

Display screen **82** is preferably a “touch screen” that includes sensors which allow the user to input information to the computer device **80** by physically contacting the screen **80** (i.e. it is another form of planar “touch device” similar to the touchpad **16**). For example, a transparent sensor film can be overlaid on the screen **80**, where the film can detect pressure from an object contacting the film. The sensor devices for implementing touch screens are well known to those skilled in the art.

[0073] The user can select graphically-displayed buttons or other graphical objects by pressing a finger or a stylus to the screen **82** at the exact location where the graphical object is displayed. Furthermore, some embodiments allow the user to “draw” or “write” on the screen by displaying graphical “ink” images **85** at locations where the user has pressed a tip of a stylus, finger, or other object. Handwritten characters can be recognized by software running on the device microprocessor as commands, data, or other input. In other embodiments, the user can provide input additionally or alternatively through voice recognition, where a microphone on the device inputs the user’s voice which is translated to appropriate commands or data by software running on the device. Physical buttons **84** can also be included in the housing of the device **80** to provide particular commands to the device **80** when the buttons are pressed. Many PDA’s are characterized by the lack of a standard keyboard for character input from the user; rather, an alternative input mode is used, such as using a stylus to draw characters on the screen, voice recognition, etc. However, some PDA’s also include a fully-functional keyboard as well as a touch screen, where the keyboard is typically much smaller than a standard-sized keyboard. In yet other embodiments, standard-size laptop computers with standard keyboards may include flat-panel touch-input display screens, and such screens (similar to screen **12** of FIG. **1**) can be provided with haptic feedback according to the present invention.

[0074] In the present invention, the touch screen **82** provides haptic feedback to the user similarly to the touchpad **16** described in previous embodiments. One or more actuators **86** can be coupled to the underside of the touch screen **82** to provide haptic feedback such as pulses, vibrations, and textures; for example, an actuator **86** can be positioned near each corner of the screen **82**, as shown in FIG. **8a**. Other configurations of actuators can also be used. The user can experience the haptic feedback through a finger or a held object such as a stylus **87** that is contacting the screen **82**.

[0075] As shown in FIG. **8b**, the touch screen **82** is preferably coupled to the housing **88** of the device **80** by one or more spring or compliant elements **90**, such as helical springs, leaf springs, flexures, or compliant material (foam, rubber, etc.) The compliant element allows the touch screen **82** to move approximately along the z-axis, thereby providing haptic feedback similarly to the touchpad embodiments described above. Actuators **86** can be piezo-electric actuators, voice coil actuators, or any of the other types of actuators described above for the touchpad embodiments. As shown in FIG. **8b**, the actuators **86** are directly coupled to the touch screen **82** similarly to the touchpad embodiment of FIG. **3**; alternatively, an inertial mass can be moved to provide inertial feedback in the z-axis of the touch screen, similarly to the touchpad embodiment of FIG. **6**. Other features described above for the touchpad are equally applicable to the touch screen embodiment **80**.

[0076] In the embodiments of touch input devices (touchpad and touch screen) described herein, it is also advantageous that contact of the user is detected by the touch input device. Since haptic feedback need only be output when the user is contacting the touch device, this detection allows haptic feedback to be stopped (actuators “turned off”) when no objects are contacting the touch input device. This feature can conserve battery power for portable devices. If a local touch device microprocessor (or similar circuitry) is being used in the computer, such a microprocessor can turn off actuator output when no user contact is sensed, thus alleviating the host processor of additional computational burden.

[0077] While this invention has been described in terms of several preferred embodiments, it is contemplated that alterations, permutations, and equivalents thereof will become apparent to those skilled in the art upon a reading of the specification and study of the drawings. For example, many different types of actuators can be used to output tactile sensations to the user. Furthermore, many of the features described in one embodiment can be used interchangeably with other embodiments. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the present invention.

What is claimed is:

1. A method for providing a user of a touch input device with interactive feedback, the method comprising:

detecting a user interaction with a first portion of the touch input device, said interaction including exertion of a degree of pressure; and

generating a haptic force proportional to or variable with said degree of pressure.

2. The method of claim 1, wherein the change in interaction comprises movement of an interaction object from the first portion to the second portion.

3. The method of claim 1, wherein pressure exertion is by way of a finger.

4. The method of claim 1, wherein pressure exertion is by way of a stylus.

5. The method of claim 1, wherein the touch input device is a touch pad.

6. The method of claim 5, wherein the touch pad is provided with a graphical representation of a button substantially corresponding to the first portion of the touch input device.

7. The method of claim 1, wherein the touch input device is a touch screen.

8. The method of claim 7, wherein the touch screen is configured to display a graphical representation of a button substantially corresponding to the first portion of the touch input device.

9. A method for providing a user of a touch input device with interactive feedback, the method comprising:

assigning a first function to a first portion of the touch input device such that interaction with the first portion initiates the first function, said interaction including exertion of a degree of pressure; and

generating a haptic force proportional to or variable with said degree of pressure.

10. The method of claim 9, wherein the touch input device is coupled to a computer and the first function is a computer function.