

sponding change in the haptic effect, such as an increase in frequency. If the user clicks the right arrow when the cursor highlights the Send To option, the secondary sub-menu 114 is displayed. Navigation through the secondary sub-menu 114 occurs in a manner similar to that which occurs in sub-menu 112. To select an option within the secondary sub-menu 114, the user clicks the center of the D-pad 106. Clicking the center of the D-pad 106 triggers the playing of yet another distinct haptic effect. In addition, the D-pad switch 106, either a 5-way or a 4-way, can provide haptic effects indicating the direction that the switch was being pressed.

The embodiment shown in FIG. 11 is applicable to a variety of applications, particularly to applications that display lists. For example, in one embodiment, an address book containing a list of names is displayed on the PDA 100. In such an embodiment, the actuator plays an effect as the user scrolls through the list. Further, the actuator plays a distinct haptic effect as the user navigates from names starting with one letter, for example A, to the next letter, B. Such an embodiment may also include a distinct effect corresponding to names that the user has previously identified as favorites in the address book.

Another embodiment of the present invention provides the user with distinct haptic effects corresponding to the operational mode of an electronic device. For example, in an embodiment utilizing a PDA, such as PDA 31 in FIG. 5, a user may activate one of many modes, including, for example, the phone interface shown in FIG. 5, the application interface shown in FIG. 11, an address book, email, or other modes. Referring to FIG. 5, in one such embodiment, the user clicks a button 32 to activate the phone application. When the user clicks the button, the PDA 31 displays a phone interface 38. While the PDA 31 is in phone mode, the actuator provides a persistent haptic effect indicating to the user that the phone mode is active. In this way, the user is able to determine the mode of the PDA 31 without visually referring to it.

Another embodiment of the present invention provides the user with distinct haptic effects for modes within a cell phone or other electronic device. Referring to FIG. 3, users of cell phones, such as cell phone 14, often store a list of number that are frequently dialed in a memory associated with one or a combination of number keys 10. In such an embodiment, the user may click a function key before clicking the number key 10, providing a signal to the phone 31 that the user will specify a number to dial by clicking a number key combination. In one embodiment of the present invention, when the user clicks the function button, the actuator provides a persistent haptic effect, indicating to the user that the cell phone is in the rapid-dialing mode. The haptic effect alerts the user to the fact that when the user selects a number-key combination, the cell phone will dial the phone number associated with the number-key combination in memory. By providing a haptic effect identifying the mode that the cell phone 31 is in, the embodiment minimizes or eliminates the user's need to refer to the cell phone 31 visually.

In another embodiment of the present invention, an actuator provides feedback when an option or function is unavailable (referred to herein as "negative feedback"). In such an embodiment implemented in a cell phone, such as cell phone 31 shown in FIG. 3, the user is able to place calls. The user dials a combination of number keys 10 and then presses the send key 11 to execute the phone call. In an embodiment utilizing negative feedback, if the user enters an invalid phone number, for example, a phone number including only 6 digits, the cell phone provides negative feedback, indicating that the send function is not available. The negative feedback may, for example, comprise a very low frequency buzz. In another

embodiment, the actuator provides negative feedback to the user if the user clicks a redial button (not shown) without having previously dialed a number.

Other embodiments and uses of the present invention will be apparent to those skilled in the art from consideration of this application and practice of the invention disclosed herein. The present description and examples should be considered exemplary only, with the true scope and spirit of the invention being indicated by the following claims. As will be understood by those of ordinary skill in the art, variations and modifications of each of the disclosed embodiments, including combinations thereof, can be made within the scope of this invention as defined by the following claims.

That which is claimed is:

1. A method, comprising:

outputting a display signal configured to display a graphical object on a touch-sensitive input device;

receiving a sensor signal from the touch-sensitive input device, the sensor signal indicating an object contacting the touch-sensitive input device;

determining an interaction between the object contacting the touch-sensitive input device and the graphical object; and

generating an actuator signal based at least in part on the interaction and haptic effect data in a lookup table.

2. The method of claim 1, wherein the actuator signal is configured to cause a haptic effect to be output.

3. The method of claim 1, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location corresponding to the graphical object.

4. The method of claim 1, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.

5. The method of claim 1, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.

6. The method of claim 5, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.

7. The method of claim 5, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.

8. The method of claim 5, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.

9. The method of claim 1, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.

10. The method of claim 1, wherein the haptic effect data comprises a plurality of haptic effects.

11. The method of claim 1, wherein the lookup table comprises one or more of input device data, position data, pressure data, or function data.

12. A system, comprising:

a touch sensitive input device configured to output a sensor signal indicating an object contacting the touch-sensitive input device;

an actuator coupled to the touch-sensitive input device, the actuator configured to receive an actuator signal and output a haptic effect to the touch-sensitive surface based at least in part on the actuator signal; and