 输出 (I/O) 接口 58、通信接口 60 及总线 62。在特定实施例中，处理器 52 可为图 1 中所图解说明的应用处理器。虽然本发明描述及图解说明具有呈特定布置的特定数目个特定组件的特定计算机系统，但本发明涵盖具有呈任何适合布置的任何适合数目个任何适合组件的任何适合计算机系统。

[0037] 在特定实施例中，处理器 52 包含用于执行指令（例如，构成计算机程序的那些指令）的硬件。作为一实例且不以限制方式，为执行指令，处理器 52 可从内部寄存器、内部高速缓冲存储器、存储器 54 或存储装置 56 检索（或提取）指令；解码并执行所述指令，且接着将一个或一个以上结果写入到内部寄存器、内部高速缓冲存储器、存储器 54 或存储装置 56。在特定实施例中，处理器 52 可包含用于数据、指令或地址的一个或一个以上内部高速缓冲存储器。虽然本发明描述及图解说明特定处理器，但本发明涵盖任何适合处理器。

[0038] 在特定实施例中，存储器 54 包含用于存储用于处理器 52 执行的指令或用于处理器 52 对其进行操作的数据的主存储器。作为一实例且不以限制方式，计算机系统 50 可将

EX1002 - Page 1149

指令从存储装置 56 或另一源（例如，另一计算机系统 50）加载到存储器 54。处理器 52 可接着将所述指令从存储器 54 加载到内部寄存器或内部高速缓冲存储器。为执行所述指令，处理器 52 可从内部寄存器或内部高速缓冲存储器检索所述指令并解码所述指令。在执行所述指令期间或之后，处理器 52 可将一个或一个以上结果（其可为中间或最终结果）写入到内部寄存器或内部高速缓冲存储器。处理器 52 可接着将那些结果中的一者或一者以上写入到存储器 54。在特定实施例中，处理器 52 仅执行一个或一个以上内部寄存器或内部高速缓冲存储器中或者存储器 54（而非存储装置 56 或其它地方）中的指令且仅对一个或一个以上内部寄存器或内部高速缓冲存储器中或者存储器 54（而非存储装置 56 或其它地方）中的数据进行操作。一个或一个以上存储器总线（其可各自包含地址总线及数据总线）可将处理器 52 耦合到存储器 54。总线 62 可包含一个或一个以上存储器总线，如下文所描述。在特定实施例中，一个或一个以上存储器管理单元 (MMU) 存在于处理器 52 与存储器 54 之间且促进由处理器 52 请求的对存储器 54 的存取。虽然本发明描述及图解说明特定存储器，但本发明涵盖任何适合存储器。

[0039] 在特定实施例中，存储装置 56 包含用于数据或指令的大容量存储装置。在适当的情况下，存储装置 56 可包含可装卸或不可装卸（即，固定）媒体。在适当的情况下，存储装置 56 可在计算机系统 50 的内部或外部。在特定实施例中，存储装置 56 为非易失性固态存储器。在适当的情况下，存储装置 56 可包含一个或一个以上存储装置 56。虽然本发明描述及图解说明特定存储装置，但本发明涵盖任何适合存储装置。

[0040] 在特定实施例中，I/O 接口 58 包含提供用于在计算机系统 50 与一个或一个以上 I/O 装置之间通信的一个或一个以上接口的硬件、软件或两者。在适当的情况下，计算机系统 50 可包含这些 I/O 装置中的一者或一者以上。这些 I/O 装置中的一者或一者以上可实现人与计算机系统 50 之间的通信。作为一实例且不以限制方式，I/O 装置可包含键盘、小键盘、话筒、监视器、鼠标、打印机、扫描器、扬声器、静态相机、手写笔、输入板、触摸屏、轨迹球、摄像机、另一适合 I/O 装置或这些装置中的两者或两者以上的组合。I/O 装置可包含一个或一个以上传感器。本发明涵盖任何适合 I/O 装置及用于其的任何适合 I/O 接口 58。在适当的情况下，I/O 接口 58 可包含使得处理器 52 能够驱动这些 I/O 装置中的一者或一者以上的一个或一个以上装置或软件驱动器。在适当的情况下，I/O 接口 58 可包含一个或一个以上 I/O 接口 58。虽然本发明描述及图解说明特定 I/O 接口，但本发明涵盖任何适合 I/O 接口。

[0041] 在特定实施例中，通信接口 60 包含提供用于在计算机系统 50 与一个或一个以上其它计算机系统 50 或一个或一个以上网络之间通信（例如，基于数据包的通信）的一个或一个以上接口的硬件、软件或两者。作为一实例且不以限制方式，通信接口 60 可包含用于与以太网或其它基于导线的网络通信的网络接口控制器 (NIC) 或网络适配器或者用于与无线网络（例如，WI-FI 网络）通信的无线 NIC(WNIC) 或无线适配器。本发明涵盖任何适合网络及用于其的任何适合通信接口 60。虽然本发明描述及图解说明特定通信接口，但本发明涵盖任何适合通信接口。

[0042] 在特定实施例中，总线 62 包含将计算机系统 50 的组件彼此耦合的硬件、软件或两者。虽然本发明描述及图解说明特定总线，但本发明涵盖任何适合总线或互连。

[0043] 本文中，在适当的情况下，一计算机可读非暂时存储媒体或多个计算机可读非暂

EX1002 - Page 1150

时存储媒体可包含一个或一个以上基于半导体的集成电路 (IC) 或其它集成电路 (IC)(例如,现场可编程门阵列 (FPGA) 或专用 IC(ASIC))、硬磁盘驱动器 (HDD)、混合硬盘驱动器 (HHD)、光盘、光盘驱动器 (ODD)、磁光盘、磁光驱动器、软盘、软盘驱动器 (FDD)、磁带、固态驱动器 (SSD)、RAM 驱动器、安全数字卡或驱动器、任何其它适合计算机可读非暂时存储媒体或这些媒体中的两者或两者以上的任何适合组合。计算机可读非暂时存储媒体可为易失性、非易失性或在适当的情况下易失性与非易失性的组合。

[0044] 本文中,"或"为包含性而非互斥性,除非上下文另有明确指示或另有指示。因此,本文中,"A 或 B"意指"A、B 或两者",除非上下文另有明确指示或另有指示。此外,"及"既为联合的又为各自的,除非上下文另有明确指示或另有指示。因此,本文中,"A 及 B"意指"A 及 B,联合地或各自地",除非上下文另有明确指示或另有指示。

[0045] 本发明囊括所属领域的技术人员将理解的对本文中的实例实施例的所有改变、替代、变化、更改及修改。此外,虽然本发明将本文中的相应实施例描述及图解说明为包含特定组件、元件、功能、操作或步骤,但这些实施例中的任一者可包含所属领域的技术人员将理解的本文中任何地方所描述或所图解说明的组件、元件、功能、操作或步骤的任何组合或其中的任一者的置换。此外,在所附权利要求书中对经调适以、经布置以、能够、经配置以、经启用以、可操作以或操作以执行特定功能的设备或系统或者设备或系统的组件的提及囊括所述设备、系统、组件,不论其或所述特定功能是否被激活、接通或解除锁定,只要所述设备、系统或组件经如此调适、经如此布置、能够如此、经如此配置、经如此启用、可如此操作或如此操作即可。

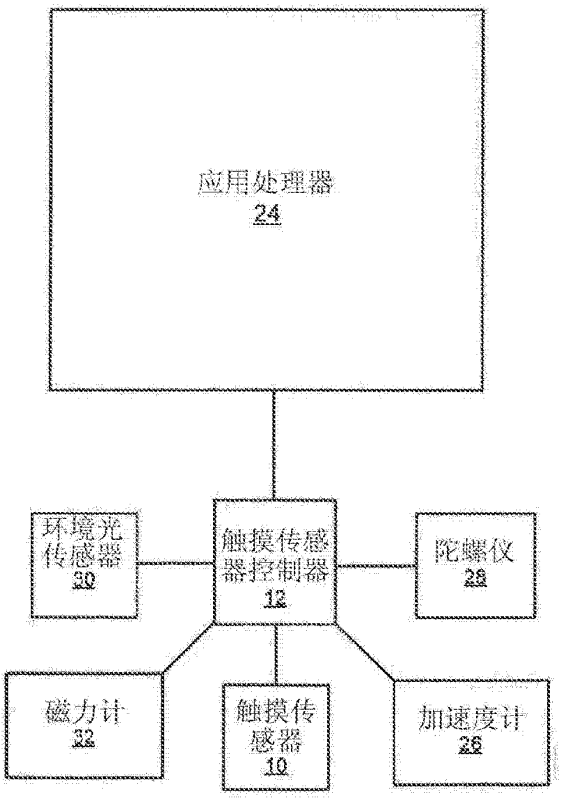


图 1

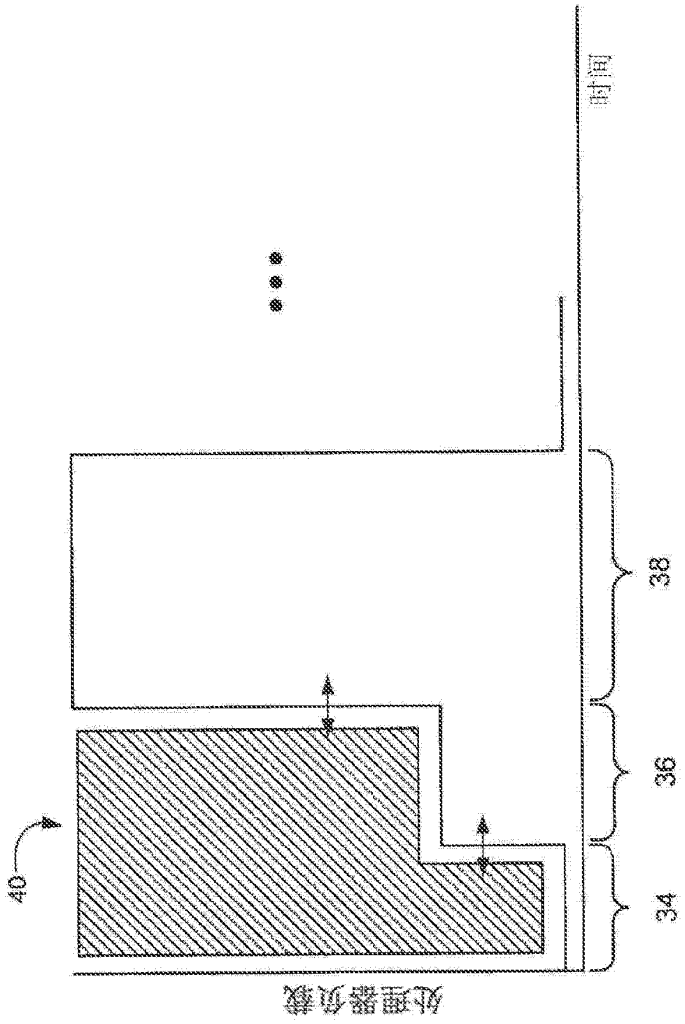


图 2

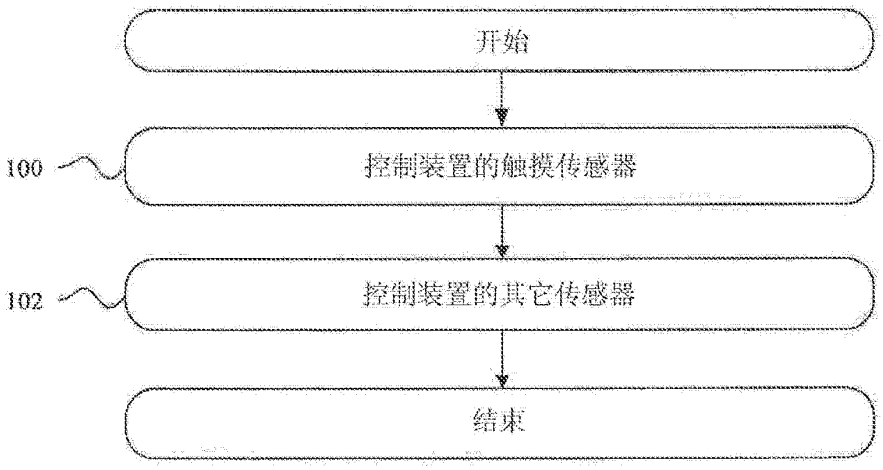


图 3

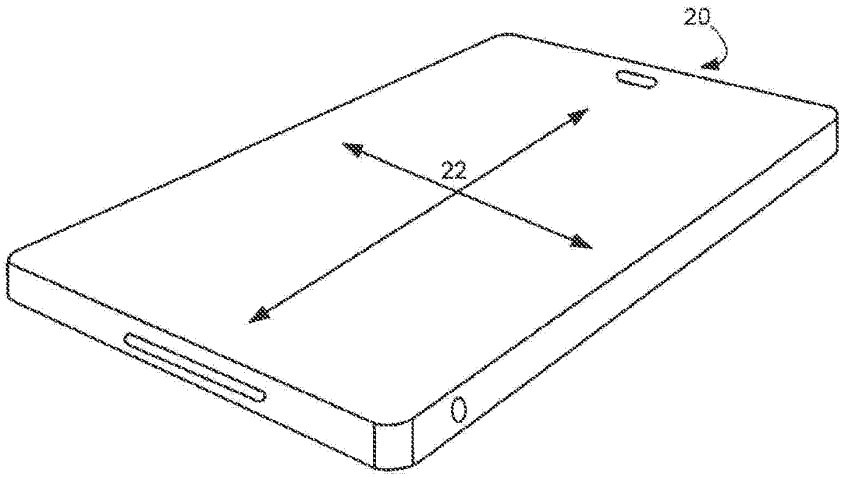


图 4

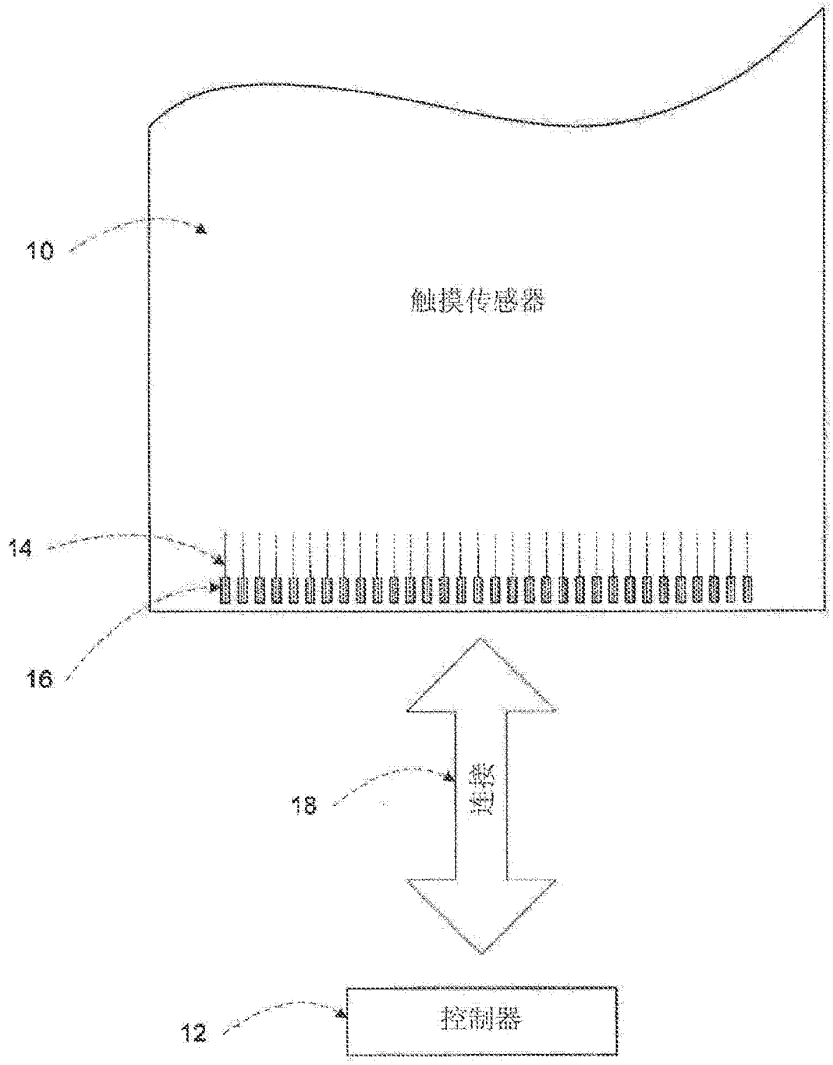


图 5

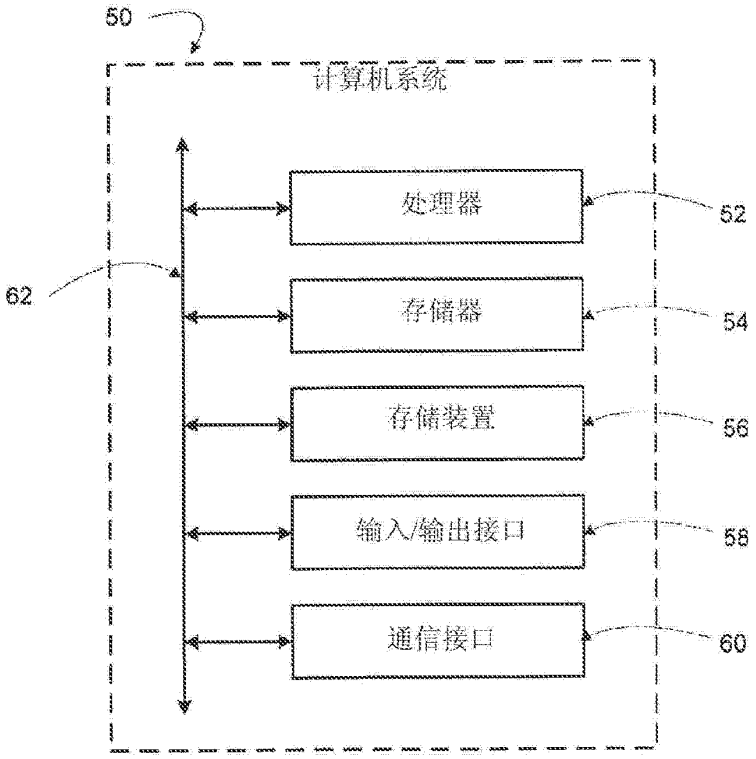


图 6

Espacenet

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Electronic touch communication

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Abstract of CN105388966 (A)

Touch inputs such as single-finger contacts and multiple-finger contacts are detected at an electronic device and translated into electronic touch communications for playback at an external electronic device.

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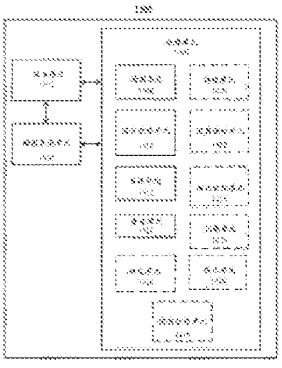
权利要求书7页 说明书57页 附图51页

(54)发明名称

电子触摸通信

(57)摘要

本公开涉及电子触摸通信。诸如单指接触和多指接触的触摸输入在电子设备处被检测，并且被转换成用于在外部电子设备处回放的电子触摸通信。



CN 105388966 A

1. 一种电子设备，包括：

显示器单元，被配置为显示图形用户界面；

触敏表面单元，被配置为接收接触；以及

耦合至所述显示器单元和所述触敏表面单元的处理单元，所述处理单元被配置为：

检测用户输入并且响应于检测所述用户输入，使能表示联系人的多个可供件的显示；

检测对所显示的表示联系人的可供件的用户选择；

响应于检测对所显示的可供件的用户选择，用标识被选定联系人的联系人信息的显示替代所述多个可供件的显示，所述被选定联系人由所选定的可供件表示；

在显示所述联系人信息的同时，检测触敏显示器上的触摸；

响应于检测所述触摸：使能绘图区域的显示，其中所述绘图区域响应于触摸输入；

检测所述绘图区域中表示第一笔画的第一触摸输入；

使能在所述绘图区域中的所述第一笔画的可视表示的显示；以及

向与所述被选定联系人相关联的外部设备发送表示所述第一笔画的数据。

2. 根据权利要求 1 所述的电子设备，其中所述处理单元进一步被配置为：

确定在所述第一触摸输入之后是否已经经过第一预定持续时间，以及

其中发送表示所述第一笔画的数据包括：响应于确定已经经过所述第一预定持续时间而发送所述数据。

3. 根据权利要求 2 所述的电子设备，其中所述处理单元进一步被配置为：

在已经经过所述第一预定持续之前，检测屏幕上绘图区域中表示第二笔画的第二触摸输入，其中所述第一笔画和第二笔画由中介时间量分开；以及

向与所述第二笔画和所述中介时间量相关联的所述外部设备发送数据。

4. 根据权利要求 1 所述的电子设备，

其中所述第一笔画具有特性运动学，以及

其中发送表示所述第一笔画的数据包括：向所述外部设备发送指示所述特性运动学的数据。

5. 根据权利要求 1 所述的电子设备，其中所述处理单元被进一步配置为：

在所述第一笔画已经被接收持续第二预定持续时间之后使能所显示的所述第一笔画的可视表示的淡出。

6. 根据权利要求 1 所述的电子设备，其中发送所述数据触发所述外部设备以：

显示接收所述数据的指示，以及

显示可供件，其中所述可供件在被选定时使得所述外部设备显示所述第一笔画的可视表示。

7. 根据权利要求 1 所述的电子设备，其中发送所述数据触发所述外部设备以显示所述第一笔画的可视表示。

8. 根据权利要求 3 所述的电子设备，其中发送所述数据触发所述外部设备以显示所述第一笔画的可视表示，随后暂停所述中介时间量，并且随后显示所述第二笔画的可视表示。

9. 根据权利要求 4 所述的电子设备，其中发送所述数据触发所述外部设备以显示具有所述特性运动学的所述第一笔画的可视表示。

10. 根据权利要求 6 所述的电子设备，其中所述处理单元进一步被配置为：

在确定所述可视表示已经被显示持续第三预定持续时间之后使能笔画的所述可视表示的淡出。

11. 根据权利要求 1 所述的电子设备，其中所述处理单元进一步被配置为：

从所述外部设备接收数据，所述数据表示由所述外部设备检测的第三触摸输入，所述第三触摸输入表示第三笔画；

在所述电子设备的所述绘图区域中使能所述第三笔画的可视表示的显示。

12. 根据权利要求 11 所述的电子设备，其中所述处理单元进一步被配置为：

在第四预定持续时间之后使能所述第三笔画的所述可视表示的淡出。

13. 根据权利要求 3 所述的电子设备，其中所述第二预定持续时间、所述第三预定持续时间和所述第四预定持续时间是相同的持续时间。

14. 根据权利要求 5 所述的电子设备，

其中笔画具有开始和结束，以及

其中淡出笔画的所述可视表示包括：在淡出对应的所述可视表示的结束之前淡出对应的所述可视表示的开始。

15. 根据权利要求 1 所述的电子设备，其中所述处理单元进一步被配置为：

在所述绘图区域中使能颜色拾取器可供件的显示，其中所述颜色拾取器可供件具有指示当前选定颜色的颜色，

其中显示所述第一笔画的所述可视表示包括：以所述当前选定颜色显示所述可视表示；以及

响应于检测对所述颜色拾取器可供件的选择，使能表示颜色的多个颜色可供件的显示。

16. 根据权利要求 15 所述的电子设备，其中所述多个颜色可供件包括表示先前选定颜色的可供件。

17. 根据权利要求 15 所述的电子设备，其中所述处理单元进一步被配置为：

响应于检测对所显示的多个颜色可供件的颜色拾取器可供件的选择，使能调色板的显示。

18. 根据权利要求 17 所述的电子设备，其中所述调色板包括具有不同颜色的多个部分，所述处理单元进一步被配置为：

响应于检测对所述调色板中的对应于选定颜色的部分的选择；

使能所述绘图区域的显示；以及

使能所述绘图区域中显示的所述颜色拾取器可供件的更新，使得所述颜色拾取器可供件被显示有所述选定颜色。

19. 根据权利要求 18 所述的电子设备，其中为了向所述外部设备发送表示所述第一笔画的数据，所述处理单元进一步被配置为发送表示所述选定颜色的数据。

20. 根据权利要求 1 所述的电子设备，其中所述电子设备包括可旋转输入机构，所述处理单元进一步被配置为：

在使能表示联系人的所述多个可供件的显示时，检测表示所述可旋转输入机构的移动的用户输入；以及

响应于检测所述用户输入：使能多个用户指定联系人的显示的缩放，其中缩放所述显

示包括改变正被显示的联系人的大小。

21. 根据权利要求 20 所述的电子设备，其中使能所述显示的缩放包括使能正被显示的联系人的数量的改变。

22. 根据权利要求 1 所述的电子设备，其中所述触敏显示器包括一个或多个传感器以检测所述触敏显示器上的触摸的强度，所述处理单元进一步被配置为：

在使能所述绘图区域的显示时，检测所述触敏显示器上的触摸，其中所述触摸具有特性强度；

确定所述特性强度是否超过预定阈值强度；

响应于所述特性强度超过所述预定阈值强度的确定：

使能呼叫可供件的显示，其中所述呼叫可供件在被选择时使得所述处理单元发起对与所述联系人相关联的所述外部设备的呼叫；以及

响应于所述特性强度没有超过所述预定阈值强度的确定，向所述外部设备发送表示所述触摸的数据。

23. 根据权利要求 1 所述的电子设备，其中所述触敏显示器包括一个或多个传感器以检测所述触敏显示器上触摸的强度，所述处理单元进一步被配置为：

在使能所述绘图区域的显示时，检测所述触敏显示器上的触摸，其中所述触摸具有特性强度；

确定所述特性强度是否超过预定阈值强度；

响应于所述特性强度超过所述预定阈值强度的确定：

使能文本可供件的显示，其中所述文本可供件在被选择时使得所述处理器发起被寻址到与所述联系人相关联的所述外部设备的消息；以及

响应于所述特性强度没有超过所述预定阈值强度的确定，向所述外部设备发送表示所述触摸的数据。

24. 根据权利要求 1 所述的电子设备，其中所述处理单元进一步被配置为：

在使能标识所述被选定联系人的联系人信息的显示时，使能呼叫可供件的显示，其中所述呼叫可供件在被选择时使得所述处理单元发起对与所述选定联系人相关联的所述外部设备的呼叫。

25. 根据权利要求 1 所述的电子设备，其中所述处理单元进一步被配置为：

在使能标识所述被选定联系人的联系人信息的显示时，使能文本可供件的显示，其中所述文本可供件在被选择时使得所述处理单元发起被寻址到与所述选定联系人相关联的所述外部设备的消息。

26. 根据权利要求 1 所述的电子设备，其中为了使能表示联系人的所述多个可供件的显示，所述处理单元进一步被配置为使能表示用户指定联系人的多个可供件的显示，用户指定联系人是可访问所述电子设备的联系人的子集。

27. 根据权利要求 1 所述的电子设备，

其中所述电子设备包括与所述触敏显示器分开的可按压输入机构，以及

其中检测用户输入包括检测所述可按压输入机构的激活。

28. 根据权利要求 1 所述的电子设备，其中所述电子设备包括可按压输入机构和麦克风，所述处理单元进一步配置为：

在使能所述绘图区域的显示时，检测所述可按压输入机构的激活；

响应于检测所述激活：在所述可按压输入机构保持被按压的同时，基于从所述麦克风接收的输入记录音频消息；

检测所述可按压输入机构的释放；以及

响应于检测所述释放：停止记录所述音频消息并且向与所述被选定联系人相关联的所述外部设备发送所记录的音频消息。

29. 一种方法，包括：

在具有触敏显示器的电子设备处，执行以下步骤：

检测用户输入并且响应于检测所述用户输入，显示表示联系人的多个可供件；

检测对所显示的表示联系人的可供件的用户选择；

响应于检测对所显示的可供件的用户选择，用标识被选定联系人的联系人信息的显示替代所述多个可供件的显示，所述被选定联系人由所选定的可供件表示；

在显示所述联系人信息的同时，检测所述触敏显示器上的触摸；

响应于检测所述触摸：显示绘图区域，其中所述绘图区域响应于触摸输入；

检测所述绘图区域中表示第一笔画的第一触摸输入；

在所述绘图区域中显示所述第一笔画的可视表示；以及

向与所述被选定联系人相关联的外部设备发送表示所述第一笔画的数据。

30. 根据权利要求 29 所述的方法，进一步包括：

确定在所述第一触摸输入之后是否已经经过第一预定持续时间，以及

其中发送表示所述第一笔画的数据包括：响应于确定已经经过所述第一预定持续时间而发送所述数据。

31. 根据权利要求 30 所述的方法，进一步包括：

在已经经过所述第一预定持续之前，检测屏幕上绘图区域中表示第二笔画的第二触摸输入，其中所述第一笔画和第二笔画由中介时间量分开；以及

向与所述第二笔画和所述中介时间量相关联的所述外部设备发送数据。

32. 根据权利要求 29 所述的方法，

其中所述第一笔画具有特性运动学，以及

其中发送表示所述第一笔画的数据包括：向所述外部设备发送指示所述特性运动学的数据。

33. 根据权利要求 29 所述的方法，进一步包括：

在所述第一笔画已经被接收持续第二预定持续时间之后淡出所显示的所述第一笔画的可视表示。

34. 根据权利要求 29 所述的方法，其中发送所述数据触发所述外部设备以：

显示接收所述数据的指示，以及

显示可供件，其中所述可供件在被选定时使得所述外部设备显示所述第一笔画的可视表示。

35. 根据权利要求 29 所述的方法，其中发送所述数据触发所述外部设备以显示所述第一笔画的可视表示。

36. 根据权利要求 31 所述的方法，其中发送所述数据触发所述外部设备以显示所述第

一笔画的可视表示，随后暂停所述中介时间量，并且随后显示所述第二笔画的可视表示。

37. 根据权利要求 32 所述的方法，其中发送所述数据触发所述外部设备以显示具有所述特性运动学的所述第一笔画的可视表示。

38. 根据权利要求 34 所述的方法，进一步包括：

在确定所述可视表示已经被显示持续第三预定持续时间之后淡出笔画的所述可视表示。

39. 根据权利要求 29 所述的方法，进一步包括：

从所述外部设备接收数据，所述数据表示由所述外部设备检测的第三触摸输入，所述第三触摸输入表示第三笔画；

在所述电子设备的所述绘图区域中显示所述第三笔画的可视表示。

40. 根据权利要求 39 所述的方法，进一步包括：

在第四预定持续时间之后淡出所述第三笔画的所述可视表示。

41. 根据权利要求 31 所述的方法，其中所述第二预定持续时间、所述第三预定持续时间和所述第四预定持续时间是相同的持续时间。

42. 根据权利要求 33 所述的方法，

其中笔画具有开始和结束，以及

其中淡出笔画的所述可视表示包括：在淡出对应的所述可视表示的结束之前淡出对应的所述可视表示的开始。

43. 根据权利要求 29 所述的方法，进一步包括：

在所述绘图区域中显示颜色拾取器可供件，其中所述颜色拾取器可供件具有指示当前选定颜色的颜色，

其中显示所述第一笔画的所述可视表示包括：以所述当前选定颜色显示所述可视表示；以及

响应于检测对所述颜色拾取器可供件的选择，显示表示颜色的多个颜色可供件。

44. 根据权利要求 43 所述的方法，其中所述多个颜色可供件包括表示先前选定颜色的可供件。

45. 根据权利要求 43 所述的方法，进一步包括：

响应于检测对所显示的多个颜色可供件的颜色拾取器可供件的选择，显示调色板。

46. 根据权利要求 45 所述的方法，其中所述调色板包括具有不同颜色的多个部分，所述方法进一步包括：

响应于检测对所述调色板中的对应于选定颜色的部分的选择；

显示所述绘图区域；以及

更新所述绘图区域中显示的所述颜色拾取器可供件，使得所述颜色拾取器可供件被显示有所述选定颜色。

47. 根据权利要求 46 所述的方法，其中向所述外部设备发送表示所述第一笔画的数据包括：发送表示所述选定颜色的数据。

48. 根据权利要求 29 所述的方法，其中所述电子设备包括可旋转输入机构，所述方法进一步包括：

在所述电子设备处，执行以下步骤：

在显示表示联系人的所述多个可供件时，检测表示所述可旋转输入机构的移动的用户输入；以及

响应于检测所述用户输入，缩放多个用户指定联系人的显示，其中缩放所述显示包括改变正被显示的联系人的大小。

49. 根据权利要求 48 所述的方法，其中缩放所述显示包括改变正被显示的联系人的数量。

50. 根据权利要求 29 所述的方法，其中所述触敏显示器包括一个或多个传感器以检测所述触敏显示器上的触摸的强度，所述方法进一步包括：

在显示所述绘图区域时，检测所述触敏显示器上的触摸，其中所述触摸具有特性强度；

确定所述特性强度是否超过预定阈值强度；

响应于所述特性强度超过所述预定阈值强度的确定：

显示呼叫可供件，其中所述呼叫可供件在被选择时使得所述电子设备发起对与所述联系人相关联的所述外部设备的呼叫；以及

响应于所述特性强度没有超过所述预定阈值强度的确定，向所述外部设备发送表示所述触摸的数据。

51. 根据权利要求 29 所述的方法，其中所述触敏显示器包括一个或多个传感器以检测所述触敏显示器上触摸的强度，所述方法进一步包括：

在显示所述绘图区域时，检测所述触敏显示器上的触摸，其中所述触摸具有特性强度；

确定所述特性强度是否超过预定阈值强度；

响应于所述特性强度超过所述预定阈值强度的确定：

显示文本可供件，其中所述文本可供件在被选择时使得所述电子设备发起被寻址到与所述联系人相关联的所述外部设备的消息；以及

响应于所述特性强度没有超过所述预定阈值强度的确定，向所述外部设备发送表示所述触摸的数据。

52. 根据权利要求 29 所述的方法，进一步包括：

在显示标识所述被选定联系人的联系人信息时，显示呼叫可供件，其中所述呼叫可供件在被选择时使得所述电子设备发起对与所述选定联系人相关联的所述外部设备的呼叫。

53. 根据权利要求 29 所述的方法，进一步包括：

在显示标识所述被选定联系人的联系人信息时，显示文本可供件，其中所述文本可供件在被选择时使得所述电子设备发起被寻址到与所述选定联系人相关联的所述外部设备的消息。

54. 根据权利要求 29 所述的方法，其中显示表示联系人的所述多个可供件包括：显示表示用户指定联系人的多个可供件，用户指定联系人是可访问所述电子设备的联系人的子集。

55. 根据权利要求 29 所述的方法，

其中所述电子设备包括与所述触敏显示器分开的可按压输入机构，以及

其中检测用户输入包括检测所述可按压输入机构的激活。

56. 根据权利要求 29 所述的方法，其中所述电子设备包括可按压输入机构和麦克风，所述方法进一步包括：

在显示所述绘图区域时，检测所述可按压输入机构的激活；

响应于检测所述激活：在所述可按压输入机构保持被按压的同时，基于从所述麦克风接收的输入记录音频消息；

检测所述可按压输入机构的释放；以及

响应于检测所述释放：停止记录所述音频消息并且向与所述被选定联系人相关联的所述外部设备发送所记录的音频消息。

电子触摸通信

[0001] 相关申请的交叉引用

[0002] 本申请要求以下申请的优先权：2014年9月2日提交的美国临时专利申请序列号62/044,961；2015年3月8日提交的美国临时专利申请序列号62/129,955；2015年6月7日提交的国际专利申请序列号PCT/US2015/034609；这些申请均通过引用以其整体并入于此。

[0003] 本申请涉及以下共同未决的申请：2013年5月8日提交的、题为"Device,Method,and Graphical User Interface for Displaying User Interface Objects Corresponding to an Application"的国际专利申请序列号PCT/US2013/040061；2013年11月11日提交的、题为"Device,Method,and Graphical User Interface for Transitioning Between Touch Input to Display Output Relationships"的国际专利申请序列号PCT/US2013/069483；2014年7月18日提交的、题为"Raise Gesture Detection in a Device"的美国临时专利申请序列号62/026,532；2014年9月2日提交的、Lawrence Yang等作为发明人的题为"REDUCED-SIZE INTERFACES FOR MANAING ALERTS"的美国临时专利申请。这些申请中的内容通过引用以其整体并入于此。

技术领域

[0004] 本发明总体上涉及计算机用户界面，并且更具体地涉及用于与其他用户通信的用户界面。

背景技术

[0005] 近些年来电子设备的使用已经显著地增加（例如，访问音乐和发送/接收消息）。设备从用户接收输入，诸如选择用于回放的歌曲、从电话本选择消息收件人、用于消息正文的文本输入和选择文档的特定页。作为增加的设备使用的结果，向这样的设备中的用户输入的频率也已经显著地增加。

发明内容

[0006] 在一些实施例中，一种方法包括，在具有触敏显示器和可旋转输入机构的电子设备处：在所述触敏显示器上显示用户界面，所述用户界面包括多个对象和可供件，所述多个对象中的每个对象与多个联系人中的联系人相关联，所述可供件具有表示所述多个联系人中的第一联系人的可视外观；接收对应于所述可旋转输入机构的旋转的第一输入；以及响应于接收到对应于所述可旋转输入机构的所述旋转的所述输入，更新所述可供件的所述可视外观以表示所述多个联系人中的第二联系人。

[0007] 在一些实施例中，一种方法包括，在具有触敏显示器的电子设备处、在具有触敏显示器和可旋转输入机构的电子设备处：在所述触敏显示器上显示用户界面，所述用户界面包括多个对象和可供件，所述多个对象中的每个对象与多个联系人中的联系人相关联，所述可供件具有表示所述多个联系人中的第一联系人的可视外观；接收对应于所述多个对象

中与所述多个联系人中的第二联系人相关联的对象的选择的第一输入；以及响应于接收到对应于所述多个对象中的所述对象上的所述联系人的所述输入，更新所述可供件的所述可视外观以表示所述多个联系人中的所述第二联系人。

附图说明

[0008] 为了更好地理解所描述的各种实施例，下面应当结合附图参考对实施例的描述，其中相似的附图标记指代附图中的对应部分。

[0009] 图 1A 是图示了根据一些实施例的具有触敏显示器的便携式多功能设备的框图。

[0010] 图 1B 是图示了根据一些实施例的用于事件处理的示例性部件的框图。

[0011] 图 2 图示了根据一些实施例的具有触摸屏的便携式多功能设备。

[0012] 图 3 是根据一些实施例的具有显示器和触敏表面的示例性多功能设备的框图。

[0013] 图 4A 图示了根据一些实施例的用于便携式多功能设备上的应用的菜单的示例性用户界面。

[0014] 图 4B 图示了根据一些实施例的用于具有与显示器分离的触敏表面的多功能设备的示例性用户界面。

[0015] 图 5A 图示了根据一些实施例的个人电子设备。

[0016] 图 5B 是图示了根据一些实施例的个人电子设备的框图。

[0017] 图 6A-6E 图示了用于电子触摸通信的示例性用户界面。

[0018] 图 7A-7E 图示了用于电子触摸通信的示例性用户界面。

[0019] 图 8 图示了用于电子触摸通信的示例性用户界面。

[0020] 图 9A-9C 图示了用于电子触摸通信的示例性用户界面。

[0021] 图 10A-10C 描绘了图示用于电子触摸通信的过程的流程图。

[0022] 图 11 是图示了用于电子触摸通信的过程的流程图。

[0023] 图 12 是图示了用于电子触摸通信的过程的流程图。

[0024] 图 13 是根据一些实施例的电子设备的功能框图。

[0025] 图 14 是根据一些实施例的电子设备的功能框图。

[0026] 图 15 是根据一些实施例的电子设备的功能框图。

[0027] 图 16 是根据一些实施例的电子设备的功能框图。

[0028] 图 17 是根据一些实施例的电子设备的功能框图。

[0029] 图 18A-18K 图示了用于电子通信的示例性用户界面。

[0030] 图 19A-19B 图示了用于电子通信的示例性用户界面。

[0031] 图 20 图示了用于电子通信的示例性用户界面。

[0032] 图 21 图示了用于电子通信的示例性用户界面。

[0033] 图 22 和 23 图示的是图示出用于电子触摸通信的过程的流程图。

[0034] 图 24 和 25 是根据一些实施例的电子设备的功能框图。

具体实施方式

[0035] 以下描述阐明了示例性方法、参数等。然而，应当认识到这样的描述并不旨在对本公开内容的范围的限制，而是相反被提供为示例性实施例的描述。

[0036] 下面，图 1A-1B、图 2、图 3、图 4A-4B 以及图 5A-5B 提供了可以提供用于电子触摸通信的这种用户界面的示例性设备的描述。图 6A-6E、图 7A-7E、图 8、图 9A-9C、图 18A-18K、图 19A-19B、图 20 以及图 21 图示了用于电子触摸通信的示例性用户界面。图中的用户界面也用来图示下面所描述的过程，包括在图 10A-10C、图 11-13、图 22 以及图 23 中的过程。

[0037] 虽然以下描述使用术语“第一”、“第二”等来描述各个元件，但是这些元件不应当被术语限制。这些术语仅用于将一个元件与另一元件进行区分。例如，第一触摸可以被称作第二触摸，并且类似地，第二触摸可以被称作第一触摸，而不脱离各种描述的实施例的范围。第一触摸和第二触摸均是触摸，但它们不是相同的触摸。

[0038] 各种描述的实施例的描述中所使用的术语在本文中仅用于描述具体实施例，并不旨在限制。除非上下文以其他方式明确指出，否则各种描述的实施例的描述以及所附权利要求书中所使用的单数形式“一”、“一个”和“所述”旨在也包括复数形式。还应当理解，本文所使用的术语“和 / 或”是指代并且涵盖相关联列出的项目的一个或多个各自中的任何项目以及所有可能的组合。进一步应当理解，术语“包括”、“具有”、“包含”和 / 或“含有”在本说明书中使用时指定了特征、整体、步骤、操作、元件和 / 或部件的存在，但并不排除一个或多个其他特征、整体、步骤、操作、元件、部件和 / 或它们的组合的存在或添加。

[0039] 术语“如果”取决于上下文可以被解读为表示“在…时”或“一旦…则”或者“响应于确定”或“响应于检测”。类似地，短语“如果确定”或“如果检测到［陈述的条件或事件］”取决于上下文可以被解读为表示“一旦确定，则”或“响应于确定”或者“一旦检测到［陈述的条件或事件］”或“响应于检测到［陈述的条件或事件］”。

[0040] 对电子设备、针对这种设备的用户界面以及用于使用此类设备的相关联过程的实施例进行描述。在一些实施例中，设备是便携式通信设备（诸如移动电话），其还包含其他功能，诸如 PDA 和 / 或音乐播放器功能。便携式多功能设备的示例性实施例包括但不限于：来自加利福尼亚州、库比蒂诺的 Apple 公司的iPhone®、iPod Touch® 和iPad® 设备。诸如具有触敏表面（例如，触摸屏显示器和 / 或触摸板）的膝上型计算机或平板计算机之类的其他便携式电子设备也可以被使用。还应当理解的是，在一些实施例中，该设备不是便携式通信设备，而是具有触敏表面（例如，触摸屏显示器和 / 或触摸板）的台式计算机。

[0041] 在以下论述中，描述了一种包括显示器和触敏表面的电子设备。然而，应当理解的是，该计算设备可以包括一个或多个其他物理用户界面设备，诸如物理键盘、鼠标和 / 或操纵杆。

[0042] 所述设备可以支持各种应用，诸如以下应用中的一个或多个应用：绘图应用、演示应用、文字处理应用、网站创建应用、盘编写应用、电子表格应用、游戏应用、电话应用、视频会议应用、电子邮件应用、即时消息收发应用、锻炼支持应用、照片管理应用、数码相机应用、数码录像机应用、web 浏览应用、数字音乐播放器应用和 / 或数字视频播放器应用。

[0043] 在设备上执行的各种应用可选地使用至少一个公共物理用户界面设备，诸如触敏表面。触敏表面的一个或多个功能以及在设备上显示的对应信息从一个应用向下一个应用和 / 或在各自应用中进行可选地调整和 / 或改变。通过此方式，设备的公共物理架构（诸如触敏表面）通过对于用户而言直观、透明的用户界面来可选地支持各种应用。

[0044] 现在把注意力转向具有触敏显示器的便携式设备的实施例。图 1A 是图示根据一些实施例的具有触敏显示器系统 112 的便携式多功能设备 100 的框图。触敏显示器 112

EX1002 - Page 1169

有时被称作“触摸屏”，并且有时被认为或被称作触敏显示器系统。设备 100 包括存储器 102（其可选地包括一个或多个计算机可读存储介质）、存储器控制器 122、一个或多个处理单元 (CPU)120、外围设备接口 118、RF 电路装置 108、音频电路装置 110、扬声器 111、麦克风 113、输入 / 输出 (I/O) 子系统 106、其他输入或控制设备 116 以及外部端口 124。设备 100 可选地包括一个或多个光学传感器 164。设备 100 可选地包括用于检测设备 100（例如，触敏表面，诸如设备 100 的触敏显示系统 112）上的接触的强度的一个或者接触强度传感器 165。设备 100 可选地包括用于在设备 100 上生成触觉输出的（例如，在触敏表面（诸如，设备 100 的触敏显示系统 112 或者设备 300 的触摸板 335）上生成触觉输出）一个或者多个触觉输出生成器 167。这些部件可选地在一个或多个通信总线或信号线 103 上进行通信。

[0045] 如说明书和权利要求中所使用的，在触敏表面上接触的术语“强度”指代在触敏表面上接触（例如，手指接触）的力或者压力（单位面积的力），或者指代用于在触敏表面上接触的力或者压力的替代（代理）。接触的强度具有包括至少四个不同的值并且更典型地包括数百个不同的值（例如，至少 256）的数值范围。可选地，使用各种方法和各种传感器或者传感器的组合来确定（或者测量）接触的强度。例如，在触敏表面下面的或者邻近于触敏表面的一个或者多个力传感器可选地用于在触敏表面上的各个点处测量力。在一些实现方式中，来自多个力传感器的力测量被组合（例如，加权平均数）以确定接触的估计的力。类似地，触笔的压敏尖端可选地用于确定在触敏表面上的触笔的压力。备选地，在触敏表面上检测到的接触区域的大小和 / 或对其的改变、接近接触的触敏表面的电容和 / 或对其的改变、接近接触的触敏表面的电阻和 / 或对其的改变可选地用作为触敏表面上的接触的力或者压力的替代。在一些实现方式中，用于接触力或者接触压力的替代测量直接地用于确定是否已经超过强度阈值（例如，强度阈值以对应于替代测量的单位被描述）。在一些实现方式中，用于接触力或者接触压力的替代测量被转换成估计的力或估计的压力，并且该估计的力或估计的压力用来确定是否已经超过强度阈值（例如，强度阈值是以压力的单位测量出的压力阈值）。将接触的强度用作用户输入的属性允许了对附加设备功能的用户访问，该附加设备功能否则在具有用于显示可供件 (affordance) 和 / 或接收用户输入（例如，经由触敏显示器、触敏表面或者物理 / 机械控制，诸如旋钮或者按钮）的有限有效面积 (real estate) 的尺寸减小的设备上（例如，在触敏显示器上）不可能由用户可访问。

[0046] 如说明书和权利要求中所使用的，术语“触觉输出”指代将由用户使用该用户的触感检测到的设备相对于设备的之前位置的物理位移、设备的部件（例如，触敏表面）相对于设备的另一部件（例如，外壳）的物理位移或者部件相对于设备的重心的位移。例如，在设备或者设备的部件与对触摸敏感的用户的表面（例如，手指、手掌或者用户的手的其他部分）接触的情况下，由物理位移产生的触觉输出将由用户解读为对应于感受到的设备或者设备的部件的物理特性中的变化的触觉感觉。例如，触敏表面（例如，触敏显示器或者触控板）的移动可选地由用户解读为物理致动器按钮的”向下点击”或者”向上点击”。在一些情况下，即使当不存在与由用户的移动物理地按压（例如位移）的触敏表面相关联的物理致动器按钮的移动时，用户将感觉到触觉感觉，诸如”向下点击”或者”向上点击”。作为另一个示例，即使当触敏表面的平滑度没有变化时，触敏表面的移动可选地由用户解读或者感觉为触敏表面的“粗糙度”。虽然由用户对触摸的这种解读将受到用户的个性化的感官知觉的影响，但是存在对大多数用户共同的触摸的许多感官知觉。因此，当触觉输出被描述为

EX1002 - Page 1170

对应于用户的特定感官知觉（例如，"向上点击"、"向下点击"、"粗糙度"）时，除非另作说明，否则将生成用于典型的（或者平均的）用户的描述的感官知觉的生成的触觉输出对应于设备或者其部件的物理位移。

[0047] 应当理解，设备 100 仅是便携式多功能设备的一个示例，并且设备 100 可选地具有比所示部件更多或更少的部件，可选地组合两个或更多部件，或者可选地具有不同的部件配置或布置。图 1A 中所示出的各个部件可以在硬件、软件或硬件和软件两者的组合、包括一个或多个信号处理和 / 或专用集成电路中进行实施。

[0048] 存储器 102 可以包括一个或者多个计算机可读存储介质。计算机可读存储介质可以是有形的和非瞬态的。存储器 102 可以包括高速随机存取存储器，并且还可以包括非易失性存储器，诸如一个或多个磁盘存储设备、闪存设备或其他非易失性固态存储器设备。存储器控制器 122 可以控制通过设备 100 的其他部件对存储器 102 的访问。

[0049] 外围设备接口 118 可以用于将设备的输入和输出外围设备耦合至 CPU 120 和存储器 102。一个或多个处理器 120 运行或执行存储器 102 中存储的各种软件程序和 / 或指令集，以执行针对设备 100 的各种功能以及用于处理数据。在一些实施例中，外围设备接口 118、CPU 120 以及存储器控制器 122 可以在单个芯片（诸如，芯片 104）上进行实施。在一些其他实施例中，它们可以在分离的芯片上进行实施。

[0050] RF（射频）电路装置 108 接收并且发送 RF 信号，也被称作电磁信号。RF 电路装置 108 将电信号转换成电磁信号 / 将电磁信号转换成电信号，并且经由电磁信号与通信网络以及其他通信设备进行通信。RF 电路装置 108 可选地包括用于执行这些功能的已知电路装置，包括但不限于：天线系统、RF 收发机、一个或多个放大器、调谐器、一个或多个振荡器、数字信号处理器、CODEC 芯片集、订户标识模块 (SIM) 卡、存储器等。RF 电路装置 108 可选地通过无线通信，与诸如也称为万维网 (WWW) 的因特网、内联网和 / 或诸如蜂窝式电话网络、无线局域网 (LAN) 和 / 或城域网 (MAN) 的无线网络以及其他设备进行通信。RF 电路装置 108 可选地包括用于检测近场通信 (NFC) 场的已知电路装置，诸如通过短程通信无线电。无线通信可选地使用多种通信标准、协议和技术中的任何一种，包括但不限于：全球移动通信系统 (GSM)、增强型数据 GSM 环境 (EDGE)、高速下行链路分组接入 (HSDPA)、高速上行链路分组接入 (HSUPA)、仅演进数据 (EV-DO)、HSPA、HSPA+、双小区 HSPA (DC-HSPDA)、长期演进 (LTE)、近场通信 (NFC)、宽带码分多址 (W-CDMA)、码分多址 (CDMA)、时分多址 (TDMA)、蓝牙、蓝牙低功耗 (BTLE)、无线高保真 (Wi-Fi)（例如，IEEE 802.11a、IEEE 802.11b、IEEE 802.11g、IEEE 802.11n 和 / 或 IEEE 802.11ac）、因特网协议语音 (VoIP)、Wi-MAX、针对电子邮件的协议（例如，因特网消息访问协议 (IMAP) 和 / 或邮局协议 (POP)）、即时消息收发（例如，可扩展消息收发和现场协议 (XMPP)、针对即时消息收发和现场平衡扩展的会话发起协议 (SIMPLE)、即时消息收发和现场服务 (IMPS)）和 / 或短消息服务 (SMS)，或者任意其他适当的通信协议，包括在此文档递交日为止还未开发出的通信协议。

[0051] 音频电路装置 110、扬声器 111 和麦克风 113 在用户与设备 100 之间提供音频接口。音频电路装置 110 从外围设备接口 118 接收音频数据，将该音频数据转换成电信号，并且向扬声器 111 传输该电信号。扬声器 111 将该电信号转换成人类可听见的声波。音频电路装置 110 还接收由麦克风 113 从声波转换的电信号。音频电路装置 110 将电信号转换成音频数据并且向外围设备接口 118 传输该音频数据用于处理。音频数据可以通过外围设备

EX1002 - Page 1171

接口 118 从存储器 102 和 / 或 RF 电路装置 108 获取和 / 或向存储器 102 和 / 或 RF 电路装置 108 传输。在一些实施例中，音频电路装置 110 还包括耳机插孔（例如，图 2 中的 212）。耳机插孔在音频电路装置 110 与可移除音频输入 / 输出外围设备（诸如只有输出的受话器或既能输出（例如，单耳或双耳的受话器）又能输入（例如，麦克风）的耳机）之间提供接口。

[0052] I/O 子系统 106 将设备 100 上的输入 / 输出外围设备（诸如触摸屏 112 和其他输入控制设备 116）耦合至外围设备接口 118。I/O 子系统 106 可选地包括显示器控制器 156、光学传感器控制器 158、强度传感器控制器 159、触感反馈控制器 161、以及针对其他输入或控制设备的一个或多个输入控制器 160。该一个或多个输入控制器 160 从其他输入或控制设备 116 接收电信号 / 向其他输入或控制设备 116 发送电信号。其他输入或控制设备 116 可选地包括物理按钮（例如，下压按钮、摇杆按钮等）、拨号盘、滑动开关、操纵杆、点击式转盘等。在一些备选实施例中，（一个或多个）输入控制器 160 可选地被耦合至以下各项中的任意项（或没有）：键盘、红外端口、USB 端口以及诸如鼠标之类的定点设备。一个或多个按钮（例如，图 2 中的 208）可选地包括针对扬声器 111 和 / 或麦克风 113 的音量控制的向上 / 向下按钮。所述一个或多个按钮可选地包括下压按钮（例如，图 2 中的 206）。

[0053] 对下压按钮的快速按压可以脱离触摸屏 112 的锁定或者开始在触摸屏上使用手势以解锁设备的过程，如在 2005 年 12 月 23 日提交的第 11/322,549 号美国专利申请、第 7,657,849 号美国专利“Unlocking a Device by Performing Gestures on an Unlock Image”中所述，其通过引用的方式整体并入于此。对下压按钮（例如，206）的较长按压可以使设备 100 通电或断电。用户可以能够自定义按钮中的一个或多个按钮的功能。触摸屏 112 被用来实现虚拟按钮或软按钮以及一个或多个软键盘。

[0054] 触敏显示器 112 在设备与用户之间提供输入接口和输出接口。显示器控制器 156 从触摸屏 112 接收电信号和 / 或向触摸屏 112 发送电信号。触摸屏 112 向用户显示视觉输出。该视觉输出可以包括图形、文本、图标、视频以及上述各项的任意组合（统称为“图形”）。在一些实施例中，一些或所有视觉输出可以对应于用户界面对象。

[0055] 触摸屏 112 具有基于触感 (haptic) 和 / 或触觉 (tactile) 接触而接受来自用户的输入的触敏表面、传感器或传感器集。触摸屏 112 和显示器控制器 156（连同存储器 102 中任意相关联的模块和 / 或指令集）检测触摸屏 112 上的接触（以及接触的任意移动或中断），并且将检测到的接触转换成与在触摸屏 112 上显示的用户界面对象（例如，一个或多个软按键、图标、网页或图像）的交互。在一个示例性实施例中，触摸屏 112 与用户之间的接触点对应于用户的手指。

[0056] 触摸屏 112 可以使用 LCD（液晶显示屏）技术、LPD（发光聚合物显示器）技术或 LED（发光二极管）技术，但在其他实施例中也可以使用其他显示技术。触摸屏 112 和显示器控制器 156 可以使用现在已知或以后开发的多种触摸感测技术的任何一种来检测接触以及接触的任何移动或中断，这些触摸感测技术包括但不限于：电容、电阻、红外和表面声波技术，以及其他接近传感器阵列或用于确定与触摸屏 112 的一个或多个接触点的元件。在一个示例性实施例中，使用诸如可以在加利福尼亚州、库比蒂诺的 Apple 公司的 iPhone® 和 iPod Touch® 中找到的投射式互电容感测技术。

[0057] 在触摸屏 112 的一些实施例中，触敏显示器可以与在以下美国专利中描述的多点

触摸敏感触摸板相似；6,323,846(Westerman 等人)，6,570,557(Westerman 等人)，和 / 或 6,677,932(Westerman)，和 / 或美国专利公开 2002/0015024A1，这些申请中的每个申请通过引用的方式将其整体并入于此。然而，触摸屏 112 显示来自设备 100 的视觉输出，而触敏触控板不提供视觉输出。

[0058] 触摸屏 112 的一些实施例中的触敏显示器可如以下申请中所描述：(1)2006 年 5 月 2 日提交的第 11/381,313 号美国专利申请“Multipoint Touch Surface Controller”；(2)2004 年 5 月 6 日提交的第 10/840,862 号美国专利申请“Multipoint Touchscreen”；(3)2004 年 7 月 30 日提交的第 10/903,964 号美国专利申请“Gestures For Touch Sensitive Input Devices”；(4)2005 年 1 月 31 日提交的第 11/048,264 号美国专利申请“Gestures For Touch Sensitive Input Devices”；(5)2005 年 1 月 18 日提交的第 11/038,590 号美国专利申请“Mode-Based Graphical User Interfaces For Touch Sensitive Input Devices”；(6)2005 年 9 月 16 日提交的第 11/228,758 号美国专利申请“Virtual Input Device Placement On A Touch Screen User Interface”；(7)2005 年 9 月 16 日提交的第 11/228,700 号美国专利申请“Operation Of A Computer With A Touch Screen Interface”；(8)2005 年 9 月 16 日提交的第 11/228,737 号美国专利申请“Activating Virtual Keys Of A Touch-Screen Virtual Keyboard”；以及 (9)2006 年 3 月 3 日提交的第 11/367,749 号美国专利申请“Multi-Functional Hand-Held Device”。所有这些申请都通过引用整体并入于此。

[0059] 触摸屏 112 可以具有超过 100dpi 的视频分辨率。在一些实施例中，触摸屏具有大约 160dpi 的视频分辨率。用户可以使用诸如触笔、手指等之类的任何适当对象或附属物与触摸屏 112 进行接触。在一些实施例中，用户界面被设计成主要通过基于手指的接触和手势来工作，由于手指在触摸屏上的接触面积较大，因此基于手指接触和手势在精度上低于基于触笔的输入。在一些实施例中，设备将粗略的基于手指的输入翻译成精确的指针 / 光标位置或用于执行用户所期望的动作的命令。

[0060] 在一些实施例中，除了触摸屏之外，设备 100 还可以包括用于激活或去激活特定功能的触摸板（未示出）。在一些实施例中，触摸板是与触摸屏不同的、不显示视觉输出的设备的触敏区域。触摸板可以是与触摸屏 112 分离的触敏表面或者是由触摸屏形成的触敏表面的延伸部分。

[0061] 设备 100 还包括用于对各种部件供电的电源系统 162。电源系统 162 可以包括电源管理系统、一个或多个电源（例如，电池、交流电 (AC)）、充电系统、电源故障检测电路、电源转换器或反相器、电源状态指示器（例如，发光二极管 (LED)）、以及与便携式设备中的电源的生成、管理和分配有关的任何其他部件。

[0062] 设备 100 还可以包括一个或多个光学传感器 164。图 1A 示出了与 I/O 子系统 106 中的光学传感器的控制器 158 耦合的光学传感器。光学传感器 164 可以包括电荷耦合器件 (CCD) 或互补金属氧化物半导体 (CMOS) 光电晶体管。光学传感器 164 接收通过一个或多个透镜投射的来自环境的光，并且将光转换成代表图像的数据。与成像模块 143（也被称作相机模块）相结合，光学传感器 164 可以捕获静态图像或视频。在一些实施例中，光学传感器位于设备 100 的背面，与设备正面的触摸屏显示器 112 相对，使得可以触摸屏显示器可以被用作静态和 / 或视频图像获取的取景器。在一些实施例中，光学传感器位于设备的正面，使

EX1002 - Page 1173

得在用户查看触摸屏显示器上的其他视频会议参与者的同时，可以为视频会议获取用户图像。在一些实施例中，光学传感器 164 的位置能够由用户改变（例如，通过旋转设备外壳中的透镜和传感器），使得单个光学传感器 164 可以与触摸屏显示器一起使用以用于视频会议以及静态和 / 或视频图像获取两者。

[0063] 设备 100 可选地还包括一个或者多个接触强度传感器 165。图 1A 示出了耦合到 I/O 子系统 106 中的强度传感器控制器 159 的接触强度传感器。接触强度传感器 165 可选地包括一个或者多个压阻应变仪、电容力传感器、电力传感器 (electric force sensor)、压电力传感器、光学力传感器、电容性触敏表面或者其他强度传感器（例如，用于在触敏表面上测量接触的力（或者压力）的传感器）。接触强度传感器 165 从环境接收接触强度信息（例如，压力信息或者用于压力信息的替代）。在一些实施例中，至少一个接触强度传感器与触敏表面（例如，触敏显示器系统 112）并置或者接近触敏表面（例如，触敏显示器系统 112）。在一些实施例中，至少一个接触强度传感器位于设备 100 的背面上，其与位于设备 100 的正面的触摸屏显示器 112 相对。

[0064] 设备 100 还可以包括一个或多个接近传感器 166。图 1A 示出了耦合至外围设备接口 118 的接近传感器 166。备选地，接近传感器 166 可以被耦合至 I/O 子系统 106 中的输入控制器 160。接近传感器 166 可以如以下美国专利申请所描述的来执行：第 11/241,839 号，“Proximity Detector In Handheld Device”；第 11/240,788 号，“Proximity Detector In Handheld Device”；第 11/620,702 号，“Using Ambient Light Sensor To Augment Proximity Sensor Output”；第 11/586,862 号，“Automated Response To And Sensing Of User Activity In Portable Devices”；以及第 11/638,251 号，“Methods And Systems For Automatic Configuration Of Peripherals”，其通过引用的方式整体并入于此。在一些实施例中，当多功能设备处于用户的耳朵附近时（例如，当用户正在进行电话呼叫时），接近传感器关闭并且禁用触摸屏 112。

[0065] 设备 100 可选地还包括一个或者多个触觉输出生成器 167。图 1A 示出了耦合到 I/O 子系统 106 中的触感反馈控制器 161 的触觉输出生成器。触觉输出生成器 167 可选地包括一个或者多个电声设备（诸如，扬声器或者其他音频部件）和 / 或将能量转换成线性运动的机电设备（诸如，电机、螺线管、电活性聚合物、压电式致动器、静电致动器或者其他触觉输出生成部件（例如，将电信号转换成设备上的触觉输出的部件））。接触强度传感器 165 从触感反馈模块 133 接收触觉反馈生成指令，并且在设备 100 上生成能够由设备 100 的用户感觉的触觉输出。在一些实施例中，至少一个触觉输出生成器与触敏表面（例如，触敏显示器系统 112）并置或者接近于触敏表面（例如，触敏显示器系统 112），并且可选地通过垂直地（例如，设备 100 的表面中 / 外）或者横向地（在与设备 100 的表面相同的平面中往复）移动触敏表面来生成触觉输出。在一些实施例中，至少一个触觉输出生成器传感器位于设备 100 的背面，其与位于设备 100 的正面的触摸屏显示器 112 相对。

[0066] 设备 100 还可以包括一个或多个加速度计 168。图 1A 示出了耦合至外围设备接口 118 的加速度计 168。备选地，加速度计 168 可以被耦合至 I/O 子系统 106 中的输入控制器 160。加速度计 168 可以如以下美国专利公开来执行：第 20050190059 号，“Acceleration-based Theft Detection System For Portable Electronic Devices”以及第 20060017692 号，“Methods And Apparatuses For Operating A Portable Device

EX1002 - Page 1174

Based On An Accelerometer",两篇专利公开都通过引用的方式整体并入于此。在一些实施例中,基于对从一个或多个加速度计接收的数据的分析而以纵向视图或者横向视图将信息显示在触摸屏显示器上。除了(一个或多个)加速度计 168 之外,设备 100 还可选地包括磁力计(未示出)和 GPS(或者 GLONASS 或者其他全球导航系统)接收器(未示出),以用于获得与设备 100 的位置和定向(例如,纵向或横向)有关的信息。

[0067] 在一些实施例中,存储在存储器 102 中的软件部件包括操作系统 126、通信模块(或指令集)128、接触/运动模块(或指令集)130、图形模块(或指令集)132、文本输入模块(或指令集)134、全球定位系统(GPS)模块(或指令集)135 以及应用(或指令集)136。此外,如图 1A 和图 3 所示,在一些实施例中,存储器 102(图 1A)或者存储器 370(图 3)存储设备/全局内部状态 157。设备/全局内部状态 157 包括以下各项中的一个或多个:活跃应用状态,指示哪些应用程序(如果有的话)当前是活跃的;显示器状态,指示什么应用、视图和其他信息占用触摸屏显示器 112 的各个区域;传感器状态,包括从设备的各个传感器和输入控制设备 116 获得的信息;以及与设备的位置和/或姿态有关的位置信息。

[0068] 操作系统 126(例如,Darwin、RTXC、LINUX、UNIX、OS X、iOS、WINDOWS、或者诸如 VxWorks 的嵌入式操作系统)包括用于控制和管理一般系统任务(例如,存储器管理、存储设备控制、电源管理等)的各种软件部件和/或驱动器,并且促使各种硬件与软件部件之间的通信。

[0069] 通信模块 128 在一个或多个外部端口 124 上促进与其他设备的通信,并且还包括用于处理通过 RF 电路装置 108 和/或外部端口 124 接收的数据的各种软件部件。外部端口 124(例如,通用串行总线(USB)、火线(FIREWIRE)等)适于直接地耦合至其他设备或通过网络(例如,因特网、无线 LAN 等)间接地耦合至其他设备。在一些实施例中,外部端口是与用在iPod®(Apple 公司的商标)设备上的 30 引脚连接器相同、相似和/或兼容的多引脚(例如,30 引脚)连接器。

[0070] 接触/运动模块 130 可选地检测与触摸屏 112(与显示器控制器 156 相结合)和其他触敏设备(例如,触摸板或物理点击式转盘)的接触。接触/运动模块 130 包括用于执行与接触的检测相关的各种操作的各种软件部件,诸如确定是否发生了接触(例如,检测手指向下事件),确定接触的强度(例如,接触的力或者压力,或者用于接触的力或者压力的替代),确定是否存在接触的移动并且跟踪跨触敏表面的移动(例如,检测一个或多个手指拖拽事件),以及确定接触是否已停止(例如,检测手指向上事件或接触中断)。接触/运动模块 130 从触敏表面接收接触数据。确定触点的移动(其由一系列接触数据所表示)可选地包括确定触点的速率(幅度)、速度(幅度和方向)、和/或加速度(幅度和/或方向上的变化)。这些操作可选地应用于单个接触(例如,一个手指接触),或者多个同时接触(例如,"多点触摸"/多个手指接触)。在一些实施例中,接触/运动模块 130 和显示器控制器 156 检测触摸板上的接触。

[0071] 在一些实施例中,接触/运动模块 130 使用一个或者多个强度阈值的集合来确定操作是否已经由用户执行(例如,确定用户是否已经"点击"图标)。在一些实施例中,根据软件参数来确定强度阈值的至少一个子集(例如,强度阈值不是由特定的物理致动器的激活阈值来确定,并且在不改变设备 100 的物理硬件的情况下进行调整)。例如,在不改变触控板或者触摸屏显示器硬件的情况下,触摸板或者触摸屏的鼠标"点击"阈值可以被设置为

EX1002 - Page 1175

任何大范围的预定阈值。此外，在一些实施例中，设备的用户被提供有用于调整强度阈值的集合中一个或者多个强度阈值的软件设置（例如，通过利用系统级点击“强度”参数来一次性调整单个和/或多个强度阈值）。

[0072] 接触/运动模块 130 可选地检测由用户输入的手势。触敏表面上不同的手势具有不同的接触模式（例如，不同的运动、计时和/或检测到的接触的强度）。因此，手势可选地通过检测特定接触模式来检测。例如，检测手指叩击手势包括：检测手指向下事件、随后是在与该手指向下事件（例如，在图标位置）相同的位置（或者基本上相同的位置）检测手指向上（例如，抬起）事件。作为另一示例，检测触摸表面上的手指轻扫（swipe）手势包括：检测手指向下事件、随后是检测一个或多个手指拖拽事件、再随后是检测手指向上（抬起）事件。

[0073] 图形模块 132 包括用于在触摸屏 112 或其他显示器上渲染和显示图形的各种已知软件部件，包括用于改变所显示图形的视觉效果（例如，亮度、透明度、饱和度、对比度或者其他视觉属性）的部件。如本文所使用的，术语“图形”包括可以向用户显示的任何对象，包括但不限于：文本、网页、图标（诸如包括软按键的用户界面对象）、数字图像、视频、动画等。

[0074] 在一些实施例中，图形模块 132 存储表示待使用图形的数据。每个图形被可选地分配对应的代码。图形模块 132 从应用等接收指定待显示图形的一个或多个代码，连同（如果有需要）坐标数据和其他图形属性数据，然后生成屏幕图像数据以向显示器控制器 156 输出。

[0075] 触感反馈模块 133 包括各种软件部件，该软件部件用于响应于与设备 100 的用户交互，生成由（一个或多个）触觉输出生成器 167 用来在设备上的一个或者多个位置处产生触觉输出的指令。

[0076] 文本输入模块 134（其可以是图形模块 132 的部件）提供用于将文本录入各种应用中（例如，联系人 137、电子邮件 140、IM 141、浏览器 147 和需要文本输入的任何其他应用）的软键盘。

[0077] GPS 模块 135 确定设备的位置，并且提供此信息供各种应用使用（例如，提供给电话 138，用于在基于位置的拨号中使用；提供给相机 143 作为图片/视频元数据；以及提供给提供基于位置的服务的应用，诸如天气微件、本地黄页微件、和地图/导航微件）。

[0078] 应用 136 可以包括以下模块（或指令集）、或其子集或超集：

[0079] • 联系人模块 137（有时被称作地址簿或联系人列表）；

[0080] • 电话模块 138；

[0081] • 视频会议模块 139；

[0082] • 电子邮件客户端模块 140

[0083] • 即时消息收发（IM）模块 141；

[0084] • 锻炼支持模块 142；

[0085] • 用于静态和/或视频图像的相机模块 143；

[0086] • 图像管理模块 144；

[0087] • 视频播放器模块；

[0088] • 音乐播放器模块；

[0089] • 浏览器模块 147；

[0090] • 日历模块 148；

[0091] • 微件模块 149，其可以包括以下各项中的一个或多个：天气微件 149-1、股票微件 149-2、计算器微件 149-3、闹钟微件 149-4、词典微件 149-5、以及由用户获得的其他微件，以及用户创建的微件 149-6；微件创建器模块 150，用于制作用户创建的微件 149-6；

[0092] • 搜索模块 151；

[0093] • 视频和音乐播放器模块 152，其合并视频播放器模块和音乐播放器模块；

[0094] • 备忘录模块 153；

[0095] • 地图模块 154；和 / 或

[0096] • 在线视频模块 155。

[0097] 可以存储在存储器 102 中的其他应用 136 的示例包括其他文字处理应用、其他图像编辑应用、绘图应用、演示应用、支持 JAVA 功能的应用、加密、数字权限管理、语音识别和语音复制。

[0098] 结合触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132 和文本输入模块 134，联系人模块 137 可以用于管理地址簿或联系人列表（例如，存储在存储器 102 或存储器 370 中的联系人模块 137 的应用内部状态 192 中），包括：将（一个或多个）姓名添加到地址簿中；从地址簿中删除（一个或多个）姓名；将（一个或多个）电话号码、（一个或多个）电子邮件地址、（一个或多个）物理地址或其他信息与姓名相关联；将图像与姓名相关联；对姓名进行分类和排序；提供电话号码或电子邮件地址以发起和 / 或促进通过电话 138、视频会议模块 139、电子邮件 140 或 IM 141 的通信等。

[0099] 结合 RF 电路装置 108、音频电路装置 110、扬声器 111、麦克风 113、触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132 和文本输入模块 134，电话模块 138 可以用于录入对应于电话号码的字符序列、访问联系人模块 137 中的一个或多个电话号码、修改已经录入的电话号码、拨打相应的电话号码、进行会话以及当会话完成时断开连接或挂断。如上所述，无线通信可以使用多种通信标准、协议和技术中的任何一种。

[0100] 结合 RF 电路装置 108、音频电路装置 110、扬声器 111、麦克风 113、触摸屏 112、显示器控制器 156、光学传感器 164、光学传感器的控制器 158、接触 / 运动模块 130、图形模块 132、文本输入模块 134、联系人模块 137 和电话模块 138，视频会议模块 139 包括用于根据用户指令发起、进行和终止用户与一个或多个其他参与者之间的视频会议的可执行指令。

[0101] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132 和文本输入模块 134，电子邮件客户端模块 140 包括用于响应于用户指令创建、发送、接收和管理电子邮件的可执行指令。结合图像管理模块 144，电子邮件客户端模块 140 使创建和发送带有利用相机模块 143 拍摄的静态或视频图像的电子邮件变得非常容易。

[0102] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132 和文本输入模块 134，即时消息收发模块 141 包括用于录入对应于即时消息的字符序列、用于修改先前录入的字符、用于传输相应的即时消息（例如，使用短消息服务 (SMS) 或多媒体消息服务 (MMS) 协议以用于基于电话的即时消息，或者使用 XMPP、SIMPLE 或 IMPS 以用于基于因特网的即时消息）、用于接收即时消息和查看所接收的即时消息的可执行指令。在一些实施例中，如 MMS 和 / 或增强型消息收发服务 (EMS) 所支持的那样，所传输和 /

EX1002 - Page 1177

或所接收的即时消息可以包括图形、照片、音频文件、视频文件和/或其他附件。如本文中所使用的，“即时消息收发”指代基于电话的消息（例如，使用 SMS 或 MMS 发送的消息）和基于因特网的消息（例如，使用 XMPP、SIMPLE 或 IMPS 的消息）。

[0103] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132、文本输入模块 134、GPS 模块 135、地图模块 154 和音乐播放器模块，锻炼支持模块 142 包括用于创建锻炼（例如，具有时间、距离和/或卡路里燃烧目标）；与锻炼传感器（运动设备）通信；接收锻炼传感器数据；校准用于监视锻炼的传感器；选择并且播放用于锻炼的音乐；以及显示、存储并且传输锻炼数据的可执行指令。

[0104] 结合触摸屏 112、显示器控制器 156、（一个或多个）光学传感器 164、光学传感器的控制器 158、接触/运动模块 130、图形模块 132 和图像管理模块 144，相机模块 143 包括用于捕获静态图像或视频（包括视频流）并且将它们存储到存储器 102 中，修改静态图像或视频的特性，或者从存储器 102 中删除静态图像或视频的可执行指令。

[0105] 结合触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132、文本输入模块 134 和相机模块 143，图像管理模块 144 包括用于布置、修改（例如，编辑）、或操纵、标注、删除、呈现（例如，在数字幻灯片演示或相册中）、以及存储静态和/或视频图像的可执行指令。

[0106] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132 和文本输入模块 134，浏览器模块 147 包括用于根据用户指令浏览因特网（包括搜索、链接、接收和显示网页或网页的多个部分以及与被链接到网页的附件和其他文件）的可执行指令。

[0107] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132、文本输入模块 134、电子邮件客户端模块 140 和浏览器模块 147，日历模块 148 包括用于根据用户指令创建、显示、修改和存储日历和与日历相关联的数据（例如，日历条目、待办事项列表等）的可执行指令。

[0108] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132、文本输入模块 134 和浏览器模块 147，微件模块 149 是可以由用户下载和使用的小型应用（例如，天气微件 149-1、股票微件 149-2、计算器微件 149-3、闹钟微件 149-4 和词典微件 149-5），或者由用户创建的小型应用（例如，用户创建的微件 149-6）。在一些实施例中，微件包括 HTML（超文本标记语言）文件、CSS（层叠样式表）文件和 JavaScript 文件。在一些实施例中，微件包括 XML（可扩充标记语言）文件和 JavaScript 文件（例如，Yahoo ! 微件）。

[0109] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132、文本输入模块 134 和浏览器模块 147，微件创建器模块 150 可以由用户用于创建微件（例如，将网页的用户指定部分转变成微件）。

[0110] 结合触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132 和文本输入模块 134，搜索模块 151 包括用于根据用户指示搜索存储器 102 中与一条或多条搜索准则（例如，一个或多个用户指定的搜索项）匹配的文本、音乐、声音、图像、视频和/或其他文件的可执行指令。

[0111] 结合触摸屏 112、显示器控制器 156、接触/运动模块 130、图形模块 132、音频电路

EX1002 - Page 1178

装置 110、扬声器 111、RF 电路装置 108 以及浏览器模块 147，视频和音乐播放器模块 152 包括允许用户下载和回放录制的音乐以及以一个或多个文件格式存储的其他声音文件（诸如 MP3 或 AAC 文件）的可执行指令，并且包括用于（例如，在触摸屏 112 上或在经由外部端口 124 外部连接的显示器上）显示、呈现或者另外回放视频的可执行指令。在一些实施例中，设备 100 可选地包括诸如 iPod(Apple 公司的商标）的 MP3 播放器的功能。

[0112] 结合触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132 和文本输入模块 134，备忘录模块 153 包括根据用户指示创建并管理备忘录、待办事项列表等的可执行指令。

[0113] 结合 RF 电路装置 108、触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132、文本输入模块 134、GPS 模块 135 和浏览器模块 147，地图模块 154 可以用于根据用户指示接收、显示、修改和存储地图以及与地图相关联的数据（例如，驾驶方向；关于在特定位置或附近的商店及其他兴趣点的数据；以及其他基于位置的数据）。

[0114] 结合触摸屏 112、显示器控制器 156、接触 / 运动模块 130、图形模块 132、音频电路装置 110、扬声器 111、RF 电路装置 108、文本输入模块 134、电子邮件客户端模块 140 和浏览器模块 147，在线视频模块 155 包括允许用户访问、浏览、接收（例如，通过流传输和 / 或下载）、（例如，在触摸屏上或在经由外部端口 124 外部连接的显示器上）回放特定在线视频、发送具有到特定在线视频链接的电子邮件并且管理诸如 H.264 之类的一个或多个文件格式的在线视频的指令。在一些实施例中，即时消息收发模块 141 而不是电子邮件客户端模块 140 被用于发送到特定在线视频的链接。在线视频应用的附加描述可以在以下专利申请中找到：2007 年 6 月 20 日提交的第 60/936,562 号美国临时专利申请“Portable Multifunction Device, Method, and Graphical User Interface for Playing Online Videos”，以及 2007 年 12 月 31 日提交的第 11/968,067 号美国专利申请“Portable Multifunction Device, Method, and Graphical User Interface for Playing Online Videos,”，其内容通过引用整体并入于此。

[0116] 上述模块和应用的每一个均对应于用于执行上文所述的一个或多个功能以及本申请中描述的方法（例如，本文所述的计算机实现方法以及其他信息处理方法）的指令集。这些模块（例如，指令集）不需要作为单独的软件程序、过程或模块来实现，因此这些模块的各种子集可以在各实施例中组合或者重新布置。例如，视频播放器模块可以与音乐播放器模块组合为单个模块（例如，图 1A 的视频和音乐播放器模块 152）。在一些实施例中，存储器 102 可以存储上述模块和数据结构的子集。此外，存储器 102 可以存储上文未描述的其他模块和数据结构。

[0116] 在一些实施例中，设备 100 是专门通过触摸屏和 / 或触摸板来执行设备上的预定义的功能集合的操作的设备。通过将触摸屏和 / 或触摸板用作操作设备 100 的主要输入控制设备，可以减少设备 100 上的物理输入控制设备（诸如下压按钮、拨号盘等）的数目。

[0117] 专门通过触摸屏和 / 或触摸板执行的该预定义的功能集合可选地包括用户界面之间的导航。在一些实施例中，当被用户触摸时，触摸板将设备 100 从在设备 100 显示上的任意用户界面导航到主屏幕、主画面或根菜单。在此类实施例中，“菜单按钮”使用触摸板进行实施。在一些其他实施例中，菜单按钮是物理下压按钮或其他物理输入控制设备而不是触摸板。

EX1002 - Page 1179

EX1002 - Page 1180

[0118] 图 1B 是图示根据一些实施例用于事件处理的示例性部件的框图。在一些实施例中，存储器 102（在图 1A）或存储器 370（图 3）包括事件分类器 170（例如，在操作系统 126 中）和相应的应用 136-1（例如，任意前述应用 137-151、155、380-390）。

[0119] 事件分类器 170 接收事件信息，并且确定应用 136-1 以及应用 136-1 中向其递送该事件信息的应用视图 191。事件分类器 170 包括事件监视器 171 和事件分派器（event dispatcher）模块 174。在一些实施例中，应用 136-1 包括应用内部状态 192，其指示当应用活跃或正在执行时触敏显示器 112 上显示的（一个或多个）当前应用视图。在一些实施例中，设备 / 全局内容状态 157 由事件分类器 170 用于确定哪个哪些应用当前是活跃的，并且应用内部状态 192 由事件分类器 170 用于确定向其递送事件信息的应用视图 191。

[0120] 在一些实施例中，应用内部状态 192 包括附加信息，诸如以下各项中的一个或多个：当应用 136-1 恢复执行时要使用的恢复信息，指示应用 136-1 正在显示或准备显示的信息的用户界面状态信息，使用户能够回到应用 136-1 的前一状态或视图的状态队列，以及由用户采取的先前动作的重做 / 撤销队列。

[0121] 事件监视器 171 从外围设备接口 118 接收事件信息。事件信息包括关于子事件（例如，作为多点触摸手势的一部分的触敏显示器 112 上的用户触摸）的信息。外围设备接口 118 传输其从 I/O 子系统 106 或传感器，诸如接近传感器 166、（一个或多个）加速度计 168 和 / 或麦克风 113（通过音频电路装置 110）接收的信息。外围设备接口 118 从 I/O 子系统 106 接收的信息包括来自触敏显示器 112 或触敏表面的信息。

[0122] 在一些实施例中，事件监视器 171 以预定间隔向外围设备接口 118 发送请求。作为响应，外围设备接口 118 发送事件信息。在其他实施例中，只在发生重要事件（例如，接收到超过预定噪声阈值和 / 或长于预定持续时间的输入）时，外围设备接口 118 才发送事件信息。

[0123] 在一些实施例中，事件分类器 170 还包括命中视图确定模块 172 和 / 或活跃事件识别器确定模块 173。

[0124] 命中视图确定模块 172 提供用于在触敏显示器 112 显示多于一个视图时，确定子事件已经在一个或多个视图中何处发生的软件程序。视图由用户在显示器上可以看到的控件和其他元件组成。

[0125] 与应用相关联的用户界面的另一方面是一组视图，在本文中有时被称为应用视图或用户界面窗口，其中显示信息并且发生基于触摸的手势。其中检测到触摸的（相应应用的）应用视图可以对应于该应用的程序或视图层次结构中的程序层级。例如，在其中检测到触摸的最低层级视图可被称为命中视图，并且可以至少部分基于开始基于触摸的手势的初始触摸的命中视图，来确定被识别为正确输入的事件集。

[0126] 命中视图确定模块 172 接收与基于触摸的手势的子事件有关的信息。当应用具有以层次结构组织的多个视图时，命中视图确定模块 172 将该层次结构中应当处理该子事件的最低层视图标识为命中视图。在大部分情况下，命中视图是其中发生了发起子事件（例如，子事件序列中形成事件或潜在事件的第一个子事件）的最低层级的视图。一旦由命中视图确定模块 172 标识命中视图，该命中视图通常接收与使其被标识为命中视图的相同触摸或输入源有关的所有子事件。

[0127] 活跃事件识别器确定模块 173 确定视图层次结构中的哪个视图或哪些视图应当

接收特定子事件序列。在一些实施例中，活跃事件识别器确定模块 173 确定只有命中视图应当接收特定子事件序列。在其他实施例中，活跃事件识别器确定模块 173 确定包括子事件的物理位置在内的所有视图都是主动参与的视图，并且因此确定所有主动参与的视图都应当接收特定子事件序列。在其他实施例中，即使触摸子事件被完全限定到与一个特定视图相关联的区域，层次结构中更高的视图将仍然保持作为主动参与的视图。

[0128] 事件分派器模块 174 将事件信息分派至事件识别器（例如，事件识别器 180）。在包括活跃事件识别器确定模块 173 的实施例中，事件分派器模块 174 将事件信息递送至由活跃事件识别器确定模块 173 确定的事件识别器。在一些实施例中，事件分派器模块 174 将事件信息存储在事件队列中，由相应的事件接收器 182 进行检索。

[0129] 在一些实施例中，操作系统 126 包括事件分类器 170。备选地，应用 136-1 包括事件分类器 170。在其他实施例中，事件分类器 170 是单独模块，或者是存储器 102 中存储的另一模块（诸如接触 / 运动模块 130）的一部分。

[0130] 在一些实施例中，应用 136-1 包括多个事件处理机 190 以及一个或多个应用视图 191，其中每一个都包括用于处理发生在该应用的用户界面的相应视图内的触摸事件的指令。应用 136-1 的每个应用视图 191 包括一个或多个事件识别器 180。通常，相应的应用视图 191 包括多个事件识别器 180。在其他实施例中，一个或多个事件识别器 180 是单独模块（诸如用户界面套件（未示出））的一部分，或者应用 136-1 从中继承方法和其他属性的更高层对象。在一些实施例中，相应事件处理机 190 包括以下各项中的一个或多个：数据更新器 176、对象更新器 177、GUI 更新器 178 和 / 或从事件分类器 170 接收的事件数据 179。事件处理机 190 可以利用或调用数据更新器 176、对象更新器 177 或 GUI 更新器 178 来更新应用内部状态 192。备选地，应用视图 191 中的一个或多个包括一个或多个相应事件处理机 190。同样，在一些实施例中，数据更新器 176、对象更新器 177 和 GUI 更新器 178 中的一个或多个包括在相应的应用视图 191 中。

[0131] 相应的事件识别器 180 从事件分类器 170 接收事件信息（例如，事件数据 179），并基于该事件信息标识事件。事件识别器 180 包括事件接收器 182 和事件比较器 184。在一些实施例中，事件识别器 180 还包括至少以下各项的子集：元数据 183 和事件递送指令 188（其可以包括子事件递送指令）。

[0132] 事件接收器 182 从事件分类器 170 接收事件信息。该事件信息包括关于子事件（例如，触摸或触摸移动）的信息。取决于子事件，事件信息还包括附加信息，诸如子事件的位置。当子事件涉及触摸的运动时，事件信息还可以包括子事件的速率和方向。在一些实施例中，事件包括设备从一个定向到另一个定向的旋转（例如，从纵向到横向的旋转，反之亦然），并且事件信息包括关于设备的当前定向（也被称作设备姿态）的对应信息。

[0133] 事件比较器 184 将事件信息与预定义的事件或子事件定义进行比较，并且基于该比较来确定事件或子事件，或者确定或更新事件或子事件的状态。在一些实施例中，事件比较器 184 包括事件定义 186。该事件定义 186 包含事件（例如，预定义的子事件序列）的定义，例如，事件 1（187-1）、事件 2（187-2）等等。在一些实施例中，事件 187 中的子事件例如包括触摸开始、触摸结束、触摸移动、触摸取消和多点触摸。在一个示例中，事件 1（187-1）的定义是对显示对象的双叩击。该双叩击例如包括对显示对象的、预定阶段的第一触摸（触摸开始）、预定阶段的第一抬起（触摸结束）、对显示对象的、预定阶段的第二触摸（触摸开

EX1002 - Page 1181

始）以及预定阶段的第二抬起（触摸结束）。在另一示例中，事件 2(187-2) 的定义是对显示对象的拖拽。该拖拽例如包括对显示对象的、预定阶段的触摸（或接触）、该触摸在触敏显示器 112 上的移动以及触摸的抬起（触摸结束）。在一些实施例中，事件还包括用于一个或多个相关联的事件处理机 190 的信息。

[0134] 在一些实施例中，事件定义 187 包括针对相应用户界面对象的事件的定义。在一些实施例中，事件比较器 184 执行命中测试，以确定与子事件相关联的用户界面对象。例如，在其中三个用户界面对象被显示在触敏显示器 112 上的应用视图中，当在触敏显示器 112 上检测到触摸时，事件比较器 184 执行命中测试，以确定三个用户界面对象中的哪个用户界面对象与该触摸（子事件）相关联。如果每个显示对象均与相应的事件处理机 190 相关联，则事件比较器使用该命中测试的结果来确定哪个事件处理机 190 应当被激活。例如，事件比较器 184 选择与触发该命中测试的子事件和对象相关联的事件处理机。

[0135] 在一些实施例中，相应事件 (187) 的定义还包括延迟动作，其延迟事件信息的递送，直到已经确定子事件序列是否与事件识别器的事件类型相对应。

[0136] 当相应事件识别器 180 确定子事件序列不与事件定义 186 中的任意事件匹配时，该相应的事件识别器 180 进入事件不可能、事件失败或者事件结束状态，此后该相应的事件识别器 180 忽视基于触摸的手势的后续子事件。在此情况下，对于命中视图保持活跃的其他事件识别器（如果有的话），继续跟踪和处理正在进行的基于触摸的手势的子事件。

[0137] 在一些实施例中，相应事件识别器 180 包括具有可配置的属性、标志 (flag) 和 / 或列表的元数据 183，其指示事件递送系统应当如何执行去往主动参与的事件识别器的子事件传递。在一些实施例中，元数据 183 包括可配置的属性、标志和 / 或列表，其指示事件识别器如何可以或者能够彼此交互。在一些实施例中，元数据 183 包括可配置的属性、标志和 / 或列表，其指示子事件是否被递送到视图或程序层次结构中的不同层级。

[0138] 在一些实施例中，相应事件识别器 180 在事件的一个或多个特定子事件被识别时激活与事件相关联的事件处理机 190。在一些实施例中，相应事件识别器 180 向事件处理机 190 递送与事件相关联的事件信息。激活事件处理机 190 不同于向相应的命中视图发送（或延迟发送）子事件。在一些实施例中，事件识别器 180 抛出与识别事件相关联的标志，并且与该标志相关联的事件处理机 190 抓住该标志并执行预定义过程。

[0139] 在一些实施例中，事件递送指令 188 包括子事件递送指令，其递送关于子事件的事件信息而不激活事件处理机。相反，子事件递送指令向与一系列子事件或主动参与的视图相关联的事件处理机递送事件信息。与一系列子事件或主动参与的视图相关联的事件处理机接收该事件信息并执行预定过程。

[0140] 在一些实施例中，数据更新器 176 创建并更新应用 136-1 中使用的数据。例如，数据更新器 176 更新联系人模块 137 中使用的电话号码，或者存储视频播放器模块 145 中使用的视频文件。在一些实施例中，对象更新器 177 创建并更新应用 136-1 中使用的数据。例如，对象更新器 177 创建新的用户界面对象或更新用户界面对象的位置。GUI 更新器 178 更新 GUI。例如，GUI 更新器 178 准备显示器信息，并且将其发送至图形模块 132 用于在触敏显示器上显示。

[0141] 在一些实施例中，（一个或多个）事件处理机 190 包括或能够访问数据更新器 176、对象更新器 177 和 GUI 更新器 178。在一些实施例中，数据更新器 176、对象更新器 177

EX1002 - Page 1182

和GUI更新器178被包括在相应的应用136-1或应用视图191的单个模块中。在其他实施例中，数据更新器176、对象更新器177和GUI更新器178被包括在两个或更多软件模块中。

[0142] 应当理解，前面关于触敏显示器上的用户触摸的事件处理的论述也适用于操作具有输入设备的多功能设备100的其他形式的用户输入，其中不是所有用户输入都是在触摸屏上发起的，例如，与单个或多个键盘按压或保持可选地相配合的鼠标移动和鼠标按钮按压；触控板上的接触运动（诸如叩击、拖拽、滚动等）；触笔输入，设备的移动；语音指令；检测到的眼睛运动，生物计量输入；和/或上述各项的任何组合，都可选地用作与定义要被识别的事件的子事件相对应的输入。

[0143] 图2图示了根据一些实施例的具有触摸屏112的便携式多功能设备100。触摸屏在用户界面(UI)200内可选地显示一个或多个图形。在该实施例以及如下所述的其他实施例中，用户能够通过对图形做出手势（例如用一个或多个手指202（在图中未按比例绘制）或一个或多个触笔（在图中未按比例绘制））来选择一个或多个图形。在一些实施例中，对一个或多个图形的选择发生在用户中断与一个或多个图形接触时。在一些实施例中，手势可选地包括一个或多个叩击、一个或多个轻扫（从左到右、从右到左、向上和/或向下）和/或已经与设备100接触的手指的转动（从右到左、从左到右、向上和/或向下）。在一些实现方式或者情况中，与图形的无意接触不会选择图形。例如，当与选择对应的手势是叩击时，扫过应用图标的轻扫手势可选地不会选择对应的应用。

[0144] 设备100还可以包括一个或多个物理按钮，诸如“主画面”或菜单按钮204。如前所述，菜单按钮204可以用于导航至可以在设备100上执行的应用集合中的任何应用136。备选地，在一些实施例中，菜单按钮被实施为触摸屏112上显示的GUI中的软按键。

[0145] 在一些实施例中，设备100包括触摸屏112、菜单按钮204、用于打开/关闭设备电源和锁定设备的下压按钮206、以及（一个或多个）音量调节按钮208、订户标识模块(SIM)卡槽210、耳机插孔212和对接/充电外部端口124。下压按钮206可选地用于通过压下该按钮并使该按钮保持在压下状态预定义的时间间隔来打开/关闭设备电源；通过压下该按钮并在经过预定义的时间间隔之前释放该按钮来锁定设备；和/或解锁设备或发起解锁过程。在一个备选实施例中，设备100还通过麦克风113接受用于激活或去激活某些功能的语音输入。设备100可选地还包括用于在触摸屏112上检测接触强度的一个或者多个接触强度传感器165和/或用于生成对设备100的用户的触觉输出的一个或者多个触觉输出生成器167。

[0146] 图3是根据一些实施例具有显示器和触敏表面的示例性多功能设备的框图。设备300不必是便携式的。在一些实施例中，设备300是膝上型计算机、台式计算机、平板计算机、多媒体播放器设备、导航设备、教育设备（诸如儿童学习玩具）、游戏系统或控制设备（例如，家用或工业控制器）。设备300通常包括一个或多个处理单元(CPU)310、一个或多个网络或其他通信接口360、存储器370、以及用于互连这些部件的一个或多个通信总线320。通信总线320可选地包括互连和控制系统部件之间通信的电路装置（有时被称作芯片组）。设备300包括含有显示器340（其通常为触摸屏显示器）的输入/输出(I/O)接口330。输入/输出接口330也可选地包括键盘和/或鼠标（或其他定点设备）350和触摸板355、用于在设备300上生成触觉输出的触觉输出生成器357（例如，类似于以上参考附图1A所描述的（一个或多个）触觉输出生成器167）、传感器359（例如，类似于以上参考附图1A所

EX1002 - Page 1183

描述的（一个或多个）接触强度传感器 165 的光学、加速度、接近、触敏和 / 或接触强度传感器）。存储器 370 包括高速随机存取存储器，诸如 DRAM、SRAM、DDR RAM 或其他随机存取固态存储设备；并且可选地包括非易失性存储器，诸如一个或多个磁盘存储设备、光盘存储设备、闪存设备或其他非易失性固态存储设备。存储器 370 可以可选地包括远离（一个或多个）CPU 310 的一个或多个存储设备。在一些实施例中，存储器 370 存储与在便携式多功能设备 100（图 1）的存储器 102 中存储的程序、模块、和数据结构类似的程序、模块、和数据结构或其子集。此外，存储器 370 可选地存储未存在于便携式多功能设备 100 的存储器 102 中的附加程序、模块、和数据结构。例如，设备 300 的存储器 370 可选地存储绘图模块 380、演示模块 382、文字处理模块 384、网站创建模块 386、盘编写模块 388 和 / 或电子表格模块 390，而便携式多功能设备 100（图 1A）的存储器 102 可选地不存储这些模块。

[0147] 图 3 中的上述元件的每个元件可以存储在一个或多个前述存储器设备中。上述模块中的每个模块对应于用于执行如上所述功能的指令集。上述模块或程序（例如，指令集）不需要实施为单独软件程序、过程或模块，因此这些模块的各种子集可以在各实施例中组合或以其他方式被重新布置。在一些实施例中，存储器 370 可以存储上述模块和数据结构的子集。此外，存储器 370 可以存储上文未描述的附加模块和数据结构。

[0148] 现在把注意力转向可以在例如便携式多功能设备 100 上实施的用户界面的实施例。

[0149] 图 4A 图示了根据一些实施例用于便携式多功能设备 100 上的应用菜单的示例性用户界面。类似用户界面可以在设备 300 上实施。在一些实施例中，用户界面 400 包括以下元件或其子集或超集：

[0150] • 信号强度指示符 402，用于（多种）无线通信，诸如蜂窝信号和 Wi-Fi 信号；

[0151] • 时间 404；

[0152] • 蓝牙指示符 405；

[0153] • 电池状态指示符 406；

[0154] • 托盘 408，具有以下频繁使用的应用的图标，诸如：

[0155] o 用于电话模块 138 的图标 416，标记为“电话”，其可选地包括未接呼叫或语音邮件消息的数目的指示符 414；

[0156] o 用于电子邮件客户端模块 140 的图标 418，标记为“邮件”，其可选地包括未读电子邮件的数目的指示符 410；

[0157] o 用于浏览器模块 147 的图标 420，标记为“浏览器”；以及

[0158] o 用于视频和音乐播放器模块 152 的图标 422，也被称为 iPod（Apple 公司的商标）模块 152，标记为“iPod”；以及

[0159] • 用于其他应用的图标，诸如：

[0160] o 用于 IM 模块 141 的图标 424，标记为“消息”；

[0161] o 用于日历模块 148 的图标 426，标记为“日历”；

[0162] o 用于图像管理模块 144 的图标 42，标记为“照片”；

[0163] o 用于相机模块 143 的图标 430，标记为“相机”；

[0164] o 用于在线视频模块 155 的图标 432，标记为“在线视频”；

[0165] o 用于股票微件 149-2 的图标 434，标记为“股票”；

[0166] o 用于地图模块 154 的图标 436，标记为“地图”；

[0167] o 用于天气微件 149-1 的图标 438，标记为“天气”；

[0168] o 用于闹钟微件 149-4 的图标 440，标记为“时钟”；

[0169] o 用于锻炼支持模块 142 的图标 442，标记为“锻炼支持”；

[0170] o 用于备忘录模块 153 的图标 444，标记为“备忘录”；

[0171] o 用于设置应用或者模块的图标 446，标记为“设置”，其提供对设备 100 及其各个应用 136 的设置的访问。

[0172] 应当理解图 4A 中所图示的图标标签仅为示例性的。例如，用于视频和音乐播放器模块 152 的图标 422 可以可选地被标记为“音乐”或“音乐播放器”。其他标签可选地用于各个应用图标。在一些实施例中，用于相应应用图标的标签包括对应于相应应用图标的应用的名称。在一些实施例中，特定应用图标的标签与对应于特定应用图标的应用的名称不同。

[0173] 图 4B 图示了具有与显示器 450（例如，触摸屏显示器 112）分离的触敏表面 451（例如，图 3 的平板或触摸板 355）的设备（例如，图 3 的设备 300）上的示例性用户界面。设备 300 还可选地包括用于在触敏表面 451 上检测接触强度的一个或者多个接触强度传感器（例如，传感器 357 中的一个或者多个传感器）和 / 或用于生成对设备 300 的用户的触觉输出的一个或者多个触觉输出生成器 359。

[0174] 虽然以下一些示例将针对在触摸屏显示器 112 上的输入给出（其中触敏表面与显示器组合在一起），但是如图 4B 所示在一些实施例中，设备检测与显示器分离的触敏表面上的输入。在一些实施例中，触敏表面（例如，图 4B 中的 451）具有对应于显示器（例如，450）上主轴（例如，图 4B 中的 453）的主轴（例如，图 4B 中的 452）。根据这些实施例，设备检测在对应于显示器上相应位置的位置处（例如，在图 4B 中，460 对应于 468 并且 462 对应于 470）的与触敏表面 451 的接触（例如，图 4B 中的 460 和 462）。通过此方式，当触敏表面与多功能设备的显示器（例如，图 4B 中的 450）分离时，设备在触敏表面（例如，图 4B 中的 451）上检测到的用户输入（例如，接触 460 和接触 462 及其移动）由设备使用以操纵多功能设备的显示器上的用户界面。应当理解，类似方法可选地用于本文所述的其他用户界面。

[0175] 此外，虽然以下示例主要参照手指输入（例如，手指接触、手指叩击手势、手指轻扫手势）给出，但是应当理解的是在一些实施例中，一个或多个手指输入可以被来自另一输入设备（例如，基于鼠标的输入或触笔输入）的输入替换。例如，轻扫手势可选地被鼠标点击（例如，而不是接触）随后沿轻扫路径移动光标（例如，而不是移动接触）替换。作为另一示例，叩击手势可选地当光标位于叩击手势的位置上（例如，而不是检测接触随后停止检测该接触）时被鼠标点击替换。类似地，当同时检测到多个用户输入时，应当理解多个计算机鼠标可选地被同时使用，或者鼠标和手指接触可选地被同时使用。

[0176] 图 5A 图示了示例性个人电子设备 500。设备 500 包括主体 502。在一些实施例中，设备 500 可以包括关于设备 100 和 300（例如，图 1A-4B）描述的特征中的一些或全部特征。在一些实施例中，设备 500 具有触敏显示屏 504，此后称为触摸屏 504。备选地，或者除了触摸屏 504 之外，设备 500 具有显示器和触敏表面。如同设备 100 和 300，在一些实施例中，触摸屏 504（或触敏表面）可以具有用于检测正在应用的接触（例如，触摸）的强度的一个或

EX1002 - Page 1185

多个强度传感器。该触摸屏 504(或触敏表面)的一个或多个强度传感器可以提供表示触摸的强度的输出数据。设备 500 的用户界面可以基于触摸的强度来对触摸进行响应,意味着不同强度的触摸可以调用设备 500 上的不同的用户界面操作。

[0177] 例如,用于检测和处理触摸强度的技术可以在以下相关申请中找到:2013 年 5 月 8 日提交、题为"Device,Method,and Graphical User Interface for Displaying User Interface Objects Corresponding to an Application"的国际专利申请序列号 PCT/US2013/040061 以及 2013 年 11 月 11 日提交的、题为"Device,Method,and Graphical User Interface for Transitioning Between Touch Input to Display Output Relationships"的国际专利申请序列号 PCT/US2013/069483,这些申请中的每个申请通过引用以其整体被并入于此。

[0178] 在一些实施例中,设备 500 具有一个或多个输入机构 506 和 508。输入机构 506 和 508(如果被包括)可以是物理的。物理输入机构的示例包括推动按钮和旋转机构。在一些实施例中,设备 500 具有一个或多个附接机构。这样的附接机构(如果被包括)可以允许设备 500 与例如,帽子、眼镜、耳饰、项链、衬衫、夹克、手链、表带、链条、裤子、皮带、鞋子、手提包,背包等附接。这些附接机构可以允许设备 500 被用户穿戴。

[0179] 图 5B 描绘了示例性个人电子设备 500。在一些实施例中,设备 500 可以包括关于图 1A、图 1B 和图 3 描述的部件中的一些或全部部件。设备 500 具有总线 512,其将 I/O 部分 514 与一个或多个计算机处理器 516 和存储器 518 操作地耦合。I/O 部分 514 可以连接到显示器 504,显示器 504 可以具有触敏部件 522 以及可选地触摸强度敏感 524。此外,I/O 部分 514 可以与通信单元 530 连接以用于使用 Wi-Fi、蓝牙、近场通信(NFC)、蜂窝和/或其他无线通信技术接收应用和操作系统数据。设备 500 可以包括输入机构 506 和/或 508。例如,输入机构 506 可以是可旋转的输入设备或者可按压和可旋转的输入设备。在一些示例中,输入机构 508 可以是按钮。

[0180] 在一些示例中,输入机构 508 可以是麦克风。个人电子设备 500 可以包括各种传感器,诸如 GPS 传感器 532、加速度计 534、方向传感器 540(例如,指南针)、陀螺仪 536、运动传感器 538 和/或它们的组合,所有这些设备可以操作地连接至 I/O 部分 514。

[0181] 个人电子设备 500 的存储器 518 可以是非瞬态计算机可读存储介质,用于存储计算机可执行指令,该指令当由一个或多个计算机处理器 516 执行时,例如,可以使得计算机处理器执行以上描述的技术,包括过程 1000-1200(图 10A-10C、图 11 和图 12)。计算机可执行指令还可以在任何非瞬态计算机可读介质内被存储和/或传输,以便由指令执行系统、装置或设备使用或者结合指令执行系统、装置或设备使用,该指令执行系统、装置或设备诸如基于计算机的系统、包含处理器的系统或者可以从指令执行系统、装置或设备中取指令并且执行该指令的其他系统。出于本文档的目的,"非瞬态计算机可读存储介质"可以是能够有形地包含或存储计算机可执行指令以便由指令执行系统、装置或设备使用或者结合指令执行系统、装置或设备使用的任何介质。非瞬态计算机可读存储介质可以包括但不限于,磁存储装置、光存储装置和/或半导体存储装置。这样的存储装置的示例包括磁盘、基于 CD、DVD、或蓝光技术的光盘,以及永久固态存储器,诸如闪存、固态驱动器等。个人电子设备 500 不限于图 5B 的部件和配置,而是可以包括具有多种配置的其他或附加的部件。

[0182] 如这里所使用的,术语"可供件"指代可以被显示在设备 100、300 和/或 500(图

EX1002 - Page 1186

1、图 3 和图 5）的显示屏上的用户交互图形用户界面对象。例如，图像（例如，图标）、按钮以及文本（例如超链接）可以各自组成可供件。

[0183] 如本文所使用的，术语“焦点选择器”指代指示用户正与其交互的用户界面的当前部分的输入元素。在包括光标或者其他位置标记的一些实现方式中，光标充当“焦点选择器”，使得当光标在特定用户界面元素（例如，按钮、窗口、滑块或者其他用户界面元素）之上的同时在触敏表面（例如，图 3 中的触摸板 355 或者图 4B 中的触敏表面 451）上检测到输入（例如，按压输入）时，根据检测到的输入来调整特定用户界面。在包括实现与触摸屏显示器上的用户界面元素直接交互的触摸屏显示器（例如，图 1A 中的触敏显示器系统 112 或者图 4A 中的触摸屏 112）的实现方式中，触摸屏上的检测到的接触充当“焦点选择器”，使得当在触摸屏显示器上在特定用户界面元素（例如，按钮、窗口、滑块或者其他用户界面元素）的位置处检测到输入（例如，通过接触的按压输入）时，根据检测到的输入来调整特定用户界面元素。在一些实现方式中，在触摸屏显示器上没有对应的光标的移动或者接触的移动的情况下（例如，通过使用跳格键或者箭头键以将焦点从一个按钮移动到另一按钮），将焦点从用户界面的一个区域移动到用户界面的另一个区域；在一些实现方式中，焦点选择器根据用户界面的不同区域之间的焦点的移动而移动。不考虑由焦点选择器采取的特定形式，焦点选择器通常是由用户控制的用户界面元素（或者触摸屏显示器上的接触），以便与用户界面通信用户的意在的交互（例如，通过向设备指示用户意在与其交互的用户界面的元素）。例如，在触敏表面（例如，触摸板或者触摸屏）上检测到按压输入时，在相应的按钮之上的焦点选择器（例如，光标、接触或者选择框）的位置将指示用户意在激活相应的按钮（而不是设备的显示器上示出的其它用户界面元素）。

[0184] 如在说明书和权利要求中所使用的，术语接触的“特性强度”指代基于一个或者多个接触强度的接触的特性。在一些实施例中，特性强度基于多个强度样本。特性强度可选地基于预定义数目的强度样本、或者在相对于预定义的事件（例如，在检测到接触之后、在检测到接触的抬起之前、在检测到接触的移动的开始之前或者之后、和 / 或在检测到接触的强度的减小之前或者之后）的预定时间段期间（例如，0.05 秒、0.1 秒、0.2 秒、0.5 秒、1 秒、2 秒、5 秒、10 秒）收集的强度样本的集合。接触的特性强度可选地基于以下各项中的一项或者多项：接触的强度的最大值、接触的强度的平均值、接触的强度的均值、接触的强度的最高 10％数值、接触的强度的半高值、接触的强度的 90％最大处的值等。在一些实施例中，接触的持续时间用于确定特性强度（例如，当特性强度是随时间变化的接触的强度的平均值）。在一些实施例中，将特性强度与一个或者多个强度阈值的集合进行比较，以确定是否已经由用户执行操作。例如，一个或者多个强度阈值的集合可以包括第一强度阈值和第二强度阈值。在该示例中，具有不超过第一阈值的特性强度的接触导致第一操作，具有超过第一阈值并且不超过第二阈值的特性强度的接触导致第二操作，并且具有超过第二阈值的特性强度的接触导致第三操作。在一些实施例中，特性强度与一个或者多个阈值之间比较用于确定是否执行一个或者多个操作（例如，是否执行相应的操作或者放弃执行相应的操作），而不被用于确定是执行第一操作还是执行第二操作。

[0185] 在一些实施例中，为了确定特性强度的目的，标识手势中的一部分手势。例如，触敏表面可以接收从开始位置转变到达结束位置的连续的轻扫接触，在结束位置的点处接触的强度增加。在该示例中，在结束位置处的接触的特性强度可以仅基于连续的轻扫接触的

EX1002 - Page 1187

一部分而不是基于整个轻扫接触（例如，仅结束位置处的轻扫接触的部分）。在一些实施例中，在确定接触的特性强度之前，可以将平滑算法应用于轻扫接触的强度。例如，平滑算法可选地包括以下各项中的一项或者多项：未加权的滑动平均平滑算法、三角平滑算法、中值滤波平滑算法、和/或指数平滑算法。在一些情况下，为了确定特性强度的目的，这些平滑算法消除了轻扫接触的强度的狭窄的峰值（spike）和谷值（dip）。

[0186] 触敏表面上接触的强度可以相对于一个或者多个强度阈值而被表征，诸如接触检测强度阈值、轻按压强度阈值、深按压强度阈值、和/或一个或者多个其他强度阈值。在一些实施例中，轻按压强度阈值对应于在其处设备将执行通常与点击物理鼠标或者触控板的按钮相关联的操作的强度。在一些实施例中，深按压强度阈值对应于在其处设备将执行不同于通常与点击物理鼠标或者触控板的按钮相关联的操作的强度。在一些实施例中，当检测到具有低于轻按压强度阈值（例如，并且高于正常接触检测强度阈值，其中低于正常接触检测强度阈值时，接触将不再被检测）的特性强度的接触时，设备将根据触敏表面上的接触的移动来移动焦点选择器，而不执行与轻按压强度阈值或者深按压强度阈值相关联的操作。总之，除非另外陈述，否则这些强度阈值在用户界面图的不同集合之间是一致的。

[0187] 从低于轻按压强度阈值的强度到在轻按压强度阈值与深按压强度阈值之间的强度的接触的特性强度的增加有时被称为“轻按压”输入。从低于深按压强度阈值的强度到高于深按压强度阈值的强度的接触的特性强度的增加有时被称为“深按压”输入。从低于接触检测强度阈值的强度到在接触检测强度阈值与轻按压强度阈值之间的强度的接触的特性强度的增加有时被称为检测触摸表面上的接触。从高于接触检测强度阈值的强度到低于接触检测强度阈值的强度的接触的特性强度的减少有时被称为检测从触摸表面的接触的抬起。在一些实施例中，接触检测强度阈值为零。在一些实施例中，接触检测强度阈值大于零。

[0188] 在本文所描述的一些实施例中，响应于检测到包括相应的按压输入的手势或者响应于检测到利用相应的接触（或者多个接触）执行的相应的按压输入，执行一个或者多个操作，其中至少部分地基于检测到接触（或者多个接触）的强度增加至高于按压输入强度阈值，检测相应的按压输入。在一些实施例中，响应于检测到相应的接触的强度增加至高于按压输入强度阈值（例如，相应的按压输入的“向下笔画（stroke）”），执行相应的操作。在一些实施例中，按压输入包括相应的接触的强度增加至高于按压输入强度阈值和接触的强度随后减少至低于按压输入强度阈值，并且响应于检测到相应的接触的强度随后减少至低于按压输入阈值（例如，相应的按压输入的“向上笔画”），执行相应的操作。

[0189] 在一些实施例中，设备采用强度迟滞以避免有时被称为“抖动”的意外输入，其中设备定义或者选择与按压输入强度阈值具有预定义的关系的迟滞强度阈值（例如，迟滞强度阈值低于按压输入强度阈值的X个强度单位，或者迟滞强度阈值是按压输入强度阈值的75%、90%、或者一些合理比例）。因此，在一些实施例中，按压输入包括相应的接触的强度增加至高于按压输入强度阈值和接触的强度随后减少至低于对应于按压输入强度阈值的迟滞强度阈值，并且响应于检测到相应的接触的强度的随后减少至低于迟滞强度阈值（例如，相应的按压输入的“向上笔画”），执行相应的操作。类似地，在一些实施例中，仅当设备检测到接触的强度从处于或者低于迟滞强度阈值增加到处于或者高于按压输入强度阈值，并且可选地接触的强度随后减少到处于或者低于迟滞强度时，检测按压输入，并且响应于

EX1002 - Page 1188

检测到按压输入（例如，接触的强度的增加或者接触的强度的减少，这取决于环境），执行相应的操作。为了便于解释，响应于与按压输入强度阈值相关联的按压或者响应于包括按压输入的手势执行的操作的描述可选地响应于检测到以下任何一项而被触发：接触的强度增加至高于按压输入强度阈值、接触的强度从低于迟滞强度阈值的强度增加到高于按压输入强度阈值的强度、接触的强度减少至低于按压输入强度阈值、和/或接触的强度减少至低于对应于按压输入强度阈值的迟滞强度阈值。此外，在操作被描述为响应于检测到接触的强度减少至低于按压输入强度阈值而被执行的示例中，操作可选地响应于检测到接触的强度减少至低于对应于并且低于按压输入强度阈值的迟滞强度阈值而被执行。

[0190] 如本文所使用的，“安装的应用”指代已经被下载到电子设备（例如，设备100、300和/或500）上并且已经准备好在设备上被启动（例如，变成打开）的软件。在一些实施例中，通过从下载包提取程序部分并且将提取的部分与计算机系统的操作系统整合的安装程序的方式，下载的应用变成安装的应用。

[0191] 如本文所使用的，术语“开放应用”或“执行的应用”指代具有保留状态信息（例如，作为设备/全局内部状态157/应用内部状态192的一部分）的软件应用。打开的或者执行的应用可以是以下类型的应用中的任何一种：

[0192] ·活跃应用，其当前被显示在应用正在其上被使用的设备的显示屏上；

[0193] ·后台应用（或后台进程），其当前没有被显示，但是用于该应用的一个或者多个进程正由一个或者多个处理器处理；以及

[0194] ·挂起或者休眠的应用，其没有在运行，但是具有被存储在存储器（分别地，易失性和非易失性）中并且可以用于恢复应用的执行的状态信息。

[0195] 如本文所使用的，术语“关闭的应用”指代不具有保留状态信息（例如，用于关闭的应用的状态信息没有被存储在设备的存储器中）的软件应用。因此，关闭应用包括停止和/或去除用于应用的应用进程并且从设备的存储器中去除应用应用的状态信息。通常，在第一应用中打开第二应用不会关闭第一应用。当第二应用被显示并且第一应用停止被显示时，第一应用变成后台应用。如本文所使用的，“启动”应用指代打开关闭的应用，以使得其变成活跃的开放应用。

[0196] 注意力现在转向可以在具有显示器和触敏表面的多功能设备（诸如，设备100、300和/或500（图1、图3和图5））上被实施以提供电子触摸通信功能的用户界面（“UI”）和相关联的过程。下面所描述的技术中的一个或者多个技术可以被称为“电子触摸”通信。

[0197] 1、示例性电子触摸通信

[0198] 图6A-6D描绘了在计算设备600与699的用户之间的示例性电子触摸通信。在一些实施例中，设备600和699中的每个设备是设备100、300或者500（图1、图3和图5）。为了清楚说明，图6A-6C中的图示的顶部对应于显示在设备600上的用户界面，图示的底部对应于显示在设备699上的用户界面。

[0199] 如所示出的，设备600显示具有用于启动设备上的各个模块的多个图标的用户界面602，包括图标604。图标604可以对应于闹钟应用，例如，这意味着当选择（例如，触摸）图标时，设备600启动对应的闹钟应用。设备600还具有输入机构606。在一些实施例中，输入机构606是按压按钮。

[0200] 当设备600检测按钮606的激活（例如，按压）时，设备600显示电话簿联系人用

EX1002 - Page 1189

户界面(UI)610。例如,电话簿联系人UI 610可以具有表示用户的朋友和家人的可供件。电话簿联系人UI 610中表示的联系人从对设备600可访问的应用数据被获得,诸如与电话或者日历应用相关联的数据。这样的数据可以被本地存储在设备上,被远程存储在同伴的蜂窝电话上、和/或被远程存储在"云"上。

[0201] 电话簿联系人UI 610可以被滚动和/或被缩放以揭示表示电话簿联系人的附加的可供件。例如,轻扫输入可以用于滚动电话簿联系人UI 610,并且收缩/去收缩输入可以用于缩放电话簿联系人UI 610。在一些实施例中,设备600具有可旋转输入机构,并且可旋转输入机构的移动使得电话簿联系人UI 610缩放(或者滚动)。在一些实施例中,在电话簿联系人UI 610上表示的联系人是对设备600可访问的电话簿联系人的全集中的子集。显示的子集可以表示之前已经由用户指定的联系人,例如,作为用户的"收藏",或者用户或系统定义的"白名单"或者"灰名单"。

[0202] 响应于对可供件611的选择,设备600显示联系人信息用户界面616,其提供关于所选的电话簿联系人的附加信息。在图示的示例中,显示了电话簿联系人的姓名617和图像620。在备选的实施例中,当联系人的图像不可用时,可以使用联系人的姓名生成首字母来提供系统生成的字母组合(monogram)。此外,联系人信息UI 616具有用于发起呼叫(音频和/或视频)的可供件618和用于发起针对电话簿联系人617的消息(例如,经由诸如SMS和MMS等的服务的短消息、经由诸如由加尼福尼亚州库比蒂诺的Apple公司提供的iMessage®等的服务的文本消息)的可供件619。

[0203] 响应于在显示联系人信息UI 616的同时检测到的用户输入,设备600转变到绘图区域630的显示(也被称为画布)。绘图区域630提供用于基于触摸的绘图的区域。在一些实施例中,用于调用绘图区域630的用户输入是电话簿联系人姓名617或者联系人图像620上的触摸。在一些实施例中,需要调用绘图区域630的用户输入是远离可供件618和619的联系人信息UI 616上的触摸。

[0204] 转到图6B,设备600检测绘图区域630中的用户输入632。用户输入632包括类似笑脸的轻扫移动。设备600显示对应于用户输入632的可视表示634。可视表示634在已经被显示一定时间量之后逐渐消失,如由虚线636所指示的。

[0205] 设备600向设备699发送表示输入632的数据。在一些实施例中,在自输入632以来预定的时间量已经过去之后,设备600发送数据。当输入632包括多个轻扫时,设备600可以等待直到在最后的轻扫之后、在发送数据之前预定时间量已经过去。在一些实施例中,数据的发送与可视表示634的淡出相协调。通过这种方式,可视表示634的淡出还有助于通知用户触摸通信已经被发送到设备699。

[0206] 在与电话簿联系人617相关联的外部设备699处,接收到传入的数据,并且提供向用户通知传入的通信的输出。在一些实施例中,设备699显示用于指示传入的通信的提醒638。在一些实施例中,设备699初始产生可听和/或触觉输出,并且在检测到设备的移动时(例如,诸如用户抬起或者拾起设备),提醒638变成显示的。在一些实施例中,在显示提醒638时,设备699产生可听和/或触觉输出。由于可穿戴电子设备699与其用户之间极为贴近—可能用户将感觉到触觉振动,因此,在这种情况下,触觉输出的使用特别有效。

[0207] 在查看提醒638时,用户可以接受或者拒绝查看传入通信。在一些实施例中,提醒638上的甲击输入,或者与看看提醒638超过阈值持续时间的持续时间的用户相关联的输

EX1002 - Page 1190

入（例如，加速度计输入或者照相机输入）指示接受。在接受时，设备 699 显示接收到的通信的可视表示。在一些实施例中，在接受查看通信时，设备 699 启动对应的电子触摸通信应用，并且显示用于示出传入绘图的绘图区域。在一些实施例中，在接受查看通信时，在不附加地启动电子触摸通信应用的情况下，设备 699 显示通信。在一些实施例中，提醒 638 上的轻扫（例如，向上或者向下）指示不予理会，并且作为响应，设备 699 不示出传入的通信。

[0208] 用于确定设备（诸如设备 699）何时被抬起或者被拾起到查看位置的技术在 2014 年 7 月 18 日提交的、题为“Raise Gesture Detection in a Device”的共同未决的美国临时专利申请序列号第 62/026,532 号中被描述。用于确定用户是否已经看着提醒超过阈值的持续时间的技术在 2014 年 9 月 2 日提交的、将 Lawrence Yang 等命名为发明人的、题为“REDUCED-SIZE INTERFACES FOR MANAGING ALERTS”的共同未决的美国临时专利申请中被描述。这些申请的内容通过引用将其整体并入于此。

[0209] 在图示的示例中，设备 699 检测用于查看通信的用户接受，并且作为响应，启动电子触摸通信应用以显示绘图区域 640。绘图区域 640 具有触摸输入 632 的可视表示 642。转到图 6C，可视表示 642 在被显示某些阈值持续时间之后逐渐消失，如由虚线 644 所描绘的。

[0210] 当显示绘图区域 640 时，设备 699 可以检测具有类似笑脸的轻扫的用户输入 650。作为响应，设备 699 显示检测到的输入 650 的可视表示 654。转到图 6D，在一段时间之后，设备 699 向设备 600 发送向设备 600 通知检测到的输入 650 的数据。设备 699 也淡出可视表示 654（如由虚线 656 所指示的）。由于设备 600 已经显示绘图区域 630，因此在从设备 699 接收到表示输入 650 的数据时，设备 650 显示输入 650 的可视表示 660（例如，笑脸）。通过这种方式，设备 600 和 699 的用户可以使用基于触摸的电子通信来彼此通信。

[0211] 在一些实施例中，由淡出所显示的可视表示的屏幕上的动画去除显示的笔画的可视表示。在一些实施例中，淡出从可视表示的一端到另一端而发生，这符合所表示的笔画的开始和结束。例如，可视表示 660（类似于笑脸）可以从左眼到右眼并且到嘴淡出，如以该顺序绘制的那样。

[0212] 在一些实施例中，轻扫输入的动力学被反应在其可视表示中。例如，如果输入 650 中的初始轻扫移动很快但是轻扫输入 650 中的后来移动很慢，则随着设备 600 渲染可视表示 660（并且随着设备 699 渲染可视表示 654），与指示在其中笔画被绘制的方式的动力学信息一致，首先快速显示笔画并且然后朝向结束缓慢地显示笔画。如另一示例，在可视表示 654 和 660 的显示期间，也表示轻扫输入 650 的移动中的抖动。动力学信息也可以被包括在设备 600 与 699 之间发送的数据中。

[0213] 在一些实施例中，随着在屏幕上显示轻扫输入的可视表示，反映轻扫输入的部分之间的暂停。例如，如果轻扫输入 650 的笑脸的眼睛被绘制有中间暂停，则眼睛被绘制有与它们在设备 600 和 699 上被显示的相同的中间暂停量（或者，成比例的暂停量）。

[0214] 在一些实施例中，绘图区域包括用于选择在显示轻扫输入的可视表示中使用的颜色的颜色选择机制。图 6E 图示了示例性颜色选择机制，被称为颜色拾取器。如所示出的，设备 600 正在显示具有颜色拾取器可供件 672 的绘图区域 670。虽然没有被示出，但是以当前颜色显示颜色拾取器可供件 672，这意味着在设备 600 与设备 699 二者中以可供件 672 的颜色来显示由设备 600 的用户绘制的笔画。

[0215] 用户可以选择颜色拾取器可供件 672 来显示颜色选择用户界面 680。颜色选择 UI

EX1002 - Page 1191

680 具有表示之前（例如，最近）使用的颜色的可供件。用户可以选择所显示的可供件中的一个可供件以将所表示的颜色选择作为当前绘图颜色。颜色选择 UI 680 可以包括用于调用调色板的可供件 682。响应于可供件 682 的用户选择，设备 600 显示为用户选择提供颜色的光谱的调色板用户界面 690。用户可以选择调色板 692 的一部分以将对应的颜色选择作为当前绘图颜色。

[0216] 在一些实施例中，设备 600 具有大于一个调色板用户界面。例如，调色板可以被分组，以用于经由附加的调色板用户界面进行呈现。如图 6E 中所示出的，调色板用户界面 690 可以具有用于指示可用的颜色的页数以及用于指示页面的集合内的当前页的顺序的分页指示符 694。在图示的示例中，在显示 UI 690 时，响应于第一方向或者第二方向（例如，水平轻扫）上的轻扫输入，设备 600 显示附加调色板用户界面 696。

[0217] 页面上的颜色的排序可以基于颜色的使用频率、颜色的使用新近性或者二者的结合。用户可以选择调色板 698 的一部分以将对应的颜色选择作为当前绘图颜色。在从调色板 UI 选择颜色时，设备 600 返回绘图区域 670。更新颜色拾取器可供件 672 以反映当前所选的颜色。

[0218] 暂时地回到图 6B-6D，在一些实施例中，颜色拾取器可供件提供附加的用户界面功能。如图 6C 中所描绘的，设备 699 有时在绘图区域 640 中显示颜色拾取器可供件 646，但是在其他时候隐藏颜色拾取器可供件 646。例如，在一些实施例中，当显示传入的通信（例如，可视表示 642）时，设备 699 没有示出颜色拾取器可供件。相反，在可视表示 642 已经逐渐消失（如经由虚线 644 所图示的）之后，示出颜色拾取器可供件 646。在这些实施例中，绘图区域中的颜色拾取器可供件的呈现向正接受触摸输入的用户发信号。再次重申，在这些实施例中，当显示传入的通信（例如，可视表示 642）时，设备暂时地停止接收绘图输入，以使得可以不间断地显示传入的通信。在某些时候，隐藏颜色拾取器可供件（例如，646），以指示至少对于绘图区域（例如，640）中的显示的表示，正在忽略绘图输入。

[0219] 作为另一示例，在一些实施例中，当用户目前正在绘图时，对传入的通信进行排队，以在当前绘图被发送之后进行显示。在这些实施例中，在发送绘图并且显示排队的绘图之后，在此期间用户不能够自己绘图。在有些时候，隐藏颜色拾取器可供件（例如，646），以指示至少对于绘图区域（例如，640）中的显示的表示，正在忽略绘图输入。

[0220] 2、附加的示例性通信技术

[0221] 图 7A-7E 图示了在电子设备 700 与 799 的用户之间的附加的示例性触摸通信技术。在一些实施例中，设备 700 和 700 是设备 100、300 和 / 或 500（图 1、图 3 和图 5）。

[0222] 注意力现在转向设备 700 如何将其触摸屏上的不连续的叩击转化成电子触摸通信。在图 7A 中，设备 700 和 799 参与通信会话。设备 700 接收在绘图区域 710 中的位置 714 处的用户输入 712。表示位置 714 处的用户输入 712 的数据由设备 700 向设备 799 发送。在接收到该数据时，设备 799 在绘图区域 720 中显示输入的可视表示 722。设备 799 在对应于位置 714 的位置处在屏幕上绘制可视表示。在输入 712 之后，设备 700 可以在不同的位置 718 处接收附加的用户输入 716。表示在位置 718 处的用户输入 716 的数据由设备 700 向设备 799 发送。在接收到该数据时，设备 799 显示输入 716 的可视表示 724。如之前的，可视表示 724 的屏幕上的位置对应于触摸输入 716 的位置 718。

[0223] 诸如触摸接触 712 和 716 之类的触摸接触（例如，绘制笔画、单指叩击、多指叩击）

EX1002 - Page 1192

的检测和显示可以由事件分类器 170、事件识别器 180 以及事件处理机 190(图 1B)实现。事件分类器 170 中的事件监视器 171 在触敏表面显示器 112 上检测接触,并且事件分派器模块 174 向应用 136-1 递送事件信息。应用 136-1 的相应事件识别器 180 比较事件信息与相应事件定义 186,并且确定在触敏表面上的第一位置处的第一接触是否对应于预定义的事件或者子事件,诸如,单指接触、多指触摸接触或者轻扫。当检测到相应的预定义的事件或者子事件时,事件识别器 180 激活与事件或者子事件的检测相关联的事件处理机 190。事件处理机 190 可以利用或调用数据更新器 176 或者对象更新器 177 以更新应用内部状态 192。在一些实施例中,事件处理机 190 访问相应的 GUI 更新器 178 以更新由应用显示的内容。

[0224] 在一些实施例中,可视表示 722 在触摸输入 714 的持续时期内被显示,这意味着可视表示 722 保持显示直到触摸输入 714 被释放。在一些实施例中,可视表示 722 被显示一定持续时间,这意味着在可视表示 722 已经被显示一段持续时期之后,从显示中去除可视表示 722,而不管触摸输入 714 是否已经被释放。在一些实施例中,通过淡出来将可视表示 722 从显示器中去除。

[0225] 虽然可视表示 722 可以是任何屏幕上的图形输出,诸如图像、动画图像、直线绘制等,但是应当注意,可视表示 722 表示触摸输入(在外部电子设备上已经被接收的)。在可视表示 722 的上下文中,"表示"意味着可视信息至少通信关于触摸输入的一些信息。可以被通信的信息的示例包括触摸的位置、持续时间、强度、触摸的接触大小以及组成触摸的触摸对象(例如,手指)的数目。因此,以下示例性触摸的可视表示是代表性的:

[0226] • 位于对应于检测到的触摸的位置的位置处的图像;

[0227] • 对于对应于检测到的触摸的持续时间的持续时间显示的图像;

[0228] • 根据触摸接触的大小而定大小的图像(例如,椭圆形);或者

[0229] • 对应于检测到的触摸的强度的颜色方案(例如,热图);然而,与此相反,由于检测到一些触摸输入,因此无需多说,即使其显示由触摸输入造成,简单显示的一般图像也不应该被认为是代表性的。

[0230] 在一些实施例中,可视表示 722 是圆形的、椭圆形的或者卵圆形的。可视表示 722 的大小可以指示触摸输入 714 的接触大小,例如用户的手指的大小。在一些实施例中,可视表示 722 包括多个圆、椭圆或者卵圆。可以同中心地显示形状。当可视表示 722 包括多个几何形状时,形状的数目可以提供暗示或者对应于接触的强度的可视表示。同样,当可视表示 722 包括多个形状时,随着可视表示 722 从屏幕显示器上退出,形状可以逐渐地淡出,类似于水中的涟漪,其提供了时间指示。

[0231] 在一些实施例中,使得设备 799 上的可视表示 722 和 724 的显示所要求的触摸输入(例如,712 和 716)是单指叩击,这意味着设备 700 上的多指触摸将不会在设备 799 上产生相同的可视表示,并且设备 700 上的单指轻扫也将不会产生相同的可视表示。在一些实施例中,可视表示 722 和 724 的显示伴随有可听和/或触觉输出。

[0232] 在一些实施例中,设备 799 能够显示可视表示 722 和/或 724,而不管其当前是否在显示绘图区域。也就是说,即使设备 799 没有活跃地运行电子触摸通信应用,设备 799 仍然可以能够显示可视表示。相反,设备 799 可以响应于关于单指叩击 712 和/或 716 的传入数据而简单开始振动和/或显示可视表示 722 和/或 724。在一些实施例中,可视表示的

EX1002 - Page 1193

显示伴随有触觉输出。在一些实施例中，首先提供触觉输出，并且如由输入（诸如，加速度计输入或者与看着设备的用户相关联的照相机输入）所确定的，在用户已经将设备移动到查看位置之后，可视表示的显示出现。

[0233] 注意力现在转向设备 700 如何将重复的不连续的叩击转化为电子触摸通信。在图 7B 中，设备 700 正在显示电话簿联系人用户界面 730，在一些实施例中，其为联系人用户界面 610（图 6A）。电话簿联系人 UI 730 具有表示电话簿联系人的可供件 731-734。当设备 700 接收作为双叩击触摸输入的用户输入 736 时，设备 700 向设备 799 发送对应于检测到的双叩击的数据。作为响应，设备 799 从不活跃状态转变到提醒 740 的显示，指示设备 700 的用户已经发送通信。在一些实施例中，提醒 740 伴随有可听和 / 或触觉输出。可听和 / 或触觉输出可以对应于由设备 700 检测的双叩击的数目。例如，设备 799 可以响应于在设备 700 处检测的每个双叩击而产生不连续的（即，不同的）振动。

[0234] 注意力现在转向设备 700 如何将其触摸屏上的持续的触摸接触转化成电子触摸通信。在图 7C 中，设备检测用户输入 752，其为绘图区域 710 中的双指触摸接触。作为响应，设备 700 向设备 799 发送表示多指输入的数据。在接收该数据时，设备 799 在绘图区域 740 上显示图像 754。在一些实施例中，图像 754 是心形的图像。设备 799 继续显示图像 754 直到从设备 700 释放双指触摸 752。

[0235] 诸如触摸接触 752 之类的触摸接触（例如，绘制笔画、单指叩击、多指叩击）的检测和显示可以由事件分类器 170、事件识别器 180 以及事件处理机 190（图 1B）实现。事件分类器 170 中的事件监视器 171 在触敏表面显示器 112 上检测接触，并且事件分派器模块 174 向应用 136-1 递送事件信息。应用 136-1 的相应事件识别器 180 比较事件信息与相应事件定义 186，并且确定在触敏表面上的第一位置处的第一接触是否对应于预定义的事件或者子事件，诸如，单指接触、多指触摸接触或者轻扫。当检测到相应的预定义的事件或者子事件时，事件识别器 180 激活与事件或者子事件的检测相关联的事件处理机 190。事件处理机 190 可以利用或调用数据更新器 176 或者对象更新器 177 以更新应用内部状态 192。在一些实施例中，事件处理机 190 访问相应的 GUI 更新器 178 以更新由应用显示的内容。

[0236] 在一些实施例中，如图 7C 中所示出的，图像 754 搏动以使得其大小随时间变化。在一些实施例中，图像 754 的搏动加入了来自设备 799 的触觉和 / 或音频。在一些实施例中，设备 700 具有感测其用户的心率的皮电反应（GSR）传感器，并且向设备 799 发送心率信息，以使得设备 799 可以与检测到生物计量信息一致地搏动图像 754。图像 754 的搏动也可以伴随有可听和触觉输出。例如，设备 799 可以与每个可视脉冲同步振动。

[0237] 在一些实施例中，设备 799 能够显示图像 754，而不管其当前是否正在显示绘图区域。也就是说，即使设备 799 没有活跃地运行电子触摸通信应用，设备 799 仍然可以能够显示图像 754。相反，设备 799 可以响应于关于多指叩击 752 的传入数据而简单开始振动和 / 或显示图像 754。在一些实施例中，图像的显示伴随有触觉输出。在一些实施例中，首先提供触觉输出，并且如由输入（诸如，加速度计输入或者与看着设备的用户相关联的照相机输入）所确定的，在用户已经将设备移动到查看位置之后，图像显示出现。

[0238] 注意力现在转向设备 700 如何在电子触摸通信会话适应口头输入。在图 7D 中，在设备 799 正在显示绘图区域 720 时，设备 700 正在绘图区域 710。绘图区域 710 和 720 具有表示进行中的电子触摸通信会话中的早期通信的画刷笔画的可视表示 762 和 764。在显示

EX1002 - Page 1194

绘图区域 710 时，设备 700 检测输入机构 772 的激活。在一些实施例中，输入机构是机械按钮。对于激活的持续时间，设备 700 记录向设备提供的输入。也就是说，设备 700 的用户可以提供随后被记录的口头消息。在释放输入机构 772 时，设备 700 向设备 799 发送音频记录，其中记录被回放。如图 7D 中所描绘的，当设备 700 在记录时，设备 799 继续显示绘图区域 720，以使得设备 799 的用户可以继续参与通信会话。

[0239] 注意力现在转向设备 700 如何可以允许在电子触摸通信会话的参与者之间的联系的备选方法。图 7E 图示了上下文用户界面 790。在一些实施例中，该上下文用户界面 790 可以从绘图区域 710 中被调用。如所示出的，设备 700 正在显示绘图区域 710 并且接收触摸输入 792。触摸输入 792 具有高的特性接触强度，这意味着其为深接触。在一些实施例中，具有高于阈值强度的特性强度的接触被认为是高强度接触。响应于在显示绘图区域 710 的同时检测到高强度触摸 792，设备 700 显示上下文用户界面 790，其具有用于发起与电子触摸通信会话的（一个或多个）参与者（例如，图 6A 中的联系人 A）的其它形式的通信的可供件。应当注意，如以上参考图 7A-7C 所讨论的，低于阈值的触摸被解释为单指接触（诸如，叩击和轻扫）和 / 或多指触摸。

[0240] 例如，上下文用户界面 790 具有可供件 794，当其被选择时，发起与联系人 A 的电话呼叫（音频和 / 或视频）。上下文用户界面 790 还具有可供件 796，当其被选择时，发起写给联系人 A 的草稿电子邮件。上下文用户界面 790 还具有可供件 798，当其被选择时，发起写给联系人 A 的消息（例如，经由诸如 SMS 和 MMS 等的服务的短消息，经由诸如由加尼福尼亚州库比蒂诺的 Apple 公司提供的 iMessage® 等的服务的文本消息）。

[0241] 3、备选通信模型

[0242] 注意力现在转向在参考图 8 和图 9A-9B 的一些实施例中使用的设备之间的电子触摸通信的其他模型。

[0243] 在一些实施例中，在由一个参与者发起并且由接收的参与者接受的会话之后发生电子触摸通信。参考图 8 讨论了这一方面。在图 8 中，设备 800（在一些实施例中为设备 100、300 或者 500（图 1、图 3 和图 5））正在显示电话簿联系人用户界面 810。响应于所显示的可供件 811-814 中的一个可供件的用户的选择，设备 800 显示联系人信息用户界面 820，在这种情况下，对于联系人“A”其由可供件 811 表示。用户通过触摸用户界面 820 来将联系人“A”继续邀请到通信会话。作为响应，设备 800 向设备 899 发送将联系人“A”邀请到通信的请求，并且显示具有指示联系人“A”被邀请的指示 834 的用户界面 830。同时，与联系人“A”相关联的设备 899 从其不活跃状态转变到提醒 840 的显示，其示出了设备 800 的用户（在该情况下为联系人“Z”）正在请求电子触摸通信。

[0244] 在一些实施例中，设备 800 的用户可以通过导航离开用户界面 830（诸如，通过轻扫输入或者设备上的另一输入机构的激活）来取消邀请。在一些实施例中，设备 899 的用户可以通过触摸提醒 840 来接受未决的邀请。用户还可以通过轻扫离开提醒 840（例如，以向上或者向下的方向）来拒绝邀请。如果接受了要求，则设备 800 和 899 继续分别地显示绘图区域 850 和 860，并且从而建立了双向的通信会话。因此，如这里所使用的，在（i）一个用户向另一用户发送用于通信的邀请和（ii）接收的用户接受之后，建立双向通信“会话”。如果拒绝了邀请（未示出），则设备 800 返回到联系人信息用户界面 820 并且识别 899 返回到其之前（不活跃）状态。

EX1002 - Page 1195

[0245] 注意力现在转向参考图 9A-9B 的实施例，在该实施例中，电子触摸通信可以协作地参与通信会话。在图 9，设备 900（在一些实施例中为设备 100、300 或者 500（图 1、图 3 和图 5））正在显示绘图区域 910。设备 999（在一些实施例中为设备 100、300 或者 500（图 1、图 3 和图 5））正在显示绘图区域 920。如所示出的，设备 900 检测轻扫输入 912，其表示绘图区域 910 上的向下笔画 914。作为响应，设备 900 显示检测到的笔画的可视表示 916。可视表示 916 可以具有画刷笔画的外观。同时，设备 900 向设备 999 发送表示笔画 914（例如，轻扫输入 912）的数据。设备 999 在接收到该信息之后，在其绘图区域 920 中显示笔画的可视表示 922。

[0246] 两个用户可以继续绘图。如所示出的，设备 900 检测表示笔画 928 的附加的轻扫输入 926，而设备 999 检测表示笔画 932 的附加的轻扫输入 930。设备 900 显示轻扫输入 926 的可视表示 936，并且识别 999 显示轻扫输入 930 的可视表示 940。表示笔画 928（轻扫输入 926）和笔画 932（轻扫输入 930）二者的数据由设备交换，这意味着设备 900 向设备 999 发送表示笔画 928（例如，轻扫输入 926）的数据，并且设备 999 向设备 900 发送表示笔画 932（例如，轻扫输入 930）的数据。在信息的该交换之后，两个设备显示对应于接收到的信息的可视表示。在设备 900 的情况下，除了可视表示 916 和 936，可视表示 946 也被显示。在设备 999 中，除了可视表示 922 和 940，可视表示 942 也被显示。在一些实施例中，所显示的可视表示具有画刷笔画的外观。如可以看出的，通过这种方式，设备 900 和 999 的用户可以互相地参与绘图会话，特别是笑脸的绘图。

[0247] 为了给用于附加的绘图的绘图区域 640 和 642 腾出地方，在一些实施例中，在给定的持续时间之后，去除所显示的可视表示。持续时间可以是预定的，例如，1 秒、2 秒或者 3 秒。如图 9B 所示出的，由于可视表示 916 和 930 由较早的用户输入造成，因此首先移除可视表示 916 和 930。随后从绘图区域中去除可视表示 936 和 946 以及 942 和 940，这是因为它们表示后来的用户输入。

[0248] 对于用户来说，很可能错过传入的电子触摸通信（例如，电源中断或者没有网络连接）。对于用户来说，也有可能忽视与传入的通信相关联的触觉和 / 或可视输出。在一些实施例中，设备 900 显示标识错过的通信的错过的通信的指示符。结合图 9C 讨论了这方面。图 9C 描绘了电话簿联系人用户界面 990（在一些实施例中为电话簿联系人用户界面 610（图 6A））。电话簿联系人 UI 990 包括表示电话簿联系人的多个可供件，包括表示联系人“D”的可供件 992。指示符 994 邻近可供件 992 被显示（意味着指示符 994 在所有显示的可供件之中最接近可供件 992）。指示符 994 向设备 900 的用户指示错过了来自联系人“D”的传入的电子触摸通信。可选地，指示符 994 的可视外观传达了关于错过的电子触摸通信的附加信息。例如，指示符 994 可以具有用于指示错过的提醒（提醒 638，图 6A）的特定的形状、针对提醒的错过的请求（提醒 840，图 8）、错过的单叩击（图 7A）、错过的双叩击（图 7B）、错过的多指触摸（图 7C）等。作为另一示例，指示符 904 的大小可以反映错过的通信的数目。在一些实施例中，可以邻近联系人可供件显示多个指示符，以指示已经错过多种类型的通信。

[0249] 在一些实施例中，电话簿联系人用户界面 990 显示关于当前没有被注册为关于设备 900 的联系人的电子触摸通信中各方的信息是可能的。例如，电话簿联系人 UI 990 可以示出设备 900 之前不知的人员的电话号码。在该示例中，电话簿联系人 UI 990 可以提供用

EX1002 - Page 1196

于将之前不知的人员注册为联系人的添加可供件。

[0250] 在一些实施例中，电话簿联系人用户界面 990 被配置为显示用户指定的和 / 或系统定义的联系人的子集。在这些实施例中，电话簿联系人用户界面 990 显示关于不是用户指定的或者系统定义的联系人的电子触摸通信的各方的信息是可能的。例如，设备 990 可以最近已经从用户的经常联系人（不是用户收藏的联系人中的一个联系人）接收传入通信。在该示例中，电话簿联系人 UI 990 可以提供用于将该联系人指定为收藏联系人的添加可供件。作为另一示例，设备 990 可以已经最近从设备 990 之前不知的人员接收传入的通信。在该示例中，电话簿联系人 UI 990 可以提供用于将之前不知的人员注册为联系人（并且可选地将新添加的联系人指定为用户收藏）的添加可供件。

[0251] 4、示例性电子触摸通信过程

[0252] 注意力现在可以在设备 100、300 和 / 或 500（图 1、3、5）上被实施以执行以上参考图 6A-6E、7A-7E、8 以及 9A-9C 所描述的技术的过程。

[0253] 图 10A-10C 描绘了图示用于电子触摸通信的过程 1000 的流程图。在各个实施例中，过程 1000 可以由电子设备（诸如，设备 100、300 和 / 或 500（图 1、图 3 和图 5））执行。在块 1002 处，显示表示联系人的多个可供件。可以由用户输入触发显示。可选地，所表示的联系人可以是可用的电话簿联系人的用户指定的子集，诸如用户的“收藏”联系人，或者系统定义的“白名单”或者“灰名单”。表示联系人的可供件的示例性显示是图 6A 中描绘的用户界面 610。在块 1004 处，设备检测显示的可供件的用户选择，并且作为响应，显示标识所选的联系人的联系人信息。该信息可以包括联系人的姓名、图像、号码等。图 6A 提供了示例性联系人信息用户界面 616。

[0254] 在块 1006 处，响应于所显示的可供件的用户选择，显示诸如绘图区域 630（图 6A）的画布。在一些实施例中，可选地，向所选的联系人或者与所选的联系人相关联的电子设备发送邀请，将联系人邀请到电子触摸通信。在一些实施例中，可选地，设备在显示绘图区域之前等待邀请的接受。

[0256] 当显示绘图区域时，在块 1008 处，检测到以轻扫形式的用户输入。在检测到用户输入时，过程继续到决定块 1010，在决定块 1010 中，做出了关于输入是单指还是多指触摸输入的确定。如果输入是多指接触，则过程继续到 1012，在 1012 中，设备向外部设备发送表示多指接触的数据。传输的数据向外部设备提供指示以生成诸如图 7C 中的图像 754 等的图像。如果输入是单指接触，过程继续到决定块 1014，在决定块 1014 中，做出关于该单指输入是轻扫还是叩击的确定。如果单只输入是叩击，过程继续到块 1016，在块 1016 中，向外部设备发送表示单指叩击的数据。传输的数据使得在外部设备上生成可视表示（诸如，图 7A 中的可视表示 722）。传输的数据可以因此具有触发外部设备上的各个可视表示的显示的效果。

[0256] 如果单指输入是轻扫，过程继续到块 1018，在块 1018 中，设备显示轻扫输入的可视表示，诸如由图 6B 中的可视表示 634 表示的笑脸中的眼睛中的一个眼睛。在块 1020 处，做出关于在最后检测的轻扫之后是否过去了阈值时间量的确定。如果已经经过阈值时间量，则过程继续到块 1022，在块 1022 中，设备向外部设备发送指示接收到的（一个或多个）轻扫输入的数据。传输的数据使得在外部设备上生成可视表示，诸如可视表示 642（图 6B）。如果还没有经过阈值时间量，则过程继续到块 1024，在块 1024，可以在绘图区域检测附加

EX1002 - Page 1197

的轻扫。在块 1024 之后，过程返回到块 1018，以使得在屏幕上显示任何附加地接收到的输入。根据需要块可以重复 1018、1020 以及 1024 的操作，直到存在对输入的一些结尾，例如，如由超过阈值持续时间的绘图输入的停止所指示的，用户完成了绘图。当这个发生时，过程继续到块 1022，在块 1022 中，设备向外部设备发送指示接收到的轻扫输入的数据。传输的数据可以因此具有触发外部设备上的各个可视表示的显示的效果。

[0257] 图 11 描绘了图示用于电子触摸通信的过程 1100 的流程图。在各个实施例中，过程 1100 可以由电子设备（诸如，设备 100、300 和 / 或 500（图 1、图 3 和图 5））执行。在块 1102 处，在执行过程 1100 的电子设备处接收对应于由外部设备检测的输入的数据。接收到的数据可以表示传入的电子触摸通信。响应于接收到数据，电子设备产生触觉输出。在块 1106 处，做出关于在发出触觉输出之后的预定时间阈值内是否接收用户输入的确定。

[0258] 如果用户在时间阈值内提供输入，则过程继续到块 1108，在块 1108 处，显示了关于传入的数据的通知（例如，图 6A 中的提醒 638，图 8 中的提醒 840）。在块 1100 处，接收所显示的提醒上的用户输入，并且作为响应，电子设备启动用于电子触摸通信的合适的应用，并且显示传入的数据的可视表示。

[0259] 在备选的实施例（图 11 中未示出）中，在块 1110 处，响应于在显示提醒的同时的用户输入，在没有打开附加的应用的情况下，电子设备显示传入的数据的可视表示。在该备选实施例中，在针对与发送者的电子触摸通信显示绘图画布之前，用户将需要采取附加的步骤来启动合适的电子触摸通信。然而，通过绕开应用的打开，电子设备可以能够更快地呈现接收到的信息，这在接收者只能够短暂地看一下传入的通信的情况下可能是有用的。

[0260] 如果用户没有在时间阈值内提供输入，过程继续到块 1112，在块 1112 处，电子设备返回其之前的过程（或者不活跃状态）。在块 1114 处，在后来的时间，电子设备显示错过的传入的通信的指示。指示可以为图 9C 中所描绘的指示符 994。

[0261] 图 12 描绘了图示用于电子触摸通信的过程 1200 的流程图。在各个实施例中，过程 1200 可以由电子设备（诸如，设备 100、300 和 / 或 500（图 1、图 3 和图 5））执行。在块 1202 处，在执行过程 1200 的电子设备处接收对应于由外部设备检测到的输入的数据。接收到的数据可以表示传入电子触摸通信。在块 1204 处，响应于接收到数据，电子设备确定其是否活跃地运行适于处理电子触摸通信的开放应用。如果合适的应用是打开的，则过程继续到块 1206，在块 1206 处，显示传入的数据的可视表示。例如，图 6D 图示了在两个设备 600 和 699 都正在显示绘图区域时，以这种方式（特别地相对于可视表示 600 的显示）处理传入的数据。如果合适的应用不是打开的，过程继续到块 1208，在块 1208 处，显示关于传入的数据的通知（例如，图 6B 中的提醒 638，图 8 中的提醒 840）。在块 1210 处，接收所显示的提醒上的用户输入，并且作为响应，电子设备启动用于电子触摸通信的合适的应用，并且显示传入的数据的可视表示（例如，图 6B 中的绘图区域 640 中的可视表示 642 的显示）。

[0262] 图 13 示出了在一些实施例中执行以上描述的功能的电子设备 1300 的示例性功能块。如图 13 中所示出的，电子设备 1300 可以包括被配置为显示图形对象的显示单元 1302；被配置为接收用户输入的人类输入接口单元 1304；被配置为检测和与外部电子设备通信的一个或者多个 RF 单元 1306；被配置用于为用户提供触觉、音频和 / 或可视反馈的一个或者多个反馈单元；以及耦合到显示单元 1302、人类输入接口单元 1304、（一个或多个）RF 单元 1306 以及反馈单元 1308 的处理单元 1310。在一些实施例中，处理单元 1312 被配置为支

EX1002 - Page 1198

持电子触摸通信处理单元 1312 和显示使能单元 1314。

[0263] 在一些实施例中，显示使能单元 1314 被配置为引起用户界面（或者用户界面的一部分）结合显示单元 1302 的显示。例如，显示使能单元 1314 可以用于显示参考图 6A-6E、7A-7E、8 以及 9A-9C 所描述的一个或者多个用户界面。

[0264] 在一些实施例中，电子触摸通信处理单元 1312 被配置为根据以上参考图 6A-6E、7A-7E、8 以及 9A-9C 所讨论的示例来处理触摸通信。如参考图 10A-10C、11 以及 12 所讨论的，电子触摸通信处理单元 1312 可以确定何时发送表示电子触摸通信的传出的数据（例如，从接收输入以来是否已经过去必要的时间阈值）、何时去除屏幕上的可视表示（例如，是否已经过去必要的显示时间阈值）。

[0265] 图 13 的单元可以用于实现以上参考图 6-12 所描述的各种技术和方法。图 13 的单元可选地由硬件、软件或者硬件和软件的组合实现，以执行各个描述的实施例原理。本领域技术人员应当理解，图 13 中所描述的功能块可选地被组合或者被分离成子块以实现各个描述的示例的原理。因此，本文的描述可选地支持本文所描述的功能块的任何可能的组合或者分离或者更一步的定义。

[0266] 根据一些实施例，图 14 示出了根据各个描述的实施例的原理配置的电子设备 1400 的功能块图。设备的功能块可选地由硬件、软件或者硬件和软件的组合实现，以执行各个描述的实施例原理。本领域技术人员应当理解，图 14 中所描述的功能块可选地被组合或者被分离成子块以实现各个描述的实施例的原理。因此，本文的描述可选地支持本文所描述的功能块的任何可能的组合或者分离或者更一步的定义。

[0267] 如图 14 所示，电子设备 1400 包括被配置为显示图形用户界面的显示单元 1402、被配置为接收接触的触敏表面单元 1404、以及耦合到显示单元 1402 和触敏表面单元 1404 的处理单元 1406。在一些实施例中，处理单元 1406 包括检测单元 1408、显示使能单元 1410、替换单元 1412、发送单元 1414、确定单元 1416、淡出使能单元 1418、接收单元 1420、更新使能单元 1422、缩放使能单元 1424、记录单元 1426 以及停止单元 1428。

[0268] 处理单元 1406 被配置为（例如，利用检测单元 1408）检测用户输入，并且响应于检测到用户输入，（例如，利用显示使能单元 1410）使能表示联系人的多个可供件的显示。处理单元 1406 被配置为（例如，利用检测单元 1408）检测表示联系人的所显示的可供件的用户选择；响应于检测到所显示的可供件的用户选择，利用标识所选的联系人的联系人信息的显示来（例如，利用替换单元 1412）替换多个可供件，所选的联系人由所选的可供件表示；在显示联系人信息时，（例如，利用检测单元 1408）检测触敏显示器上的触摸；并且响应于检测到触摸；（例如，利用显示使能单元 1410）使能绘图区域的显示，其中绘图区域响应于触摸输入。处理单元 1406 被进一步配置为在绘图区域中（例如，利用检测单元 1408）检测表示第一笔画的第一触摸输入；在绘图区域中（例如，利用显示使能单元 1410）使能第一笔画的可视表示的显示；并且（例如，利用发送单元 1414）向与所选的联系人相关联的外部设备发送表示第一笔画的数据。

[0269] 在一些实施例中，处理单元 1406 被进一步配置为（例如，利用确定单元 1416）确定在第一触摸输入之后是否经过第一预定持续时间，其中发送表示第一笔画的数据包括：响应于确定已经经过第一预定持续时间而发送数据。

[0270] 在一些实施例中，处理单元 1406 被进一步配置为：在已经经过第一预定持续时间

EX1002 - Page 1199

之前，在屏幕上的绘图区域中（例如，利用检测单元 1408）检测表示第二笔画的第二触摸输入，其中第一笔画和第二笔画由中间时间量分离；并且（例如，利用发送单元 1414）向与第二笔画和中间时间量相关联的外部设备发送数据。

[0271] 在一些实施例中，第一笔画具有特性动力学，并且发送表示第一笔画的数据包括：向外部设备发送指示特性动力学的数据。

[0272] 在一些实施例中，处理单元 1406 被进一步配置为在已经接收第一笔画第二预定持续时间之后（例如，利用淡出使能单元 1418）使能第一笔画的所显示的可视表示的淡出。

[0273] 在一些实施例中，发送数据触发外部设备以：显示接收到数据的指示，并且显示可供件，其中当选择可供件时，使得外部设备显示第一笔画的可视表示。

[0274] 在一些实施例中，发送数据触发外部设备以显示第一笔画的可视表示。

[0275] 在一些实施例中，发送数据触发外部设备以显示第一笔画的可视表示，接着中间时间量的暂停，并且然后显示第二笔画的可视表示。

[0276] 在一些实施例中，发送数据触发外部设备以显示具有特性动力学的第一笔画的可视表示。

[0277] 在一些实施例中，处理单元 1406 被进一步配置为：在确定已经显示可视表示第三预定持续时间之后（例如，利用淡出使能单元 1418）使能笔画的可视表示的淡出。

[0278] 在一些实施例中，处理单元 1406 被进一步配置为：从外部设备（例如，利用接收单元 1402）接收数据，数据表示由外部设备检测的第三触摸输入，第三触摸输出表示第三笔画；并且在电子设备的绘图区域（例如，利用显示使能单元 1410）使能第三笔画的可视表示的显示。

[0279] 在一些实施例中，处理单元 1406 被进一步配置为：在第四预定持续时间之后，（利用淡出使能单元 1418）使能第三笔画的可视表示的淡出。

[0280] 在一些实施例中，第二预定持续时间、第三预定持续时间以及第四预定持续时间是相同的持续时间。

[0281] 在一些实施例中，笔画具有开始和结束，并且淡出笔画的可视表示包括：在淡出可视表示的对应的结束之前，淡出可视表示的对应的开始。

[0282] 在一些实施例中，处理单元 1406 被进一步配置为：（例如，利用显示使能单元 1410）使能绘图区域中的颜色拾取器的可供件的显示，其中颜色拾取器可供件具有指示当前所选的颜色的颜色，其中显示第一笔画的可供件包括：以当前所选的颜色显示可视表示；并且响应于检测到颜色拾取器可供件的选择，（例如，利用显示使能单元 1410）使能表示颜色的多个颜色可供件的显示。

[0283] 在一些实施例中，多个颜色可供件包括表示之前所选的颜色的多个颜色可供件。

[0284] 在一些实施例中，处理单元 1406 被进一步配置为：响应于检测到所显示的多个颜色可供件的颜色可供件的选择，（例如，利用显示使能单元）使能调色板的显示。

[0285] 在一些实施例中，调色板包括具有不同颜色的多个部分，并且处理单元 1406 被进一步配置为：响应于检测到对应于所选的颜色的调色板的一部分的选择：（例如，利用显示使能单元 1410）使能绘图区域的显示；并且（例如，利用更新使能单元 1422）使能绘图区域中所显示的颜色拾取器可供件的更新，以使得利用所选的颜色来更新颜色拾取器可供件。

[0286] 在一些实施例中，向外部设备发送表示第一笔画的数据包括：发送表示所选的颜

色的数据。

[0287] 在一些实施例中，电子设备包括可旋转输入机构，并且处理单元 1406 被进一步配置为：当使能表示联系人的多个可供件的显示时，（例如，利用检测单元 1408）检测表示可旋转输入机构的移动的用户输入；并且响应于检测到的用户输入：（例如，利用缩放使能单元 1424）使能多个用户指定的联系人的显示的缩放，其中缩放显示包括改变正在被显示的联系人的大小。

[0288] 在一些实施例中，使能显示的缩放包括：使能正在被显示的联系人的数目的变化。

[0289] 在一些实施例中，触敏显示器包括用于检测触敏显示器上的触摸的强度的一个或者多个传感器，并且处理单元 1406 被进一步配置为：当使能绘图区域的显示时，（例如，利用检测单元 1408）检测触敏显示器上的触摸，其中触摸具有特性强度；（例如，利用确定单元 1416）确定特性强度是否超过预定阈值强度；响应于确定特性强度超过预定阈值强度：（例如，利用显示使能单元 1410）使能呼叫可供件的显示，其中当呼叫可供件被选择时，使得处理单元发起对与联系人相关联的外部设备的呼叫；并且响应于确定特性强度没有超过预定阈值强度，（例如，利用发送单元 1414）向外部设备发送表示触摸的数据。

[0290] 在一些实施例中，触敏显示器包括用于检测触敏显示器上的触摸的强度的一个或者多个传感器，并且处理单元 1406 被进一步配置为：当使能绘图区域的显示时，（例如，利用检测单元 1408）检测触敏显示器上的触摸，其中触摸具有特性强度；（例如，利用确定单元 1416）确定特性强度是否超过预定阈值强度；响应于确定特性强度超过预定阈值强度：（例如，利用显示使能单元 1410）使能文本可供件的显示，其中当文本可供件被选择时，使得处理单元发起针对与联系人相关联的外部设备的消息；并且响应于确定特性强度没有超过预定阈值强度，（例如，利用发送单元 1414）向外部设备发送表示触摸的数据。

[0291] 在一些实施例中，处理单元 1406 被进一步配置为：当使能标识所选的联系人的联系人信息的显示时，（例如，利用显示使能单元 1410）使能呼叫可供件的显示，其中当呼叫可供件被选择时，使得处理单元 1406 发起对与所选的联系人相关联的外部设备的呼叫。

[0292] 在一些实施例中，处理单元 1406 被进一步配置为：当使能标识所选的联系人的联系人信息的显示时，（例如，利用显示使能单元 1410）使能文本可供件的显示，其中当文本可供件被选择时，使得处理单元 1406 发起针对与所选的联系人相关联的外部设备的消息。

[0293] 在一些实施例中，使能表示联系人的多个可供件的显示包括：使能表示用户指定的联系人的多个可供件的显示，用户指定的联系人是对电子设备可访问的联系人的子集。

[0294] 在一些实施例中，电子设备包括与触敏显示器分离的可按压的输入机构，并且检测用户输入包括：检测可按压输入机构的激活。

[0295] 在一些实施例中，电子设备包括可按压输入机构和麦克风，处理单元被进一步配置为：当使能绘图区域的显示时，（例如，利用检测单元 1408）检测可按压的输入机构的激活的显示；响应于检测到激活：在可按压输入机构保持按压时，基于从麦克风接收的输入来（例如，利用记录单元 1426）记录音频消息；（例如，利用检测单元 1408）检测可按压输入机构的释放；并且响应于检测到释放：（例如，利用停止单元 1428）停止记录音频消息，并且向与所选的联系人相关联的外部设备发送所记录的音频消息。

[0296] 以上参考图 10A-10C 所描述的操作可选地由图 1A-1B 或者图 14 中所描绘的部件实现。例如，显示操作 1002 和 1018、检测操作 1004、1006 和 1008、确定操作 1010、1014 和

EX1002 - Page 1201

1020、发送操作 1012、1016 和 1022 以及可选的接收操作 1024 可选地由事件分类器 170、事件识别器 180 以及事件处理机 190 实现。事件分类器 170 中的事件监视器 171 在触敏表面显示器 112 上检测接触，并且事件分派器模块 174 向应用 136-1 递送事件信息。应用 136-1 的相应事件识别器 180 比较事件信息与相应事件定义 186，并且确定在触敏表面上的第一位置处的第一接触是否对应于预定义的事件或者子事件，诸如，用户界面上的对象的选择、从一个方向到另一方向的设备的旋转。当检测到相应的预定义的事件或者子事件时，事件识别器 180 激活与事件或者子事件的检测相关联的事件处理机 190。事件处理机 190 可以利用或调用数据更新器 176 或者对象更新器 177 以更新应用内部状态 192。在一些实施例中，事件处理机 190 访问相应的 GUI 更新器 178 以更新由应用显示的内容。类似地，对于本领域技术人员来说，如何基于图 1A-1B 所描绘的部件来实现其他过程将是清楚的。

[0297] 根据一些实施例，图 15 示出了根据各个描述的实施例的原理配置的电子设备 1500 的功能块图。设备的功能块可选地由硬件、软件或者硬件和软件的组合实现，以执行各个描述的实施例原理。本领域技术人员应当理解，图 15 中所描述的功能块可选地被组合或者被分离成子块以实现各个描述的实施例原理。因此，本文的描述可选地支持本文所描述的功能块的任何可能的组合或者分离或者更一步的定义。

[0298] 如图 15 所示出的，电子设备 1500 包括被配置为显示图形用户界面的显示单元 1502、被配置为接收接触的触敏表面单元 1504、以及耦合到显示单元 1502 和触敏表面单元 1504 的处理单元 1506。在一些实施例中，处理单元 1506 包括接收单元 1508、检测单元 1510、确定单元 1512 以及发送单元 1514。电子设备可选地被配置为与关联于联系人的外部设备进行通信。

[0299] 处理单元 1506 被配置为：（例如，利用接收单元 1508）接收表示联系人的所显示的可供件的用户选择；在接收该选择之后，（例如，利用检测单元 1510）检测触敏显示器上的用户输入；（例如，利用确定单元 1512）确定触摸输入是单指触摸输入还是多指触摸输入；并且根据触摸是单指触摸输入的确定，（例如，利用发送单元 1514）向外部设备发送数据，该数据表示单指触摸输入。

[0300] 在一些实施例中，发送数据触发外部设备以提供对应于单指触摸输入的输出。

[0301] 在一些实施例中，发送数据触发外部设备以显示接收到数据的通知，并且当可供件被选择时，使得外部设备显示单指触摸输入的可视表示。

[0302] 在一些实施例中，在电子设备的触敏显示器上检测用户输入包括：在触敏显示器的位置处检测单指触摸输入，并且当显示单指触摸输入的可视表示时，在外部设备的显示屏上的对应于检测到单指触摸输入的位置的位置处显示单指触摸输入的可视表示。

[0303] 在一些实施例中，可视指示包括一个或者多个圆、椭圆和 / 或卵圆。

[0304] 在一些实施例中，可视指示包括两个或者更多个同中心的圆、椭圆和 / 或卵圆。

[0305] 在一些实施例中，在显示可视指示预定时间量之后，外部设备上的可视指示淡出。

[0306] 在一些实施例中，单指触摸是单指呷击。

[0307] 在一些实施例中，处理单元 1506 被进一步配置为：根据检测到的用户输入表示多指触摸输入的确定，（例如，利用发送单元 1514）向外部设备发送数据，其中发送数据触发外部设备以持续地显示多指触摸输入的可视指示。

[0308] 在一些实施例中，输出包括接收到数据的通知，并且当选择可供件时，使得处理单

EX1002 - Page 1202

元使能多指触摸输入的可视指示符的持续地显示。

[0309] 在一些实施例中，可视指示符是图像。

[0310] 在一些实施例中，可视指示符是动画图像。

[0311] 在一些实施例中，可视指示符是搏动的心跳的动画图像。

[0312] 在一些实施例中，电子设备进一步包括被配置为检测心跳的速率的生物传感器，其中搏动的心跳的搏动的速率基于检测到的心跳的速率。

[0313] 在一些实施例中，电子设备进一步包括被配置为检测心跳的速率的生物传感器，其中发送数据触发外部设备以提供对应于检测到的心跳的速率的触觉输出。

[0314] 在一些实施例中，发送数据触发外部设备以提供触觉输出。

[0315] 在一些实施例中，电子设备包括可旋转输入机构，其中接收接触的用户选择包括：使能表示联系人的多个可供件的显示；检测表示可旋转输入机构的移动的用户输入；并且响应于检测到用户输入，使能多个用户指定的联系人的显示，其中缩放显示包括改变正被显示的联系人的大小。

[0316] 在一些实施例中，使能显示的缩放包括使能正被显示的联系人的数目的变化。

[0317] 在一些实施例中，处理单元 1506 被进一步配置为：当使能表示联系人的多个可供件的显示时，（例如，利用检测单元 1510）检测所显示的可供件上的用户输入；并且响应于检测到触摸输入，（例如，利用发送单元 1514）向与联系人相关联的外部设备发送数据，其中发送数据触发外部设备以提供触觉输出。

[0318] 在一些实施例中，检测所显示的可供件上的触摸输入包括：检测第一触摸并且在预定持续时间内释放所显示的可供件，然后检测第二触摸并且在预定持续时间内释放所显示的可供件。

[0319] 以上参考图 10A-10C 所描述的操作可选地由图 1A-1B 或者图 15 中所描绘的部件实现。例如，显示操作 1002 和 1018、检测操作 1004、1006 和 1008、确定操作 1010、1014 和 1020、发送操作 1012、1016 和 1022 以及可选的接收操作 1024 可选地由事件分类器 170、事件识别器 180 以及事件处理机 190 实现。事件分类器 170 中的事件监视器 171 在触敏表面显示器 112 上检测接触，并且事件分派器模块 174 向应用 136-1 递送事件信息。应用 136-1 的相应事件识别器 180 比较事件信息与相应事件定义 186，并且确定在触敏表面上的第一位置处的第一接触（或者设备是否旋转）是否对应于预定义的事件或者子事件，诸如，对用户界面上的对象的选择、从一个方向到另一方向的设备的旋转。当检测到相应的预定义的事件或者子事件时，事件识别器 180 激活与事件或者子事件的检测相关联的事件处理机 190。事件处理机 190 可以利用或调用数据更新器 176 或者对象更新器 177 以更新应用内部状态 192。在一些实施例中，事件处理机 190 访问相应的 GUI 更新器 178 以更新由应用显示的内容。类似地，对于本领域技术人员来说，如何基于图 1A-1B 所描绘的部件来实现其他过程将是清楚的。

[0320] 根据一些实施例，图 16 示出了根据各个描述的实施例的原理配置的电子设备 1600 的功能块图。设备的功能块可选地由硬件、软件或者硬件和软件的组合实现，以执行各个描述的实施例原理。本领域技术人员应当理解，图 16 中所描述的功能块可选地被组合或者被分离成子块以实现各个描述的实施例原理。因此，本文的描述可选地支持本文所描述的功能块的任何可能的组合或者分离或者更一步的定义。

EX1002 - Page 1203

[0321] 如图16所示出的，电子设备1600包括被配置显示图形用户界面的显示单元1602、被配置为接收接触的触敏表面单元1604、以及耦合到显示单元1602和触敏表面单元1604的处理单元1606。在一些实施例中，处理单元1606包括接收单元1608、发出单元1610、检测单元1612、确定单元1614、显示使能单元1616、替换单元1618、播放单元1620以及标识单元1622。电子设备可选地被配置为与外部设备进行通信。

[0322] 处理单元1606被配置为：(例如，利用接收单元1608)接收对应于由外部设备检测的输入的数据；响应于接收到该数据，(例如，利用发出单元1610)发出触觉输出；在发出触觉输出之后，(例如，利用检测单元1612)检测用户输入；(例如，利用确定单元1614)确定在触觉输出之后的预定时间间隔内是否检测到用户输入；并且根据在预定时间间隔内检测到用户输入的确定，在显示器上(例如，利用显示使能单元1616)使能通知的显示，其中该通知指示用于回放的信息的可用性。

[0323] 在一些实施例中，处理单元1606被进一步配置为：在使能停止的显示时，(例如，利用检测单元1612)检测第二用户输入；(例如，利用确定单元1614)确定接收到的数据是否包括可视信息；并且根据接收到的数据包括可视信息的确定：利用可视信息(例如，利用替换单元1618)替换所显示的通知。

[0324] 在一些实施例中，处理单元1606被进一步配置为：(例如，利用确定单元1614)确定接收到的数据是否包括音频信息；并且根据接收到的数据包括音频信息的确定：通过操作地连接到电子设备的扬声器(例如，利用播放单元1620)播放音频信息。

[0325] 在一些实施例中，处理单元1606被进一步配置为：(例如，利用标识单元1622)标识与外部设备相关联的用户；并且根据在预定时间间隔之后检测到用户输入的确定：(例如，利用显示使能单元1616)使能表示用户指定的联系人的多个可供件的显示，并且可供件表示与外部设备相关联的用户；并且(例如，利用显示使能单元1616)使能对应于表示与外部设备相关联的用户的可供件的指示符的显示，指示符指示从与外部设备相关联的用户接收到的用于回放的信息的可用性。

[0326] 在一些实施例中，处理单元1606被进一步配置为：(例如，利用标识单元1622)标识对电子设备可访问的多个联系人；(例如，利用确定单元1614)确定外部设备是否与对电子设备可访问的多个联系人中的联系人相关联；根据外部设备与对电子设备可访问的多个联系人中的联系人不相关联的确定：(例如，利用显示使能单元1616)使能添加联系人可供件的显示，其中当添加联系人可供件被选择时，使得处理单元使能用于注册联系人并且将设备与联系人相关联的用户界面屏幕的显示。

[0327] 在一些实施例中，处理单元1606被进一步配置为：(例如，利用标识单元1622)将对电子设备可访问的多个联系人的子集标识为多个用户指定的联系人；(例如，利用确定单元1614)确定外部设备是否与多个用户指定的联系人中的用户指定的联系人相关联；并且根据外部设备与对电子设备可访问的多个联系人中的联系人相关联、但是与多个用户指定的联系人中的用户指定的联系人不相关联的确定：(例如，利用显示使能单元1616)使能指定可供件的显示，其中当指定可供件被选择时，使得处理单元使能用于将与外部设备相关联的联系人指定为用户指定的联系人的用户界面屏幕的显示。

[0328] 在一些实施例中，处理单元1606被进一步配置为：(例如，利用标识单元1622)标识与外部设备相关联的联系人姓名，其中在显示器上使能通知的显示包括使能联系人姓名

EX1002 - Page 1204

EX1002 - Page 1205

的标识的显示。

[0329] 在一些实施例中，处理单元 1606 被进一步配置为：（例如，利用标识单元 1622）标识与联系人姓名相关联的图像，其中在显示器上使能通知的显示包括使能图像的显示。

[0330] 在一些实施例中，检测用户输入包括检测电子设备的移动。

[0331] 在一些实施例中，检测用户输入包括检测电子设备的抬起。

[0332] 以上参考图 11 所描述的操作可选地由图 1A-1B 或者图 16 中所描绘的部件实现。例如，接收操作 1101 和 1110、检测操作 1104、确定操作 1006、显示操作 1008 和 1114 以及返回操作 1112 可选地由事件分类器 170、事件识别器 180 以及事件处理机 190 实现。事件分类器 170 中的事件监视器 171 在触敏表面显示器 112 上检测接触，并且事件分派器模块 174 向应用 136-1 递送事件信息。应用 136-1 的相应事件识别器 180 比较事件信息与相应事件定义 186，并且确定在触敏表面上的第一位置处的第一接触（或者设备是否旋转）是否对应于预定义的事件或者子事件，诸如，对用户界面上的对象的选择、从一个方向到另一方向的设备的旋转。当检测到相应的预定义的事件或者子事件时，事件识别器 180 激活与事件或者子事件的检测相关联的事件处理机 190。事件处理机 190 可以利用或调用数据更新器 176 或者对象更新器 177 以更新应用内部状态 192。在一些实施例中，事件处理机 190 访问相应的 GUI 更新器 178 以更新由应用显示的内容。类似地，对于本领域技术人员来说，如何基于图 1A-1B 所描绘的部件来实现其他过程将是清楚的。

[0333] 根据一些实施例，图 17 示出了根据各个描述的实施例的原理配置的电子设备 1700 的功能块图。设备的功能块可选地由硬件、软件或者硬件和软件的组合实现，以执行各个描述的实施例原理。本领域技术人员应当理解，图 17 中所描述的功能块可选地被组合或者被分离成子块以实现各个描述的实施例原理。因此，本文的描述可选地支持本文所描述的功能块的任何可能的组合或者分离或者更一步的定义。

[0334] 如图 17 所示，电子设备 1700 包括配置为显示图形用户界面的显示单元 1702、配置为接收触摸的触敏表面单元 1704、以及耦合到显示单元 1702 和触敏表面单元 1704 的处理单元 1706。在一些实施例中，处理单元 1706 包括接收单元 1708、确定单元 1710、回放单元 1712、显示使能单元 1714、提供单元 1716 和淡出使能单元 1718。电子设备可选地配置为与外部设备通信。

[0335] 处理单元 1706 配置为接收（例如用接收单元 1708）来自表示外部设备处接收的用户输入的外部设备的数据；确定（例如用确定单元 1710）电子设备是否在活跃地执行回放应用；根据确定了电子设备在活跃地执行回放应用，回放（例如用回放单元 1712）接收的数据；以及根据确定了电子设备没有在活跃地执行回放应用：使得能够显示（例如用显示使能单元 1714）数据接收的指示；以及使得能够显示（例如用显示使能单元 1714）可供件，其中可供件当被选择时发起回放应用并且使得电子设备回放接收的数据。

[0336] 在一些实施例中，处理单元还配置为根据确定了电子设备没有在活跃地执行回放应用，响应于接收数据提供（例如用提供单元 1716）触觉输出。

[0337] 在一些实施例中，回放接收的数据还包括，根据确定了用户输入是外部设备上的单指触摸输入，使得能够在电子设备的屏幕上对应于单指触摸输入被检测的外部设备上的位置显示单指触摸输入的视觉表示。

[0338] 在一些实施例中，视觉指示包括一个或多个圆、椭圆和 / 或卵圆。

[0339] 在一些实施例中，视觉指示包括两个或多个同心的圆、椭圆和 / 或弹圆。

[0340] 在一些实施例中，处理单元 1706 还配置为使得能够在预定时间量之后淡出（例如用淡出使能单元 1718）视觉指示。

[0341] 在一些实施例中，回放接收的数据还包括：根据确定了用户输入是外部设备上的多指触摸输入，使得能够显示针对多指触摸输入的持续的可视指示符。

[0342] 在一些实施例中，可视指示符是图像。

[0343] 在一些实施例中，可视指示符是动画图像。

[0344] 在一些实施例中，可视指示符是搏动的心脏的动画图像。

[0345] 在一些实施例中，处理单元 1706 还配置为：在使得能够显示可视指示符的同时，提供（例如用提供单元 1716）触觉输出。

[0346] 在一些实施例中，回放接收的数据还包括：根据确定了用户输入是外部设备上的双叩击，使得能够显示与外部设备相关联的用户的标识，并且在显示标识的同时提供触觉输出。

[0347] 在一些实施例中，回放接收的数据还包括：根据确定了用户输入是使用外部设备的麦克风记录的音频记录，播放音频记录。

[0348] 在一些实施例中，回放接收的数据还包括：根据确定了用户输入是外部设备上表示笔画（stroke）的轻扫接触（contact），使得能够显示笔画的视觉表示。

[0349] 在一些实施例中，处理单元 1706 还配置为使得能够在预定持续时间之后淡出笔画。

[0350] 上面关于图 12 描述的操作可选地由图 1A-1B 和图 17 中描绘的部件来实施。例如，接收操作 1202 和 1210、确定操作 1204 和显示操作 1206 和 1208 可选地由事件分类器 170、事件识别器 180 和事件处理机 190 来实施。事件分类器 170 中的事件监视器 171 检测触敏显示器 112 上的接触，事件分派器模块 174 将事件信息递送到应用 136-1。应用 136-1 的相应的事件识别器 180 将事件信息与相应的事件定义 186 比较，并且确定触敏表面（或者设备的旋转）上第一位置处的第一接触对应于预定义的事件或子事件，诸如在用户界面上选择对象、或者旋转设备从一个定向到另一定向。当相应的预定义事件或子事件被检测时，事件识别器 180 激活与事件或子事件检测相关联的事件处理机 190。事件处理机 190 可选地使用或调用数据更新器 176 或对象更新器 177 以更新应用外部状态 192。在一些实施例中，事件处理机 190 访问相应的 GUI 更新器 178 以更新由应用来显示什么。相似地，本领域普通技术人员应清楚的是其它过程可以怎样基于图 1A-1B 中描绘的部件来实施。

[0351] 图 18A-18B 图示包括电子设备 1800 处的用户界面 1802 的触敏显示器的示例实施例。用户界面 1802 和下面描述的方法允许用户与其信息存储在电子设备 1800 上的一个或多个联系人通信。在一些实施例中，用户可能已经在电子设备 1800 上存储大量的联系人并且因此需要有效的方法用于标识和与特定联系人通信。而且，在一些情况下，用户可能经常地仅占用所存储的联系人的子集。如此，每次用户期望与特定联系人通信时，将不方便滚动通过联系人列表。因此，为了增强用户体验并且改善有效的通信，可能期望对于电子设备 1800 来显示包括由用户选择的有限数量的一个或多个联系人的用户界面。

[0352] 电子设备 1800 可以与便携式多功能设备 100 和 / 或设备 500 相同或相似。而且，电子设备 1800 可以包括可旋转输入机构 1820，其可以与可旋转输入机构 506 相同或相似。

电子设备 1800 可以包括触敏显示器，其可以包括用户界面 1802，并且可以与触敏显示器系统 112 和 / 或显示器 504 相同或相似。

[0353] 如图 18A 图示，电子设备 1800 可以配置为在包括用户界面 1802 的触敏显示器上显示布置或以其它方式定位在可供件 1804 周围的多个对象（例如第一对象 1808、第二对象 1810、第三对象 1812 和对象 1840a-1840i）。在一些实施例中，多个对象的一个或多个对象可以与多个联系人的一个联系人相关联。例如，第一对象 1808 可以与联系人 Steve Jones 相关联。相应地，第一对象 1808 可以包括首字母的集合（例如 SJ），其可以显示在第一对象 1808 内。在一些实施例中，首字母的几何可以是文织字母 (monogram)，诸如但不限于风格化的 (stylized)、内部交织 (inter-woven) 或交叠的首字母。相似地，第二对象 1810 可以包括首字母“AS”，并且第三对象 1812 可以包括首字母“IS”。在一些实施例中，用户界面可以包括 12 个对象，每个布置在对应于标准时钟或表盘中的小时的位置中（例如一小时处、两小时处、三小时处的对象等等）。在其它实施例中，可以有 6 个对象布置在对应于标准时钟中每两个小时的位置处，或者 24 个对象对应于每 30 分钟的位置处。

[0354] 用户界面 1802 还可以包括可供件 1804，其可以根据可视指示符 1806 相对于多个对象中的对象的位置来显示可视外观。例如，可供件的可视外观可以是表示多个联系人的联系人的首字母的集合，或者是表示多个联系人的联系人的图像的集合。如图 18A 中所示，可供件 1804 的可视外观可以是与第一对象 1808 相关联的联系人的图像。

[0355] 在一些实施例中，电子设备 1800 可以配置为接收对应于可旋转输入机构 1820 的旋转的第一输入。而且，如图 18B 中所示，电子设备 1800 可以配置为响应于接收与可旋转输入机构 1820 的旋转对应的输入，更新可供件 1804 的可视外观以表示多个联系人中的第二联系人（例如“IS”）。而且，用户界面 1802 可以包括与多个对象的第一对象 1808 相关联的可视指示符 1806，多个联系人的第一联系人（例如“Steve”）相关联的第一对象。

[0356] 作为示例，电子设备 1800 可以配置为从用户接收期望通信或以其它方式细想多个联系人的另一联系人的输入。基于可旋转输入机构 1820 的旋转，可供件 1804 的可视外观可以从第一对象 1808 变化到第三对象 1812，如图 18B 所示。附加地，可视指示符 1806 的位置和移动可以对应于可旋转输入机构 1820 的旋转。如此，当可旋转输入机构被旋转时，可视指示符 1806 可以以循环的方式围绕可供件 1804 从一个对象移动到另一个对象。

[0357] 特别地，例如，响应于接收对应于可旋转输入机构 1820 的旋转的第一输入，电子设备 1800 可以配置为停止将可视指示符 1806 与多个对象的第一对象 1808 相关联，而将可视指示符 1806 与多个对象中与多个联系人的第二联系人（例如与第二对象 1810 相关联的联系人）相关联的对象进行关联。

[0358] 在一些实施例中，电子设备 1800 可以配置为根据位置值来显示作为部分用户界面 1802 的可视指示符 1806。例如，该值可以在位置值的范围内，其中多个对象中的每个对象可以与位置值范围内的位置相关联。而且，电子设备 1800 可以配置为确定第一输入是否是请求更新可视指示符 1806 的位置值到第二位置值，该第二位置值不与多个对象的对象相关联。

[0359] 如此，电子设备 1800 可以配置为将可视指示符快动 (snap) 到多个对象中最近或最接近的对象。特别地，电子设备配置为将可视指示符 1806 的位置值更新到第二位置值并且根据第二位置值更新可视指示符的显示，该第二位置值对应于多个对象中最接近位置值

范围内的第二位置值的对象的位置值。例如，前述的显示更新可以基于确定了第一输入是请求更新可视指示符 1806 的位置值到第二位置值来执行，该第二位置值不与多个对象的对象相关联。

[0360] 电子设备 1800 也可以基于接收的输入快动到或以其它方式移动到最近的或另一对象以便增强用户体验。例如，为了确保可视指示符 1806 靠近或者以其它方式与对象相关联，电子设备 1800 可以配置为初始地确定可旋转输入机构的旋转没有导致可视指示符 1806 与多个联系人的第二联系人（例如第二对象 1810）相关联。而且，电子设备可以配置为根据确定了可旋转输入机构的旋转没有导致可视指示符与多个联系人的第二联系人相关联，来确定可视指示符 1806 的位置是否在对象转换区域中。在一些实施例中，对象转换区域可以是位于第一对象 1808 之后的区域以及位于与第二联系人相关联的第二对象 1810 之前的区域。

[0361] 附加地，电子设备 1800 可以配置为根据确定了可视指示符 1806 的位置在对象转换区域中，将可视指示符 1806 与多个联系人的第二联系人相关联。而且，电子设备 1800 可以配置为根据确定了可视指示符 1806 的位置不在对象转换区域中，来维持可视指示符 1806 与多个联系人的第一对象 1806 的关联。

[0362] 在一些实施例中，如图 18C 中图示，电子设备 1800 可以配置为接收第一输入，该第一输入对应于在包括用户界面 1802 的触敏显示器上的对象（例如第三对象 1812）的联系人处的接触。例如，输入可以表示在包括用户界面 1802 的触敏显示器上经由手指 1830 的触摸 / 接触。而且，电子设备 1800 可以配置为响应于接收对应于在包括用户界面 1802 的触敏显示器上的对象（例如第三对象 1812）的位置处的联系人的输入，更新可供件 1804 的可视外观以表示多个联系人中的第二联系人（例如“1S”）。

[0363] 在一些实施例中，多个对象中的每个对象可以不与联系人相关联。例如，对象 1840a-1840i 其中每个都可以不与相应的联系人相关联，可以显示的与和联系人相关联的对象（例如第一对象 1808、第二对象 1810 和第三对象 1812）不同。如此，不同的尺寸、形状和 / 或图案可以指示可用的或空的对象位置。

[0364] 而且，在一些实施例中，多个对象中的每个可以与唯一的颜色方案相关联和 / 或包括唯一的颜色方案。例如，第一对象 1808 可以是第一颜色，第二对象 1810 可以是第二颜色，第三对象 1812 可以是第三颜色，并且对象 1840a-1840i 中的每个对象可以是另一颜色。在这样的实施例中，每个对象的颜色可以与另一颜色不同。如此，在非限制性示例中，图 18A 可以包括 12 个不同的颜色，每个颜色与单个对象相关联。

[0365] 在一些实施例中，可视指示符 1806 可以是离散的区域，其中可供件 1804 的一个或多个所显示的颜色被改变。例如，电子设备 1800 可以配置为改变可视指示符的颜色从基于多个对象中的第一对象 1808 的颜色的第一颜色到基于多个对象中的第二对象 1810 的颜色的第二颜色。此外，电子设备 1800 可以配置为改变可视指示符 1806 的颜色从与多个对象中的第一对象 1808 相关联的第一颜色到与多个联系人的第二联系人（例如和第二对象 1810）相关联的第二颜色。特别地，电子设备 1800 可以配置为随着可视指示符 1806 从与第一对象 1808 相关联的第一位置移动到与联系人相关联的第二对象 1810 的位置之前的第二位置，而混合第一颜色和第二颜色。

[0366] 在进一步实施例中，当可视指示符 1806 处于与第一对象 1808 的至少一部分交叠

EX1002 - Page 1208

的第一位置并且第一对象 1808 的一个或多个显示颜色被改变时，可视指示符 1806 可以与多个对象中的第一对象 1808 相关联。电子设备 1800 可以配置为显示可视指示符 1806 的移动。特别地，电子设备 1800 可以配置为将可视指示符 1806 从第一位置转移到与第二对象 1810 的至少部分相交叠的第二位置并且第二对象 1810 的一个或多个显示颜色被改变。

[0367] 在一些实施例中，电子设备 1800 可以配置为更新可供件 1804 的可视外观。附加地，在更新可供件的可视外观之后，电子设备 1800 可以配置为接收与多个对象中选择第三对象 1812 相对应的第二输入，其中第三对象与第一对象 1808 和第二对象 1810 不同。相应的，电子设备 1800 可以配置为更新可供件 1806 的可视外观以表示多个联系人中的第三联系人。

[0368] 在图 18F 中所示的另一实施例中，电子设备 1800 可以配置为显示用户界面屏幕 1802-1 用于与由可供件 1804 表示且与可供件 1804 相关联的所选择的联系人（例如图 18F 中所示的 Steve）交互。在一些实施例中，设备 1800 在接收合适的输入或满足某一条件之后，在显示关于图 18A-18D 所描述的多个接口中的一个接口的同时，显示联系人屏幕 1802-1。例如，电子设备 1800 可以在预定时间量已经流逝而没有进一步旋转机构 1820 时，进入联系人特定屏幕 1802-1。特别地，电子设备 1800 可以配置为在更新可供件 1804 的可视外观之后确定对于时间段没有接收到输入。在一些实施例中，电子设备 1800 可以响应于确定对于时间段没有接收到输入，来停止显示多个对象。电子设备还可以响应于确定对于时间段没有接收到输入，来显示一个或多个第二可供件（例如可供件 1834）。

[0369] 在另一实施例中，电子设备可以基于检测到第三输入而进入联系人 - 特定屏幕，该第三输入对于在更新可供件 1806 的可视外观之后可供件的选择。相应地，电子设备 1800 可以响应于检测第三输入而放弃（fogo）显示多个对象。电子设备 1800 可以响应于检测第三输入而显示第二可供件。

[0370] 在一些实施例中，在联系人 - 特定屏幕内的第二可供件（例如图 18F 可以包括一个或多个可供件，诸如但不限于呼叫可供件 1814、消息可供件 1816、辅导可供件 1832、恢复包括含有可供件 1834 的多个对象的用户界面的可供件、以及绘图可供件 1818，每个在后面详细描述）。在一些实施例中，可供件 1834 用作“后退”按钮以恢复先前的屏幕或预先选择的屏幕（例如图 18A 到 18D 的用户界面）。例如，电子设备可以检测辅导可供件 1832 的选择。特别地，电子设备可以检测对应于辅导可供件 1832 的选择的第四输入。响应于第四输入，电子设备 1800 可以显示包括用于操作电子设备的一个或多个指令（例如用于如何绘制图像或发送触摸的指令）的用户界面，在一些方面，辅导可供件 1832 可以在其已经被访问设定的次数之后而消失。用户界面屏幕 1802-1 提供用户一个或多个可供件用于与由可供件 1804 表示的联系人（即表示的联系人）联系，而且同时通过省略或停止显示不与当前选择的联系人相关联的显示对象来减少认知失调。

[0371] 附加地，在一些实施例中，如图 18A 所示，多个对象中的每个对象可以与时钟的小时标记相关联和 / 或根据时钟的小时标记来定位。在一些实施例中，多个对象可以包括 12 个圆形的对象位于可供件 1804 周围。然而，应理解的是多于 12 个或少于 12 个对象可以定位在用户界面 1802 上。

[0372] 用户界面 1802 可以还包括呼叫 / 电话可供件 1814。例如，一旦接收到表示呼叫 / 电话可供件 1814 的联系人或选择的输入，电子设备 1800 可以使得能够呼叫多个联系人中

EX1002 - Page 1209

的联系人（例如显示在中央可供件 1804 处的所选择的联系人）。用户界面 1802 还可以包括消息可供件 1816。例如，一旦接收到表示消息可供件 1816 的联系人或选择的输入，电子设备 1800 可以使得能够呼叫多个联系人中的联系人（例如显示在中央可供件 1804 处的所选择的联系人）。

[0373] 用户界面 1802 指示符 1824（图 18A），其提供来自与和指示符（对象 1812）相邻的对象相关联的联系人的一个或多个未读消息的指示。在一些实施例中，指示符 1824 可以包括数字或未读消息的数量的一些其它视觉指示。相应地，电子设备 1800 可以配置为确定从多个联系人中的一个联系人接收的一个或多个消息是否没有被读取，以及根据确定从多个联系人中的一个联系人接收的消息没有被读取，来显示靠近与一个或多个消息相关联的多个对象中的对象（例如图 18A 中的第三对象 1824）的指示符 1824。

[0374] 图 18E 图示示例用户界面用于增加或以其它方式将联系人关联到对象。在一些实施例中，可视指示符可以定位靠近空对象 1840a。空对象 1840a 可以是转换成包括加号图标的空的圆圈位置。而且，可供件 1804 还可以包括指示联系人增加进程的加号图标。附加地，在图 18E 中选择可供件 1804 可以启动或以其它方式触发联系人选择进程。

[0375] 例如，电子设备 1800 可以接收表示可旋转输入机构 1820 的第二旋转的输入，并且作为响应，可以确定可视指示符 1804 是否靠近不与任何联系人相关联的对象（例如对象 1804a）。而且，电子设备 1800 可以根据确定了可视指示符 1806 靠近不与任何联系人相关联的对象，来更新可供件 1804 的显示到增加联系人可供件。电子设备 1800 可以接收对应于增加联系人的选择的另一输入，并且响应于接收第十四输入，显示用户界面用于增加联系人。

[0376] 图 18G-18I 图示触敏显示器的附加的示例实施例，包括在电子设备 1800 处的用户界面 1802 并且具有与第一对象 1808 相关联的可视指示符 1850。如图 18G 中所示，第一对象 1808 与由中央可供件 1804 表示的当前所选择的联系人相关联。在这样的实施例中，可视指示符 1850 可以提供用户与对象 1808 相关联的联系人被当前选择的指示。在图 18G 中，可视指示符 1850 被描绘为稍大于 1808 的圆形；然而，在其它实施例中，可视指示符 1850 可以不同地呈现并且仍然向用户传达当前选择的对象。

[0377] 在一些实施例中，可视指示符 1850 可以被呈现为具有与当前选择的对象（例如对象 1808）相同尺度和维度的形成的对象。在一些实施例中，可视指示符是在用户界面的前台中呈现的对象，以便其挡住在可视指示符下方的用户界面的元素。在其它实施例中，可视指示符是半透明的或透明的前台对象，以便用户界面的下面的元素在可视指示符下方是可见的。在这样的实施例中，可视指示符可以操作为过滤器以改变可视指示符下方的用户界面元素的可视外观。

[0378] 在其它实施例中，可视指示符可以被分离地显示；甚至可视指示符 1850 可以是预定义区域，其中接口的下方的元素的外观（例如颜色、亮度、对比度的变化）被改变。在一些这样的实施例中，可视指示符可以呈现像“聚光灯”效果，由此由可视指示符 1850 占用的当前预定义区域内的部分或全部下降的对象具有被改变的外观，以便它们的外观（或者可视指示符区域内的至少部分）被强调或改变（例如颜色、亮度、对比度的变化）。注意这样的效果可以视觉上非常类似于操作为过滤交叠的可视指示符，如上文所述，尽管本领域技术人员将意识到相似的视觉效果不同地被实施。在一些实施例中，像聚光灯的可视指示符

EX1002 - Page 1210

可以仅改变可供件 1804 周围的圆形中呈阵列的对象（例如 1808、1810、1812）的外观，而不改变可以在可视指示符的区域内的用户界面 1802 的背景的任意部分的外观。

[0379] 在一些实施例中，可视指示符 1850 的外观可以是混合颜色，该混合颜色由随着可视指示符 1850 在对象之间移动的一个对象的颜色和另一个对象的颜色组成。特别地，可视指示符 1850 的外观可以是基于交叠的百分比的混合颜色。例如，蓝色可以与第一对象 1850 相关联，而红色与第二对象 1810 相关联。相应地，可视指示符 1850 的颜色可以是第一颜色的第一百分比和第二颜色的第二百分比，取决于 X 和 Y 交叠。如此，随着可视指示符 1850 在对象之间移动，其颜色可以基于前面的对象（例如第一对象 1808）的颜色和相邻的对象（例如第二对象 1810）的颜色之间的逆成比例关系而被动态地更新。也即，随着可视指示符 1850 朝着第二对象移动，第二对象的颜色将比第一对象的颜色在可视指示符 1850 的颜色中权重更重。换言之，随着可视指示符 1850 从第一对象移动到第二对象，形成可视指示符 1850 的颜色的第一对象的颜色百分比将随着可视指示符 1850 朝向或更接近第二对象 1810 移动而减小，并且如此，第二对象的颜色的百分比将增大。

[0380] 在图 18H 中，响应于对应于机构 1820 的旋转的输入，可视指示符 1850 已经移动到在对象 1808 和对象 1810 之间中的第二位置。可视指示符 1808 现在与对象 1808 和对象 1810 中的每个部分地交叠。图 18I 示出第三位置中的可视指示符，并且现在与对象 1810 相关联并且不再交叠，或者与对象 1808 相关联。虽然没有描绘，在机构 1820 上继续的旋转输入可以使得可视指示符进一步移动沿着圆形到对象 1812 等，以便可视指示符可以沿着形成在可供件 1804 周围的回路从对象到对象移动。为了实现用户能够沿着回路（例如从对象 1808、1810、1812 等）控制可视指示符 1850 的移动，“磁性的”关系与每个可选择的对象和可视指示符 1850 之间相关联。每个元素（例如 1808、1810、1812）与仿真的磁性值相关联。在该示例中，元素 1808、1810、1812 的磁性值是相等的。在其它示例中，磁性值可以不同，以便可视指示符 1850 可以具有针对一个对象相对于另一对象的更多磁性亲和力。

[0381] 在对象和可视指示符 1850 之间使用磁性关系，基于物理的建模可以用于仿真对象和可视指示符之间的磁性吸引力。结果，当用户输入在可视指示符 1850 没有与任意对象对准（例如图 18H 中描绘的第二位置）的同时没有取得时，可视指示符 1850 最后在其与对象中的一个（例如 1808、1810、1812 等）对准的地方到达稳定的状态。当可视指示符由于旋转机构 1820 没有被转换或者移动时，可视指示符 1850 被认为处于稳定状态中。该基于物理的磁性建模导致用户界面展示虚拟制动，其协助用户使用可视指示符 1850 来选择对象，而不需要用于可视指示符的精确的定位或者重新定位。而且，该行为限制其中两个对象同时由可视指示符 1850（例如图 18H）指示的实例，其减少认知失调。

[0382] 在该示例中，基于物理的磁性建模被实现，例如通过将每个对象（例如 1808、1810、1812 等）建模为由创建其自身持续磁场的磁化材料制作的对象，并且将可视指示符 1850 建模为被吸引到磁体的材料，诸如铁磁材料，包括铁、钴和镍。在另一示例中，基于物理的建模可以通过将每个对象建模为由吸引到磁体的材料制成的对象来实现，以及将可视指示符 1850 建模为创建其自身持续磁场的材料。在另一示例中，基于物理的建模可以通过将每个对象建模为创建其自身持续磁场的对象，以及将可视指示符 1850 建模为还创建其自身持续磁场的材料，诸如吸引的两个磁体。这些基于物理的模型的每个模型可以适于包括变化而不是保持持续的磁场，基于某些因素，诸如给定对象和可视指示符 1850 之间

EX1002 - Page 1211

的距离、可视指示符 1850 的速度、可视指示符 1850 的加速度或基于两个或更多因素的组合。例如，变化的磁场可以通过使用电磁体而被仿真，该电磁体可以被开启或关断并且可以具有变化的强度。在一些实施例中，磁性建模是于 2014 年 9 月 3 日提交的名称为“USER INTERFACE FOR MANIPULATING USER INTERFACE OBJECTS WITH MAGNETIC PROPERTIES”的美国非临时专利申请 14/476,657 或者于 2014 年 9 月 3 日提交的名称为“USER INTERFACE FOR MANIPULATING USER INTERFACE OBJECTS WITH MAGNETIC PROPERTIES”的 PCT 专利申请序列号 PCT/US2014/053961 中描述的模型，两者针对至少它们的运动的磁性模型的公开内容通过引用合并于此。

[0383] 参考图 18H 和 18I，在一些实施例中，如果机构 1820 的转动会导致可视指示符 1850 转换到诸如图 18H 中所示的位置，则设备 1800 可以将可视指示符 1850 快动到最近的对象（在这种情况下，对象 1810）。如图 18I 中所示，不允许可视指示符 1850 在对象 1808 和 1810 之间维持稳定状态，设备 1800 确定对象在可视指示符 1850 上具有最多磁性影响（例如在对象 1808 和 1810 具有相同的磁性值的情况下的最接近的对象）并且将可视指示符“快动”到那个对象。如图 18I 中所示，该确定导致将可视指示符快动到对象 1810。

[0384] 在一些实施例中，沿着可供件 1804 周围形成的回路的可视的可视指示符从对象到对象的运动被建模为可视指示符可以占用的一系列潜在位置或潜在位置的范围。对象（例如 1808、1810、1812 等）可以与沿着一系列潜在位置或潜在位置范围的特定位置相关联。响应于机构 1820 的旋转，设备 1800 可以确定输入是否会导致可视指示符转变到与任意对象不关联的系列或范围内的位置（例如图 18H 中可视指示符 1850 的位置）。如果是这样，则设备 1800 可以将可视指示符的位置更新到与对象（图 18H 中对象 1810）关联的最近位置并且随后显示该更新位置处的可视指示符。在一些实施例中，根据基于一系列位置或位置范围的模型的可视指示符的建模运动是根据于 2014 年 9 月 3 日提交的名称为“USER INTERFACE FOR MANIPULATING USER INTERFACE OBJECTS WITH MAGNETIC PROPERTIES”的美国非临时专利申请 14/476,657 或者于 2014 年 9 月 3 日提交的名称为“USER INTERFACE FOR MANIPULATING USER INTERFACE OBJECTS WITH MAGNETIC PROPERTIES”的 PCT 专利申请序列号 PCT/US2014/053961 中描述的模型来实现，两者通过引用合并于此针对至少它们的基于位置范围或一系列位置建模的公开内容（例如，如关于每个申请的图 6A 到 9B 描绘和描述）。

[0385] 在一些实施例中，诸如图 18G-18I 的实施例，可视指示符被显示在与多个对象中的第一对象（对象 1808）相关联的第一位置中。响应于接收对应于可旋转输入机构的转动的第一输入，设备 1800 停止将可视指示符与多个对象中的第一对象相关联，而将可视指示符与多个对象中与多个联系人中的第二联系人相关联的对象（对象 1810）相关联。

[0386] 在一些实施例中，诸如图 18G-18I 的实施例，作为用户界面的部分，设备 1800 根据位置值来显示可视指示符（可视指示符 1850），该值在位置值的范围内，多个对象中的每个对象（例如 1808、1810、1812 等）与位置值范围内的位置相关联。进一步响应于第一输入（机构 1820 的旋转），设备 1800 确定第一输入是否是请求更新可视指示符的位置值到第二位置值，该第二位置值不与多个对象中的对象相关联，或者不与多个对象中的单个对象相关联。根据确定第一输入是请求更新可视指示符的位置值到第二位置值，该第二位置值不与多个对象中的对象相关联，或者不与多个对象中的单个对象相关联，设备 1800 更新可视

EX1002 - Page 1212

指示符的位置值到第三位置值，该第三位置值对应于多个对象中最接近位置值范围内的第二位置值的对象的位置值，并且还根据第三位置值来更新可视指示符的显示。

[0387] 在一些实施例中，诸如图 18G-18I 的实施例，可视指示符被显示在与多个对象中的第一对象（对象 1808）相关联的第一位置中。响应于接收对应于可旋转输入机构的旋转的第一输入，设备 1800 停止将可视指示符与多个对象中的第一对象相关联，而通过以下方式将可视指示符与多个联系人中的第二联系人相关联：确定可旋转输入机构的旋转没有导致可视指示符与多个联系人中的第二联系人相关联。根据确定可旋转输入机构的旋转没有导致可视指示符与多个联系人中的第二联系人相关联，设备 1800 确定可视指示符的位置是否处于对象转换区域中，其中对象转换区域是位于第一对象之后并且位于与第二联系人相关联的第二对象之前的区域。根据确定可视指示符的位置处于对象转换区域中，设备 1800 将对象转换区域与多个联系人中的第二联系人相关联；并且根据确定可视指示符的位置不处于对象转换区域中，设备 1800 维持可视指示符与多个对象中的第一对象的关联。

[0388] 图 18J-18K 图示包括在电子设备 1800 的用户界面 1802 并且具有页面指示符 1860 的触敏显示器的实施例。特别地，基于由电子设备 1800 确定对象的数目满足或超过对象显示限制 / 阈值，电子设备 1800 配置为在用户界面 1802 上显示一个或多个附加的页面和 / 或一个或多个对象（例如联系人）的用户界面。也即，在一些实施例中，电子设备 1800 使得用户能够选择并且使得显示的任意数目的对象（例如联系人）以本文关于图 18A-18I 描述的相似的方式在附加的（例如两个或更多）页面或用户界面上。

[0389] 例如，在图 18J，电子设备 1800 可以显示一个或多个对象 1862 的第一集合。附加地，电子设备 1800 在触敏显示器 1802 上显示页面指示符 1860，该页面指示符 1860 指示对象在其处指示的页面或用户界面。如图 18I 中所示，页面指示符 1860 可以是指示第一页面的第一位置。例如，如图 18J 所示，第一用户界面包括一个或多个对象的第一集合。在显示第一用户界面（例如第一页面）的同时，电子设备 1800 可以配置为接收对应于请求显示第二页面的输入。该输入可以是由用户手指 1830 检测和由触敏显示器 1802 检测的轻扫手势。

[0390] 电子设备 1800 可以配置为响应于接收输入而用第二用户界面（例如第二页面）代替第一用户界面的显示，如图 18J 所示。电子设备 1800 可以在第二用户界面处不同于第一位置的第二位置显示页面指示符 1860。在一些实施例中，第二页面可以不同于第一页面以便第二页面包括一个或多个对象（例如联系人）的第二集合，每个与多个联系人的联系人相关联。在一些实施例中，一个或多个对象的集合中的对象（例如联系人）可以每个与群组相关联。在一些实施例中，群组是不同的，如在页面之间。例如，第一页面可以具有每个被标识为用户的家庭成员（例如通过用户或基于与联系人相关联的数据）的联系人；第二页面可以具有每个被标识为电子设备 1800 的用户的同事（例如通过用户或基于与联系人相关联的数据）的联系人。

[0391] 在一些实施例中，提供用户多个页面和 / 或一个或多个对象（例如联系人）的群组可以运行快速访问与用户联系人的通信，由此减少在用户上的认知负担并且通过减少不需要的、外来的、重复的和 / 或冗余的输入量来产生更有效的人机接口，并且可以创建更快和更有效的用户输入布置，其可以减少所需要的输入量，减少处理功率，并且减少针对其用户界面需要被显示以便用于要访问和执行的期望功能的时间量。

[0392] 图 19A-19B 图示示例用户界面用于显示栩栩如生的联系人的表示。例如，电子设

EX1002 - Page 1213

备可以包括包含用户界面 1910 的触敏显示器 1900。附加地，电子设备可以在触敏显示器 1910 上显示联系人 1920 的栩栩如生的表示。用户界面 1910 还可以显示联系人 1920 的状态 1930，其可以包括当前状态和位置。在一个实施例中，联系人 1920 可以是可用的并且位于伦敦。在另一实施例中并且在另一时间点，联系人 1920 的状态 1930 可以被更新以反映曼彻斯特的位置和睡眠的当前状态。

[0393] 在一些实施例中，当可供件表示第一联系人时，可供件（例如可供件 1804）的可视外观可以是第一联系人的动画表示。在一些实施例中，更新可供件（例如可供件 1804）的可视外观以表示多个联系人中的第二联系人可以包括更新可供件的可视外观到第二联系人的动画表示，如图 19A-19B 所示。而且，第一联系人的动画表示可以是动态的并且基于第二联系人的一个或多个时区信息、第二联系人的位置信息、关于由第二联系人指定的状态的信息（例如请勿打扰）。

[0394] 图 20 图示示例用户界面 2000 用于使得能够在绘图区域内绘图。在一些实施例中，电子设备 1800（图 18A）可以接收对应于选择绘图可供件 1818 的输入。特别地，电子设备 1800（图 18A）可以检测对应于选择绘图可供件 1818 的第五输入并且可以显示绘图区域 2010。绘图区域对应于触摸输入。在另一实施例中，电子设备 1800 可以检测对应于绘图区域 2010 中第一笔画的第六输入并且相应地，在绘图区域中显示第一笔画的视觉表示。在一些实施例中，用户界面 2000 是或者以相似于绘图区域 630 或绘图区域 710 的方式来操作。

[0395] 在一些实施例中，电子设备 1800（图 18A）可以显示沿着笔画的残留 2130 的动画消散。在一些实施例中，残留的动画消散是彗星样的效果，其被显示在表示用户接触 2020 的显示器上的位置的尾端。因此，随着用户接触触敏显示器并且在维持接触的同时移动手指，彗星样的效果将形成并被显示在最近的接触位置处。附加地，电子设备 1800（图 18A）额可以显示在来自绘图区域的笔画的视觉表示的烟雾形状 21401 中的淡出。在一些实施例中，淡出视觉表示包括显示笔画的逐渐消散的动画（例如消失的绘图笔画的烟雾样的效果）。

[0396] 图 21 图示示例用户界面 2100，具有时钟可供件 2120 转换成发送可供件 2120，基于用户期望将绘图发送到外部设备。特别地，绘图区域 2110 可以包括绘图时钟可供件 2120，其允许仅在绘图区域 2110 中绘图。而且，对应于选择绘图时钟可供件的输入可以被接收导致禁用绘图区域 2110 中表示任意笔画的数据的发送。附加地，绘图时钟可供件 2120 可以用发送可供件 2120 来代替，发送可供件 2120 允许传输绘图到外部设备。

[0397] 在一些实施例中，用户还可以摇动电子设备 1800 以去除绘图区域中的最近笔画。例如，电子设备 1800 可以接收对应于绘图区域中笔画的输入。而且，电子设备 1800 可以响应于接收该输入而在绘图区域中显示笔画的视觉表示。电子设备 1800 可以接着检测指示摇动或振动的运动，并且作为响应，可以确定电子设备的运动是否满足运动阈值。如此，电子设备 1800 可以响应于检测指示摇动运动的输入并且根据确定该运动满足或超过运动阈值而停止显示笔画的视觉表示。

[0398] 在一些实施例中，电子设备 1800 可以配置为检测或以其它方式确定用户期望与其通信的另一设备是否能够占用绘图进程。如此，如果联系人没有能够处理和显示表示绘图中笔画的数据的设备，则绘图可供件 181 不会被提供。

[0399] 在附加的实施例中，电子设备 1800 可以配置为基于在触敏显示器上的长按而记

EX1002 - Page 1214

录和发送短的音频消息，同时例如在联系人－特定的屏幕中。特别地，电子设备 1800 可以配置为检测表示触敏显示器上联系人的另一输入。电子设备 1800 可以配置为确定 12 个输入的持续满足或超过接触持续阈值。相应地，电子设备 1800 根据确定 12 个输入的持续满足或超过接触持续阈值，记录音频消息。附加地，电子设备 1800 将音频消息发送到与第二联系人相关联的电子设备。

[0400] 图 22 是图示根据一些实施例的更新可供件的可视外观的方法 2200 的流程图。方法 2200 可以在具有触敏显示器和可旋转输入机构的设备处执行（例如 100、300、500、550 和 1800）。方法 2200 中的一些操作可以被组合，一些操作的顺序可以被改变，并且一些操作可以被省略。

[0401] 在一些实施例中，可旋转输入机构（例如可旋转输入机构 506）可以配置为接收用户输入。在一些实施例中，方法 2200 可以在具有触敏表面／显示器（例如 112、355 和 504）的电子设备处被执行。可以执行方法 2200 的示例设备包括设备 100、300、500、550 和 1800（图 1A、图 3、图 5A 和图 18A~18I）。

[0402] 如下面所示，方法 2200 提供直觉的方式用于通过更新可供件的可视外观来与电子设备交互。该方法减少用户上的物理和／或认知负担，该用户可以在各种活动中占用可旋转输入机构，由此创建更有效的人机接口。

[0403] 在框 2202，方法 2200 可以在触敏显示器上显示包括多个对象的用户界面，每个对象与多个联系人中的联系人以及具有表示多个联系人中的第一联系人的可视外观的可供件相关联。在框 2204，方法 2200 可以接收对应于可旋转输入机构的旋转的第一输入。在框 2206，方法 2200 可以响应于接收对应于可旋转输入机构的旋转的输入，更新可供件的可视外观以表示多个联系人中的第二联系人。

[0404] 根据一些实施例，用户界面还包括与多个对象中的第一对象相关联的可视指示符，第一对象与多个联系人中的第一联系人相关联。

[0405] 根据一些实施例，还响应于接收对应于可旋转输入机构的旋转的第一输入：停止将可视指示符与多个对象中的第一对象相关联；而将可视指示符与多个对象中与多个联系人中的第二联系人相关联的对象相关联。

[0406] 根据一些实施例，作为用户界面的部分，根据位置值来显示可视指示符，该值在位置值的范围内，多个对象中的每个对象与位置值范围内的位置相关联；还响应于第一输入，确定第一输入是否是请求将可视指示符的位置值更新到不与多个对象中的对象相关联的第二位置值；根据确定第一输入是请求将可视指示符的位置值更新到不与多个对象中的对象相关联的第二位置值；将可视指示符的位置值更新到第三位置并且根据该第三位置值来更新可视指示符的显示，该第三位置响应于多个对象中最接近位置值范围内的第二位置的位置值。

[0407] 根据一些实施例，其中停止将可视指示符与多个对象中的第一对象相关联，而将可视指示符与可视指示符与多个联系人中的第二联系相关联包括：确定可旋转输入机构的旋转没有导致可视指示符与多个联系人中的第二联系人的关联；根据确定可旋转输入机构的旋转没有导致可视指示符与多个联系人中的第二联系人的关联，确定可视指示符的位置是否在对象转换区域中，其中对象转换区域是位于第一对象之后以及位于与第二联系人相关联的第二对象之前的区域；根据确定可视指示符的位置是在对象转换区域中，将可视指

EX1002 - Page 1215