



PROVISIONAL APPLICATION COVER SHEET

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Sir: This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c).

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TITLE OF INVENTION (280 characters max)

MULTI-FUNCTIONAL HAND-HELD DEVICE

CORRESPONDENCE ADDRESS

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ENCLOSED APPLICATION PARTS (check all that apply)

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| ☒ Specification | Number of Pages <u>51</u> | ☒ Other (specify) <u>Appendix A, 48 Pgs.; Cover Sheet (1pg.)</u> |
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- ☐ Applicant is entitled to Small Entity Status under 37 C.F.R. § 1.27.
- ☒ A check or money order is enclosed to cover the Provisional filing fees. Provisional Filing Fee Amount \$200
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- ☒ The commissioner is hereby authorized to charge any additional fees which may be required or credit any overpayment to Deposit Account No. 500388 (Order No. APL1P378P).

Respectfully Submitted,

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PROVISIONAL APPLICATION FILING ONLY

MULTI-FUNCTIONAL HAND-HELD DEVICE

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CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to the following applications, which are all herein incorporated by reference: (1) U.S. Patent Application No.: 10/188,182, titled,
10 “TOUCH PAD FOR HANDHELD DEVICE” filed on July 1, 2002; (2) U.S. Patent Application No.: 10/722,948, titled, “TOUCH PAD FOR HANDHELD DEVICE” filed on November 25, 2003; (3) U.S. Patent Application No.: 10/643,256, titled, “MOVABLE TOUCH PAD WITH ADDED FUNCTIONALITY” filed on August 18, 2003; (4) U.S. Patent Application No.: 10/654,108, titled, “AMBIDEXTROUS
15 MOUSE” filed on September 2, 2003; (5) U.S. Patent Application No.: 10/840,862, titled, “MULTIPOINT TOUCHSCREEN” filed on May 6, 2004; (6) U.S. Patent Application No.: 10/903,964, titled, “GESTURES FOR TOUCH SENSITIVE INPUT DEVICES” filed on July 30, 2004; (7) U.S. Patent Application No.: 11/038,590, titled, “MODE-BASED GRAPHICAL USER INTERFACES FOR TOUCH
20 SENSITIVE INPUT DEVICES” filed on January 18, 2005; and (8) U.S. Patent Application No.: 11/057,050, titled, “DISPLAY ACTUATOR” filed on February 11, 2005.

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BACKGROUND OF THE INVENTION

There exist today many types of hand-held electronic devices, each of which utilizes some sort of user interface. The user interface typically includes an output device in the form of a fixed display such as a Liquid Crystal Display (LCD) and one
30 or more input devices, which can be mechanically actuated (e.g., switches, buttons, keys, dials, joysticks, joy pads), or electrically activated (e.g., touch pads or touch screens). The display is typically configured to present visual information such as text and graphics, and the input devices are typically configured perform operations such as issuing commands, making selections or moving a cursor or selector in the

electronic device. Each of these well known devices has considerations such as size and shape limitations, costs, functionality, complexity, etc. that must be taken into account when designing the hand-held electronic device. In most cases, the user interface is positioned on the front face (or front surface) of the hand-held device for easy viewing of the display and easy manipulation of the input devices.

Figs. 1A-1F are diagrams of various hand-held electronic devices including for example a telephone 10A (Fig. 1A), a PDA 10B (Fig. 1B), a media player 10C (Fig. 1C), a remote control 10D (Fig. 1D), a camera 10E (Fig. 1E), and a GPS module 10F (Fig. 1F). In each of these devices 10, a display 12, which is secured inside the housing of the device 10, and which can be seen through an opening in the housing, is typically positioned in a first region of the electronic device 10 and one or more input devices 14 are typically positioned in a second region of the electronic device 10 next to the display 12.

To elaborate, the telephone 10A typically includes a display 12 such as a character or graphical display, and input devices 14 such as a number pad and in some cases a navigation pad. The PDA 10B typically includes a display 12 such as a graphical display, and input devices 14 such as a stylus based resistive touch screen and buttons. The media player 10C typically includes a display 12 such as a character or graphic display and input devices 14 such as buttons or wheels. The iPod® manufactured by Apple Computer, Inc. of Cupertino, CA is one example of a media player that includes both a display and input devices disposed next to the display. The remote control 10D typically includes an input device 14 such as a keypad and may or may not have a character display 12. The camera 10E typically includes a display 12 such as a graphic display and input devices 14 such as buttons. The GPS module 10F typically includes a display 12 such as graphic display and input devices 14 such as buttons, and in some cases a joy pad.

Recently, traditionally separate hand-held electronic devices are beginning to be combined in limited ways. For example, the telephone 10A has been combined with the PDA 10B. One problem that will be encountered as these device merge more rapidly is in the way inputs are made into the device. Each of these devices has a particular set of input mechanisms for providing inputs into the device. Some of

these input mechanisms are generic to all the devices (e.g., power button) while others are not. The ones that are not generic are typically dedicated to a particular functionality of the device. By way of example, PDAs typically include four dedicated buttons while cell phones typically include a keypad and at least two
5 dedicated buttons.

The design challenge will be designing a merged device with limited input devices without adversely affecting the dedicated inputs for each device. As should be appreciated, it is generally preferable not to overload the hand-held devices with a
10 large number of input mechanisms as this tends to confuse the user and take up valuable real estate. In the case of hand-held devices, the real estate is at a premium because of their small size. At some point there is not enough real estate on the device for housing all the necessary buttons and switches, etc. This is especially true when considering that all these devices need a display that typically takes up a large
15 amount of real estate on its own. In order to increase the number of input devices designers would have to decrease the size of the display. This, however, would leave a negative impression on the user since the user typically desires the largest display possible. Alternatively, designers may opt to increase the size of the device. This too would leave a negative impression on a user since this would make one handed
20 operations difficult. At some point, the size of the device would reach a point where it is no longer considered a hand-held device.

Although the user interface arrangements described above work particularly well for each device, an improved user interface that works for multi-functional
25 devices is needed.

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BRIEF DESCRIPTION OF THE DRAWINGS

The invention may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

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Figs. 1A-1F are diagrams of various electronic devices.

Fig. 2 is a simplified diagram of a multi-functional hand-held device, in accordance with one embodiment of the present invention.

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Fig. 3 is a perspective view of a substantially full screen hand-held device with limited buttons, in accordance with one embodiment of the present invention.

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Fig. 4 is a front view of a hand-held device with at least one button, in accordance with one embodiment of the present invention.

Fig. 5 is a diagram of a GUI separated into a standard region and a control region, in accordance with one embodiment of the present invention.

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Fig. 6 is a diagram of a GUI separated into a standard region and a control region, in accordance with one embodiment of the present invention.

Fig. 7 is a diagram of a GUI separated into a standard region and a control region, in accordance with one embodiment of the present invention.

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Fig. 8 is a diagram of a GUI separated into a standard region and a control region, in accordance with one embodiment of the present invention.

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Fig. 9 is a GUI for a PDA, in accordance with one embodiment of the present invention.

Fig. 10 is a GUI for a cell phone, in accordance with one embodiment of the present invention.

Fig. 11 is a GUI for a music player, in accordance with one embodiment of the present invention.

5 Fig. 12 is a GUI for a video player, in accordance with one embodiment of the present invention.

Fig. 13 is a GUI for a game player, in accordance with one embodiment of the present invention.

10 Fig. 14 is a GUI for a camera, in accordance with one embodiment of the present invention.

Fig. 15 is a GUI for a GPS, in accordance with one embodiment of the present invention.
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Fig. 16 is a GUI for a remote control, in accordance with one embodiment of the present invention.

Fig. 17 is a GUI for a hand top, in accordance with one embodiment of the present invention.
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Fig. 18 is a GUI for a main menu of a hand held device, in accordance with one embodiment of the present invention.

25 Fig. 19 is a side elevation view, in cross section, of a hand-held device that utilizes a force sensitive display, in accordance with one embodiment of the present invention.

Fig. 20 illustrates an input device that combines touch sensing and force
30 sensing devices in order to provide x, y and z components when touched, in accordance with one embodiment of the present invention.

Fig. 21 is a side elevation view of an I/O device that combines a display with touch screen and a force sensing mechanism, in accordance with one embodiment of the present invention.

5 Fig. 22 is a side elevation view of an input device, in accordance with one embodiment of the present invention.

Fig. 23 is a side view, in cross section, of a hand-held device that utilizes a squeeze feature, in accordance with one embodiment of the present invention.
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Fig. 24 is a side view, in cross section, of a hand-held electronic device, in accordance with one embodiment of the present invention.

Fig. 25 is a diagram of a touch method, in accordance with one embodiment
15 of the present invention.

• Fig. 26 is a touch method, in accordance with another embodiment of the
• present invention.

20 Figs. 27A-E are tables representing one example of a touch vocabulary associated with a music player, in accordance with another embodiment of the present invention.

Fig. 28 is a block diagram of an exemplary hand-held device, in accordance
25 with one embodiment of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

The present invention describes a multi-functional device capable of configuring user inputs based on how the device is to be used. According to one aspect of the invention, the multi-function device has at most only a few physical buttons, keys or switches so that its display size can be substantially increased. In other words, by eliminating physical buttons, keys or switches from a front surface of an electronic device, additional surface area becomes useable for an increased size display, such as a full screen display. A full screen display is a display that consumes, or at least dominates, a surface (e.g., front surface) of an electronic device.

Embodiments of the invention are discussed below with reference to Figs. 2-28. However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these figures is for explanatory purposes as the invention extends beyond these limited embodiments.

I. MULTI-FUNCTIONALITY

Traditionally separate hand-held electronic devices can be combined to form multi-function devices. By having a single multi-function device, a user is not burdened with carrying, purchasing and maintaining multiple devices. Further, the user is not limited in the operations that can be performed, i.e., the user can perform different operations that would have otherwise been limited to a different device.

As used herein, the term “multi-functional” is used to define a device that has the capabilities of two or more devices in a single device. The multi-functional device may, for example, include at least two or more of the following device functionalities: PDA, Cell Phone, Music Player, Video Player, Game Player, Camera, Handtop, Internet terminal, or remote control. As should be appreciated, for each new device functionality that is added to a single device, the complexity and size of the device tends to increase. Therefore, with hand-held devices, there is typically a trade-off that must be performed during the design process that keeps the footprint small and complexity low while maximizing the functionality.

It should be emphasized that this is not a trivial task. In some cases, the devices include redundant components (hardware) and therefore the components can be reused for different device functionalities. In other cases, the components are distinct to each device and therefore space and connectivity for additional components needs to be made available. Furthermore, each device functionality typically has its own programming or application software and, therefore, the multi-function device must be designed with enough storage to contain all the various software components.

A Personal Digital Assistant (PDA) is a mobile hand-held device that provides computing and information storage and retrieval capabilities for personal and/or business use. PDAs are capable of tracking names, addresses, phone numbers and appointments. They are also capable of taking notes, performing calculations, paging, data messaging, and electronic mail. Some PDAs also include functionality for playing simple games and music. Examples of PDAs are Palm Pilot and Blackberry. Like most hand-held devices, the PDA includes at least a display and various input devices. The input devices may, for example, include a stylus and touch screen that work in combination with a handwriting recognition program. The input devices may further include keypads, mini-keyboards, a navigation pad and/or soft or fixed function buttons.

Cell phones are mobile telephones that allow a user to connect to other telephones using a cellular network. Cell phones typically include a transceiver for transmitting and receiving telephone calls, and controls such as a navigation pad for traversing through a display, a keypad for making numeric entries (and in some cases alphabet entries), and soft or fixed function buttons. For example, one fixed function button is for starting a call and another fixed function button is for ending a call.

Music players come in a variety of forms. Music players are generally configured to store, process and output music. Music players can be based on the MP3 or AAC format, which is a compression system for music. Music Players typically include a microprocessor, memory, display, audio jack, data port and playback controls. The playback controls typically include features such as menu,

play/pause, next, previous, volume up, and volume down. The iPod® manufactured by Apple Computer, Inc. of Cupertino, CA is one example of a music player.

5 Video Players are similar to music players in most respects. In some cases, they may include a data storage device for receiving a removable storage medium such as a DVD.

10 Handtops push the envelope of being considered hand-held. Handtops are similar to laptops, but in a smaller form factor. They typically include a display and a full keyboard.

Fig. 2 is a simplified diagram of a multi-functional hand-held device 100, in accordance with one embodiment of the present invention. The multi-functional hand-held device 100 integrates at least two devices 102 into a single device. As shown, each device 102 includes both hardware and software components 104 and 106 that are required to operate each device 102. These components 104 and 106 are integrated into the same multi-functional hand-held device 100. In some cases, the devices 102 include shared components (hardware or software), which can be used to operate each integrated device 102. In other cases, the components 104 and 106 are distinct to each device 102 and therefore space and connectivity has to be made available. It should be pointed out that the multi-functional hand-held device 100 is not limited to only two devices, and may in fact integrate more than two devices. Any number of devices may be integrated including three, four and five and so on.

25 In one embodiment, the multi-functional device 100 includes switching means 110 that allows the functionality of the multi-functional device 100 to be switched from one device to another device (and so on). For example, the switching means 110 may allow a user to select the desired device functionality. Once selected, the multi-functional device 100 operates as the selected device. For example, the programming related to the selected device is activated for use by the multi-functional hand-held device. The programming may include reconfiguring the UI based on the selected device so that the inputs made by the user correlate to the device in use. For example, the functions of any physical buttons, switches or dials as well as soft buttons, switches or dials can be reconfigured to correspond to the selected device.

1. FORM FACTOR

The form factor of a hand-held device is a device that can easily be held in
5 one hand. A typical hand-held device includes a small landscape display in an upper
portion of the front surface of the device, and input controls in a lower portion of the
front surface of the device. The device may additionally include controls and ports
on the top, bottom and side surfaces. While this has worked well, the small display
provides certain amount of dissatisfaction with users. It is generally preferred to have
10 large displays so that more information can be displayed or the information being
displayed can be viewed more easily (larger). In the case of video players and game
players, in particular, large displays are much preferred over smaller ones. Large
displays however have been limited in the past because the controls take up a
nontrivial portion of the available space. Furthermore, as the device functionality
15 converges, the number of controls on the device typically increases (each device
includes its own dedicated controls) and therefore the device must be made larger or
the display smaller to accommodate all the new controls. Both of these outcomes are
unsatisfactory. Larger devices are bulky and hard to use, and smaller screens are
difficult to utilize for both relaying information and reading information from the
20 screen.

A. HAND-HELD

As used herein, the term “hand-held” means that the electronic device has a
25 form factor that is small enough to be comfortably held in one hand. A hand-held
electronic device may be directed at one-handed operation or two-handed operation.
In one-handed operation, a single hand is used to both support the device as well as to
perform operations with the user interface during use. Cellular phones, and media
players are examples of hand-held devices that can be operated solely with one hand.
30 In the case of a cell phone, for example, a user may grasp the phone in one hand
between the fingers and the palm and use the thumb to make entries using keys,
buttons or a joy pad. In two-handed operation, one hand is used to support the device
while the other hand performs operations with a user interface during use or
alternatively both hands support the device as well as perform operations during use.

PDA's and game players are examples of hand-held device that are typically operated with two hands. In the case of the PDA, for example, the user may grasp the device with one hand and make entries using the other hand, as for example using a stylus. In the case of the game player, the user typically grasps the device in both hands and
5 make entries using either or both hands while holding the device.

B. FOOTPRINT/SIZE

Each device typically includes a different footprint. The footprint is typically
10 associated with how the device is going to be used. Palm sized devices such as PDAs are typically used with both hands and thus they tend to be larger while hand sized devices such as cell phone handsets are typically used with only one hand and thus they tend to be smaller. Because of their size, the smaller devices are typically placed in a pocket while the larger devices are not. When integrating multiple devices
15 together, it is a non-trivial task to determine the desired footprint of the device. Some believe that PDAs seem too large for phone use while cell phones handsets seem too small for PDA use. Designers generally must consider the primary use of the device and gear the footprint of the device towards that use. Although there are different footprints, there are typically minimum and maximum footprints. If the footprint is
20 too large or too small, the device may be difficult to use.

In one embodiment, the media player is a hand-held device that is sized for placement into a pocket of the user. By being pocket-sized, the user does not have to directly carry the device and therefore the device can be taken almost anywhere the
25 user travels (e.g., the user is not limited by carrying a large, bulky and often heavy device, as in a laptop or notebook computer).

C. FULL SCREEN DISPLAY, OR NEAR FULL SCREEN DISPLAY

30 Since the footprint is substantially fixed, it becomes a non-trivial task for designers to determine a layout for the UI. By way of example, some PDAs include a limited number of buttons and a large display while other PDAs include a large number of buttons (keyboards) and a small display.

In accordance with one embodiment of the present invention, the hand-held device is configured with a full screen display or a near full screen display. A full screen display is a display that consumes, or at least dominates, a surface (e.g., front surface) of an electronic device. In one embodiment, a full screen display consumes substantially the entire front surface of the hand-held device (in both directions). It may extend edge to edge or it may fit within a small bezel of the housing at the edge of the device. The full screen display may have a variety of different configurations depending on the overall footprint of the device. If the device is wide, the full screen display may have a traditional aspect ratio of about 4:3. If the device is elongated, the full screen display may have an aspect ratio that is more panoramic such as 16:9.

In one embodiment, the full screen display consumes at least 90% of a front surface of a housing for a hand-held electronic device.

D. LIMITED NUMBER OF MECHANICAL ACTUATORS

In order to accommodate a full screen display, the hand-held device is typically configured with a limited number of physical buttons. As mentioned before, buttons take up space that can be otherwise used for the display. Because at most only a limited number of buttons are provided, the hand-held device may utilize a touch screen as the primary input means necessary to interact with the hand-held electronic device. Touch screens are transparent touch sensing devices that are positioned over displays. They typically work in conjunction with a GUI presented on the display. For example, the GUI may present an on-screen button, and the touch screen may detect when a user presses the on-screen button (e.g., places their finger or stylus over the on-screen button). Touch screens and GUI's will be described in greater detail below.

In one embodiment, the hand-held device only includes cross-functional physical buttons, i.e., there are no buttons dedicated to individual devices. These type of buttons may include power buttons and hold switches, which are not platform dependent. In another embodiment, the hand-held device does not include any physical buttons at all. In another embodiment, the physical buttons of the hand-held device are limited to only the sides and back surface of the hand-held device, i.e., no

buttons on the front surface. In another embodiment, the physical buttons of the hand-held device are limited to the upper and lower regions of the sides, i.e., no buttons in the holding region of the sides. In another embodiment, the physical buttons are located at the front surface, but only in the bezel region surrounding the display. In another embodiment, the buttons are located on only the top and bottom surfaces of the device.

Fig. 3 is a perspective view of a substantially full screen hand-held device 120 with limited buttons, in accordance with one embodiment of the present invention. In this particular embodiment, there are no physical buttons on the front and side surfaces 124 and 126. The front surface real estate is used entirely for the display 122 and thus it can be considered a full screen display. Further, because the sides 126 are used for grasping the device 120 it is typically preferably to leave the sides free from buttons in order to prevent accidental entries when the user inadvertently presses a button. For example, when a user repositions their hand, accidental entries are possible so having the side surfaces 126 substantially free of buttons is helpful. Although the top surface 128 does not have the same problems as the side 126 and front surfaces 124, it typically is not used for buttons that are often actuated since it would be hard to reach such buttons when operating the device with one hand. The top 128 is typically reserved for buttons that have limited action and generic functions that are cross-functional, as for example, power and hold switches. The top and bottom surfaces 128 and 130 are also well suited for placement of I/O and communication ports. The top surface 128 may, for example, include a headset/microphone jack (and possibly an antenna), and the bottom surface 130 may include power and data port(s).

It should also be pointed out that although buttons are not normally placed on the side surfaces 126, in some cases, it may be desirable to place them in the upper or lower regions of the side surfaces 126 out of the way of the grasping hand. This may be particularly well suited for elongated devices that are larger than the width of the grasping hand. As shown in Fig. 4, the hand-held device 120 includes a button 140 in the upper region on the side surface 126 of the hand-held device 120. Because the button 140 is in the upper region, it tends to be out of the way of the grasping hand and therefore accidental activation is substantially eliminated. In one embodiment, the

upper button is configured to switch the functionality of the multi-functional device. For example, by pressing the button 140, a new device functionality is activated, and the current device functionality is deactivated. Although the term button is used, it should be appreciated that the button 140 may correspond to a dial, wheel, switch
5 and/or the like.

2. ADAPTABILITY

In order to limit the number of physical controls on the device (thereby
10 maximizing the display), the multi-functional hand-held device is adaptable. By adaptable, it is meant that the device is capable of changing its UI based on how the device is to be used. For example, if a cell phone functionality of the multi-functional device is to be used, the UI changes to accommodate the cell phone. Alternatively, if the PDA aspect of the multi-functional device is to be used, the UI changes to
15 accommodate the PDA (and so on). In essence, the multi-functional device is capable of reconfiguring its user interface based on the state or mode of the device.

In one embodiment, the adaptability is accomplished by reassigning the functions of the limited physical buttons for each device functionality. For example,
20 a button may mean one thing when a first device is activated and another thing when another device is activated. While this may work, it does suffer from physical limitations (number of buttons) and can be confusing to the user since they have to keep track of different button meanings.

In another embodiment, therefore, the adaptability is accomplished by
25 virtually incorporating the physical input means into the GUI (in conjunction with a touch screen). The GUI can adapt to whatever device is selected, and the touch screen can receive inputs over the GUI. In most cases, there is a GUI dedicated to each device functionality that has been integrated into the multi-functional hand-held
30 device. As a result, the UI for the hand-held device adapts such that in effect the multi-function device becomes a particular device. By way of example, if the cell phone functionality is selected, then the GUI may present a set of virtual or soft controls that looks similar to the physical controls typically used on a cell phone, such as a keypad, function buttons and possibly a navigation pad, for example.

In some cases, the entire display is used to present this information, and in other cases only a portion of the display may be used for the GUI controls. In the later case, for example, and referring to Figs. 5-6, the GUI 150 may be separated into a standard region 152 and a control region 154. The standard region 152 represents what would normally be displayed on the display 122 when using a particular device. That is, the standard GUI screens associated with the selected device are displayed in the standard region. For example, in the case of the PDA, a main menu (window with a set of icons), calendar, address book or date book may be displayed in the standard region 152. The control region 154, on the other hand, virtually represents the physical controls that would normally be physically placed on a particular device. That is, the virtual controls that mimic the physical controls are displayed in the control region 154. For example, in the case of the PDA, the control region 154 may include virtual representations of a hand writing recognition area, a navigation pad and the standard function buttons.

The standard and control regions 152 and 154 can be positioned at any point on the display 122 (top, bottom, sides, center, etc.). For example, as shown in Fig. 5, they may be positioned vertically relative to one another (one on top of the other) or as shown in Fig. 6, they may be positioned horizontally relative to one another (side by side). These configurations can be used in either portrait or landscape modes. By way of example, in cases where the device is operated in landscape mode, the standard region 152 may be placed on one side and the control region may be placed on the opposite side. Landscape orientation may, for example, facilitate one handed operation. In some cases, the side on which the controls are displayed is based on the handedness of the user. For example, the controls may be place on the right side for right-handed users, and the controls may be placed on the left side for left-handed users. Alternatively, the controls may be placed on both sides as shown in Fig. 7. This arrangement is particularly well suited for game playing. Furthermore, the amount of area dedicated to each portion may be widely varied. In some cases, the screen is divided equally and in other cases one or the other portion constitutes a greater amount of the display. In some cases, the standard region 154 is maximized to increase the normal viewing area of the display (as shown).

When selected for use, the hand-held device typically loads the software for the selected device and configures the GUI 150 including the standard region 152 and the control region 154. The controls in the control region 154 can therefore be used to control whatever is being shown in the standard region 152. In some cases, the control region 154 may even change in accordance with the needs of each displayed window for the particular device.

Alternatively, as shown in Fig. 8, virtual controls 160 may be overlaid on top of the standard region 152 so that the standard region 152 can fully utilize the entire display 122. In fact, the virtual controls 160 may appear and disappear as needed. For example, the user may touch the screen and this may drive the device to display the controls over a portion of the display including whatever is already displayed. Examples of virtual controls that operate in this manner can be found in U.S. Patent Application No.: 11/038,590, titled, "MODE-BASED GRAPHICAL USER INTERFACES FOR TOUCH SENSITIVE INPUT DEVICES" filed on January 18, 2005

A. GUI BASED ON DEVICE

Figs. 9-17 are examples of GUIs for different states or modes of the multi-functional device.

Fig. 9 is a diagram of a GUI 170 that is used in a PDA mode. As shown, the GUI is divided into a standard region 152 and a control region 154. Located inside the control region 154 are a virtual handwriting pad 172, four virtual buttons 174 and a virtual navigation pad 176.

Fig. 10 is a diagram of a GUI 180 that is used in a Cell Phone mode. As shown, the GUI 180 is divided into a standard region 152 and a control region 154. Located inside the control region 154 are a virtual keypad 182, a virtual navigation pad 184 and two virtual buttons 186.

Fig. 11 is a diagram of a GUI 190 that is used in a Music Player mode. As shown, the GUI 190 is divided into a standard region 152 and a control region 154.

.. Located inside the control region 154 are a virtual scroll wheel 192 and five virtual buttons 194. Additional details on a virtual scroll wheel are provided in U.S. Patent Application No.: 11/038,590, titled, "MODE-BASED GRAPHICAL USER INTERFACES FOR TOUCH SENSITIVE INPUT DEVICES" filed on January 18, 5 2005.

Fig. 12 is a diagram of a GUI 200 that is used in a Video Player mode. As shown, the GUI 200 is divided into a standard region 152 and a control region 154. Located inside the control region 154 are a plurality of virtual buttons 202. 10 Alternatively, the controls may appears and disappears as needed since the video player is primarily used in conjunction with a full screen viewing mode.

Fig. 13 is a diagram of a GUI 210 that is used in a Game Player mode. As shown, the GUI 210 is divided into a standard region 152 and two control regions 15 154A and 154B on the sides of the standard region 152. The left side control region 154A includes a navigation or directional pad 212, and the right side control region includes four virtual buttons 214 (or vice versa depending on the users particular needs, left or right handed).

Fig. 14 is a diagram of a GUI 220 that is used in a Camera mode. As shown, 20 the GUI 220 is divided into a standard region 152 and a control region 154. The standard region 152 may represent the view finder. Located inside the control region 154 are various buttons 222 including for example picture click, zoom, flash, etc. A navigation pad 224 may also be included so that the pictures can be scrolled through 25 or for menu navigation.

Fig. 15 is a diagram of a GUI 230 that is used in a GPS Receiver mode. As shown, the GUI 230 is divided into a standard region 152 and a control region 154. Located inside the control region 154 are various buttons 222 including for example 30 zoom, pan, etc. A navigation pad 224 may also be included.

Fig. 16 is a diagram of a GUI 240 that is used in a hand top mode. As shown, the GUI 240 is divided into a standard region 152 and a control region 154. Located inside the control region 154 is a virtual keyboard 242.

Fig. 17 is a diagram of a GUI 250 that is used in a Remote Control. As shown, the GUI 250 is divided into a standard region 152 and a control region 154. Located inside the control region 154 are various keys and buttons 252 associated with controlling a remote device such as a TV, DVD player, A/V amplifier, VHS, CD player, etc.

B. SWITCHING BETWEEN DEVICES (GUI)

Before a particular device of the multi-functional device can be used by a user, it is typically selected for use. The selection can come in a variety of forms. In one implementation, the selection is made via a main menu that includes soft buttons or icons that, when selected, activate the device functionality associated with the soft button. During activation, the GUI for that particular device is brought into view on the display (see Figs. 9-17) and the software associated with the device is installed, loaded or woken up. From that point on, the multi-functional device operates like the selected device.

Fig. 18 is an example of one embodiment of a main menu GUI 260 of a multi-functional device. As shown, the GUI 260 includes icons/buttons 262 for launching each of the various device functionalities. In this particular example, the main menu page 260 includes a PDA button 262A, a cell phone button 262B, a music player button 262C, a game player button 262D, a video player button 262E, a GPS button 262F, a remote control button 262G, a camera button 262H and a handtop button 262I. The various buttons 262 are virtual buttons. When the button is pressed, the main page for the selected icon as shown in Figs. 9-17 is brought into view on the display. As an example, in order to select another device, the user simply selects a soft home button 264 located in the GUI of each device in order to load the main menu page 260, and thereafter selects the desired device in the main menu page 260.

The selection may also come in a more active form including flipping (or scrolling) through the various GUIs until the desired GUI is found. For example, the different GUIs may be incrementally brought into view page after page (or frame after frame) when a next (flip) command signal is generated (e.g., slide show effect).

The transition between pages may be widely varied. The transition may be from side to side, top to bottom or center to center. The transition may also include fading in and out, popping in and out, or enlarging and reducing.

5 The command signal may be generated by a physical or virtual button or wheel. Using a button, each press may cause a new page to be displayed. Using a wheel, a predetermined amount of rotation may cause a new page to be displayed.

10 The command signal may also be generated by gestures initiated on the touch screen. For example, sliding a finger (or stylus) across the display may cause a new page to be displayed. If slid to the right, the next page may be displayed. If slid to the left, the previous page may be displayed.

15 The command signal may also be generated by 3D device gestures created when the entire hand-held device is moved spatially. By way of example, shaking the device may cause a new page to be displayed.

20 The command signal may also be generated by forces that are applied to the device. By way of example, squeezing the device may cause a new page to be displayed.

25 The command signal may also be generated by sensing the orientation of the device. If the device is at 0 degrees, a first page is displayed, at 90 degrees a second page is displayed, at 180 degrees a third page is displayed and at 270 degrees a fourth page is displayed.

30 The command signal may also be generated by monitoring a user's voice (i.e., voice recognition). If the user calls out "Phone", the page associated with the phone is displayed, if the user calls out PDA, the page associated with the PDA is displayed.

 The command signal may also be generated by monitoring incoming signals from other systems (whether transmitted wirelessly or via a cable). For example, if

a call is received, the device may automatically configure the system as a phone. Alternatively, it may only present a control panel for taking or passing on the call.

Although not a requirement, in one embodiment, the device is configured to
5 keep the various modes separate. That is, the device does not merge the functionality together (integrated layers and GUIs), but instead keeps them distinct from one another. By keeping them distinct, the user is less confused.

C. OPERATING AT LEAST TWO FUNCTIONALITIES 10 SIMULTANEOUSLY

In one embodiment, the device instead of activating one device, may also activate two devices (or more). In cases such as these, the software for both devices is activated and the display operates in a split screen mode where the screen is parsed
15 into different sections, each section including the device GUI. By way of example, in a landscape mode, a first device GUI may be presented on the left side of the display screen and a second device GUI may be presented on the right side of the display screen. In cases such as this, the GUI would be reduced to accommodate the new space. The dual mode may be selected in a variety of ways. In one implementation,
20 when the user simultaneously touches two device icons, the device activates both device functionalities and brings both GUIs into view on the screen.

D. CONFIGURABLE GUI (USER PREFERENCES)

25 In one embodiment, the GUI control panels for each device may be configurable. For example, the user may design their own UI for each device, and assign functions to the various elements of the UI. By way of example, the functions may include initiating commands, selecting an item, opening a file or document, launching a program, executing instructions, viewing a menu on the display screen,
30 and/or the like. The design may include selecting the number and type of GUI elements (buttons) as well as the location of the GUI elements on the page. In some cases, the system may include a design palette that allows a user to review and/or customize the UI layout, i.e., the user may quickly and conveniently review the layout

and make changes thereto. Once changed, the modified layout will be automatically saved and thereby employed to handle future events.

3. INPUT DEVICES

5

Problems with current input devices: 1) there is no realistic way to fit all the dedicated physical buttons that are needed for each device (more and more buttons are crammed into a small space), 2) as more physical buttons are incorporated into the device, the buttons get closer together thereby challenging the dexterity of the user (it becomes easy to overshoot the desired button and select one of the adjacent buttons), 3) because physical buttons stick out they can be accidentally activated during normal use or while the device is transported as for example in a user's pocket, 4) large numbers of small physical buttons can be confusing to the user as well as aesthetically unpleasing.

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In order to overcome the above, the present invention proposes using a variety of alternative inputs means (in addition to or in place of physical ones). The idea is to reduce the number of physical and mechanical input mechanisms (and therefore the amount of real estate needed on the surface of the device) and/or eliminate the physical and mechanical input mechanisms altogether. By reducing or eliminating the physical input devices, the display of the electronic device can be maximized, or alternatively the electronic device can be minimized to the size of the display. Furthermore, the device is more aesthetically pleasing, and in many cases can be made smaller without sacrificing screen size, which is very beneficial for hand-held electronic device especially those hand-held electronic device that are operated using one hand (some hand-held electronic device require two handed operation while others do not). In some cases, the hand-held device can be configured so that it appears to only have a display and no physical input means.

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In some cases, the alternative input means are hidden. By hidden, it is meant that they are not visible to the user. As a result of using hidden input means, the hand-held electronic device appears to only have a display and no input means (no visible buttons). The device is therefore more aesthetically pleasing (e.g., smooth

surface with no breaks gaps or lines), and in many cases can be made smaller without sacrificing screen size and input functionality.

A. TOUCHSCREEN

5

In accordance with one embodiment of the present invention, a touch screen is configured as the primary input means of the hand-held device (in conjunction with GUI). The touch screen is a transparent input panel positioned in front of the display. The touch screen generates input signals when an object such as a finger (or stylus) is moved across the surface of the touch screen, from an object holding a particular position on the touch screen and/or by a finger tapping on the touch screen. In most cases, touch screens allow a user to make selections and initiate movements in a GUI by simply touching the display screen via a finger. For example, a user may make a selection by pointing directly to a graphical object displayed on the display screen.

10 The graphical object may, for example, correspond to an on-screen button for performing specific actions in the hand-held electronic device. In general, the touch screen recognizes the touch and position of the touch on the display and a controller of the hand-held electronic device interprets the touch and thereafter performs an action based on the touch event. There are several types of touch screen technologies including resistive, capacitive, infrared and surface acoustic wave.

15 20

In one implementation, the touch screen is a multipoint capacitive touch screen that is divided into several independent and spatially distinct sensing points, nodes or regions that are positioned throughout the touch screen. The sensing points, which are typically hidden from view (transparent), are dispersed about the touch screen with each sensing point representing a different position on the surface of the touch screen (or touch screen plane). The sensing points may be positioned in a grid or a pixel array where each pixelated sensing point is capable of generating a signal. In the simplest case, a signal is produced each time an object is positioned over a sensing point. When an object is placed over multiple sensing points or when the object is moved between or over multiple sensing point, multiple signals can be generated. The sensing points generally map the touch screen plane into a coordinate system such as a Cartesian coordinate system a Polar coordinate system or some other coordinate system. By way of example, the touch screen may generally correspond to

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the touch screen disclosed in U.S. Patent Application No.: 10/840,862, titled, "MULTIPOINT TOUCHSCREEN" filed on May 6, 2004.

B. TOUCH SENSITIVE HOUSING

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In accordance with another embodiment, a hand-held electronic device may include a touch sensitive surface that provides either a larger surface for tracking touch inputs or smaller dedicated areas such as touch buttons for performing dedicated functions. The touch sensitive surface can be located on any surface of the housing, any side of the housing, any portion of any side of the housing or at dedicated locations on the surface of the housing. By way of example, the touch regions may be located on the sides or back surface of the housing, and may even be located at the bezel located at the front surface of the housing. In all of these cases, a large portion of the front surface of the housing is saved for the display so that the viewing area of the hand-held electronic device can be maximized.

15

The touch sensitive surface may take the form of one or more touch panels that are positioned within the housing. The touch sensitive surface may be alternatively or additionally be provided directly by the housing. That is, the touch sensing components are integrated or incorporated into or disposed underneath the housing such that the housing itself is the touch sensing device (rather than using a separate touch panel). This particular implementation is believed to be more aesthetically pleasing than using touch panels in that the housing can have a uniform appearance with no lines, breaks or openings in the surface. That is, the surface of the housing is continuous smooth surface that can be made to look like it does not have any input devices, just a display and a housing (e.g., a device with no visible input devices).

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Similar to the touch screen, the touch sensitive housing recognizes the touch and position of the touch on the surface and a controller of the hand-held electronic device interprets the touch and thereafter performs an action based on the touch event. There are several types of touch screen technologies including resistive, capacitive, infrared and surface acoustic wave.

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In one particular implementation, the touch sensitive surface is a multipoint capacitive touch device that is divided into several independent and spatially distinct sensing points, nodes or regions that are positioned throughout the device. The sensing points, which are typically hidden from view (transparent), are dispersed about the device with each sensing point representing a different position on the surface of the touch screen (or touch screen plane). The sensing points may be positioned in a grid or a pixel array where each pixilated sensing point is capable of generating a signal. In the simplest case, a signal is produced each time an object is positioned over a sensing point. When an object is placed over multiple sensing points or when the object is moved between or over multiple sensing point, multiple signals can be generated. Like the touch screen, the sensing points generally map the plane of the touch surface into a coordinate system such as a Cartesian coordinate system a Polar coordinate system or some other coordinate system.

By way of example, the touch sensitive housing may generally correspond to the touch sensitive housing described in greater detail below in APPENDIX A.

C. DISPLAY ACTUATOR

In accordance with another embodiment, a hand-held electronic device may include a display actuator. A display actuator is an input device that mechanically utilizes the display of the hand-held device to provide inputs into the device (rather than electrically as with a touch screen). The display actuator may be used separately or in combination with the touch screen. One of the advantage of the display actuator is that because the display provides user inputs, physical input means on hand-held devices having displays can be reduced or substantially eliminated. Furthermore, the size of the display can be maximized since the real estate is no longer needed for the conventional input means. For example, the display can be configured to substantially fill the entire user interface portion of a hand-held electronic device without impairing the user input functionality. Alternatively, the hand-held electronic device can be minimized to the size of the display. In either case, the display is allowed to utilize a greater amount of the real estate of the electronic device.

In one embodiment, the display actuator includes a movable display that along with presenting visual information, such as text, characters and graphics via display signals from display control circuitry, also causes one or more input signals to be generated when moved. The movements of the display may be widely varied. For example, the movable display may be configured to translate, slide, pivot, and/or rotate relative to the frame. The input signals can be used to initiate commands, make selections, or control motion in a display. The display is typically movable relative to a frame or housing that movably supports the display in its various positions. In some cases, the display is movably coupled to the frame, and in other cases the frame movably restrains a floating display. Furthermore, the input signals are typically generated by a detection mechanism that monitors the movements of the display and produces signals indicative of such movements. The detection mechanism may, for example, one or more switches, sensors, encoders, and/or the like. Any suitable mechanical, electrical and/or optical switch, sensor or encoder may be used. For example, tact switches, force sensitive resistors, pressure sensors, proximity sensors, infrared sensors, mechanical or optical encoders and/or the like may be used. The movement indicators may be placed underneath the display or at the sides of the display in order to monitor the movements of the display. Alternatively or additionally, these movement indicators may be attached to the display or some component of the display. By way of example, the display actuator may generally correspond to the display actuator disclosed in U.S. Patent Application No.: 11/057,050, titled "DISPLAY ACTUATOR," filed on February 11, 2005, and which is herein incorporated by reference.

D. PRESSURE OR FORCE SENSING DEVICES

In order to obtain the force or pressure of a touch, the hand-held electronic device described above may further include force or pressure sensing devices.

i. Force Sensitive Display

In accordance with another embodiment, the hand-held device may include a force sensitive display that along with presenting visual information, such as text, characters and graphics via display signals from display control circuitry, also causes

one or more input signals to be generated when pressure is exerted thereon. The input signals can be used to initiate commands, make selections, or control motion in a display. The display provides a slight amount of flex (unnoticeable to the user) so that any forces exerted thereon can be measured by a force detection arrangement
5 provided underneath the display. The force detection arrangement monitors the forces exerted on the display and produces signals indicative thereof. The force detection arrangement may, for example, include one or more force sensors such as force sensitive resistors, force sensitive capacitors, load cells, pressure plates, piezoelectric transducers, strain gauges and/or the like. The force sensors may be
10 attached to the back of the display or to a structural platform located within the housing of the device. When a force is applied to the display, it is transmitted through the display to the force sensor located underneath the display. Put another way, the display flexes minimally, but still enough to sandwich the force sensor between the display and the structural platform.

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Fig. 19 is a side elevation view, in cross section, of a hand-held device 300 that utilizes a force sensitive display 302. The force sensitive display 302 includes a display 308 and one or more force sensors 310 disposed underneath the display 308 (between the display and a structural platform 306). In most cases, the force sensitive
20 display 302 includes a plurality of sensors 310 that are laid out in an array. For example, the sensors 310 may be positioned side by side in rows and columns. The force sensors 310 measure the amount of force being applied to the display and when a desired force threshold is reached a control signal is generated. In some cases, an elastomer 312 is placed between the display and the structural platform in order to
25 help transmit the force being exerted on the surface of the display to the force sensors disposed below the display.

In one embodiment, the force sensing is provided in conjunction with a touch screen in order to differentiate between light and hard touches. The determination of
30 whether a touch is a light touch or a hard touch may be made by monitoring the force with the force sensors and comparing the force to a predetermined threshold. When the force threshold is not exceeded, the touch is considered a light touch. When the force threshold is exceeded, the touch is considered a hard touch. Each type of touch may be used to control different aspects of the device. Light touches may be

associated with passive events such as navigation (e.g., cursor control) or gestures (e.g., scrolling, panning, zoom, rotation, etc.) and hard touches may be associated with active events such as selections or commands (e.g., button click).

5 Fig. 20 illustrates an input device 320 that combines touch sensing and force sensing devices in order to provide x, y and z components when touched. The touch sensing device provides position sensing in the x and y directions, and the force sensing device provides variable force sensing in the z direction. These devices cooperate to output x, y location and z pressure information whenever there is a touch
10 on the touch surface.

 Fig. 21 is a side elevation view of an I/O device 330 that combines a display 332 with touch screen 334 and a force sensing mechanism 336 according to one embodiment. The touch screen 334 provides high resolution touch locations, and the
15 force sensing mechanism 336 provides an approximate measure of where the force is coming from (low resolution) as well as how much total force there is in that region (distinguishable levels of force). As shown in this embodiment, the touch screen 334 is disposed over the display 332, and the force sensing mechanism 336 is disposed below the display 332.

20

 The touch screen 334 may be widely varied. In one embodiment, the touch screen 334 is capacitive touch screen as described in U.S. Patent Application No.: 10/840,862, titled, "MULTIPOINT TOUCHSCREEN" filed on May 6, 2004.

25 The force sensing mechanism 336 may also be widely varied. In the illustrated embodiment, the force sensing mechanism 336 is based on capacitance, and more particularly, self capacitance. In this embodiment, the force sensing mechanism 336 is formed from various layers including an electrode layer 338, an elastomer layer 340 and a conductive layer 342.

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 The electrode layer 338 includes a plurality of spatially separated electrodes 339 that are positioned across the bottom of the display 332. The electrodes 339 are typically positioned in an array of rows and columns. Any number of electrodes may be used. In one implementation, 16 electrodes are used.

The elastomer layer 340 includes one or more elastic members 341 positioned between the electrode layer 338 and the conductive layer 342. The elastic members 341 allow the display 332 to move inwardly with a limited amount of displacement.

5 In one implementation, the elastic members 441 are silicon patches with a thickness of about 0.2 mm.

The conductive layer 342 typically takes the form of a metal plate 343 that is grounded. A capacitive circuit is therefore formed between each of the electrodes
10 339 and the grounded metal plate 343. When a user pushes down on the display 332, the force being exerted thereon causes the display 332 to displace inwardly against the elastic members 341 (e.g., compresses the elastic members). This causes a capacitive change between the electrodes 339 and the metal plate 343 that is sensed by a control circuit operatively coupled to each of the electrodes 339.

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Fig. 22 is a side elevation view of an input device 350 that may be positioned over a display. The input device 350 combines touch sensing and force sensing into a single device. In this embodiment, both the touch sensing and force sensing is provided by mutual capacitance. As shown, the input device 350 is formed from
20 various layers including a top drive layer 352, a middle sense layer 354, and a bottom drive layer 356. Furthermore, the middle sense layer 354 is positioned on an elastomer layer 358 disposed between the middle sense layer 354 and the bottom drive layer 356. The top and bottom drive layers 353 and 356 include a plurality of spatially separated lines in rows and the middle sense layer 354 includes a plurality of
25 spatially separated lines in columns. The top and middle layers 352 and 354 therefore form a pixilated grid, and the bottom and middle layers 356 and 354 form a pixilated grid. During operation, the lines on the top layer 352 are scanned, and thereafter the lines on the bottom layer 356 are scanned (or vice versa). When there is a touch, the mutual capacitance measured between the top drive layer 352 and the middle sense
30 layer 354 provide the x and y location of the touch. In addition, the mutual capacitance measured between the bottom drive layer 356 and the middle sense layer 354 provide the amount of force of the touch. This particular arrangement provides a full image of force superimposed on a full image of touch. By way of example, the input device including the touch layers and the force layers may be operated similarly

to the methods described in U.S. Patent Application No.: 10/840,862, titled,
“MULTIPOINT TOUCHSCREEN” filed on May 6, 2004.

ii. Force Sensitive Housing

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In accordance with another embodiment, the hand-held device may include a force sensitive housing. The force sensitive housing provides inputs when forces are applied to the housing of the hand-held device. The input signals can be used to initiate commands, make selections, or control motion in a display. The housing
10 provides a slight amount of flex (possibly unnoticeable to the user) so that any forces exerted thereon can be distributed to a force detection arrangement located underneath the housing. The force detection arrangement monitors the forces on the housing and produces signals indicative thereof. The force detection mechanism may for example include one or more force sensors such as force sensitive resistors, force
15 sensitive capacitors, load cells, pressure plates, piezoelectric transducers, strain gauges and/or the like. The force sensors may be attached to the back of the housing or to a structural platform located within the housing of the device. When a force is applied to the housing (squeezing or pushing on the housing), it is transmitted through the housing to the force sensor located underneath the housing. Put another way, the
20 housing flexes minimally, but still enough to be sensed by the force sensor between the housing and the structural platform.

This particular implementation is believed to be aesthetically pleasing in that the housing can have a uniform appearance with no lines, breaks or openings in the
25 surface. That is, the surface of the housing is continuous smooth surface that can be made to look like it does not have any input devices, just a display and a housing (e.g., a device with no visible input devices).

The force sensitive portions of the housing can be located on any surface of
30 the housing, any side of the housing, any portion of any side of the housing or at dedicated locations on the surface of the housing. By way of example, the force sensing regions may be located on the sides or back surface of the housing, and may even be located at the bezel located at the front surface of the housing. In all of these

cases, a large portion of the front surface of the housing is saved for the display so that the viewing area of the hand-held electronic device can be maximized.

5 In one particular embodiment, the force sensing is located on the sides of the housing. The sides of the housing are ideal places for implementing a squeeze feature. This is because the users fingers are typically positioned on one side of the device and thumb on the other and therefore the hand may easily squeeze the sides via a pinching action. Because it is so convenient to activate the squeeze feature, special care must be taken when designing the squeeze feature so that it will not be
10 accidentally activate during normal use, i.e., needs to be able to differentiate between light and hard squeezes. The squeeze feature may be implemented using force sensitive sensors such as a force sensitive resistor (FSR) or capacitor (FSC). FSR's, in particular, exhibit a decrease in resistance with an increase in force applied to its active surface. A comparator circuit can be used to output a high signal to indicate
15 activation when a preset force threshold is reached.

Fig. 23 is a side view, in cross section, of a hand-held device 370 that utilizes a squeeze feature. As shown, the device 370 includes a housing 372 and a support platform 374 inside the housing 372. Between the support platform 374 and the inner
20 surface of the housing 372 are a pair of force sensors 376. When a force is applied to the housing 372 as for example by the pinching nature of the hand, the housing 372 flexes inwardly under the pressure. This causes the force sensors 376 to be sandwiched between the housing 372 and the support platform 374. The force sensors 376 measure the amount of force being exerted and when a desired force
25 threshold is reached, the force sensors 376 generate a control signal. For example, as a result of being sandwiched, a force resistive sensor may exhibit a reduced resistance and when a desired threshold is reached, a control signal is generated.

30 In one embodiment, the force sensing is provided in conjunction with a touch pad or touch housing in order to differentiate between light and hard touches. The determination of whether a touch is a light touch or a hard touch may be made by monitoring the force with the force sensors and comparing the force to a predetermine threshold. When the force threshold is not exceeded, the touch is considered a light touch. When the force threshold is exceeded, the touch is considered a hard touch.

Each type of touch may be used to control different aspects of the device. Light touches may be associated with passive events such as navigation or gestures and hard touches may be associated with active events such as selections or commands (e.g., button click).

5

E. MOTION ACTUATED INPUT DEVICE

In accordance with another embodiment, a hand-held electronic device can include a motion actuated input device that is placed inside the device. The motion
10 actuated input device provides inputs when the hand-held device is in motion or is placed in a certain orientation. The input signals can be used to initiate commands, make selections, or control motion in a display. The motion actuated input device typically includes a motion sensor that monitors the motion of the device along the x, y and/or z axis and produces signals indicative thereof. The motion sensor may, for
15 example, include an accelerometer. The accelerometer can be a single, biaxial or tri-axial accelerometer depending on the needs of the system. The accelerometer as the term used herein covers both a raw accelerometer and any accelerometer that also includes other components such as an ASIC. The motion sensors may be attached to the housing or to some other structural component located within the housing of the
20 device. When motion is applied to the device (gesturing, shaking, hand waving, etc.), it is transmitted through the housing to the motion sensor.

Because the accelerometer measures all motion not just intended motion, the intended information typically needs to be separated from the other motion
25 information to produce an accurate command signal. As should be appreciated, large scale movements such as shaking the device may produce low frequency information and small scale movements such as vibrations may produce high frequency information. The high frequency information can be filtered out thereby leaving only low frequency information indicative of the large scale movements (e.g., shaking).
30 The filtered information can then be converted into a control signal.

Fig. 24 is a side view, in cross section, of a hand-held electronic device 380. The hand-held device 380 includes an accelerometer 382 that is attached to a housing 384 of the hand-held device 380. When the device 380 is moved about by the user,

the accelerometer 382 recognizes the motion and a controller of the hand-held electronic device 380 interprets the motion and thereafter performs an action based on the motion event.

5 **F. MECHANICAL ACTUATORS**

While one would like to eliminate all surface mounted actuators such as buttons and wheels, it is sometime impractical. Therefore, in some cases, the hand-held device may include a limited number of surface mounted actuators. By limited it
10 is generally meant three or less, and more particularly two or less, and even more particularly one, and yet even more particularly zero. In one embodiment, these actuators are generic to each of the integrated devices. That is, their meaning is the same regardless of what device functionality is activated. Furthermore, in order to preserve the front surface for the display, the limited number of surface mounted
15 actuators are typically placed on surfaces other than the front surface, which houses the viewing region of the display (although this is not a requirement). The limited number of actuators may be placed on the top and bottom surfaces and can in some circumstance be placed on the sides and back surfaces as, for example, the upper and lower regions of the sides and back surface (out of the way of the grasping hand).

20

In one embodiment, the hand-held electronic device includes a hold switch. The hold switch is configured to activate and deactivate the input means. This is generally done to prevent unwanted entries, as for example, when the device is stored inside a user's pocket. That is, the hold switch prevents inadvertent or accidental
25 entries that may occur while the device is being carried. When turned on, signals from the input means are not sent or are disregarded by the device. When turned off, signals from the input means are sent and therefore received and processed by the device. In one implementation, the hold switch is placed on the top surface out of the way of the grasping hand, but in a position for easy access (as opposed to the
30 bottom surface). The hold switch can not only deactivate mechanical actuators but also touch screens or touch surfaces.

In another embodiment, the hand-held device includes a power switch. When the power switch is turned on, the device is powered up and ready to go. When the

power switch is turned off, the device is shut down. In one implementation, the hold switch is placed on the top surface out of the way of the grasping hand, but in a position for easy access (as opposed to the bottom surface).

5 In another embodiment, the hand-held device may include a navigation pad. The navigation pad is typically included with many hand-held devices. The only problem with including a navigation pad is that it takes up a large amount of real estate. In some cases, the functionality of the navigation pad changes according to the mode of the device. For example, the directional keys may be assigned different
10 functionality. In the case of a music player for example, the directional keys may be assigned, play/pause, Next, Previous, and volume up and down. Other assignable buttons may also be included on the device (although in a limited number).

 In another embodiment, the hand-held device includes a switching actuator.
15 The switching actuator is configured to change the functionality of the device, i.e., by activating the switching actuator the mode or state of the device switches from one mode to another. The switching actuator may be widely varied.

 In one implementation, the switching actuator is a dial or wheel. By
20 incrementally rotating the wheel, the device is incrementally switched from one device to the other (generally in some predetermined order). A full rotation of each device generally cycles through the entire group of integrated devices. The wheel or dial may for example operate like a scroll wheel. Although the placement may be widely varied, the switching wheel may be placed in the upper region of the sides of
25 the device. By placing the wheel here, a users thumb may be used to easily rotate the wheel. For example, the users thumb may be extended from the grasping action so that the wheel can be rotated. In another implementation, the switching actuator is a button. By incrementally pressing on the button, the device is incrementally switched from one device to another (generally in some predetermined order). Although the
30 placement may be widely varied, the switching button may be placed in the upper region of the sides of the device. By placing the button here, a users thumb or index finger may be used to easily press the button.

In another embodiment, the hand-held device may include any commercially available touch pad. Several examples of touch pads may be found in U.S. Patent Application No.: 10/188,182, titled, "TOUCH PAD FOR HANDHELD DEVICE" filed on July 1, 2002, U.S. Patent Application No.: 10/722,948, titled, "TOUCH PAD FOR HANDHELD DEVICE" filed on November 25, 2003, and U.S. Patent Application No.: 10/643,256, titled, "MOVABLE TOUCH PAD WITH ADDED FUNCTIONALITY" filed on August 18, 2003, all of which are herein incorporated by reference.

In another embodiment, the hand-held device may include a scroll wheel. Scroll wheels can be used in each device to scroll through a window.

G. MICROPHONE

The hand-held device may also include a microphone that picks-up audio sounds. The microphone may be used in conjunction with a cell phone to transmit sounds, such as the user's voice. The microphone may also be used to record sounds. The microphone may also be used to enter voice commands into the hand-held device. For example, using voice recognition software, the hand-held device may be able to recognize voice commands and generated control signals associated therewith. In one embodiment, the microphone is placed in the bottom surface of the hand-held device or possible in the front lower bezel. This particular configuration is well suited for picking up a users voice during a phone call.

H. IMAGE SENSOR

A hand-held electronic device may also include an image sensor and lens related components so that the hand-held device can operate like a camera. The image sensor may, for example, include a charge coupled device (CCD) camera.

4. INPUT DEVICE FUNCTIONALITY

A. TOUCH GESTURES

A hand-held electronic device may be designed to recognize touch gestures applied to a touch screen and/or touch sensitive surface of the housing and to control aspects of the hand-held electronic device based on the gestures. Gestures may be defined as a stylized interaction with an input device that is mapped to one or more specific computing operations. The gestures may be made through various hand, and more particularly finger motions. Alternatively or additionally, the gestures may be made with a stylus. In all of these cases, the input devices (touch screen and touch sensitive surface) receive the gestures and a controller of the hand-held electronic device executes instructions to carry out operations associated with the gestures. The hand-held electronic device may include a touch gesture operational program, which may be part of the operating system or a separate application. The gesture operation program generally includes a set of instructions that recognizes the occurrence of gestures and informs one or more software agents of the gestures and/or what action(s) to take in response to the gestures. By way of example, gestures that can be used are disclosed in greater detail in U.S. Patent Application No: 10/903,964, titled, "GESTURES FOR TOUCH SENSITIVE INPUT DEVICES" filed on July 30, 2004, and U.S. Patent Application No.: 11/038,590, titled, "MODE-BASED GRAPHICAL USER INTERFACES FOR TOUCH SENSITIVE INPUT DEVICES" filed on January 18, 2005, which is herein incorporated by reference.

B. 3-D SPATIAL GESTURES

In accordance with one embodiment, the hand-held electronic device may be designed to recognize 3-D spatial gestures measured by an accelerometer and to control aspects of the hand-held electronic device based on the 3-D spatial gestures. 3-D spatial gestures may be defined as a stylized motion of the device itself that is mapped to one or more specific computing operations. The 3-D spatial gestures may be made through various hand and arm motions, such as for example shaking, waving and the like. The accelerometer measures the motion related to the 3-D spatial gestures and a controller recognizes the motion as a 3-D spatial gesture and thereafter executes instructions to carry out operations associated with the 3-D spatial gestures. The hand-held electronic device may include a 3-D spatial gesture operational program, which may be part of the operating system or a separate application. The gesture operation program generally includes a set of instructions that recognizes the

occurrence of gestures and informs one or more software agents of the gestures and/or what action(s) to take in response to the gestures.

5 In one implementation, shaking the hand-held device causes the device to shift between modes or states.

In another implementation, shaking the hand-held device causes a selection event to occur. For example, in the case of a media player, shaking the device may cause the device to randomly select a picture or song in group of pictures or songs.
10 Alternatively, shaking the device may cause the device to select the next picture or song in a sequence of songs.

In another implementation, translating the hand-held device (while it is face up) from side to side initiates panning or scrolling in the device, or moving the device
15 up and down (while it is face up) initiates zooming.

In another implementation, rotating the device causes the device to shift modes or states. In some cases, for example, the orientation of the device may correspond to a particular mode. For example, a first mode may be associated with 0
20 degrees, a second mode may be associated with 90 degrees, a third mode may be associated with 180 degrees and a fourth mode may be associated with 270 degrees. In all these cases, the device can be configured to keep the displayed portion upright as the device is turned. That is, it maintains an upright image no matter what orientation the device is in.

25

The 3-D spatial gestures may even be based on charade like motions. Sign language, writing motion (characters), etc.

C. PERFORM ACTION BASED ON MULTIPLE INPUTS

30

In accordance with one embodiment, a hand-held device is configured to receive simultaneous inputs from different inputs means, and perform actions based on the simultaneous inputs. By way of example, multiple inputs may be combined to produce a new command. The inputs, which may be combined to produce new

commands may be selected from voice, 2-D touch gestures, 3-D spatial gestures, actuators, and the like. This feature may be helpful when making calls via voice selection. As should be appreciated, a caller may verbalize “TOM”, which causes the device to dial “TOM” phone number. Unfortunately, TOM may have multiple numbers. By combining the verbal command “TOM” with a 3-D spatial gesture such as shaking, the device may select Tom’s second phone number.

D. SIGNALS FROM INPUT DEVICES HAVE DIFFERENT MEANINGS DEPENDING ON THE MODE OF THE DEVICE

In accordance with one embodiment, the signals from the various input devices have different meanings or outputs based on the current mode of the device. For example, signals from the microphone can be used differently for each device. In a PDA mode, the signals may be used for recording notes. In cellular phone, the signals are used for voice communications over a cellular network or alternatively as commands to dial a phone number. In music players, the microphone signals may be used to traverse through a playlist or to find a song.

E. DIFFERENTIATING BETWEEN LIGHT AND HARD TOUCHES

By monitoring the force exerted on a touch sensing surface, a user is capable of perform two distinct types of interactions, light touch interactions and hard touch or button click interactions. In one embodiment, the light touches can be used to perform passive actions such as navigating through content, and content manipulation generally without causing a major event to occur. Examples of passive events include moving a cursor, scrolling, panning, etc. In one embodiment, the hard touch interactions, on the other hand, can be used to select on screen buttons or initiate commands (e.g., causes a significant change to occur).

Fig. 25 is a diagram of a touch method 400, in accordance with one embodiment of the present invention. The touch method 400 begins at block 402 where one or more touches are detected. The touches include not only x any y components but also z components. The x and y components are supplied by a touch sensing device such as touch screen, touch pad or touch housing. The z component,

on the other hand, is generally provided by force sensors located behind the touch surface of the touch sensing device. By way of example, the x, y and z components may be supplied by a display arrangement that includes a touch screen positioned over a display and a force sensing device disposed underneath the display. The x, y and z components may also be supplied by a touch pad or touch housing that includes a touch sensitive surface and force sensing device underneath the touch sensitive surface. Additionally or alternatively, the z component may be supplied by a physical switch located behind the touch surface (display actuator), or possibly using the touch surface itself (e.g., contact patch areas that increase in size based on increases in touch pressure).

Following block 402, the method proceeds to block 404 where a determination is made as to whether the touch is a light or hard touch (e.g., differentiating whether the detected touch is a light touch or a hard touch). The determination is generally based on the force or pressure of the touch (z component). For example, if the force of the touch is smaller than a predetermined threshold then the touch is considered a light touch and if the force of the touch is larger than the predetermined threshold then the touch is considered a hard touch. If it is determined that the touch is a light touch, the method proceeds to block 406 where a passive action is initiated when a touch event is performed. Examples of passive actions include navigation, moving a cursor, scrolling, panning, etc. If it is determined that the touch is hard touch, an active action is initiated when a touch event is performed. Examples of active actions include making selections and implementing commands.

Although not a requirement, the touch method may additionally include a block where the one or more touches are classified as a primary touch or a secondary touch. Primary touches are touches that are intended to cause an action while secondary touches are touches that are not intended to cause an action. Gestures are examples of primary touches while a thumb positioned over the touch area in order to hold the hand-held device is an example of a secondary touch. Once the touches are classified as primary or secondary, the secondary touches are filtered out, and the determination of whether a touch is a light or hard touch is made with the primary touches.

F. EXAMPLE OF NEW TOUCH VOCABULARY

The z pressure exerted on a touch sensing device can be combined with the x and y locations of the touch to form a new touch vocabulary. As should be appreciated, up to this point touch vocabularies have only included x and y locations, not z pressure.

The new touch vocabulary includes variety of variables including the UI mode, the force of the touch (e.g., light or hard), the number of fingers used, whether or not there is any movement during the touch, the duration of the touch, and the touch location, all or some of which can be combined to form a variety of behaviors and user feedback.

The UI mode is generally related to the mode or state of the device, i.e., what software layer is the device in. Each device includes a variety of state or layers, and each state or layer may require a different UI mode in order to operate effectively within the state or layer. Media players may, for example, include a set of hierarchal layers with each layer requiring a substantially different UI.

The force of the touch may be described as light or hard. A light touch may occur when a user lightly touches the surface of the touch surface, i.e., the finger hovers on top of the surface and is primarily moved in the x and y directions. A hard touch may occur when the a user presses on the touch surface with a certain amount of force, i.e., the finger is primarily moved in the z direction against the touch surface.

Motion during the touch is used to describe whether the finger has remained stationary during a touch event or has substantially moved in the X/Y plane (e.g., translation, rotation). The motion may be described as none at all or a swipe or twist in some particular direction. By way of example, the swipe may be up, down, right or left, and the twist may be clockwise or counterclockwise.

Duration is defined as the amount of time the finger stays at any one point. Duration may be variable or it may include states such as short and long.

The touch location may be a random point or a specific location such as an onscreen button.

Fig. 26 is a touch method 500 in accordance with another embodiment of the present invention. The method begins at block 502 where one or more touches are detected. Thereafter, in block 504, the UI mode is determined. In block 506, a determination is made as to whether the touches are light touches or hard touches. In block 508, the number of distinct touches (e.g., fingers) is determined. In block 510, a determination is made as to whether the touches are stationary or in motion. In block 512, the duration of the touches is determined. In block 514, the locations of the touches are determined. Following blocks 502-514, the method proceeds to block 516 where an action is performed based on the UI mode, the pressure of the touch, the number of touches, whether or not the touch is moving, the duration of the touch, and the touch location. The actions may be passive or active depending on the values of each characteristic.

One example of a touch vocabulary associated with a music player is shown in Figs 27A-E.

5. OUTPUT DEVICES

A. DISPLAY

A hand-held electronic device includes a display disposed within and viewable through an opening in the housing. The display, which is typically placed on the front surface of the device, can be configured to substantially fill only a portion of the front surface of the housing, or alternatively can be configured to fill the entire front surface of the housing. The display provides visual information in the form of text, characters or graphics. The display is typically selected from flat panel devices although this is not a requirement and other types of displays may be utilized. Flat panel devices typically provide a planar platform that is suitable for hand-held devices. By way of example, the display may correspond to a liquid crystal display (LCD) such as a character LCD that is capable of presenting text and symbols or a graphical LCD that is capable of presenting images, video, and graphical user

interfaces (GUI). Alternatively, the display may correspond to a display based on organic light emitting diodes (OLED), or a display that is based on electronic inks.

5 In one embodiment, the display is configured to substantially fill the front surface of the housing. By way of example, the display may extend from one edge of the housing to the opposite edge of the housing or in some cases the housing may include a small bezel that surrounds the edges of the display at the front surface of the housing. In either case, the display makes up a substantial portion of the front surface of the hand-held electronic device thereby eliminating any real estate for placing
10 buttons or switches associated with a conventional user interface. In essence, the size of the display is maximized to the size of the hand-held electronic device or, alternatively, the hand-held electronic device is minimized to the size of the display. Either way, the display is allowed to utilize a greater amount of the real estate of the hand-held electronic device than would otherwise be allowed in conventional hand-
15 held electronic devices that are limited by buttons and switches located with the display on the front surface.

As mentioned above, besides outputting visual information, the display may also act like an input device. For example, a touch screen may be positioned over the
20 display, and/or sensors may be disposed underneath the display to sense when the device is pressed or otherwise moved. In most cases, the small form factor of hand-held devices requires central placement of the input interfaces to permit operation while being carried around and used by the hand. The display region provides a central location, which can be accessed by both the left and right hands.

25

In one embodiment, the display region is formed by more than one display. The display region may for example be formed by a pair of displays that are side by side or one on top of the other. A first display may be used to present the standard screen and a second display may be used to present the control screen. Furthermore,
30 a first display may be a conventional display while the second display may be a display actuator. Moreover, a first display may be of a first type and a second display may be of a second type. For example, the first display may be an LCD while the second display may be a display based on electronic inks. The decision to use different types may be based on the fact that one of the displays may be dedicated to a

standard viewing area while another may be dedicated to a control area. Because these two areas require different resolutions, a higher resolution screen may be used in the standard area while a lower resolution screen may be used in the control area. Alternatively or additionally, one of the displays may be selected for use in order to reduce battery consumption especially in the control area where lower resolution is acceptable. In some cases, although two different displays are used, the images displayed thereon are combined to form a single unified image.

B. SPEAKER

A hand-held device may include a speaker. Speakers are components that accept audio signals from an amplifier and convert them into sound waves for listening at some distance. The speakers may be used to listen to music or to listen to an incoming call in conjunction with a cell phone. The speaker may be placed on the top surface or possibly on the front top bezel of the hand-held device. This arrangement works particularly well when the device is used as a cell phone.

C. INDICATOR (LED)

A device may include one or more indicators that provide user feedback or indicate events associated with the device. The events may relate to signals, conditions or status of the device. For example, the indicators provide status of battery life or alert a user when there is an incoming call. The indicators, which include light sources such as light emitting diodes (LED), are typically illuminated when an event occurs, and not illuminated when the event is stopped. Furthermore, the indicator may turn on and off (blink) or cycle with increasing or decreasing intensity, and in some cases may even change colors in order to provide more detailed information about the event that is being monitored.

The indicators may be conventional indicators that typically include a small clear plastic insert, which is located in front of the LED, and which is inserted within an opening in the housing thus causing it to exist at the surface of the housing. The LED itself may also be placed in the opening in the housing rather than using an insert. Alternatively, the indicator can be configured not to break the surface of the

housing. In this configuration, the light source is disposed entirely inside the housing, and is configured to illuminate a portion of the housing thereby causing the housing to change its appearance, i.e., change its color.

5 **D. AUDIO/TACTILE FEEDBACK DEVICES**

 The hand-held device may include speakers or buzzers to give audio feedback to the user. These may work similarly to the indicators described above, or they may be used to enhance the feel of actuating a GUI element such as a soft button or scroll
10 wheel. For example, the speaker may be configured to output a “clicking” noise when a user presses on a virtual button, or rotates a virtual scroll wheel. This particular feature enhances the user experience and makes the soft UI feel more like a physical UI.

15 The hand-held device may also include a haptics mechanism. Haptics is the science of applying tactile sensation and control to interaction with computer applications. Haptics essentially allows a user to feel information, i.e., signals are sent to the hand. The haptics mechanisms may be widely varied. They may include motors, vibrators, electromagnets, etc, all of which are capable of providing force
20 feedback in the form of vibration or shaking. The haptics mechanisms may work similarly to the indicators described above (alert), or they may be used to enhance the feel of actuating a GUI element such as a soft button or scroll wheel. For example, the haptics mechanism may be configured to vibrate when a user presses on a virtual button, or rotates a virtual scroll wheel. This particular feature enhances the users
25 experience and makes the soft UI feel more like a physical UI. Haptics may also be used simultaneously with onscreen actions. For example, during movies or game playing, the haptics mechanism can simulate the action being displayed. For example, the haptics mechanism may provide force feedback in the form of vibration when a car explodes during a movie or game.

30

 In cases where haptics is used to enhance the feel of actuating a GUI element, such as a soft button or scroll wheel, the haptics mechanism may be located in the region of the display and further underneath the display so as to provide force feedback directly underneath the user action. In fact, multiple haptics mechanisms

may be used regionally across the display to further enhance the feel. It is generally believed that the closer the vibration is to the user action, the greater the haptics effect. In one implementation, the haptics mechanisms are spaced out in an array underneath the display. That is, they are spatially separated and placed at different locations. By way of example, they may be positioned in a 2x2, 2x4, 4x4, 4x8, 8x8 array and so on underneath the display.

6. OUTPUT DEVICE FUNCTIONALITY

A. USING AUDIO/TACTILE FEEDBACK IN CONJUNCTION WITH USER ACTION

In accordance with one embodiment, the audio and tactile feedback can be used to alert a user that a user input has been made. For example, in response to touching a virtual button on the GUI, the haptics may provide force feedback in the form of vibration and the speaker may provide audio feedback in the form of a click. The tactile audio feedback can be used in conjunction with an input event including touch events, motion events, squeeze events. The feedback may provide information so that the user knows that they actually implemented an input (simulates the audio and tactile feel of a button or switch). In one implementation, the feedback is tied to the level of force being applied to the force sensing devices. For example, when a certain force threshold is reached, the audio feedback device may create a “click” on the press and a “clock” on the release. The force threshold used may be similar to the threshold used to determine whether a touch is a light or hard touch. The “click” and “clock” may be used to simulate a button click when a hard touch is made.

7. COMMUNICATION DEVICES

A. WIRED

The hand-held device may also include one or more connectors for receiving and transmitting data to and from the device. By way of example, the device may include one or more audio jacks, video jacks, data ports, docking ports and the like.

The media player may also include one or more connectors for receiving and transmitting power to and from the hand-held device.

5 In one embodiment, the hand-held device includes a headphone/microphone jack and a data port. The jack is capable of receiving a speaker and/or microphone plug so that audio may be inputted and outputted to and from the device. The data port, on the other hand, is capable of receiving a data plug/cable assembly configured for transmitting and receiving data to and from a host device such as a general purpose computer (e.g., desktop computer, portable computer). By way of example, 10 the data port may be used to upload or download data to and from the hand-held device. For example, the data port may be used to download songs and play lists, audio books, ebooks, photos, and the like into the storage mechanism of the hand-held device. The data port may be widely varied. For example, the data port may be a PS/2 port, a serial port, a parallel port, network interface port, a USB port, a Firewire 15 port and/or the like. The hand-held device may also include a power port that receives a power plug/cable assembly configured for delivering power to the hand-held device. In some cases, the data port may serve as both a data and power port.

B. WIRELESS

20

In order to send and receive data, the device generally includes a transmitter, a receiver or a transceiver as well as some sort of antenna. The data is generally sent via the transmitter and the data is generally received via the receiver. The wireless communication link may correspond to FM, RF, Bluetooth, WiFi (802.11), UWB 25 (ultra wide band), IR (infrared), magnetic link (induction) and/or the like. The antenna may be fully contained within the device or they may extend outside the device. The antenna may for example be a rugged rubber duck that consists of a coiled up element encased in rubber.

30 FM (frequency modulation) is a method of impressing data onto an electromagnetic wave by varying the instantaneous frequency of the wave. This scheme can be used with analog or digital data. The frequencies associated with RF cover a wide range of the electromagnetic radiation spectrum as for example from about 9kHz to thousands of GHz. Bluetooth generally refers to a computing and

telecommunications industry specification that describes how mobile phones, computers and personal digital assistants can easily interconnect with each other using short range wireless connection. 802.11 generally refers to a family of specification for wireless local area networks (WLANs) developed by a working group of the Institute of Electrical and Electronics Engineers (IEEE). UWB refers to a wireless technology for transmitting large amounts of digital data over a wide spectrum of frequency bands with very low power for a short distance. IR generally refers wireless technologies that convey data through infrared radiation.

10 In accordance with one embodiment, the hand-held device includes a radio transceiver for communications with a cellular network.

In accordance with another embodiment, the hand-held device includes a GPS receiver.

15

8. COMMUNICATION FUNCTIONALITY

A. CHANGE UI BASED ON RECEIVED SIGNALS

20 In accordance with one embodiment, a hand-held electronic device may be configured to actively look for signals in the surrounding environment, and change its mode based on the signal. That is, the device tries to match the mode with the signal. If the device receives a phone signal over the cellular network, the device may turn into a phone, i.e., the phone mode is activated or brought forward relative to the other modes. If a device receives an email, the device may turn into an email terminal. As another example, when a user walks into a home theater room, the device may sense signals from the media control unit and turn itself into a remote control including functionality to control the various devices of the home theater (TV, amp, DVD, lighting). In other cases, the device may sense signals, which are being broadcast in physical stores, and turn itself into a device that is well suited for that store. For example, in a bank, the device may change into a calculator or bring a money payment device or bring a grocery list into view.

9. OTHER COMPONENTS OF HAND-HELD DEVICE

The hand held device may additionally include one or more of the following hardware components:

5

A. CONTROLLER

Microprocessor

DSP

A/D, D/A converters

10

Compression, decompression

B. MEMORY

RAM

ROM

15

Solid state (flash)

Microdrive

C. REMOVABLE STORAGE MEDIUM

SD card slots

20

miniDVD

D. BATTERY

Lithium ion battery

25

In one embodiment, the device includes a rechargeable battery. The battery may be charged through a transformer and power cord or through a host device or through a docking station. In the cases of the docking station, the charging may be transmitted through electrical ports or possibly through an inductance charging means that does not require a physical electrical connection to be made.

30

10. OVERALL BLOCK DIAGRAM

Fig. 28 is a block diagram of an exemplary hand-held device 600 in accordance with one embodiment of the present invention. The hand-held device 600

typically includes a controller 602 (e.g., CPU) configured to execute instructions and to carry out operations associated with the hand-held device. For example, using instructions retrieved for example from memory, the controller 602 may control the reception and manipulation of input and output data between components of the hand-held device 600. The controller 602 can be implemented on a single-chip, multiple chips or multiple electrical components. For example, various architectures can be used for the controller 602, including dedicated or embedded processor, single purpose processor, controller, ASIC, and so forth. By way of example, the controller may include microprocessors, DSP, A/D converters, D/A converters, compression, decompression, etc.

In most cases, the controller 602 together with an operating system operates to execute computer code and produce and use data. The operating system may correspond to well known operating systems such as OS/2, DOS, Unix, Linux, and Palm OS, or alternatively to special purpose operating system, such as those used for limited purpose appliance-type devices. The operating system, other computer code and data may reside within a memory block 604 that is operatively coupled to the controller 602. Memory block 604 generally provides a place to store computer code and data that are used by the hand-held device. By way of example, the memory block 604 may include Read-Only Memory (ROM), Random-Access Memory (RAM), hard disk drive (micro drive), flash memory and/or the like. In conjunction with the memory block 604, the hand-held device may include a removable storage device such as an optical disc player that receives and plays DVDs, or card slots for receiving mediums such as memory cards (or memory sticks). Because the form factor of the hand-held device is small, the optical drive may only be configured for mini DVDs.

The hand-held device 600 also includes various input devices 606 that are operatively coupled to the controller 602. The input devices 606 are configured to transfer data from the outside world into the hand-held device 600. As shown, the input devices 606 may correspond to both data entry mechanisms and data capture mechanisms. In particular, the input devices 606 may include touch sensing devices 608 such as touch screens, touch pads and touch sensing surfaces, mechanical actuators 610 such as button or wheels or hold switches (611), motion sensing devices

612 such as accelerometers, force sensing devices 614 such as force sensitive displays and housings, image sensors 616, and microphones 618. The input devices 606 may also include a clickable display actuator 619.

5 The hand-held device 600 also includes various output devices 620 that are operatively coupled to the controller 602. The output devices 620 are configured to transfer data from the hand-held device 600 to the outside world. The output devices 620 may include a display 622 such as an LCD, speakers or jacks 624, audio/tactile feedback devices 626, light indicators 628, and the like

10

 The hand-held device 600 also includes various communication devices 630 that are operatively coupled to the controller 602. The communication devices 630 may, for example, include both wired and wireless connectivity selected from I/O ports 632 such as IR, USB or Firewire ports, GPS receiver 634, and a radio receiver
15 636.

 The hand-held device 600 also includes a battery 650 and possibly a charging system 652.

20 The various aspects, features, embodiments or implementations of the invention described above can be used alone or in various combinations.

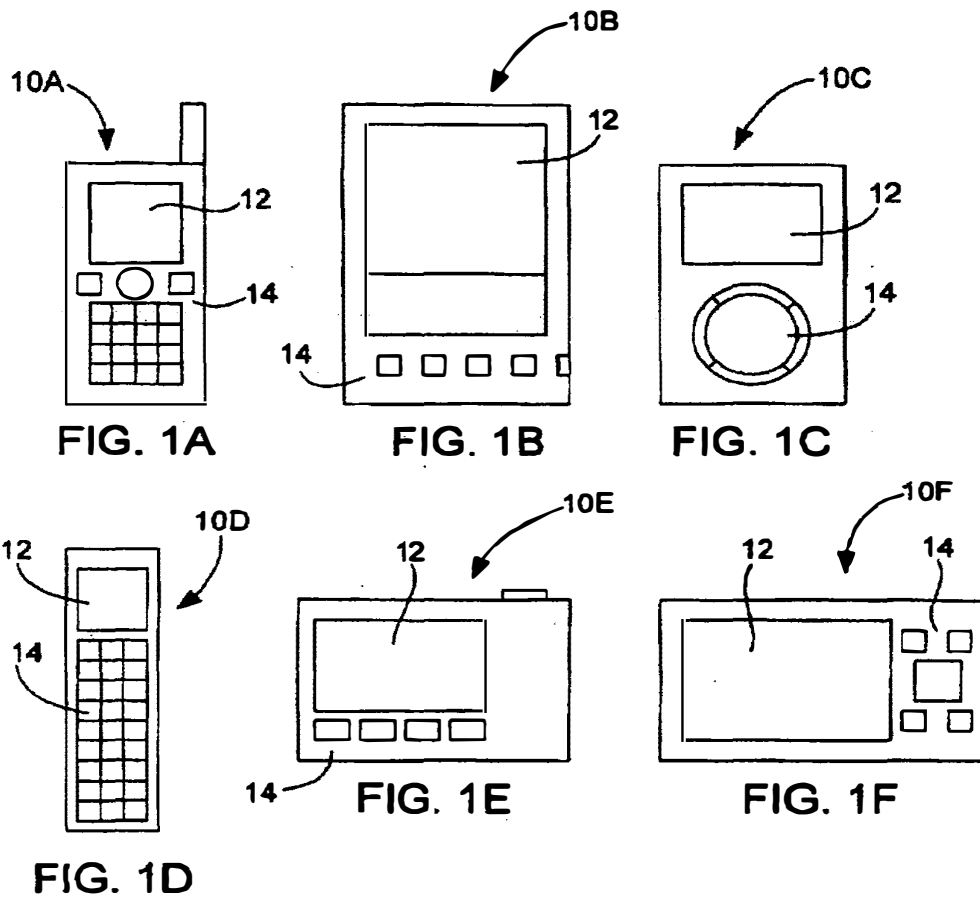
 The methods of this invention can be implemented by software, hardware or a combination of hardware and software. The invention can also be embodied as computer readable code on a computer readable medium. The computer readable
25 medium is any data storage device that can store data which can thereafter be read by a computer system, including both transfer and non-transfer devices as defined above. Examples of the computer readable medium include read-only memory, random-access memory, CD-ROMs, flash memory cards, DVDs, magnetic tape, optical data storage devices, and carrier waves. The computer readable medium can also be
30 distributed over network-coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

While this invention has been described in terms of several preferred embodiments, there are alterations, permutations, and equivalents, which fall within the scope of this invention. It should also be noted that there are many alternative
5 ways of implementing the methods and apparatuses of the present invention. It is therefore intended that the following appended claims be interpreted as including all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

10

What is claimed is:

1. A multi-functional device as shown or described herein.



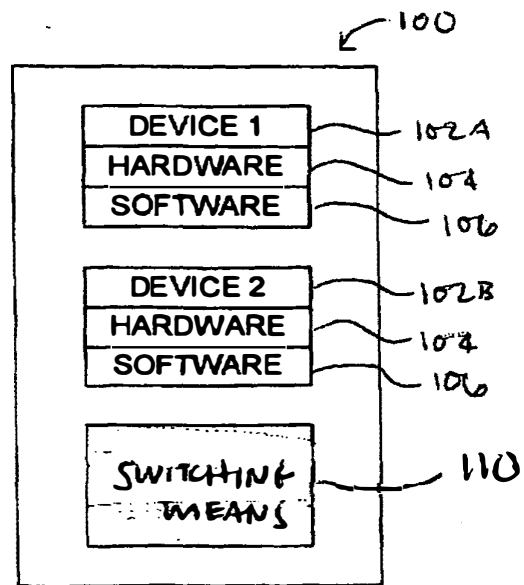


FIG. 2

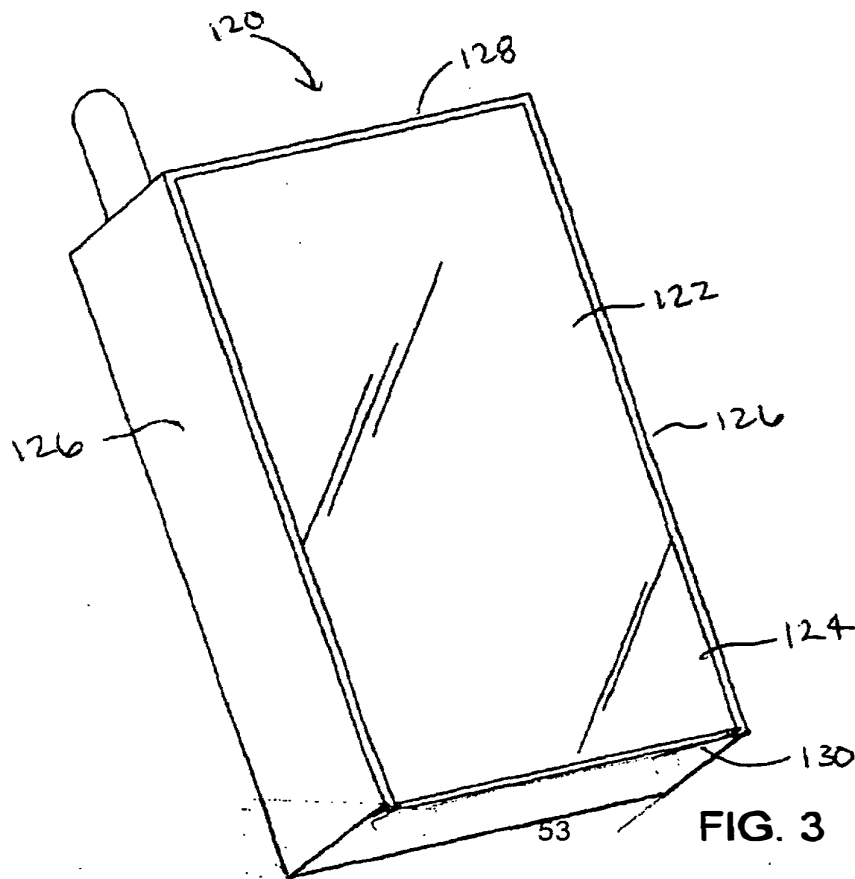


FIG. 3

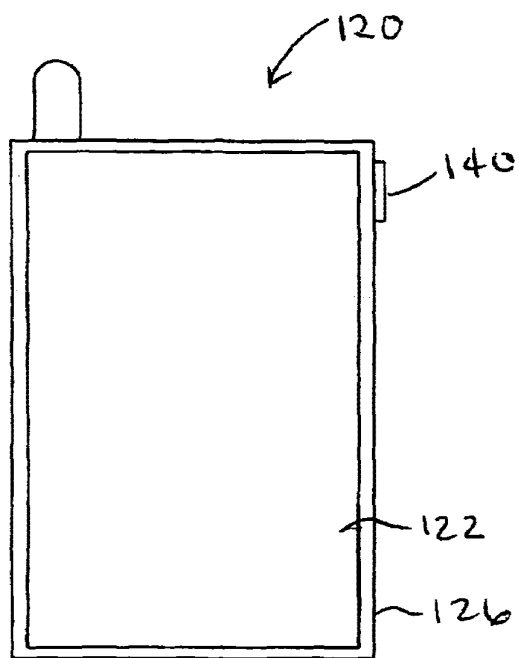


FIG. 4

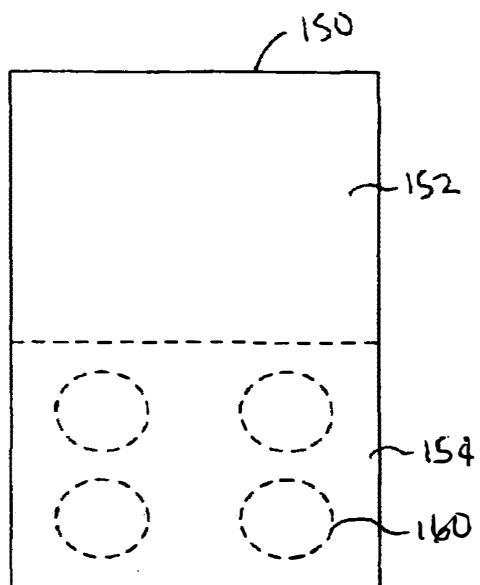


FIG. 5

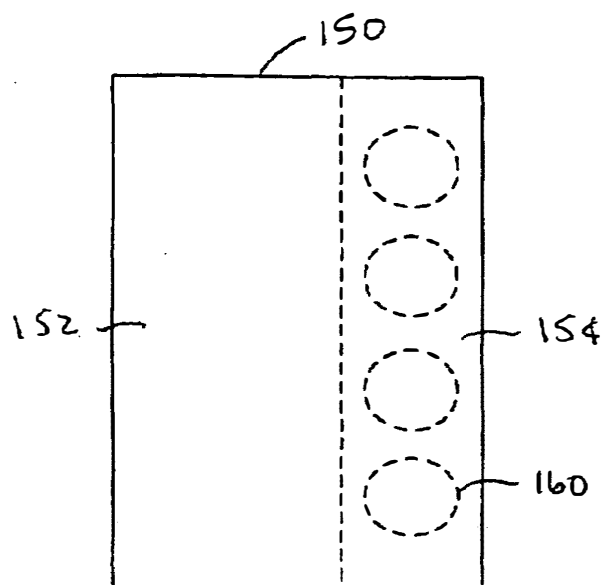


FIG. 6

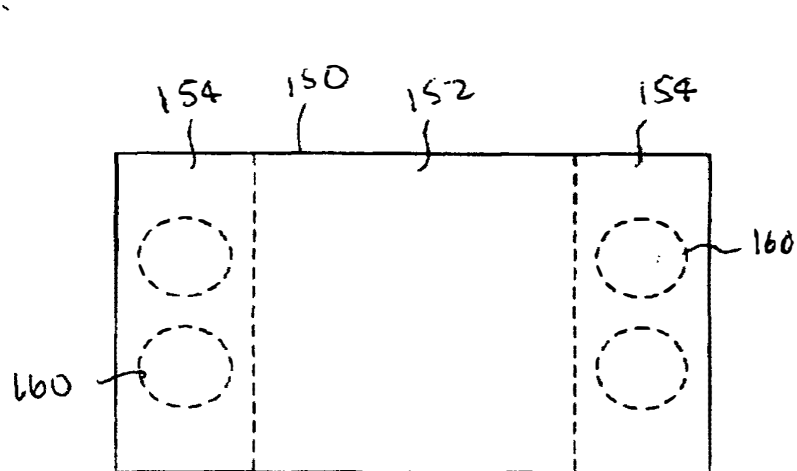


FIG. 7

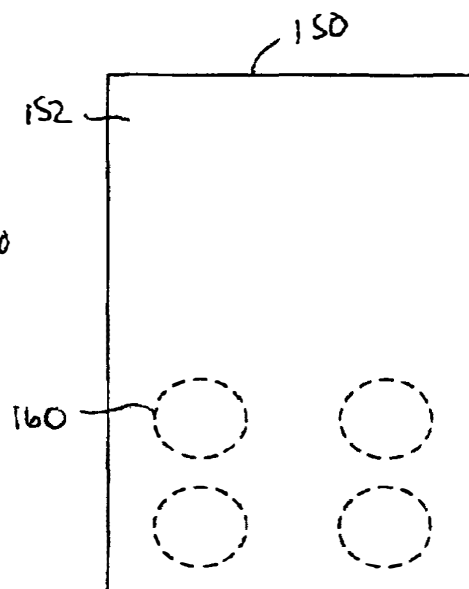


FIG. 8

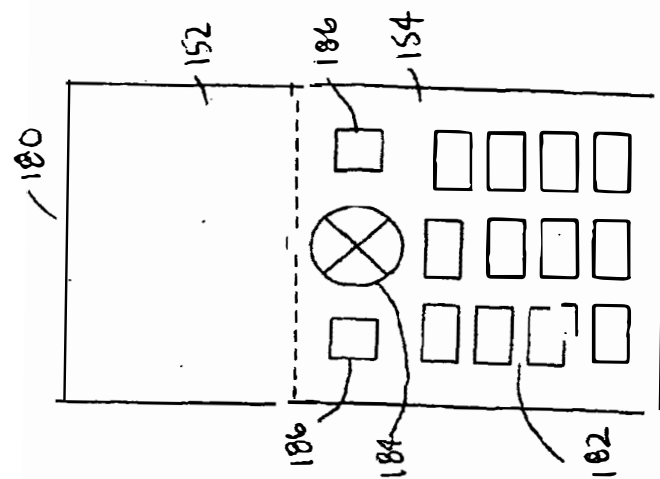


FIG. 10

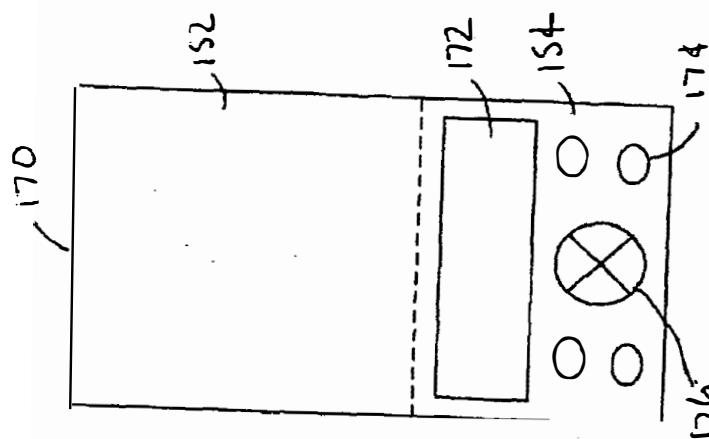


FIG. 9

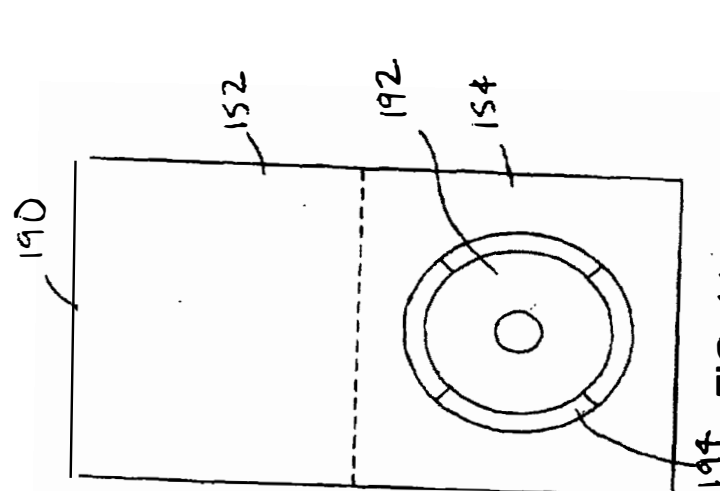


FIG. 11

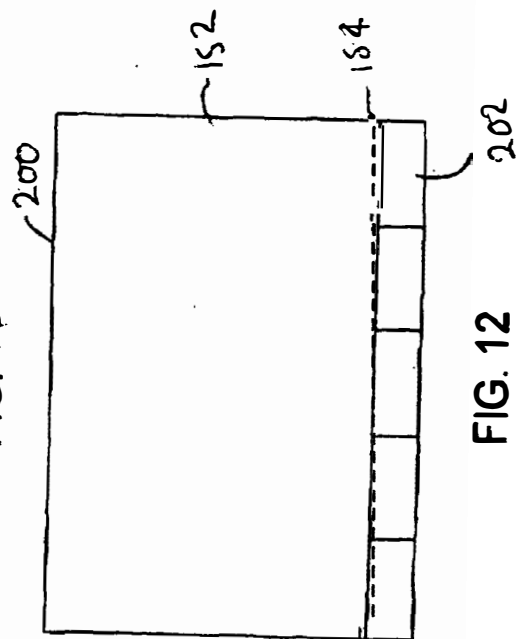


FIG. 12

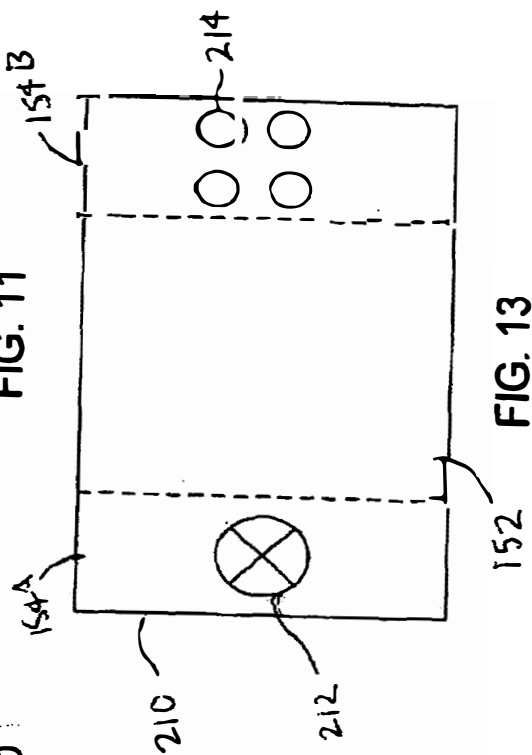


FIG. 13

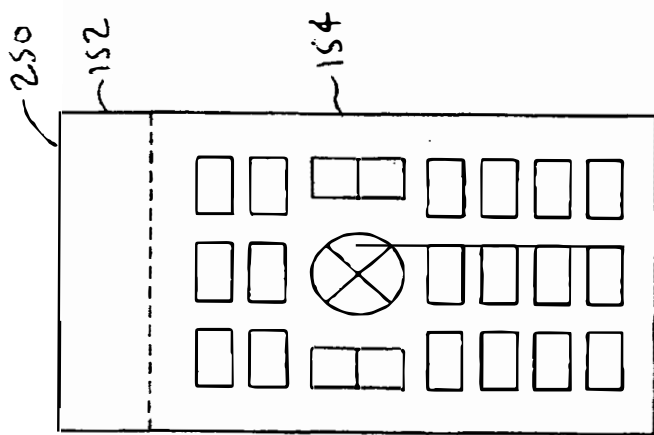


FIG. 17

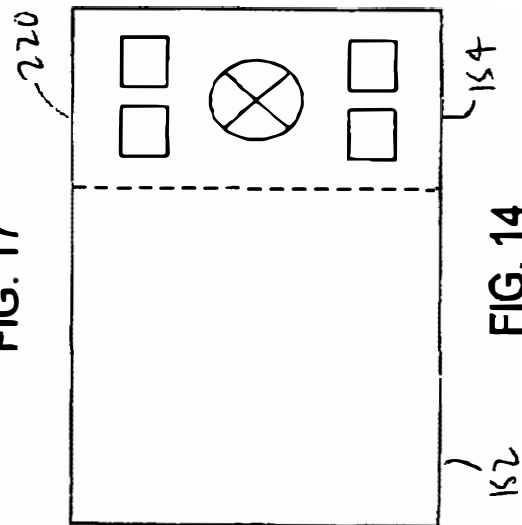


FIG. 14

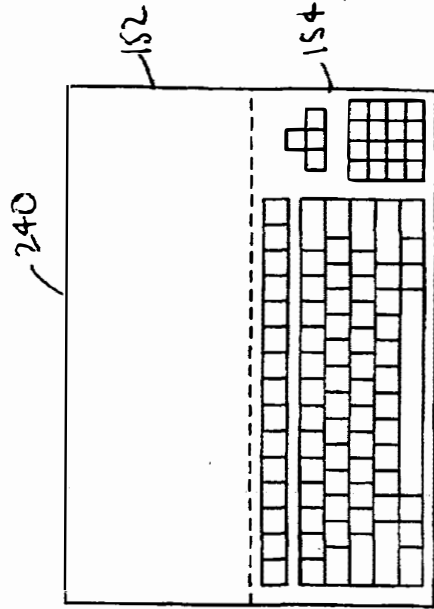


FIG. 16

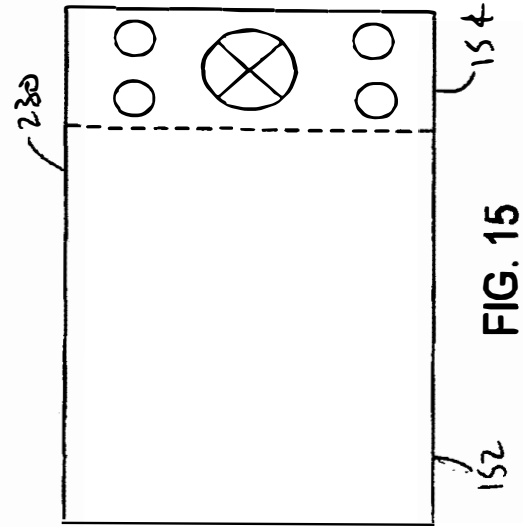


FIG. 15

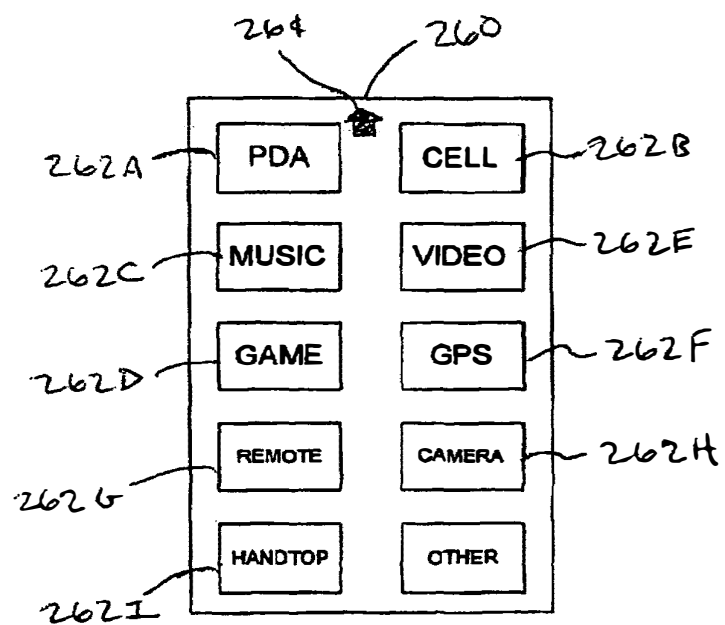


FIG. 18

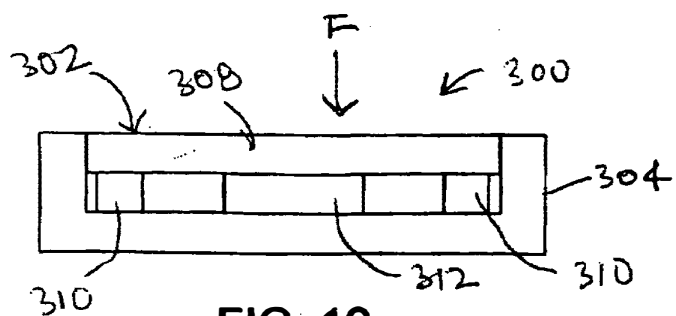


FIG. 19

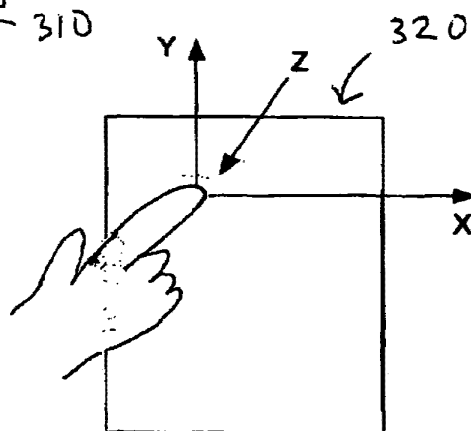


FIG. 20

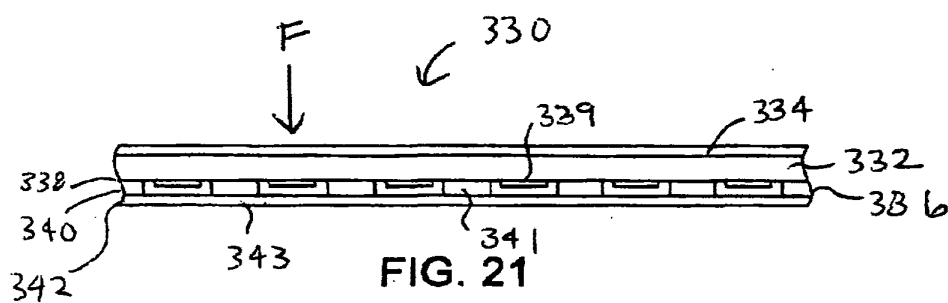


FIG. 21

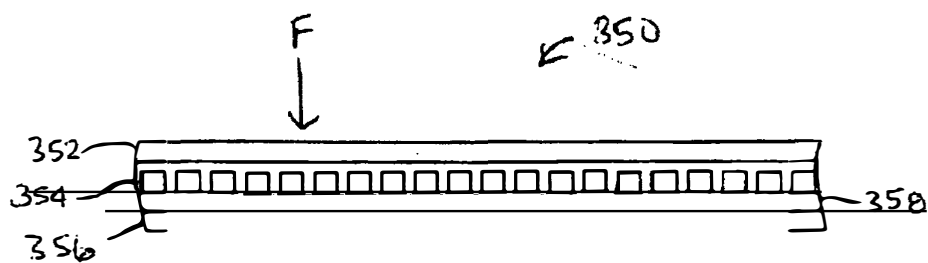


FIG. 22

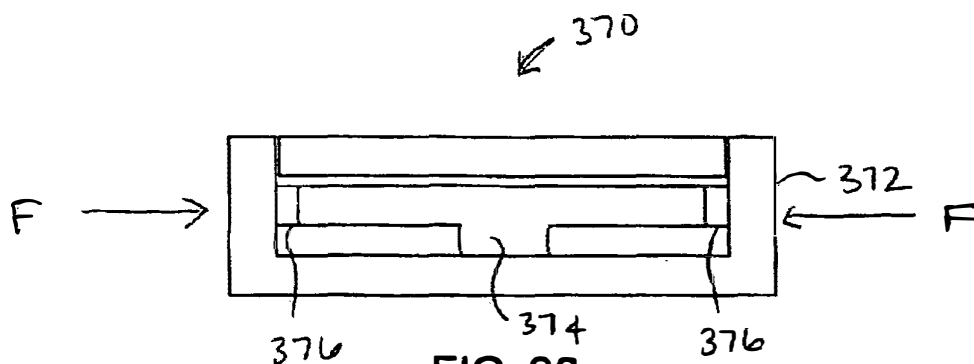


FIG. 23

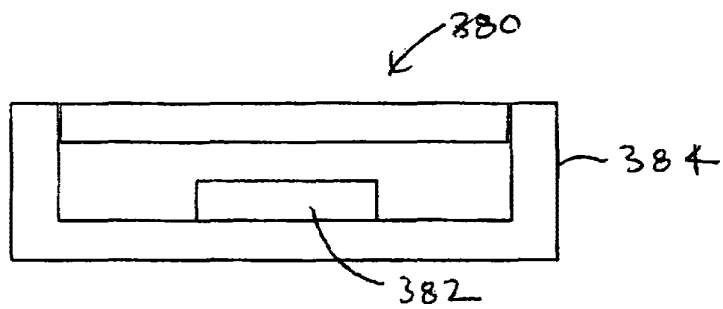


FIG. 24

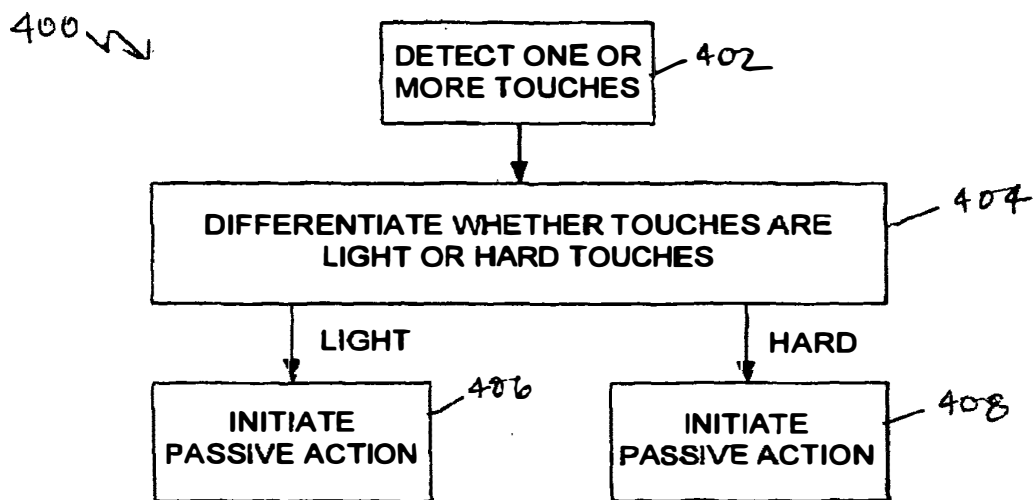


FIG. 25

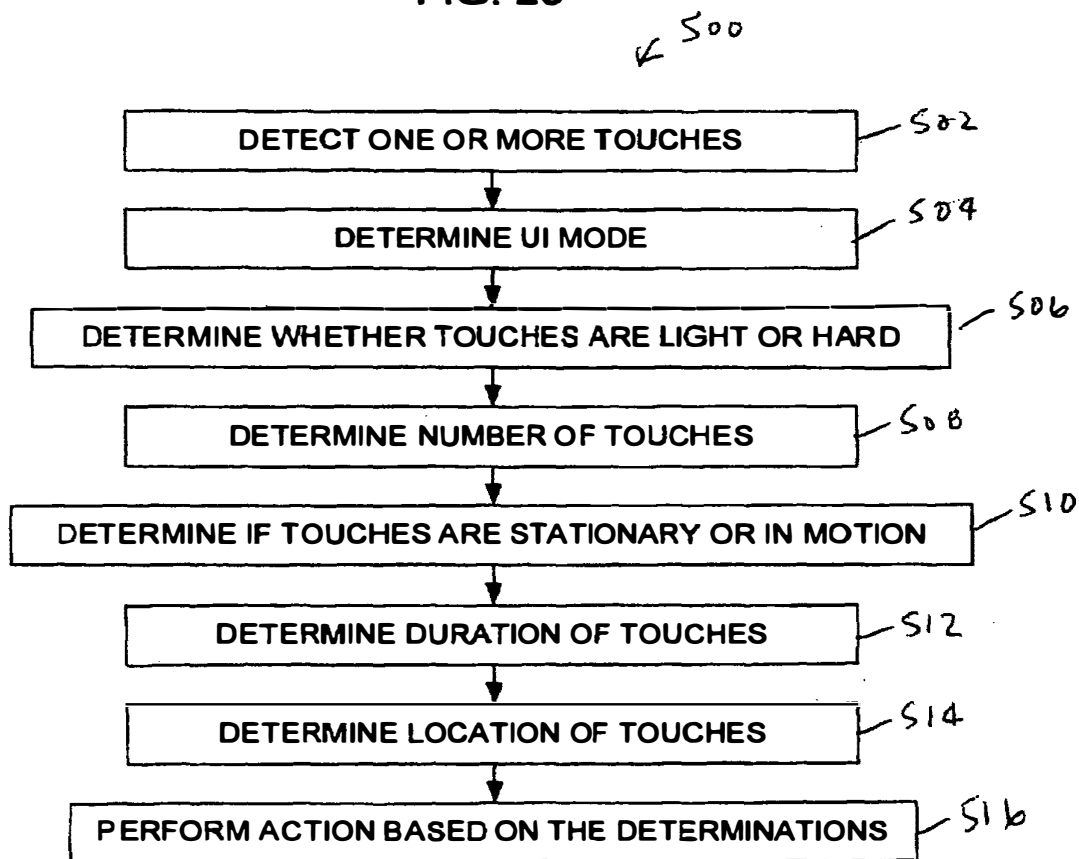


FIG. 26

#	UI Mode	Light Touch or Tactile Click	# Fingers used	Movement during touch or click	Duration	Touchdown location (virtual button?)	Proposed Behavior	Feedback
Basic list navigation								
List Nav.	light	light	1	none	any	anywhere	On touch-down, do nothing. On lift-off, highlight item(if any) under touch	highlight item touched
List Nav.	click	click	1	NONE	short	virtual button / list item	On touch-down, do nothing. On click-down highlight item under touch (if any). On un-click, execute the item clicked	animate screen sliding RIGHT to expose new screen
List Nav.	click	click	1	NONE	short	PLAY / PAUSE virtual button	On touch-down, do nothing. On click-down highlight Play/Pause icon. On un-click, PLAY/PAUSE	Change PLAY/PAUSE icon
List Nav.	click	click	1	NONE	LONG	virtual button	On touch-down, do nothing. On click-down highlight item under touch (if any). After delay, bring-up context sensitive menu.	Context sensitive menu pop-up
List Nav.	light or click	light or click	1	UP/DOWN	any	anywhere	On touch-down, do nothing. Scroll list UP/DOWN depending on UP/DOWN distance moved, use inertia & brakes, disregard LEFT/RIGHT motion during gesture. If highlighted item slides off visible screen, change highlighted item to one that is visible.	list scrolling UP/DOWN, first few letters enlarged
List Nav.	light or click	light or click	1	LEFT	any	anywhere	On touch-down, do nothing. On left motion, open highlighted folder or execute highlighted item (like legacy SELECT button)	animate screen sliding LEFT
List Nav.	light or click	light or click	1	RIGHT	any	anywhere	On touch-down, do nothing. On right motion, go back out a folder (like legacy MENU function)	animate screen sliding RIGHT

Fig. 27A

#	UI Mode	Light Touch or Tactile Click	# Fingers used	Movement during touch or click	Duration	Touchdown location (virtual button?)	Proposed Behavior	Feedback
2D photo thumbnail preview / navigation								
③	photo preview	light	1	none	any	anywhere	On touch-down, do nothing. On lift-off, highlight item (if any) under touch	highlight item touched
	photo preview	click	1	NONE	short	virtual button / thumbnail	On touch-down, do nothing. On click-down highlight item under touch (if any). On un-click, execute the item clicked	animate screen sliding RIGHT to expose new screen
	photo preview	click	1	NONE	short	PLAY / PAUSE virtual button	On touch-down, do nothing. On click-down highlight Play/Pause icon. On un-click, PLAY/PAUSE	Change PLAY/PAUSE icon
	photo preview	click	1	NONE	LONG	virtual button	On touch-down, do nothing. On click-down highlight item under touch (if any). After delay, bring-up context sensitive menu.	Context sensitive menu pop-up
	photo preview	light or click	1	UP/DOWN	any	anywhere	On touch-down, do nothing. Scroll list of thumbnails UP/DOWN depending on UP/DOWN distance moved, use inertia & brakes, disregard LEFT/RIGHT motion during gesture. If highlighted item slides off visible screen, change highlighted item to one that is visible.	list of thumbnails scrolling UP/DOWN
	photo preview	light or click	1	LEFT	any	anywhere	On touch-down, do nothing. On left motion, open highlighted folder or execute highlighted item (like legacy SELECT button)	animate screen sliding LEFT
	photo preview	light or click	1	RIGHT	any	anywhere	On touch-down, do nothing. On right motion, go back out a folder (like legacy MENU function)	animate screen sliding RIGHT

Fig 27B

#	UI Mode	Light Touch or Tactile Click	# Fingers used	Movement during touch or click	Duration	Touchdown location (virtual button?)	Proposed Behavior	Feedback
4	Now Playing							
	Now Playing	light	1	none	any	anywhere	do nothing	n/a
	Now Playing	click	1	NONE	any	anywhere	On touch-down, do nothing. On click-down PLAY / PAUSE.	change PLAY/PAUSE icon
	Now Playing	light	1	UP/DOWN	any	anywhere	do nothing	n/a
	Now Playing	light	1	LEFT	any	anywhere	do nothing	n/a
	Now Playing	light	1	RIGHT	any	anywhere	On touch-down, do nothing. On right motion, go back out a folder (like legacy MENU function)	animate screen sliding RIGHT
	Now Playing	click	1	UP/DOWN	any	anywhere	On touch-down & click-down, do nothing. On UP/DOWN motion detect, increase/decrease volume and disregard LEFT/RIGHT motion	Volume slider moves UP/DOWN
	Now Playing	click	1	LEFT	any	anywhere	On touch-down & click-down, do nothing. On left motion, go to next track (like legacy NEXT button)	animate screen sliding LEFT
	Now Playing	click	1	RIGHT	any	anywhere	On touch-down & click-down, do nothing. On right motion detect, go to prev. track (like legacy PREV button)	animate screen sliding RIGHT

FIG. 27C

#	UI Mode	Light Touch or Tactile Click	# Fingers used	Movement during touch or click	Duration	Touchdown location (virtual button?)	Proposed Behavior	Feedback
Full-screen Item (Photo, map view, calendar day, single contact view, etc.)								
	Full-screen item	light	1	none	any	anywhere	do nothing	n/a
	Full-screen item	click	1	NONE	any	anywhere	On touch-down, do nothing. On click-down PLAY / PAUSE.	change PLAY/PAUSE icon
	Full-screen item	light	1	UP/DOWN	any	anywhere	do nothing	n/a
	Full-screen item	light	1	LEFT	any	anywhere	do nothing	n/a
	Full-screen item	light	1	RIGHT	any	anywhere	On touch-down, do nothing. On right motion, go back out a folder (like legacy MENU function)	animate screen sliding RIGHT
	Full-screen item	click	1	UP/DOWN	any	anywhere	On touch-down & click-down, do nothing. On UP/DOWN motion detect, increase/decrease volume and disregard LEFT/RIGHT motion	Volume slider moves UP/DOWN
	Full-screen item	click	1	LEFT	any	anywhere	On touch-down & click-down, do nothing. On left motion, go to next item (like legacy NEXT button)	animate screen sliding LEFT
	Full-screen item	click	1	RIGHT	any	anywhere	On touch-down & click-down, do nothing. On right motion detect, go to prev. item (like legacy PREV button)	animate screen sliding RIGHT

FIG. 27D

#	UI Mode	Light Touch or Tactile Click	# Fingers used	Movement during touch or click	Duration	Touchdown location (virtual button?)	Proposed Behavior	Feedback
Optional Multi-touch gestures on full-screen item								
	Full-screen item	light or click	2 or more	Up, down, right, left	any	anywhere	translate image according to total incremental centroid translation of contacts, scale (zoom) image according to total incremental spread (radius of gyration) of contacts, rotate image according to incremental rotation of contacts	image translation, scaling and rotation

Fig. 27E

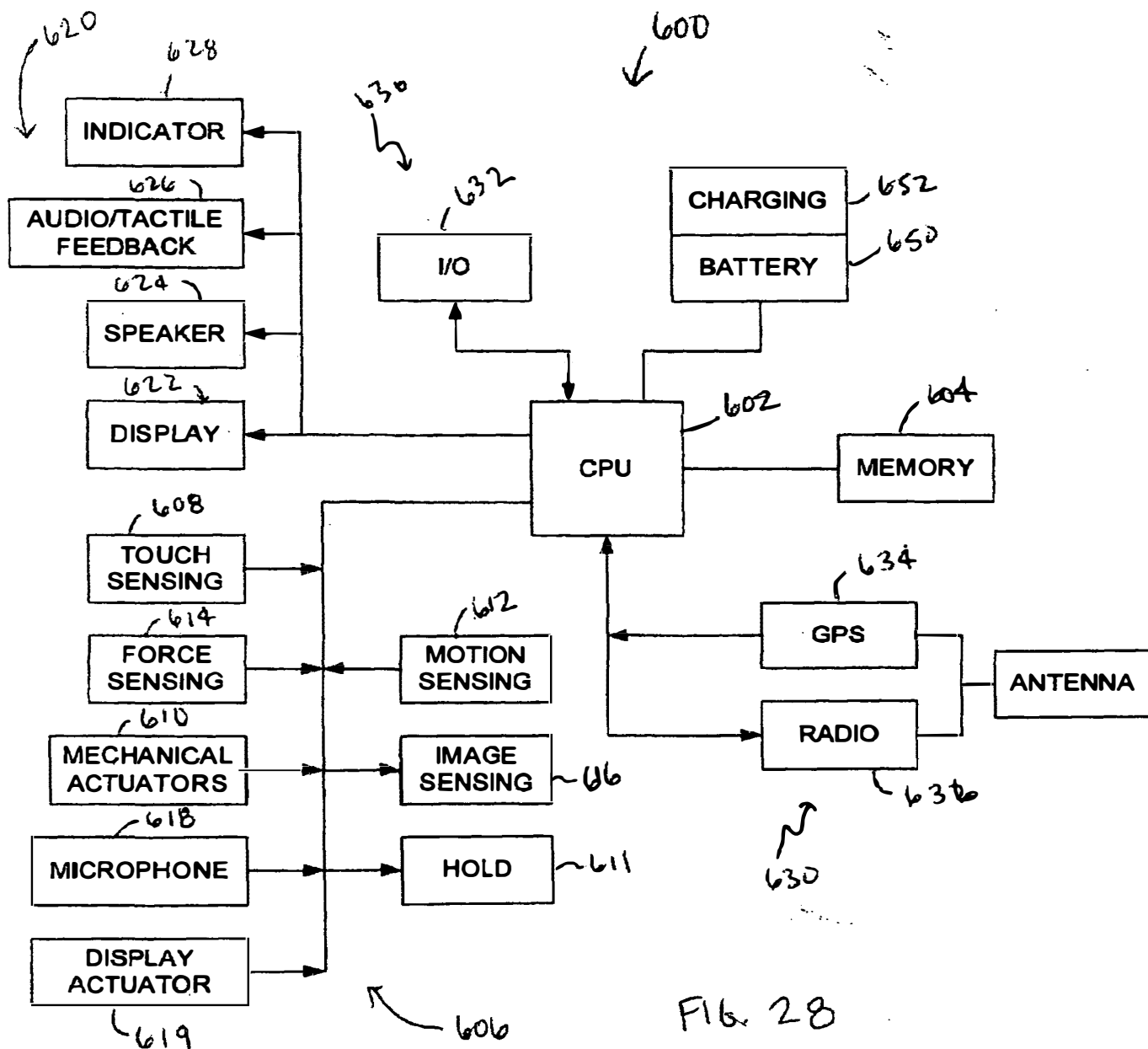


Fig. 28

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APPENDIX A

HAND HELD ELECTRONIC DEVICE WITH MULTIPLE TOUCH SENSING DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to the following applications, which are all herein incorporated by reference:

[0002] U.S. Patent Application No.: 10/188,182, titled, “TOUCH PAD FOR HANDHELD DEVICE” filed on July 1, 2002, and which is herein incorporated by reference.

[0003] U.S. Patent Application No.: 10/722,948, titled, “TOUCH PAD FOR HANDHELD DEVICE” filed on November 25, 2003, and which is herein incorporated by reference.

[0004] U.S. Patent Application No.: 10/643,256, titled, “MOVABLE TOUCH PAD WITH ADDED FUNCTIONALITY” filed on August 18, 2003, and which is herein incorporated by reference.

[0005] U.S. Patent Application No.: 10/654,108, titled, “AMBIDEXTROUS MOUSE” filed on September 2, 2003, and which is herein incorporated by reference.

[0006] U.S. Patent Application No.: 10/840,862, titled, “MULTIPOINT TOUCHSCREEN” filed on May 6, 2004, and which is herein incorporated by reference.

[0007] U.S. Patent Application No: 10/903,964, titled, “GESTURES FOR TOUCH SENSITIVE INPUT DEVICES” filed on July 30, 2004, and which is herein incorporated by reference.

[0008] U.S. Patent Application No.: 11/038,590, titled, "MODE-BASED GRAPHICAL USER INTERFACES FOR TOUCH SENSITIVE INPUT DEVICES" filed on January 18, 2005, and which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0009] The present invention relates generally to hand held electronic device. More particularly, the present invention relates to hand held electronic devices with touch sensing components.

Description of the Related Art

[0010] There exist today many types of consumer electronic devices, each of which utilizes some sort of user interface. The user interface typically includes an output device in the form of a fixed display such as an LCD and one or more input devices, which can be mechanically actuated as for example, switches, buttons, keys, dials, joysticks, joy pads, or electrically activated as for example touch pads and touch screens. The display is typically configured to present visual information such as text and graphics, and the input devices are typically configured perform operations such as issuing commands, making selections or moving a cursor or selector in the consumer electronic device. Each of these well known devices has considerations such as size and shape limitations, costs, functionality, complexity, etc. that must be taken into account when designing the consumer electronic device. In most cases, the user interface is positioned on the front face of the electronic device for easy viewing of the display and easy manipulation of the input devices.

[0011] Figs. 1A-1F are diagrams of various handheld electronic devices including for example a telephone 10A (Fig. 1A), a PDA 10B (Fig. 1B), a media player 10C (Fig. 1C), a remote control 10D (Fig. 1D), a camera 10E (Fig. 1E), and a GPS module 10F

(Fig. 1F). In each of these devices 10, a display 12, which is secured inside the housing of the device 10, and which can be seen through an opening in the housing, is typically positioned in a first region of the electronic device 10 and one or more input devices 14 are typically positioned in a second region of the electronic device 10 next to the display 12 (excluding touch screens, which are positioned over the display).

[0012] To elaborate, the telephone 10A typically includes a display 12 such as a character or graphical display, and input devices 14 such as a number pad and in some cases a joy pad. The PDA 10B typically includes a display 12 such as a graphical display, and input devices 14 such as a touch screen and buttons. The media player 10C typically includes a display 12 such as a character or graphic display and input devices 14 such as buttons or wheels. The iPod manufactured by Apple Computer, Inc. of Cupertino, CA is one example of a media player that includes both a display and input devices disposed next to the display. The remote control 10D typically includes an input device 14 such as a keypad and may or may not have a character display 12. The camera 10E typically includes a display 12 such as a graphic display and input devices 14 such as buttons. The GPS module 10F typically includes a display 12 such as graphic display and input devices 14 such as buttons, and in some cases a joy pad.

[0013] Although the I/O arrangements described above work particularly well, improved I/O arrangements and layouts are needed to improved the functionality of the device in which they are used.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

Figs. 1A-1F are diagrams of various electronic devices.

Fig. 2 is a simplified diagram of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 3 is a simplified side elevation view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 4 is a simplified side elevation view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 5 is a simplified side elevation view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 6 is a simplified side elevation view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 7 is a simplified side elevation view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 8 is a simplified front view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 9 is a simplified side elevation view of a portable electronic device, in accordance with one embodiment of the present invention.

Fig. 10 is a perspective diagram of a hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 11 is a perspective diagram of a one handed hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 12 is a perspective diagram of a one handed hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 13 is a side view diagram of a one handed hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 14 is a back view diagram of a two handed hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 15 is a front view diagram of a two handed hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 16 is a perspective diagram of a hand held electronic device, in accordance with one embodiment of the present invention.

Figs. 17A-17D are various diagrams of the hand held electronic device shown in Fig. 16 including contact patch areas created by a hand holding the hand held electronic device, in accordance with one embodiment of the present invention.

Fig. 18 is a diagram of the hand held electronic device, in accordance with another embodiment of the present invention.

Fig. 19 is an operational method in accordance with one embodiment of the present invention.

Fig. 20 is a handedness determination method, in accordance with one embodiment of the present invention.

Fig. 21 is an actual user determination method, in accordance with one embodiment of the present invention.

Fig. 22 is an absolute mapping method, in accordance with one embodiment of the present invention.

Fig. 23 is a relative mapping method, in accordance with one embodiment of the present invention.

Fig. 24 is a block diagram of an exemplary electronic device, in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] The present invention relates generally to hand held electronic devices and more particularly, the present invention relates to hand held electronic devices with touch sensing components. One aspect of the invention pertains to hand held electronic devices with multiple touch sensing devices. The touch sensing devices may be selected from touch panels, touch screens or touch sensitive housings. By providing multiple touch sensing devices, it is believed that the number of mechanical or physical buttons or switches at the surface of the housing may be limited and that the size of the display may be maximized. In so doing, the functionality and appearance of the device is greatly improved. Another aspect of the invention pertains to the placement of the touch sensing components. The touch sensing components can be placed on the sides, top, bottom, front and back surfaces of the device. In one example, the touch sensing device is placed on the back of the device opposite the display. In cases such as these, the touch plane may be mapped to the display such that there is a one to one relationship therebetween.

[0015] Embodiments of the invention are discussed below with reference to Figs. 2-24. However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these figures is for explanatory purposes as the invention extends beyond these limited embodiments.

[0016] Fig. 2 is a simplified diagram of a portable electronic device 50, in accordance with one embodiment of the present invention. The portable electronic device 50 may for example be a hand held electronic device. As used herein, the term “hand held” means that the electronic device is typically operated while being held in a hand. The hand held electronic device may be directed at one-handed operation or two-handed operation. In one-handed operation, a single hand is used to both support the device as well as to perform operations with the user interface during use. Cellular phones, PDAs, media players, and GPS units are examples of portable devices that can be operated solely with one hand. In the case of a cell phone, for example, a user may grasp the phone in one hand between the fingers and the palm and use the thumb to make entries using keys, buttons or a joy pad. In two-handed operation, one hand

is used to support the device while the other hand performs operations with a user interface during use or alternatively both hands support the device as well as perform operations during use. Tablet PCs and game players are examples of portable device that are typically operated with two hands. In the case of the tablet PC, for example, the user may grasp the tablet with one hand and make entries in the tablet using the other hand, or alternatively grasp the tablet in both hands and make entries using either or both hands while holding the tablet PC.

[0017] The portable electronic device 50 is configured with one or more touch sensing devices 52 for providing inputs to the portable electronic device 50. In the illustrated embodiment, the portable electronic device 50 includes at least a first touch sensing device 52A that is located in a first region of the portable electronic device, and may include a second touch sensing device 52B that is located in a second region of the portable electronic device 50. The first and second touch sensing devices 52A and 52B, which can be located on the same side (in different regions) or a different side of the portable electronic device 50, can be positioned on any side of the portable electronic device 50 including for example the front, back, top, bottom, right side and/or left side. Furthermore, they can be configured to take up any amount of real estate including large (e.g., an entire side or sides) or small (e.g., a portion of a side). In one particular embodiment, the first and second touch sensing devices 52A and 52B are located on opposite sides of the portable electronic device, and more particularly on the front and back of the portable electronic device 50. This particular set up allows for one handed operation, i.e., the users thumb can be used to actuate the front side touch sensing device 52B and one of the fingers can be used to actuate the back side touch sensing device 52A. In some cases, the touch sensing devices 52 substantially cover the entire front and back surfaces. In other cases, the touch sensing devices 52 only cover a portion of the front and back surfaces.

[0018] The touch sensing devices 52 may be widely varied. The touch sensing devices 52 may correspond to any commercially known touch panel such as touch pads and touch screens (among others). Touch pads are typically positioned within a housing 54 of the portable electronic device 50. The touch pads may for example be accessed through an opening in the housing 54. Touch screens, on the other hand, are transparent input devices that are positioned over a display 56 of the portable

electronic device 50. By way of example, touch pads and touch screens that may be used are disclosed in U.S. Patent Application Nos. 10/188,182, 10/722,948, 10/643,256, 10/840,862, all of which are herein incorporated by reference.

[0019] In each of these examples (e.g., touch pads and touch screens), the touch sensing device 52 consists of a sensor arrangement 58. The sensor arrangement 58 is configured to detect the presence of an object such as a finger as well as the location and pressure being exerted on the surface of the panel by the finger or palm of the hand. By way of example, the sensor arrangement 58 may be based on capacitive sensing, resistive sensing, surface acoustic wave sensing, and/or the like. The sensor arrangement 58 may further be based on pressure sensing such as strain gauges, force sensitive resistors, load cells, pressure plates, piezoelectric transducers or the like.

[0020] Alternatively, one or more of the touch sensing devices 52 may be integrated directly into the housing 54 of the portable electronic device 50 thereby forming a touch sensitive housing. In cases such as this, the sensor arrangement 58 is either integral with the housing 54 or positioned behind the housing 54 (rather than being part of a separate device such as a touch pad that is positioned inside the housing). The touch sensitive housing can be configured to cover the entire housing 54, or alternatively only a portion of the housing 54, as for example, one or more sides of the housing 54, portions of one or more sides of the housing 54, and the like. In some cases, the sensor arrangement 58 may only be located in specific area of the housing 54 in order to form distinct buttons on the surface of the portable electronic device 50.

[0021] The configuration of the portable electronic device 50 and its various components can be widely varied. Several configurations are shown in Figs. 3-9. It should be noted, however, that these configurations are by way of example and not by way of limitation.

[0022] As shown in Fig. 3, the portable electronic device 50 includes a housing 54 and a display 56 situated in a front surface of the housing 54. The portable electronic device 50 also includes a touch sensing device 52A in the form of a touch panel such as a touch pad that is situated on the back surface of the housing 54 opposite the display 56. In some cases, the touch sensing device 52A is sized and dimensioned

similarly to the display 56. Furthermore, the touch sensing device 52A may be positioned so that the center point of the touch sensing device 52A coincides with the center point of the display 56. The touch sensing device 52A and display 56 therefore have a one to one relationship. In fact, the touch sensing nodes of the touch sensing device 52A may be mapped to the plane of the display 56 so that inputs on the touch sensing device 52A correspond to similar points on the display 56 (similar to a touch screen). In some cases, the portable electronic device 50 further includes a second touch sensing device 52B in the form of a touch screen that is positioned over the display 56. The second touch sensing device 52B is therefore positioned opposite the first touching sensing device 52A.

[0023] As shown in Fig. 4, the portable electronic device 50 includes a housing 54 with first and second touch sensing devices 52A and 52B. The touch sensing devices may for example be touch panels such as touch pads that are positioned in the housing 54. The first touch sensing device 52A is located on the back surface of the housing 54 and the second touch sensing device 52B is located on the front surface of the housing 54. Alternatively, the touch sensing devices 52 may be associated with a touch sensitive housing. In either case, the portable electronic device 50 may or may not include a display (e.g., some portable devices do not require a display as for example the iShuffle™ manufactured by Apple Computer, Inc., of Cupertino, CA).

[0024] As shown in Fig. 5, the portable electronic device 50 includes a housing 54 with a display 56 and a plurality of touch sensing devices 52. A first touch sensing device 52A is located on the back surface of the housing 54 and a second touch sensing device 52B is located on a first side of the housing 54. In some cases, a third touch sensing device 52C is located on a second side of the housing 54. And in other cases, although not shown, fourth and fifth sensing devices may be located at the other sides of the housing 54. The touch sensing devices 52 are shown as touch panels, but it should be noted that this embodiment may also be implemented with a touch sensitive housing.

[0025] As shown in Fig. 6, the portable electronic device 50 includes a housing 54 with a first display 56A situated in a back surface of the housing 54 and a second display 56B situated in a front surface of the housing 54. The portable electronic

device 50 also includes a first touch sensing device 52A in the form of a first touch screen positioned in front of the first display 56A and a second touch sensing device 52B in the form of a second touch screen in front of the second display 56B.

[0026] As shown in Fig. 7, the portable electronic device 50 includes a housing 54 and a display 56 situated in a front surface of the housing 54. The portable electronic device 50 also includes a plurality of touch sensing devices 52 located at one side of the housing 54. In the illustrated embodiment, the portable electronic device 50 includes first and second touch sensing devices 52A and 52A' that are positioned on the back surface of the housing 54. Although on the same side, the touch sensing devices 52A and 52A' are separate and spatially distinct input devices. This particular implementation may be well suited for portable electronic devices such as tablet PCs and game players that are operated with two hands. The touch sensing devices 52A and 52A' may be placed at locations on the back surface so that one touch sensing device is actuated by a left hand and the other touch sensing device is actuated by a right hand while the portable electronic device is held by both hands. By way of example, the first touch sensing device 52A may be placed on the left back surface so that the fingers of the left hand can actuate the first touch sensing device 52A, and the second touch sensing device 52A' may be placed on the right back surface so that the fingers of the right hand can actuate the second touch sensing device 52A'.

[0027] As shown in Fig. 8, the portable electronic device 50 includes a housing 54 and a display 56 situated in a front surface of the housing 54. The portable electronic device 50 also includes a plurality of distinct touch sensing devices 52 located at one side of the housing 54. In the illustrated embodiment, the portable electronic device 50 includes first, second and third touch sensing devices 52A, 52B and 52C that are positioned on the same side surface of the housing 54 (e.g., left or right side). Although on the same side, the touch sensing devices 52A – 52C are separate and spatially distinct input devices. This particular implementation may be well suited for portable electronic devices such as cellular phones, PDAs and media players that are operated with one hand. The touch sensing devices 52A – 52C may be placed at locations on the side surface so that one touch sensing device 52A is actuated by an index finger, another touch sensing device 52B is actuated by a middle finger and yet

another touch sensing device is actuated by the ring finger while the device is held in a single hand.

[0028] As shown in Fig. 9, the portable electronic device 50 includes a touch sensitive housing 54 and a display 56 situated in a front surface of the touch sensitive housing 54. The touch sensitive housing 54 includes sensing components 58 that are positioned on the interior surface of the housing 54. Alternatively, they can be placed within the walls of the housing 54. The sensing components 58 are placed at least on one side of the housing 54, and may be placed on all sides of the housing 54. In the illustrated embodiment, the sensing components 58 cover the entire interior surface of the housing 54 including a bezel 60 of the housing 54. In some cases, the portable electronic device 50 additionally includes a touch sensing device 52 in the form of a touch screen positioned in front of the display 56. In cases such as this, the entire outer surface of the portable electronic device 50 is considered touch sensitive, i.e., the entire surface of the housing 54 and the entire surface of the display 56.

[0029] It should be noted that in embodiments associated with being hand held, the portable electronic device described above may correspond to any consumer related electronic product configured for handheld use. By way of example, the portable electronic device may correspond to tablet PCs, PDAs, media players (music, images, video), game players, telephones, cellular phones, mobile radios, cameras, GPS modules, remote controls, and/or the like.

[0030] It should also be pointed out that while laptops, tablet PCs, and PDAs (to name a few), are all portable electronic devices, only a few of them can truly be considered hand held devices. Hand held implies that the devices are manipulated while being held in the hand. That is, they are used primarily in the users hand during use (no reference surface is needed). This typically eliminates laptops from having the hand held designation. As should be appreciated, input devices on laptops (e.g., touch pads, buttons and keyboards) are typically not manipulated while the laptop is held in the hand, but rather while the laptop is supported on the lap or on a surface such as a desktop. This allows a user for example to use both hands when keyboarding.

[0031] Fig. 10 is a perspective diagram of a hand held electronic device 100, in accordance with one embodiment of the present invention. The hand held electronic device 100 includes a housing 102 that encloses internally various electrical components including integrated circuit chips and other circuitry to provide computing operations for the hand held electronic device 100. By way of example, the housing 102 may contain a microprocessor (e.g., CPU), memory (ROM, RAM), a power supply (e.g., battery), a printed circuit board (PCB), a hard drive or other memory (e.g., flash) and/or various input/output (I/O) support circuitry. In addition, the housing 102 may also define the shape or form of the hand held electronic device 100. That is, the contour of the housing 102 may embody the outward physical appearance of the hand held electronic device 100. The size and shape of the housing 102 may be widely varied, but is typically configured for hand held use.

[0032] The hand held electronic device 100 also includes a display 104 disposed within and viewable through an opening in the housing 102. The display 104, which is typically placed on the front surface of the device 100, can be configured to fill only a portion of the front surface of the housing 102, or alternatively can be configured to fill the entire front surface of the housing 102 (which will be discussed below). The display 104 provides visual information in the form of text, characters or graphics. The display 104 is typically selected from flat panel devices although this is not a requirement and other types of displays may be utilized. Flat panel devices typically provide a planar platform that is ideal for hand held devices. By way of example, the display 104 may correspond to a liquid crystal display (LCD) such as a character LCD that is capable of presenting text and symbols or a graphical LCD that is capable of presenting images, video, and graphical user interfaces (GUI). Alternatively, the display 104 may correspond to a display based on organic light emitting diodes (OLED), or a display that is based on electronic inks.

[0033] In one embodiment, the display 104 is configured to substantially fill the front surface of the housing 102. By way of example, the display 104 may extend from one edge of the housing 102 to the opposite edge of the housing 102 or in some cases the housing 102 may include a small bezel 102A that surrounds the edges of the display 104 at the front surface of the housing 102 (as shown). In either case, the display 104 makes up a substantial portion of the front surface of the hand held electronic device

100 thereby eliminating any real estate for placing buttons or switches associated with a conventional user interface. In essence, the size of the display 104 is maximized to the size of the hand held electronic device 100 or alternatively, the hand held electronic device 100 is minimized to the size of the display 104. Either way, the display 104 is allowed to utilize a greater amount of the real estate of the hand held electronic device 100 than would otherwise be allowed in conventional hand held electronic devices that are limited by buttons and switches located with the display on the front surface.

[0034] In order to generate user inputs, the hand held electronic device 100 may include a touch screen 106 that is a transparent input panel positioned in front of the display 104. The touch screen 106 generates input signals when an object such as a finger (or stylus) is moved across the surface of the touch screen 106 (e.g., linearly, radially, rotary, etc.), from an object holding a particular position on the touch screen 106 and/or by a finger tapping on the touch screen 106. In most cases, touch screens allow a user to make selections and initiate movements in a GUI by simply touching the display screen via a finger. For example, a user may make a selection by pointing directly to a graphical object displayed on the display screen. The graphical object may for example correspond to an on-screen button for performing specific actions in the hand held electronic device 100. In general, the touch screen 106 recognizes the touch and position of the touch on the display 104 and a controller of the hand held electronic device 100 interprets the touch and thereafter performs an action based on the touch event. There are several types of touch screen technologies including resistive, capacitive, infrared and surface acoustic wave.

[0035] In one implementation, the touch screen 106 is a multipoint capacitive touch screen that is divided into several independent and spatially distinct sensing points, nodes or regions that are positioned throughout the touch screen. The sensing points, which are typically hidden from view (transparent), are dispersed about the touch screen with each sensing point representing a different position on the surface of the touch screen (or touch screen plane). The sensing points may be positioned in a grid or a pixel array where each pixilated sensing point is capable of generating a signal. In the simplest case, a signal is produced each time an object is positioned over a sensing point. When an object is placed over multiple sensing points or when the

object is moved between or over multiple sensing point, multiple signals can be generated. The sensing points generally map the touch screen plane into a coordinate system such as a Cartesian coordinate system a Polar coordinate system or some other coordinate system. An example of a multipoint capacitive touch screen may be found in U.S. Patent No.: 10/840,862, Which is herein incorporated by reference.

[0036] In accordance with another embodiment, the housing 102 may include a touch sensitive surface 108 that provides either a larger surface for tracking touch inputs or smaller dedicated areas such as touch buttons for performing dedicated functions. The touch sensitive surface 108 can be located on any surface of the housing 102, any side of the housing 102, any portion of any side of the housing 102 or at dedicated locations on the surface of the housing 104. By way of example, the touch regions may be located on the sides or back surface of the housing 102, and may even be located at the bezel 102A located at the front surface of the housing 102. In all of these cases, a large portion of the front surface of the housing 102 is saved for the display 104 so that the viewing area of the hand held electronic device 100 can be maximized. Furthermore, placing touch sensing regions at these locations tend to encourage one handed use. For example, the touch sensing regions can be placed at locations where the finger of the hand are normally positioned when holding the hand held electronic device 100. The fingers can therefore be used to initiate inputs as well as hold the hand held electronic device 100 during use. Moreover, the hand does not have to be constantly repositioned in order to actuate different input devices since they are located in the area of the various digits of the hand.

[0037] The touch sensitive surface 108 may take the form of one or more touch panels that are positioned within the housing 104. For example, a touch pad or touch screen like device (with or without a display) may be used. The touch sensitive surface 108 may be alternatively or additionally be provided directly by the housing 104. That is, the touch sensing components are integrated or incorporated into or disposed underneath the housing 104 such that the housing 104 itself is the touch sensing device (rather than using a separate touch panel). This particular implementation is believed to be more aesthetically pleasing than using touch panels in that the housing 104 can have a uniform appearance with no lines, breaks or openings in the surface. That is, the surface of the housing 104 is continuous smooth

surface that can be made to look like it does not have any input devices, just a display and a housing (e.g., a device with no visible input devices).

[0038] Similar to the touch screen, the touch sensitive surface (whether from a touch pad, touch housing or touch screen) may be a multipoint capacitive touch device that is divided into several independent and spatially distinct sensing points, nodes or regions that are positioned throughout the device. The sensing points, which are typically hidden from view (transparent), are dispersed about the device with each sensing point representing a different position on the surface of the touch screen (or touch screen plane). The sensing points may be positioned in a grid or a pixel array where each pixilated sensing point is capable of generating a signal. In the simplest case, a signal is produced each time an object is positioned over a sensing point. When an object is placed over multiple sensing points or when the object is moved between or over multiple sensing point, multiple signals can be generated. Like the touchscreen, the sensing points generally map the touch screen plane into a coordinate system such as a Cartesian coordinate system a Polar coordinate system or some other coordinate system. As mentioned above, multipoint capacitive touch sensing devices are disclosed in U.S. Patent No.: 10/840,862.

[0039] In one particular embodiment, the only way to generate user inputs in the hand held electronic device 100 is through the touch screen 106 and/or the touch sensitive surface 108 of the housing 102. The touch screen 106 and touch sensitive surface 108 completely replace all other input means of the hand held electronic device 100. No other input devices such as mechanical buttons and switches are included thus saving the real estate for the display 104. In some cases, however, it may be desirable to include a hold switch that locks and unlocks the one or more touch sensing device from receiving inputs (e.g., the hold switch prevents inputs when not desired). In cases such as these, the hold switch is not located on the front surface with the display thereby enabling the display to fill the front surface. Rather, the hold switch is located on one of the side surfaces such as the top surface of the device.

[0040] It should be noted however that this is not a limitation and that the device may include a limited number of physical buttons and switches. It is generally desirable to

keep the number limited on the front surface so that the available space of the device can be saved for the display.

[0041] The hand held electronic device 100 may be designed to recognize gestures applied to the touch screen 106 and/or touch sensitive surface 108 of the housing (track pads) and to control aspects of the hand held electronic device 100 based on the gestures. Gestures may be defined as a stylized interaction with an input device that is mapped to one or more specific computing operations. The gestures may be made through various hand, and more particularly finger motions. Alternatively or additionally, the gestures may be made with a stylus. In all of these cases, the input devices (touch screen and touch sensitive surface) receive the gestures and the controller of the hand held electronic device 100 executes instructions to carry out operations associated with the gestures. The hand held electronic device 100 may include a gesture operational program, which may be part of the operating system or a separate application. The gestural operation program generally includes a set of instructions that recognizes the occurrence of gestures and informs one or more software agents of the gestures and/or what action(s) to take in response to the gestures. By way of example, gestures that can be used are disclosed in greater detail in U.S. Patent No.: 10/903,964, which is herein incorporated by reference. Other touch related techniques may also be found in U.S. Patent No.: 11/038,590, which is herein incorporated by reference.

[0042] Alternatively or additionally, the hand held electronic device may be designed to recognize hand images and to control aspects of the hand held electronic device based on the hand images. Each hand image represents a profile of the fingers or other portions of the hand in contact with the touch sensitive surface as well as the touch screen at a particular instant in time, i.e., the hand image describes how the device is held. The hand images (or signals) may be used to initiate certain functions or to make a determination as to what user is using the hand held electronic device. By way of example, the functions may include initiating commands, selecting an item, opening a file or document, launching a program, executing instructions, viewing a menu on the display screen, and/or the like. With regards to the determination, the hand signal may be used to determine the identity of the user (e.g., Bob or Carol) or to a type of user (e.g., left or right handed user). The hand held

device may contain a list of hand profiles with actions associated therewith. The hand profiles generally describe how the device is held while the actions describe what type of action to perform based on the hand profile.

[0043] In addition, the hand image may be used to determine the orientation of the device as for example when the device is held at 0, 90, 180 and 270 degrees. With this information, the device may be configured to always display images in an upright no matter what orientation the device is in.

[0044] In one embodiment, the hand held electronic device 100 is a “one-handed” hand held electronic device. The housing 102 is therefore sized and dimensioned to fit into a single hand, and the touch sensitive surface 108 is configured to receive inputs from the various fingers of the single hand. As shown in Fig. 11, the “one-handed” hand held electronic device 100 is sized and shaped for comfortable placement into the user’s hand 116. The single hand 116 essentially cups the device 100, with the thumb 116A and palm 116B being positioned on one side of the device 100, and the fingers 116C being positioned on the opposite side (thereby gripping the device). Although the shape of the device 100 may be widely varied, it should be pointed out that the general size including height, width and thickness is typically “pocket sized” so that the device 100 can easily be placed in the pocket of the user during transport.

[0045] Referring to Figs. 11 -13, one example of a “one-handed” hand held electronic device will be described in greater detail. As shown in Fig. 11, the “one-handed” hand held electronic device 130 includes a full screen display 132 located in the front of the device 130. The “one-handed” hand held electronic device 130 is also configured with one or more touch buttons 134 located on one or more sides of the device 130. The touch buttons 134 may be located in the vicinity of where the various fingers are placed to hold the device 130 (e.g., left and right sides). The user simply has to press harder or tap in the area of the touch button 134 in order to actuate the touch button 134. In the case of a media player such as a music player, the touch buttons 134 may represent button functions such as next, previous, volume up, volume down and/or play/pause.

[0046] The “one-handed” hand held electronic device 130 is also configured with a touch surface 136 on the back surface of the hand held electronic device 130. The touch surface 136 is located directly behind the display 132. The touch surface may be provided by a touch panel and/or a touch sensitive housing. As shown in Fig. 12, the user simply moves their finger from the side position to the back position in order use the touch surface 136. The finger may be tapped, pressed, or slid across the touch surface 136 in order to generate tracking inputs. In some cases, gestures may be performed.

[0047] In one embodiment, the touch surface is mapped to the display. When mapped, points on the touch surface coincide with points on the display, i.e., have the same coordinates (x and y). Therefore, when a user touches the touch surface, it will appear as if the user is touching the image at the same location but on the other side of the touch.

[0048] The “one-handed” hand held electronic device 130 also includes a touch screen 138 disposed over the display 132. The touch screen 138 provides another way to input into the hand held electronic device 130. As shown in Fig. 13, the user simply moves their thumb from the side position to the front position in order to use the touch screen 138. The thumb may be tapped, pressed, or slid across the display 132 in order to generate inputs. In some cases, gestures may be performed.

[0049] In one embodiment, the device 130 is an ambidextrous device that can be used equally by both left and right hands. In cases such as this, the device 130 is configured to have the same feel and function for both the left and right hands. For example, the device 130 may include the same touch regions for both hands of the user. Alternatively, the device may include a touch surface on only one side, which can be utilized by both hands when the device is flipped 180 degrees. In cases such as this, the display is configured to rotate the displayed image so that the image is upright in either orientation.

[0050] The device 130 may further include a handedness selection system for configuring the device 130 for right handed or left handed use. In one implementation, the handedness selection system is a user actuated system that allows

a user to select which hand configuration is desired (e.g., left or right). For example, the handedness of the device 130 may be selected via software as for example through a control panel located on a graphical user interface.

[0051] In another implementation, the handedness selection system is a device actuated system that allows the device 130 to automatically configure the device 130 for right handed or left handed use based on how the user grabs the device 130 (e.g., position and pressure). If a left handed user grabs the device 130, then the device 130 configures itself to be a left handed device during use. If a right handed user grabs the device 130, then the device configures itself to be a right handed device. By way of example, the device 130 may analyze the hand image created by the touch sensing devices and thereafter make a determination as to whether the hand is left or the right hand based on what was detected. For example, if the sensors detect the presence of fingers on the left side then the device 130 may determine that the device 130 is being used by a right handed user, or alternatively if the sensors detect the presence of fingers on the right side then the device 130 may determine that the device 130 is being used by a left handed user. Once the determination is made, the device 130 can turn on the functionality of the touch buttons corresponding to the hand being used and turn off the functionality of the touch buttons corresponding to the hand not in use.

[0052] In another embodiment, the hand held electronic device 100 is a “two-handed” hand held electronic device 100. The housing 102 is therefore sized and dimension to fit into two hands, and the touch sensitive surface 108 is configured to receive inputs from the various fingers of the both hands. The two handed hand held electronic device may for example correspond to a tablet PC or game player.

[0053] As shown in Figs. 14 and 15, the “two-handed” hand electronic device 100 in the form of a tablet PC is sized and shaped for comfortable placement into both of the user’s hands. Each hand essentially cups the sides of the device 100, with one hand gripping the device on one side and the other hand gripping the device on the opposite side. Alternatively, the user is also able to hold the device 100 in one hand while inputting into the device 100 with the opposite hand.

[0054] It should be emphasized that page sized is not as transportable as pocket sized. However, by being page sized the device can include increased functionality that is not capable in smaller devices. Furthermore, page sized devices typically must be used by two hands and therefore they are not as convenient to use when on the go.

[0055] As shown in Fig. 14, the “two-handed” hand held electronic device 140 may be configured with two touch regions 142A and 142B on the back surface of the device 100 opposite the display 104. The touch regions 142 are located in the vicinity of where the various fingers are placed to hold the device 140. The first touch region 142A is located on the left back surface in the region where the left hand and more particularly the left fingers are placed to hold the device 140, and the second touch region 142B is located on the right back surface in the region where the right hand and more particularly the right fingers are placed to hold the device 140. Each of the touch regions 142 may be formed by one or more touch sensing devices (or zones if using the touch sensitive housing). For example, the touch regions 142 may include one large touch sensing device (or zones) or several smaller touch sensing devices (or zones). The touch regions may be implemented by touch panels and/or touch sensitive housings.

[0056] In the illustrated embodiment, the left touch region 142A is provided by one large touch surface while the right touch region 142B is broken up into smaller touch surfaces such as for example touch buttons 144. Like the “one-handed” device mentioned above, the fingers may be tapped, pressed, or slid across the touch surface in order to generate inputs. In some cases, gestures may be performed. Furthermore, the fingers may select the touch buttons in order to generate button inputs. The “two-handed” hand held electronic device 140 also includes a touch screen 146 disposed over a display 148. The touch screen 146 provides another way to input into the hand held electronic device 140. As shown in Fig. 15, the user simply moves their thumb over the display 148 in order to generate inputs. The thumb may be tapped, pressed, or slid across the touch screen 146 in order to generate inputs. In some cases, gestures may be performed.

[0057] Fig. 16 is a perspective diagram of a hand held electronic device 150, in accordance with one embodiment of the present invention. In this embodiment, the

hand held electronic device 150 includes a completely touch sensitive housing 152 and a display 154 with a touch screen 156 that covers the entire display 154. The device 150 is therefore completely touch sensitive. That is, substantially all locations on the surface of the device 150 are capable of sensing surface contact so that the device 150 knows where and when the fingers and palm are touching the device 150 and how much pressure there is at each point. The touch sensitive housing 152 includes a first sensor arrangement 158, and the touch screen 156 includes a second sensor arrangement 160. The first sensor arrangement 158 may be integrally formed into the wall of the housing 152 or they may be located behind the wall within the enclosed space defined by the housing 152 (e.g., adjacent the interior wall). The second sensor arrangement 160 may be integrally formed over the display 154 or it may be a separate unit disposed over the display 154. Both sensor arrangements 158 and 160 are configured to detect the presence of an object such as a finger or palm of the hand as for example when the hand grasps the housing 152.

[0058] As shown, each sensor arrangement 158 and 160 is divided into several independent and spatially distinct sensing points 162 (or regions) that are positioned within the respective component. The sensing points 162 are generally dispersed about the respective component with each sensing point 162 representing a different position on the surface of the component and thus the device 150. The sensing points 162 may be positioned in a grid or a pixel array where each pixilated sensing point 162 is capable of generating a signal. The number and configuration of the sensing points 162 may be widely varied. The number and configuration of sensing points 162 generally depends on the desired resolution of the touch sensitive surface. In the simplest case, a signal is produced each time the finger is positioned over a sensing point 162. When an object is placed over multiple sensing points or when the object is moved between or over multiple sensing points, multiple position signals are generated. In most cases, the signals are monitored by a control system (not shown) that converts the number, combination and frequency of the signals into control information. As should be appreciated, the number, combination and frequency of signals in a given time frame may indicate size, location, direction, speed, acceleration and the pressure of the finger or palm on the surface of the device. By way of example, the control system may be a microcontroller located within the housing 152.

[0059] The sensing points 162 may be based on capacitance. As should be appreciated, whenever two electrically conductive objects come near one another without touching, their electric fields interact to form capacitance. By detecting when the capacitance changes (e.g., increase, decreases) the device's electronics can determine when and where the finger and palm of the hand are touching. Any conventional form of capacitance sensing may be used. The simplicity of capacitance allows for a great deal of flexibility in design and construction of the sensor arrangement (e.g., mutual capacitance sensing, self capacitance, etc.).

[0060] In the illustrated embodiment, the sensor arrangements 158 and 160 include a two layer grid of spatially separated electrodes or wires and that are connected to the control system of the device 150. The upper layer includes electrodes in rows while the lower layer includes electrodes in columns (e.g., orthogonal). As should be appreciated, when a portion of a hand nears the intersection of two electrodes and, the capacitance at the electrodes and changes since the hand has very different dielectric properties than air. These changes can be used to determine the positions of the finger and/or palm when they grab the device. In some cases, the amount of capacitance at each of the electrodes and can be measured by the control system when a portion of a hand nears the intersection of two electrodes (e.g., sensing point). In other cases, capacitance from each of the row electrodes to each of the column electrodes can be measured by the microcontroller when a portion of a hand nears the intersection of two electrodes (e.g., sensing point).

[0061] The signals generated at the sensing points 162 may be used to determine how the user is holding the mouse. By way of example and referring to Fig. 11 and Figs. 17A - 17D, each portion of the hand in contact with the device 150 produces a contact patch area. Each of the contact patch areas covers several sensing points 162 thus generating several signals. The signals may be grouped together to form a hand signal that represents how the user is holding the device 150. In essence, the hand signal is a pixilated image of the hand in contact with the device 150.

[0062] In one embodiment, the difference between a current hand signal and a last hand signal may indicate the user's desire to implement a button function. As should

be appreciated, when a user presses on the surface of the device 150 the area of some of the contact patch areas increases thereby activating more sensing points 162 than previously activated. A significant difference indicates the user's desire to implement a button function. Changes between contact patch areas may further indicate the particular button function.

[0063] In relative mapping, the difference at each particular contact patch area is compared relative to the other particular contact patch areas. For example, if the contact patch area for the index finger grows more significantly than the contact patch area for the middle or ring fingers between first and second signals then a first button function may be implemented. Furthermore, if the contact patch area for the middle finger grows more significantly than the contact patch area for the index and ring fingers between first and second signals a second button function may be implemented. Moreover, if the contact patch area for the ring finger grows more significantly than the contact patch area for the index and middle fingers between first and second signals a third button function may be implemented.

[0064] In absolute mapping, the touch surface is divided into one or more button zones that represent regions of the device that when selected implement the particular button function associated with the button zone. The button zone having the contact patch area with the most significant change between first and second hand signals is the one that is typically implemented. The user may customize the device by setting the configuration of button zones before use. For example, the device may be configured as a one button device, two button device, three button device or the like. The position and size of the button zones may also be customizable. For example, the device may be configured with button zones on only the front or back of the device or on the side of the device. The customization may be performed by the user and/or the device.

[0065] In another embodiment, the similarity between a baseline hand signal and a current hand signal may indicate the user's desire to implement a control function (e.g., gesturing). For example, if the baseline hand signal corresponds to a first button function and the current hand signal is similar to the baseline hand signal then

the device can implement the first button function. The user may customize the device by setting the baseline hand signal before use (e.g., calibration).

[0066] In another embodiment, the similarity between a baseline hand signal and a current hand signal may also indicate the user type (e.g., handedness of the user or the identity of the user). For example, if the baseline hand signal corresponds to a left hand user and the current hand signal is similar to the baseline hand signal then the device knows that the user is left handed. The user may customize the device by setting the baseline hand signal before use (e.g., calibration).

[0067] Fig. 18 is a diagram of the hand held electronic device 180, in accordance with another embodiment of the present invention. In this embodiment, the device 180 includes a touch sensitive housing 182 having a plurality of spatially separated electrodes or platforms 184 that are positioned in the same layer. Each of the electrodes 184 generates a signal when the hand nears the region of the housing 182 where the electrode is located. The signals may be used to perform button functions, i.e., a button function for each electrode, or to perform tracking when a finger is moved across adjacent electrodes. The signals may also be used to determine the user type. For example, the electrodes 184 may generate a first group of signals for a right handed user and a second set of signals for a left handed user.

[0068] Fig. 19 is an operational method 220 in accordance with one embodiment of the present invention. The method 220 generally begins at block 222 where the device is in standby. Standby generally implies that the device is in a state of readiness waiting for something to happen, i.e., a user initiating an action therewith. Following block 222, the process flow proceeds to block 224 where a determination is made as to whether the user is touching the device. This is generally accomplished with touch sensing device capable of generating signals when a hand nears the device and a control system configured to monitor the activity of the touch sensing device. If it is determined that the user is not touching the device, then the process flow proceeds back to block 222 thereby keeping the device in standby. If it is determined that the user is touching the device, then the process flow proceeds to block 226 where the user is determined.

[0069] In one embodiment, block 226 includes determining the handedness of the user. In another embodiment, block 226 includes determining the actual user (e.g., Bob or Carol). The determination may be performed automatically or it may be selective, i.e., user initiated. Once the user is determined, the process flow proceeds to block 228 where the device is configured based on the user. In one embodiment, the button zones of the device are configured based on the handedness of the user. In another embodiment, the button zones are configured based on the actual user (e.g., Bob or Carol).

[0070] Following block 228 the process flow proceeds to block 232, where touch events are monitored. Following block 232, the process flow proceeds to block 236 where signals are generated based on the touch event. The signals may be used to perform actions in the device. For example, the signals may be used to initiate commands, make selections or provide motion in the display (e.g., cursor control, scrolling, panning, etc.).

[0071] Fig. 20 is a handedness determination method 240, in accordance with one embodiment of the present invention. By way of example, the method may be included in block 226 of Fig. 19. The method generally begins at block 242 where a current hand signal is generated. Following block 242 the process flow proceeds to block 244 where the current hand signal is compared to baseline left and/or right hand signals. Following block 244 the process flow proceeds to block 246 where a determination is made as whether the current hand signal is similar to the baseline left hand signal. If the current hand signal is similar, then the process flow proceeds to block 248 where the device is configured for left hand use. That is, the button zones are set for the left handed user. If the current hand signal is not similar to the left hand profile, then the process flow proceeds to block 250 where a determination is made as to whether the current hand signal is similar to a baseline right hand signal. If the current hand signal is similar then the process flow proceeds to block 252 where the device is configured for right hand use. If the current hand signal is not similar to the right hand profile then the process flow proceeds back to block 242 or in some cases one configuration may be chosen as a default (e.g., right hand may be the default)

[0072] Fig. 21 is an actual user determination method 260, in accordance with one embodiment of the present invention. By way of example, the method may be included in block 226 of Fig. 19. The method is generally performed in multiple steps including a calibration step 262 and an in use step 264. The calibration step 262 is performed before the use step 264. The calibration step is generally performed once while the use step is continuously used during device use. The calibration step 262 generally begins at block 266 where baseline hand signals are generated for each user. Following block 266 the process flow proceeds to block 268 where the user settings (e.g., button zones) for the baseline hand signal are configured. Following block 268, the process flow proceeds to block 270 where the baseline hand signal and user settings are stored in a user profile database.

[0073] The use step 264 generally begins at block at block 272 where a current hand signal is generated. Following block 272, the process flow proceeds to block 274 where the current hand signal is compared to the baseline hand signals stored in the user profile database. Following block 274, the process flow proceeds to block 276 where the baseline hand signal most similar to the current hand signal is selected. If there is no signal similar to the current signal then the user may be prompted to go through the calibration step 262. Following block 276, the process flow proceeds to block 268 where the device is configured according to the user settings associated with the selected baseline hand signal.

[0074] Fig. 22 is an absolute mapping method 280, in accordance with one embodiment of the present invention. By way of example, the method 280 may be included in block 232 of Fig. 19. The method 280 generally begins at block 282 where one or more button zones are provided. Button zones are area of the mouse that may be actuated by a user to implement an action. The button zones may be based on a training sequence, selected from a menu, or they may be preset. Following block 282 the process flow proceeds to block 284 where a hand signal is generated. Following block 284, the process flow proceeds to block 286 where a determination is made as to which button zone was selected based on the hand signal. For example, position coordinates generated by touch may correspond to a particular button zone. Following block 286, the process flow proceeds to block 288 where a button signal is generated based on the selected button zone.

[0075] Fig. 23 is a relative mapping method 290, in accordance with one embodiment of the present invention. By way of example, the method may be included in block 232 of Fig. 19. The method 290 generally begins at block 292 where a first hand signal is generated. Following block 292, the process flow proceeds to block 294 where a second hand signal is generated. In this embodiment, the first hand signal generally corresponds to a hand signal generated before the second hand signal. For example, the first hand signal may be the last hand signal while the second hand signal may be the current hand signal. Following block 294, the process flow proceeds to block 296 where the difference between the current hand signal and the baseline hand signal is determined. If the difference is within a threshold value, then the process flow proceeds back to block 294. This serves as a filter element or noise reduction. As should be appreciated, the user tends to continuously adjust hand position during use even if they are not making a selection (e.g., noise). If the difference is outside a threshold value then the process flow proceeds to block 298 where a button signal is generated based on the difference between the first hand signal and the second hand signal.

[0076] Fig. 24 is a block diagram of an exemplary electronic device 350, in accordance with one embodiment of the present invention. The electronic device typically includes a processor 356 configured to execute instructions and to carry out operations associated with the electronic device 350. For example, using instructions retrieved for example from memory, the processor 356 may control the reception and manipulation of input and output data between components of the electronic device 350. The processor 356 can be implemented on a single-chip, multiple chips or multiple electrical components. For example, various architectures can be used for the processor 356, including dedicated or embedded processor, single purpose processor, controller, ASIC, and so forth.

[0077] In most cases, the processor 356 together with an operating system operates to execute computer code and produce and use data. The operating system may correspond to well known operating systems such as OS/2, DOS, Unix, Linux, and Palm OS, or alternatively to special purpose operating system, such as those used for limited purpose appliance-type devices (e.g., media players). The operating system,

other computer code and data may reside within a memory block 358 that is operatively coupled to the processor 56. Memory block 358 generally provides a place to store computer code and data that are used by the electronic device 350. By way of example, the memory block 58 may include Read-Only Memory (ROM), Random-Access Memory (RAM), hard disk drive, flash memory and/or the like.

[0078] The electronic device 350 also includes a display 368 that is operatively coupled to the processor 356. The display 368 is generally configured to display a graphical user interface (GUI) that provides an easy to use interface between a user of the electronic device 350 and the operating system or application running thereon. The display 368 may for example be a liquid crystal display (LCD).

[0079] The electronic device 350 also includes a touch screen 370 that is operatively coupled to the processor 356. The touch screen 370 is configured to transfer data from the outside world into the electronic device 350. The touch screen 370 may for example be used to perform tracking and to make selections with respect to the GUI on the display 368. The touch screen 70 may also be used to issue commands in the electronic device 350.

[0080] The touch screen 370, which is positioned in front of the display 368, recognizes touches, as well as the position and magnitude of touches on a touch sensitive surface. The touch screen 370 reports the touches to the processor 356 and the processor 356 interprets the touches in accordance with its programming. For example, the processor 356 may initiate a task in accordance with a particular touch. A dedicated processor can be used to process touches locally and reduce demand for the main processor of the electronic device.

[0081] The touch screen 370 may be based on sensing technologies including but not limited to capacitive sensing, resistive sensing, surface acoustic wave sensing, and/or the like. Furthermore, the touch screen may be based on single point sensing or multipoint sensing. Single point sensing is capable of only distinguishing a single touch, while multipoint sensing is capable of distinguishing multiple touches that occur at the same time.

[0082] The electronic device 350 also includes a touch sensing device 380 that is operatively coupled to the processor 356. The touch sensing device 380 is configured to transfer data from the outside world into the electronic device 350. The touch sensing device 380 may for example be used to perform tracking and to make selections with respect to the GUI on the display 368. The touch sensing device 380 may also be used to issue commands in the electronic device 350.

[0083] The touch sensing device 380, which is positioned in the housing, recognizes touches, as well as the position and magnitude of touches on a touch sensitive surface. The touch sensing device 380 reports the touches to the processor 356 and the processor 356 interprets the touches in accordance with its programming. For example, the processor 356 may initiate a task in accordance with a particular touch. A dedicated processor can be used to process touches locally and reduce demand for the main processor of the electronic device.

[0084] The touch sensing device may be based on sensing technologies including but not limited to capacitive sensing, resistive sensing, surface acoustic wave sensing, and/or the like. Furthermore, the touch sensing device may be based on single point sensing or multipoint sensing. Single point sensing is capable of only distinguishing a single touch, while multipoint sensing is capable of distinguishing multiple touches that occur at the same time.

[0085] In one particular embodiment of the present invention, the electronic devices described above correspond to hand-held electronic devices with small form factors. As used herein, the term “hand held” means that the electronic device is typically operated while being held in a hand and thus the device is sized and dimension for such use. Examples of hand held devices include PDAs, Cellular Phones, Media players (e.g., music players, video players, game players), Cameras, GPS receivers, Remote Controls, and the like.

[0086] In cases such as these, the display presents the visual information associated with the hand held electronic device, while the touch sensitivity of the touch screen and touch sensing devices provide the input means necessary to interact with the hand held electronic device. The touch screen and touch sensing device can reduce the

number of input devices needed to support the device and in many cases completely eliminate input devices other than the touch sensing devices. As a result, the hand held electronic device appears to only have a display and no input means. The device is therefore more aesthetically pleasing (e.g., smooth surface with no breaks gaps or lines), and in many cases can be made smaller without sacrificing screen size and input functionality, which is very beneficial for hand held electronic device especially those hand held electronic device that are operated using one hand (some hand held electronic device require two handed operation while others do not).

[0087] The multiple touch sensing devices of the present invention are a perfect fit for small form factor devices such as hand held devices, which have limited space available for input interfaces, and which require adaptable placement of input interfaces to permit operation while being carried around. This is especially true when you consider that the functionality of handheld devices have begun to merge into a single hand held device (e.g., smart phones). At some point, there is not enough real estate on the device for housing all the necessary buttons and switches without decreasing the size of the display or increasing the size of the device, both of which leave a negative impression on the user. In fact, increasing the size of the device may lead to devices, which are no longer considered “hand-held.”

[0088] In one particular implementation, the hand held device is a music player and the display is configured to substantially fill the entire front surface of the music player. In this embodiment, the touch sensing devices are the primary input means of the music player and in some cases is the only input means. Furthermore, the touch sensing devices may configured to generate control signals associated with a music player. For example, the touch surface on the housing may include button functions including, Select, Play/Pause, Next, Previous and Menu. Alternatively or additionally, the button functions may include volume up and volume down.

[0089] While this invention has been described in terms of several preferred embodiments, there are alterations, permutations, and equivalents, which fall within the scope of this invention. It should also be noted that there are many alternative ways of implementing the methods and apparatuses of the present invention. It is therefore intended that the following appended claims be interpreted as including all

such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

What is claimed is:

1. A hand held electronic device, comprising:
a first touch sensing device located in a first region of the hand held electronic device; and
a second touch sensing device located in a second region of the hand held electronic device, the second region being at a different location than the first region of the hand held electronic device.
2. The hand held electronic device as recited in claim 1 further comprising a display that forms a viewing region of the hand held electronic device, and wherein the first touch sensing device is a touch screen positioned over the display in the viewing region of the display.
3. The hand held electronic device as recited in claim 2 further comprising a second display that forms a second viewing region of the hand held electronic device, and wherein the second touch sensing device is a second touch screen positioned over the second display in the second viewing region of the second display.
4. The hand held electronic device as recited in claim 3 wherein the first display is positioned on a first side of the hand held electronic device, and wherein the second display is positioned on a second side of the hand held electronic device, the second side being located opposite the first side.
5. The hand held electronic device as recited in claim 4 wherein the first side is the front side of the hand held electronic device, and wherein the second side is the back side of the hand held electronic device.
6. The hand held electronic device as recited in claim 2 wherein the second touch sensing device is a touch sensitive surface located on the hand held electronic device in a region other than the viewing region of the display.
7. The hand held electronic device as recited in claim 6 wherein the display is positioned on a first side of the hand held electronic device, and wherein the second

touch sensing device is positioned on a second side of the hand held electronic device, the second side being located opposite the first side.

8. The hand held electronic device as recited in claim 6 wherein the touch sensitive surface is provided by a touch panel.

9. The hand held electronic device as recited in claim 8 wherein the touch panel is a touch pad.

10. The hand held electronic device as recited in claim 6 wherein the touch sensitive surface is formed by a touch sensitive housing.

11. The hand held electronic device as recited in claim 1 wherein the first touch sensing device is located on a first side of the housing, and wherein the second touching device is located on a second side of the housing, the second side being opposite the first side.

12. A hand held electronic device, comprising:
a housing;
a display located on a first side of the housing;
a touch sensing device located on a second side of the housing, the second side being opposite the first side.

13. The hand held electronic device as recited in claim 12 wherein the touch sensing device is sized and dimensioned similarly to the display and wherein the center point of the touch sensing device coincides with the center point of the display,

14. The hand held electronic device as recited in claim 12 wherein the sensing nodes of the touch sensing device are mapped to the display.

15. A hand held electronic device including touch sensing devices located on different sides of the device, the touch sensing devices being configured for mode and feature selection input.

162. The hand held device as recited in claim 15 wherein at least one touch sensing device is a touch pad.

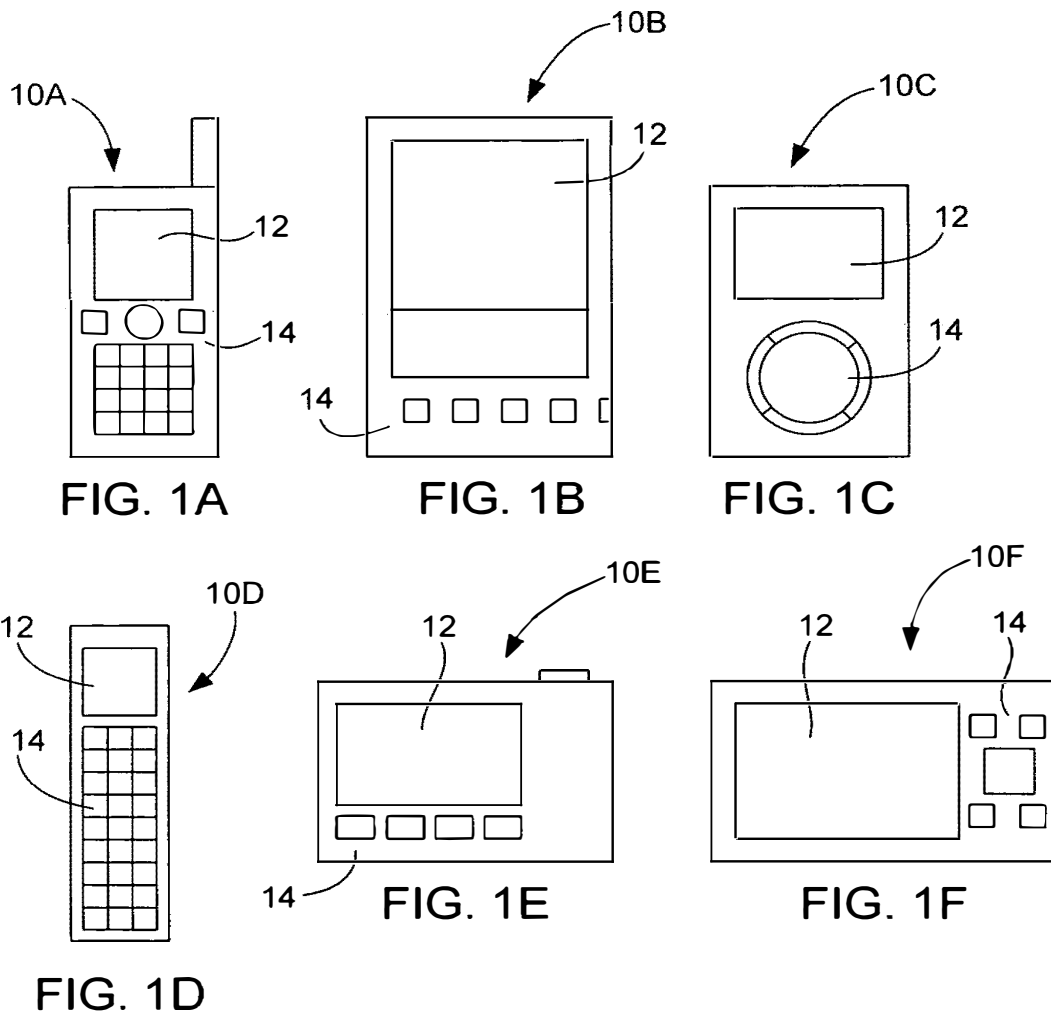
17. The hand held device as recited in claim 15 wherein at least one touch sensing device is a touch screen positioned over a display.

18. The hand held device as recited in claim 15 wherein at least one touch sensing device is a touch sensitive housing.

HAND HELD ELECTRONIC DEVICE WITH MULTIPLE TOUCH SENSING DEVICES

ABSTRACT OF THE DISCLOSURE

Hand held devices with multiple touch sensing devices are disclosed. The touch sensing devices may for example be selected from touch panels, touch screens or touch sensitive housings.



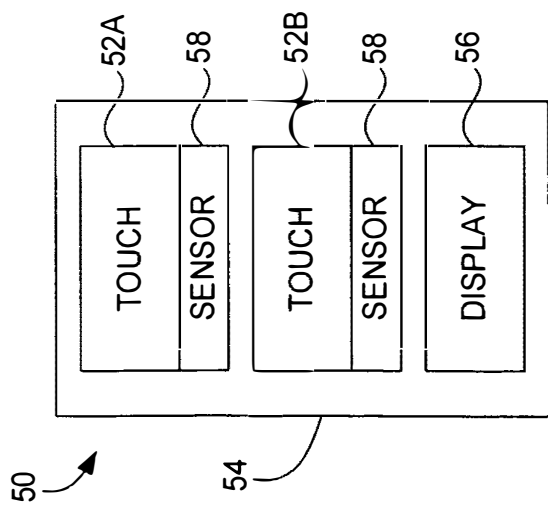


FIG. 2

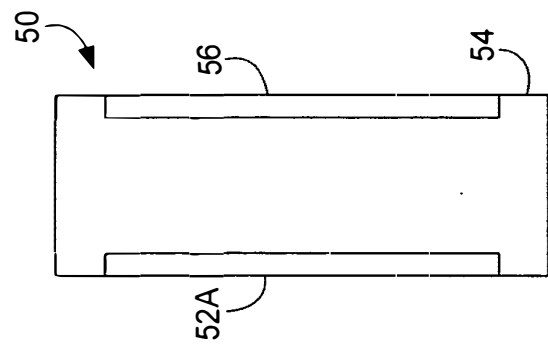


FIG. 3

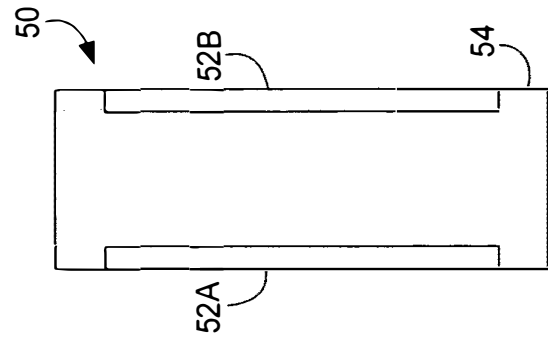


FIG. 4

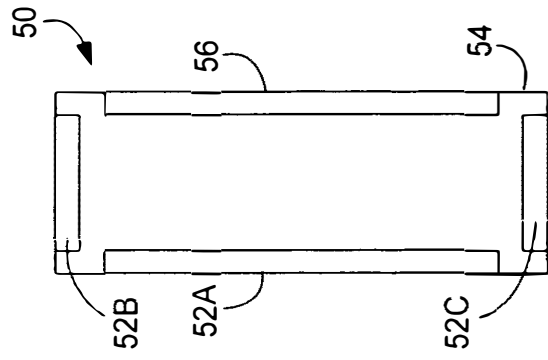


FIG. 5

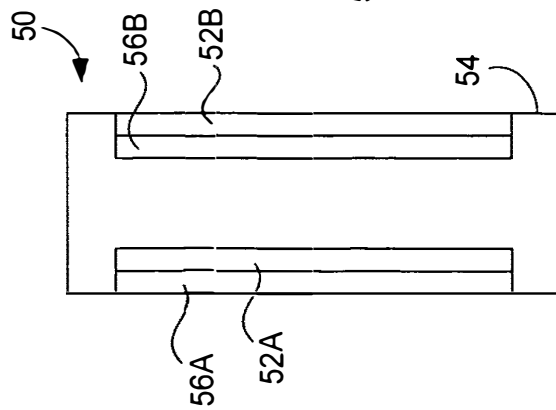


FIG. 6

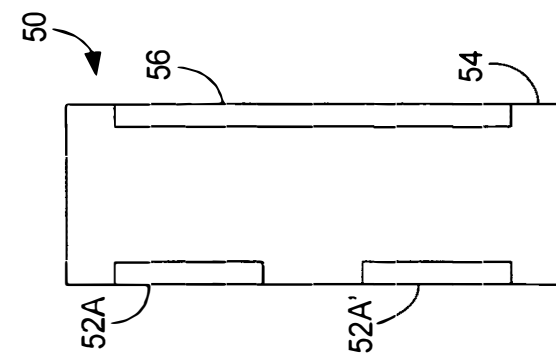


FIG. 7

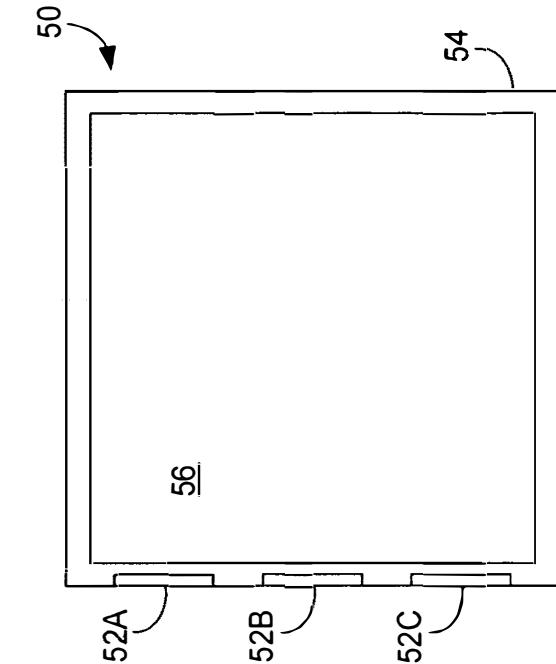


FIG. 8

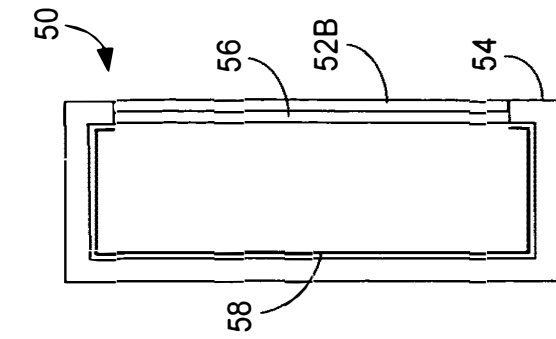


FIG. 9

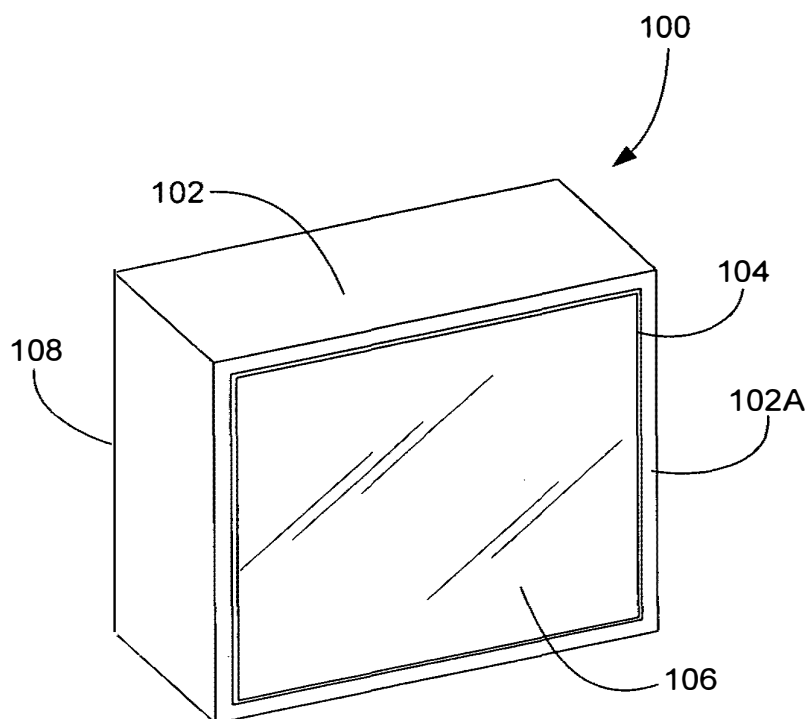


FIG. 10

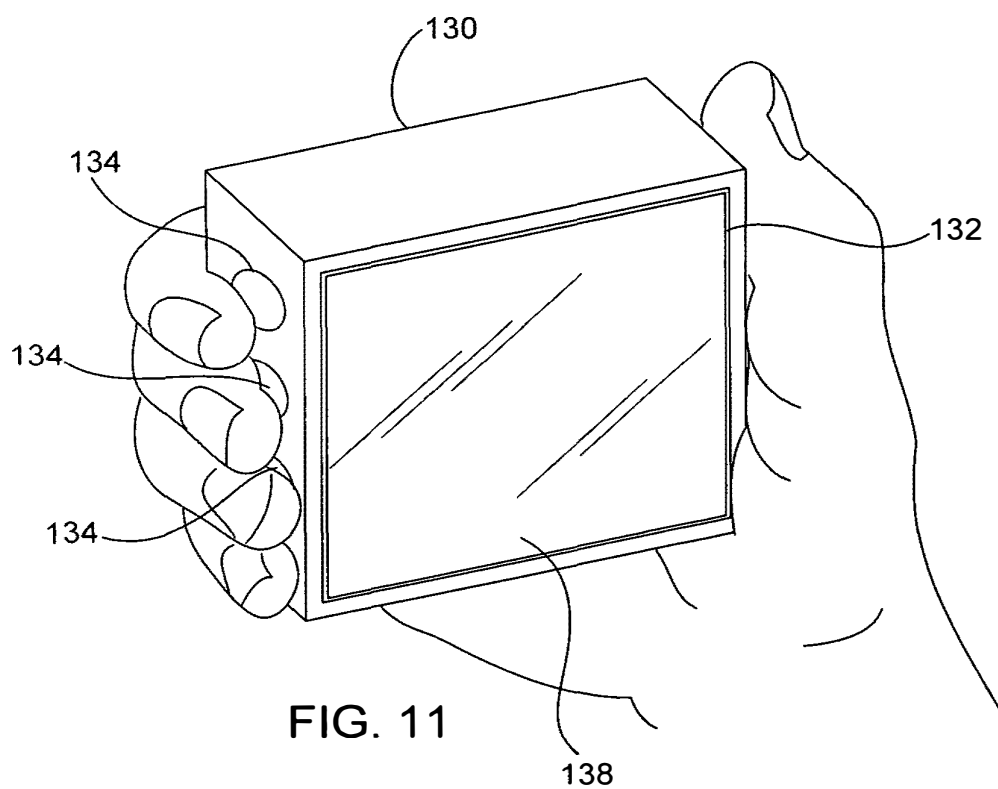


FIG. 11

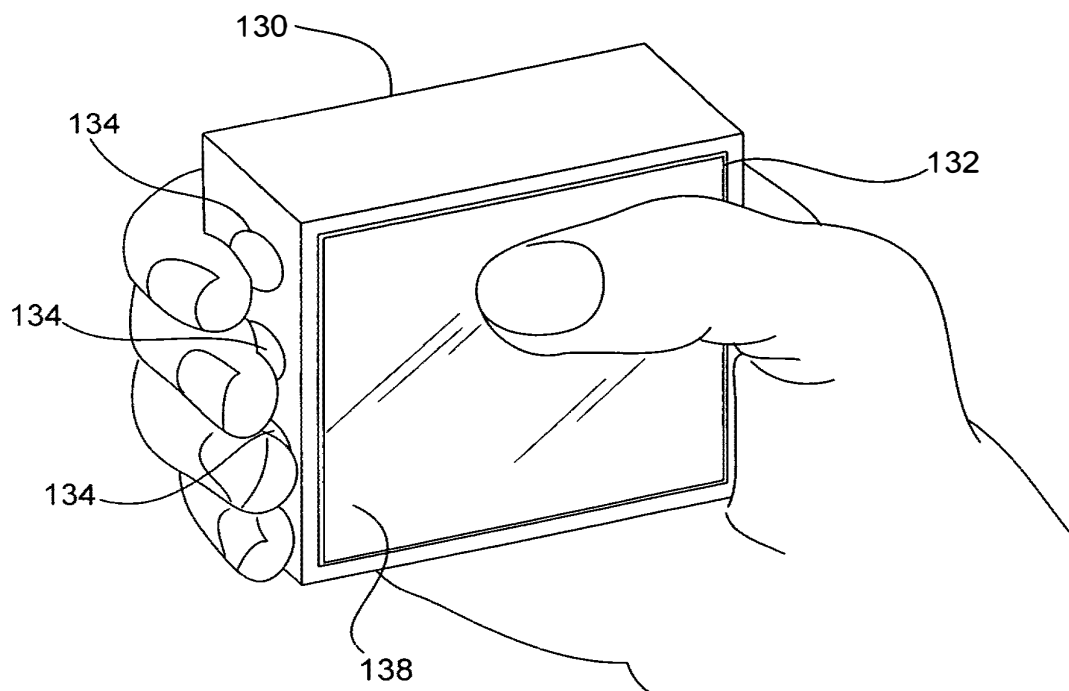


FIG. 12

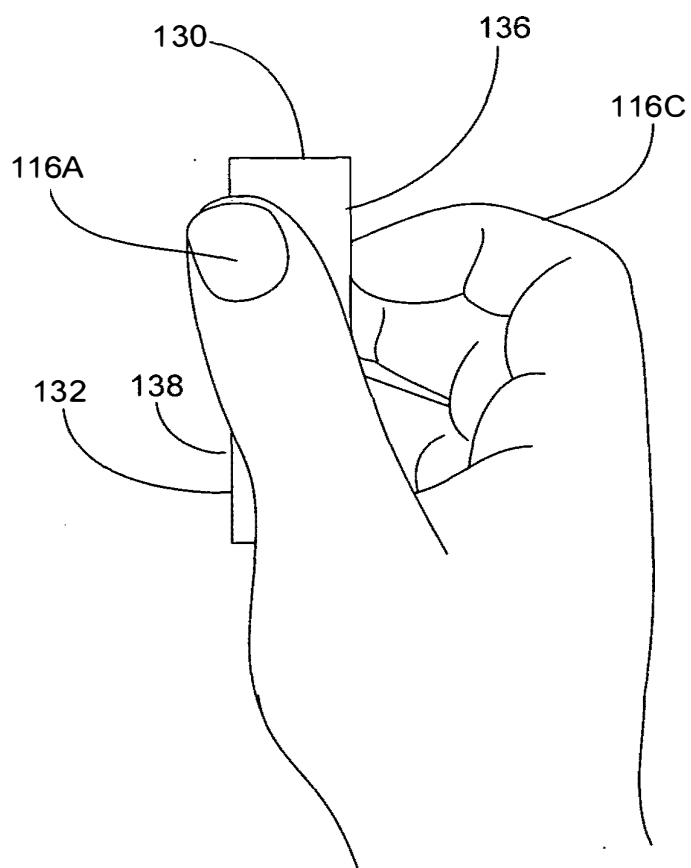


FIG. 13

A-40

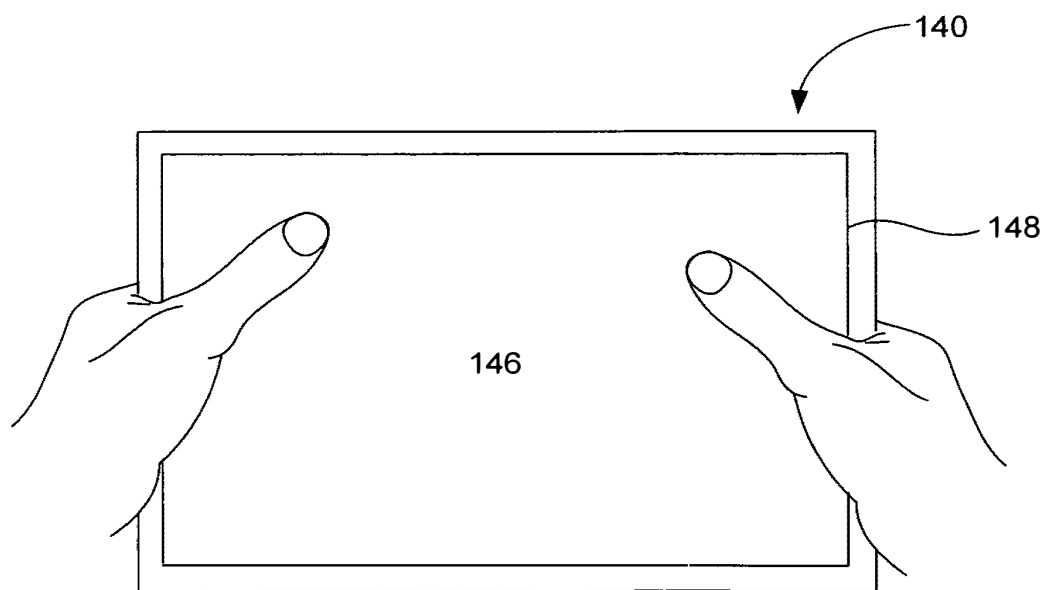
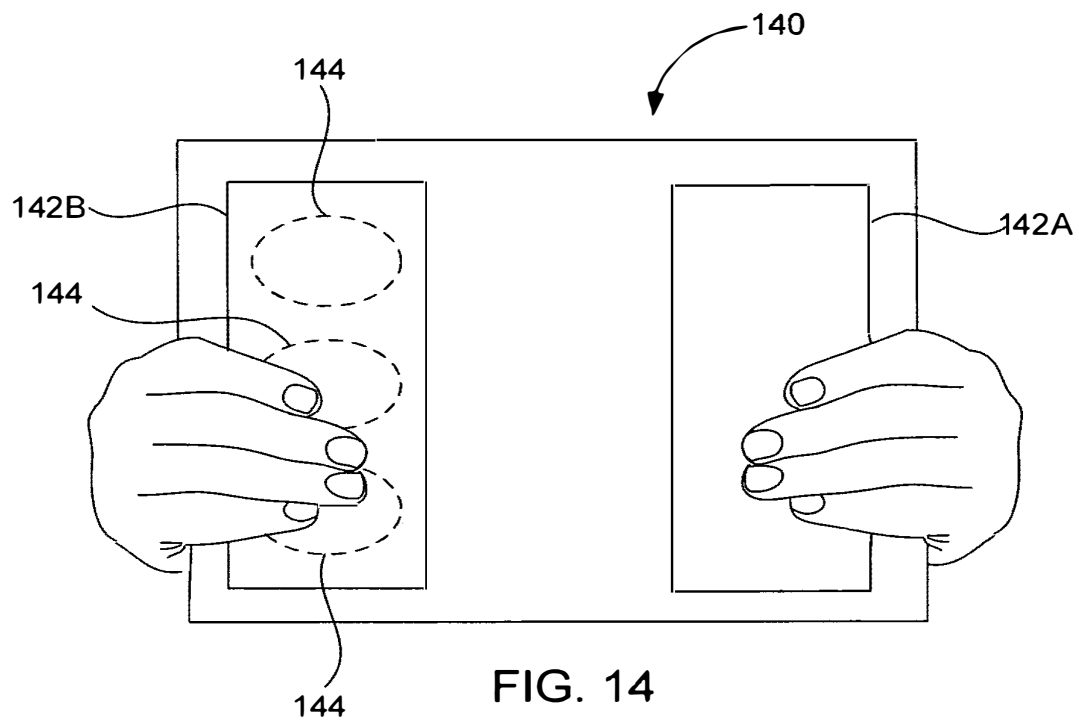
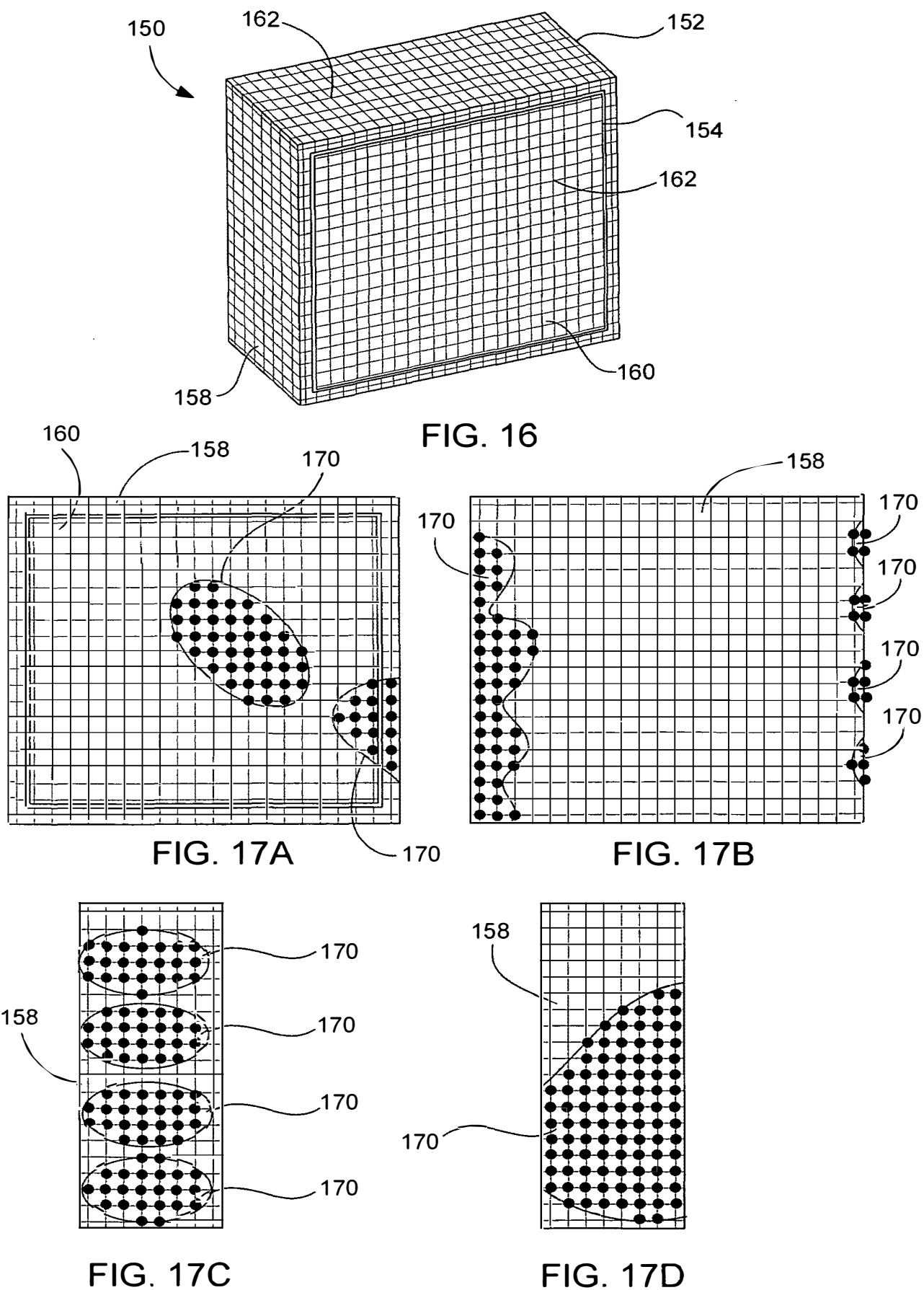


FIG. 15



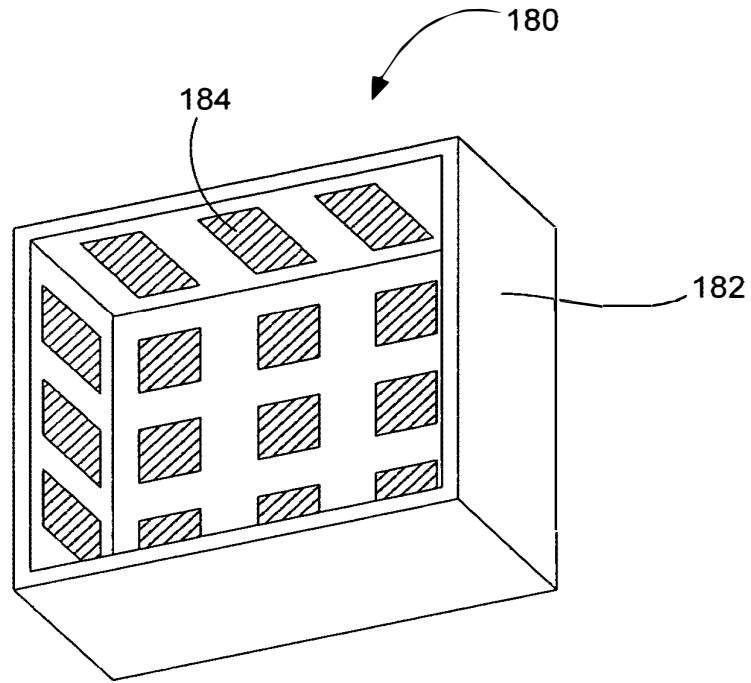


FIG. 18

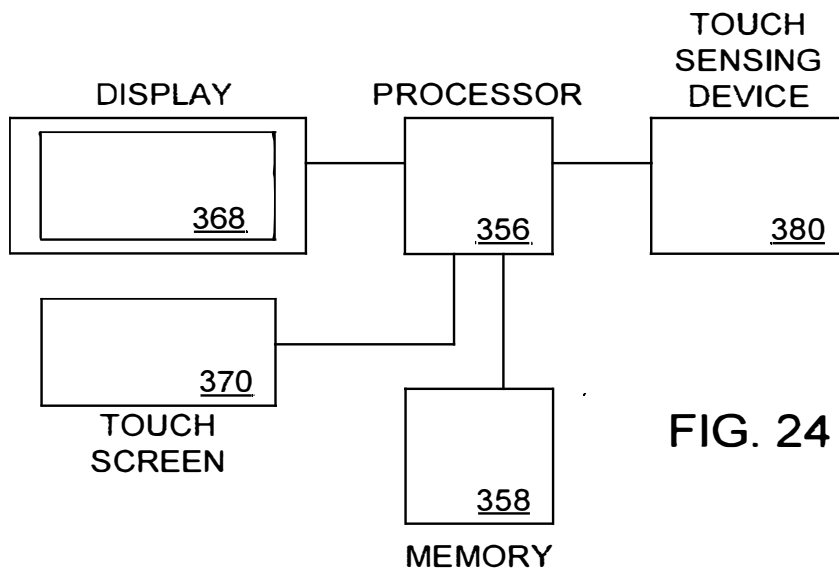


FIG. 24

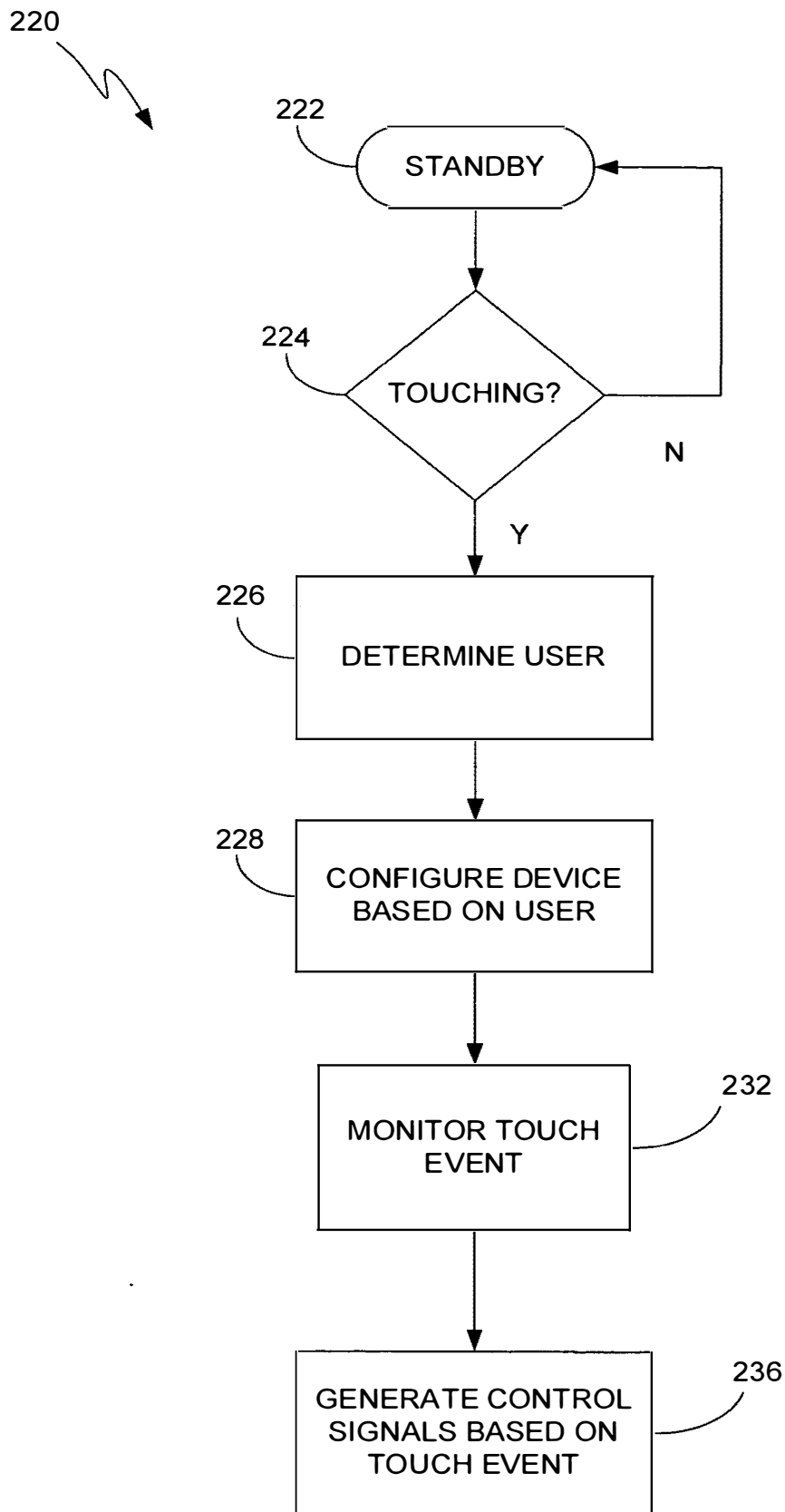


FIG. 19

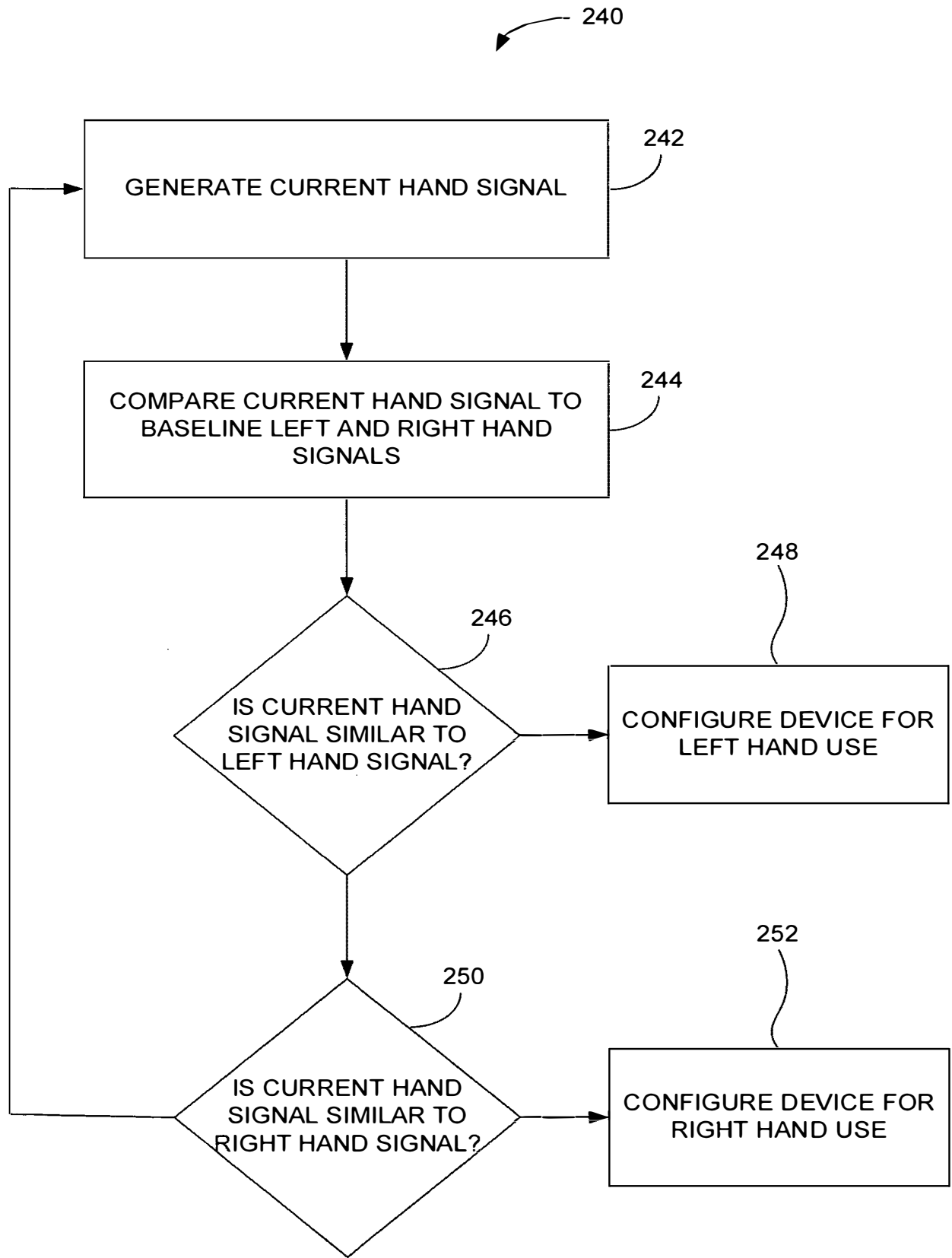


FIG. 20

A-45

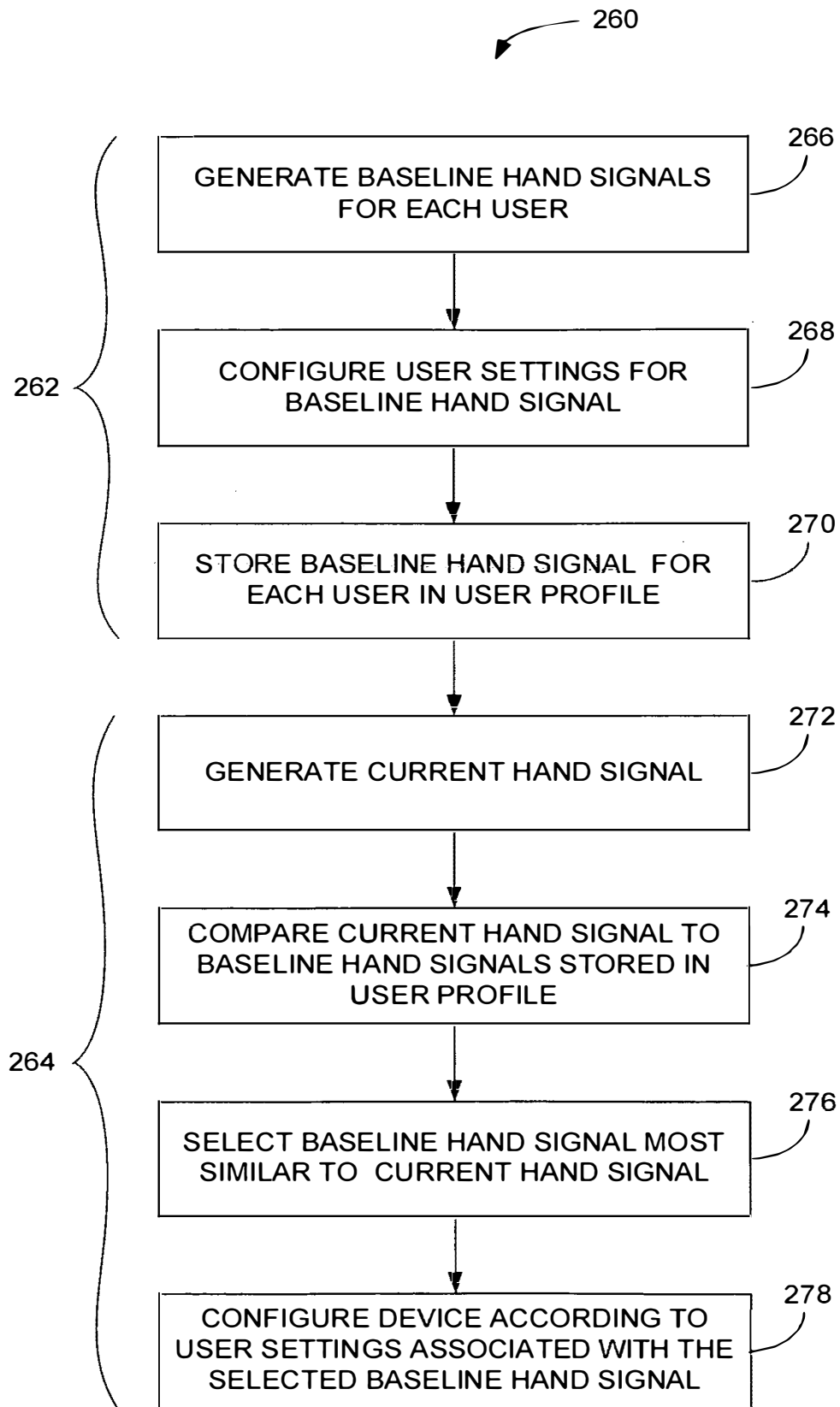


FIG. 21

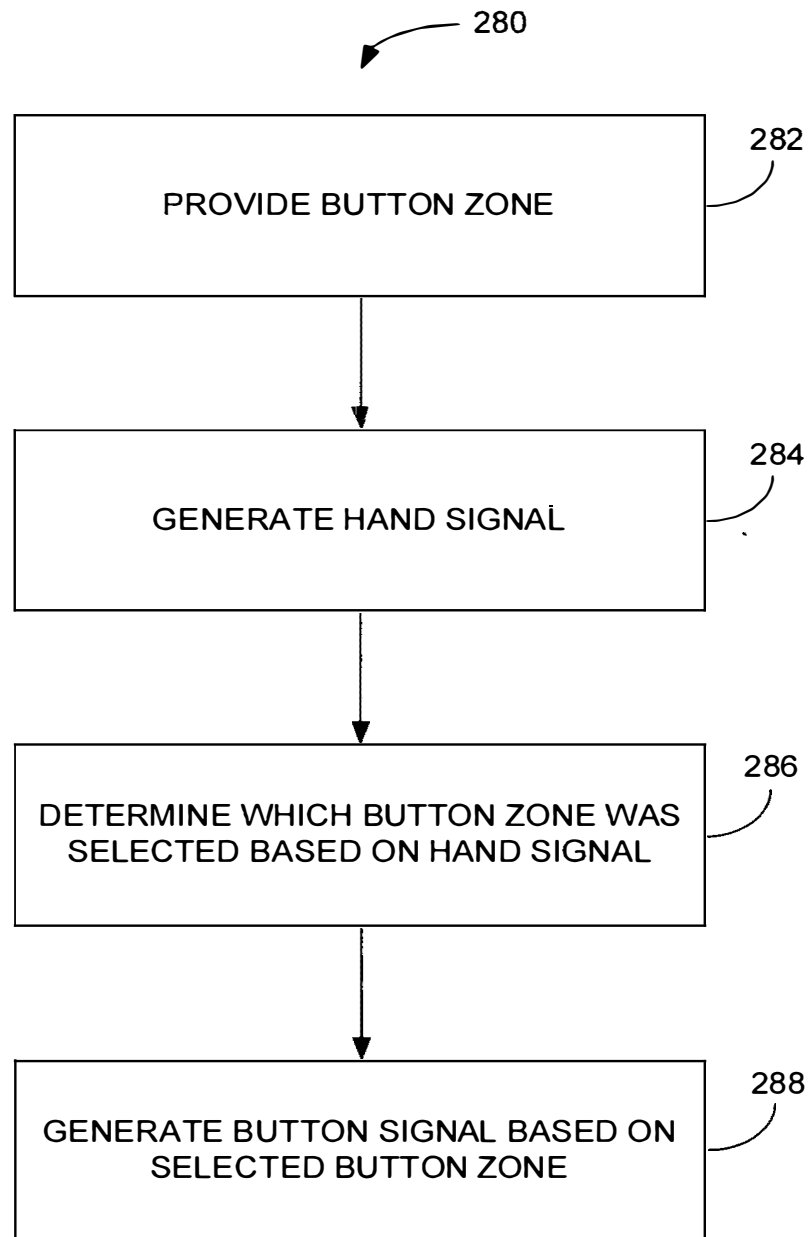


FIG. 22

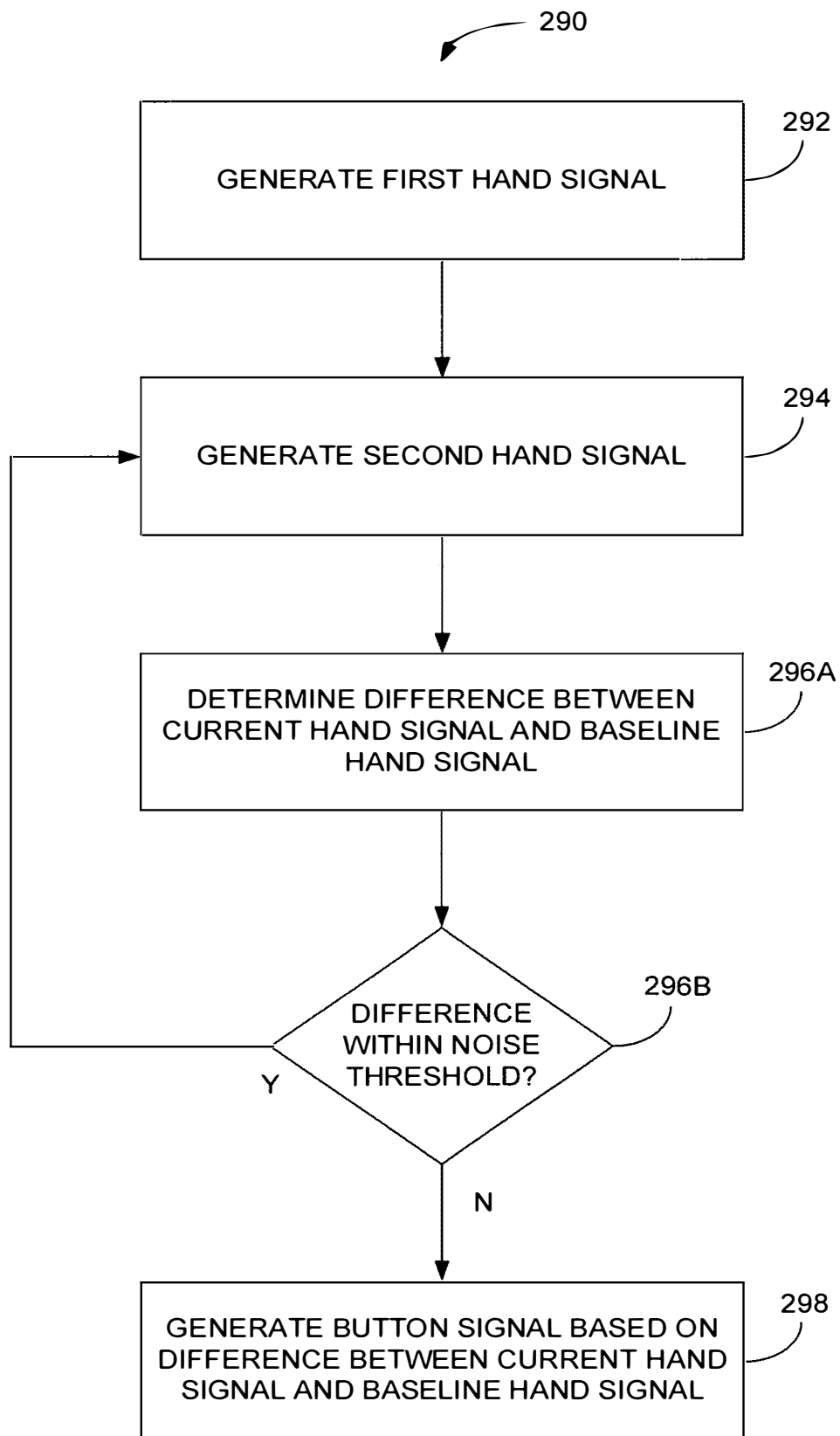


FIG. 23

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

03/10/2005 EFLORES 00000069 60658777

01 FC:1005	200.00 OP
02 FC:1085	250.00 OP

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