

function associated with the second level of button 10i, in this case the selection of the letter "W." In embodiments, the controller 9, upon so determining, also transmits a signal to the actuator 61 to cause the actuator 61 to vibrate at a frequency, magnitude, and/or wave-form indicative of selection of the function.

[0048] In one embodiment, in addition to providing haptic feedback to the input device, the controller 9 also sends a signal to the display 17 to cause the alphanumeric character associated with the input signal to be displayed. For example, in one embodiment, upon detecting the presence of a first pressure (through receipt of a first input signal) and sufficient dwell time to indicate a selection, the controller sends a signal to the display 17 indicating that the display should display the letter "X." Upon detecting the presence of a second pressure (through receipt of a second input signal) and sufficient dwell time to indicate a selection, the controller sends a signal to the display 17 indicating that the display should display the letter "Y." Upon detecting the presence of a third pressure (through receipt of a third input signal) and sufficient dwell time to indicate a selection, the controller sends a signal to the display 17 indicating that the display should display the letter "Z." The display 17 then displays each of these characters, X, Y, Z.

[0049] Various other embodiments may be employed. For example, instead of having a single actuator to provide feedback to all input devices receiving such feedback, like the embodiments shown in **Figs. 2-3**, other embodiments have two or more actuators. These two or more actuators may be in communication with all or part of the input devices that provide tactile feedback. The two actuators may each provide significantly different types of feedback to the same set of input devices, or each may be in communication with a different group of input devices to provide the same or different types of feedback. As another example, the actuator and input devices may be configured to provide vibration to only the button that is receiving pressure from the user, or they may be configured to provide vibration to all buttons or at least more buttons than the one(s) receiving pressure from the user.

[0050] Moreover, although the actuator 61 is shown as disposed below the PCB 62 in **Fig. 4**, in other embodiments the actuator 61 may be disposed at other locations within the device having such apparatus, whether the device is a mobile telephone, PDA, or other device. Preferably, the actuator is disposed within the housing of the device. Preferably, it is communication with the PCB 62, but is placed anywhere in communication with the PCB 62 as the size and space restrictions of the application will allow. In other embodiments, the actuator 61 is located outside the housing of the device (such as beside it). In still other embodiments, the actuator 61 is in communication with the input devices other than through the PCB 62.

[0051] In the embodiment shown, a distinct tactile sensation is produced for each of the various levels at each of the various keys. In other embodiments, the controller 6 selects one of a pre-selected group of sensations to provide in response to the various signals received by the controller.

[0052] **Fig. 5** shows another embodiment of the present invention. Referring to **Fig. 5**, a PDA 31 having an input device in the form of a pressure-sensitive touchpad 30 is shown. The PDA 31 also includes a plurality of mechanical

type buttons 32. The PDA 31 also includes a display panel 33 capable of displaying computer generated graphics. Suitable display panels include flat-panel type displays including a Liquid Crystal Display (LCD), plasma displays, Thin Film Transistor (TFT) type displays or other flat displays, such as are found in laptops and color PDA's, and conventional cathode ray tube displays.

[0053] **Fig. 6** shows a cross-sectional view of the PDA 31 of **Fig. 5** along line 6-6. As is best displayed in **Fig. 6**, the display 33 is underneath the touchpad 30 and is in communication with the touchpad 30 to transmit tactile sensations thereto. The display 33 is also in communication with an actuator 64 to receive a tactile sensation therefrom for communication to the touchpad 30. Other arrangements of the touchpad 30, display 33 and actuator 64 are also possible including arrangements in which the actuator 64 is in direct contact with the touchpad 30. The display 33 is in communication with the touchpad 30 through two spacers 34. Suitable spacers are constructed of a material that can transmit the tactile sensations between the display 33 and the touchpad 30. In other embodiments, the touchpad 30 and display 33 are in direct physical contact, and the touchpad 30 and display 33 are not in communication. The tactile sensations produced in the touchpad 30 are transmitted to the object 24 when the object 24 is brought into contact with a surface 35 of the touchpad 30.

[0054] Referring again to **Fig. 5**, the display 33 displays a plurality of software-generated buttons or keys, called softkeys 36a-i. The softkeys 36a-i provide a graphical user interface for the PDA 31 and are arranged in a desired pattern or grid. Each softkey 36 occupies a distinct location on the display panel. As illustrated, the PDA 31 can function as a mobile telephone, and the softkeys 36 are arranged as a telephone keypad to provide the same functionality as the mechanical keys on a conventional telephone keypad. The display 33 of the PDA 31 also includes additional graphical outputs 37 and areas 38 without graphical output. The displayed softkeys 36 are viewable through the touchpad 30 and represent corresponding unique positions on the touchpad 30.

[0055] An object 24, for example a human finger, selects a desired softkey 36a-i by contacting the touchpad 30 at the appropriate location. A controller (not shown) is in communication with the touchpad 30. The controller of this embodiment is similar in structure and functionality to the controller described in relation to the embodiment of **Fig. 3**. The controller is capable of determining the location on the display screen 33 that is touched by the object 24, and the softkey 36 corresponding to the touched location. Based upon this information, the controller causes the actuator 64 to provide a corresponding tactile sensation. The actuator 64 can cause vibrations in the touchpad 35 in a direction parallel to the surface 35 of the touch pad or perpendicular to the surface 35 of the touchpad 30. The controller also determines when an input is ambiguous, such as when two or more softkeys are simultaneously selected or when an area of the display containing no graphics 38 is touched, and causes the actuator to output an appropriate tactile sensation. Preferably, the same controller that controls the displayed softkeys 36 also controls the tactile feedback sensations produced by the actuator 64.

[0056] Certain softkeys 36b-i represent multiple positions or multiple inputs, each input or position corresponding to a