TACTILE TOUCH-SENSING SYSTEM

BACKGROUND

[0001] As computers and other electronic devices become more ubiquitous, touch-sensing systems are becoming more prevalent as a means for inputting data. For example, touch-sensing systems may now be found in workshops, warehouses, manufacturing facilities, restaurants, on hand-held personal digital assistants, automatic teller machines, casino game-machines, and the like.

[0002] A touch-sensing system often includes a touch sensor and a display device. The display device usually includes a display screen for presenting graphical information to users. A touch sensor ordinarily includes a transparent sensing circuit placed on top of the display screen for sensing the position of a touch on the screen. Touch-sensitive displays are often used as a replacement for conventional hardware input devices. For example, the display screen may be used to illustrate icons that look like buttons. A user may touch the screen in the location of the icon, resulting in a signal corresponding to the button. The result is as if the user had "pressed" the button.

[0003] In many ways, touch-sensing systems are superior to conventional input systems with buttons and switches. For example, because touch-sensing systems typically have few or even no moving parts, they are also more reliable than conventional input system. In addition, a touch-sensing system can be programmed to change button meanings dynamically. This provides a flexible and user-friendly input mechanism that can be custom-tailored for a specific application or context. Control mechanisms in a touch-sensing system may be consolidated by presenting input selections to the user in multiple layers of menus, saving space and manufacturing cost.

[0004] While touch-sensing systems are gradually replacing conventional input systems in many applications, there are still some applications where touch-sensing systems are not viewed as acceptable. One criticism of touch-sensing systems is their failure to provide tactile feedback. Tactile feedback allows a user to know, by a sense of touch, whether he has located the right input mechanism or has successfully entered an input. In many operating environments and applications of electronic devices, tactile feedback is often the only safe and effective means of providing feedback to a user. Visual and audible feedback is sometimes used. However, if an electronic device is used in an environment where ambient noise is intense or lighting is limited, auditory or visual feedback may not be effective. Similarly, tactile feedback may be the only viable option for a user who has visual or hearing impairments.

[0005] Tactile switches have been provided as separate elements having their own associated electronics and circuitry in a system that also includes a touch screen. In another application, a resistive touch screen was modified so that discrete areas of the touch screen behave like tactile switches. A spacer adhesive was positioned between the top and bottom substrates of a 4-wire resistive touch screen and covering a portion of the active area. Round apertures were made in the spacer adhesive to define discrete areas where contact could be made between the top and bottom substrates under a sufficient touch force. Metal snap domes were placed over the aperture regions and secured in place. When the snap dome was pressed, the center dimple of the snap dome would make the conductive surface of the top substrate of the touch screen contact the lower conductive surface in a specific location. The portion of the touch screen outside of the area covered by the spacer adhesive could be used as a conventional resistive touch screen.

SUMMARY OF THE INVENTION

[0006] Briefly stated, the present invention is directed to a tactile touch-sensing system that includes a touch sensor, touch-generating pads, and tactile buttons. The touch sensor is configured to produce an electrical signal in response to a touch. The touch-generating pads are positioned proximate to the touch sensor and are configured so that they do not cause a detectable touch on the touch sensor until they are activated. A user can activate a touch-generating pad by pressing a tactile button associated with the touch-generating pad. The tactile button may be in close proximity to the touch-generating pad, or may be remotely located from the touch-generating pad but still capable of activating the touch-generating pad. A one-to-one correspondence of tactile buttons to touch-generating pads is not required. The touch-generating pad can be positioned in any location proximate to the touch screen where activation of the touch pad can be detected as a touch on the touch sensor. For example, the pad can be located in front of the touch sensor, behind the touch sensor, along the periphery of the touch senor, and so forth.

[0007] In response to being pressed, the tactile button is configured to provide tactile feedback to the user and to activate the touch-generating pad. The touch-generating pad, when activated by the tactile button, causes a detectable touch on the touch sensor. In this way, tactile button activation can be detected by the touch sensor, as opposed to detection only by separate circuitry associated with the tactile button. In some designs, it may be desirable to be able to detect touch pad activation by the touch sensor as well as by circuitry dedicated to the touch pad. This may provide additional signals that can be used for calibration, diagnostics, redundancy, or to access additional functionalities.

[0008] The present invention provides a simple way to configure a touch-sensing system to provide users with tactile feedback. Conventional touch-sensing systems typically have a smooth, one-piece surface for receiving touches and essentially provide no tactile feedback. The tactile touch-sensing system of the present invention provides tactile feedback to the user without the cost and complication associated with adding a conventional control circuit with buttons and switches to an ordinary touch-sensing system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

[0010] **FIG. 1** is a schematic representation of one implementation of the present invention, showing an exemplary tactile touch-sensing system;

[0011] **FIG. 2** is an exploded view of an exemplary embodiment of a tactile touch-sensing system;