

received from haptic controller 20. In one embodiment, the haptic effects are in the form of vibration, and different haptic effects can be generated by varying the magnitude, frequency and duration of the vibrations. Actuators 25-28 can include one or more force applying mechanisms which are capable of applying a vibrotactile force to a user of touch panel 10 (e.g., via touch sensitive surface 15). This force can be transmitted, for example, in the form of vibration movement caused by a rotating mass, a piezo-electric device, or other vibrating actuator type. Although in FIG. 1 actuators 25-28 are located at the corners of touch sensitive surface 15, in other embodiments one or more actuators can be used to generate the haptic effects, and the one or more actuators may be located in other areas of touch panel 10.

[0016] In the embodiment shown in FIG. 1, touch panel 10 is a numeric keypad and key #5 (32) is a reference key. In other embodiments, however, touch panel 10 may be an alphanumeric QWERTY keyboard or may have a non-conventional key layout. In other embodiments, any other graphical object may be used besides alphanumeric keys as long as at least one graphical object functions as a reference object or key in relation to other graphical objects displayed on the screen of touch panel 10. Through programming, video screen 18 of FIG. 1 allows a variation of keys or graphical objects to be displayed. However, in other embodiments, such as a keypad, system 10 does not include video screen 18 and other methods of displaying keys, such as through silk screening or other permanent graphical display methods, on touch sensitive panel 15 can be used.

[0017] The layout of the keys of touch panel 10 of FIG. 1 has the numbers 0-9 and other keys "*" and "#" and is configured as a standard layout found in most numerical keypads such as telephone and computer keypads. Controller 20 is configured to designate a first haptic signal to one or more reference keys, and cause actuators 25-28 to generate a haptic effect associated with the first haptic signal when touch sensitive surface 15 senses the user's finger touching reference key (32), which is the "5" key in the embodiment of FIG. 1.

[0018] Once the "5" key position is located with assistance of the first haptic effect, the user can move to the "2" key position, referred to as moving up, or move to the "8" key position, referred to as moving down, or move to other keys. This is accomplished by a combination of prior knowledge of the standardized keyboard layout (i.e., from memory), and through the use of a second haptic effect to indicate to the user that a non-reference key, such as the "2" or "8" key, is being touched.

[0019] In the embodiment of FIG. 1 having a numerical keypad, the contact area designated as the reference numeral 32, is haptically enabled so that touching key 32 generates a unique haptic response to the user. This unique haptic response alerts the user that the reference key has been touched. In one embodiment, an audio sound may be provided in addition to or alternatively to the unique haptic sensation.

[0020] In addition, when the user is navigating between different keys on touch screen 10, controller 20 will provide a different haptic signal to actuators 25-28, which will output a different haptic sensation to the user when the user touches the non-reference keys (keys 0-4, 6-9, "*", and "#"). Therefore, each time the user contacts one or more non-reference keys (i.e., 1-4, 6-0 and */#), a second haptic effect will be

felt. In one embodiment, during sliding contact on the screen, in areas not part of the numbered areas, no haptic effect will be generated.

[0021] The generation of a second haptic effect allows the user to locate reference key 32 as well as determine when the user is positioned over any key other than the reference key. Therefore, once a user locates reference key 32, the user can slide his/her finger up and out of the boundaries and will no longer feel any haptic effect once the finger leaves the boundaries of reference key 32. The user will then feel the second haptic effect once the user's finger enters the boundaries of a non-reference key, such as the "2" key. In this way, with only two distinct haptic effects, a user can navigate and select any desired key without the need for visual guidance.

[0022] In other embodiments, a third, fourth, etc. haptic effect can be generated by controller 20 and actuators 25-28 to impart more information to the user. For example, if a key is depressed, a third haptic effect can be generated. If contact pressure is maintained on that key, a fourth haptic effect can be generated. The third haptic can confirm the selection, and the fourth can add the same value multiple times to the input device or perform some other function. Alternately, removing and re-contacting the same numbered key can allow for multiple input of the same value to the input device. Further, in other embodiments, the sliding motion of a finger on touch screen 15 may generate a fifth haptic effect, and a sixth haptic effect may be generated when the finger encounters the edge of one of the keys.

[0023] As disclosed, one embodiment of the invention may be directed to multiple reference keys on an alphanumeric keyboard displayed on a touch screen. In one embodiment, two haptic effects (i.e., two different feelings to a user) are generated for a standard QWERTY keyboard. FIG. 2 illustrates the QWERTY keyboard 40 of a touch panel in accordance to one embodiment of the present invention with reference keys "F" and "J". The "F" and "J" keys (i.e., the surface area defining each key) are provided with a first haptic effect to a user and contact with the surface areas of the remaining alphanumeric keys, along with other keys, produces a second haptic effect. In this way, a user can locate the neutral keys (F & J) from which all other keys can be determined. The location of the letter keys, the number keys, the function keys (F1-F12), the shift key, the control, delete, insert, tab, caps lock, esc, etc. keys can all be located with these two haptic effects and the user's prior knowledge of the keyboard layout.

[0024] FIG. 3 illustrates a non-standard keyboard portion 50 of a touch panel in accordance to one embodiment of the present invention. A keyboard that is not "standard", here a touch panel controlling a copier, may become "standardized" as a result of memory of the key locations gained through use and one or more of the keys may be designated as reference keys.

[0025] FIG. 4 is a flow diagram of the functionality performed by touch panel 10 in order to haptically generate a reference key in accordance with one embodiment of the present invention. In one embodiment, the functionality of FIG. 4 is implemented by software stored in a memory and executed by a processor. In other embodiments, the functionality can be performed exclusively by hardware, or by any combination of hardware and software. Further, in other embodiments, the touch panel, rather than being flat, may be