USER INTERFACE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application Ser. No. 61/451,565, filed on 10 Mar. 2011 and entitled "User Interface System," which is incorporated herein by reference.

[0002] This application is a continuation-in-part of U.S. patent application Ser. No. 12/319,334, filed on 5 Jan. 2009 and "User Interface System," which is incorporated herein by reference, which is a continuation-in-part of U.S. patent application Ser. No. 11/969,848, filed on 4 Jan. 2008 and entitled "System and Method for Raised Touch Screens," which is incorporated herein by reference.

TECHNICAL FIELD

[0003] This invention relates generally to touch sensitive displays. More particularly, this invention relates to systems and methods for selectively raising portions of touch sensitive displays.

BACKGROUND

[0004] Touch sensitive displays, e.g., touch screens, are very useful in applications where a user can input commands and data directly on a display. Common applications for touch screens include consumer products such as cellular telephones and user interfaces for industrial process control. Depending on their specific applications, these touch sensitive displays are commonly used in devices ranging from small handheld PDAs, to medium sized tablet computers, to large pieces of industrial equipment.

[0005] It is often convenient to be able to input and output data to and from the user on the same display. Unlike a dedicated input device such as a keypad with discrete well-defined keys, most touch sensitive displays are generally flat. As a result, touch sensitive screens do not provide any tactile guidance for one or more control "buttons". Instead, touch sensitive displays rely on visual guidance for user input.

[0006] Hence a serious drawback of touch sensitive displays is its inherent difficulty to input data accurately because adjacent buttons are not distinguishable by feel. Wrongly entered key strokes are common and the user is forced to keep his or her eyes on the display. The importance of tactile guidance is readily apparent in the competition between the Apple iPhone and the BlackBerry 8800. With a limited size, the mobile phones prior to this invention could include either a large screen or tactile buttons. With this invention, mobile phones and other suitable electronic devices can include both.

BRIEF DESCRIPTION OF THE FIGURES

[0007] FIG. **1** is a top view of the user interface system of a preferred embodiment.

[0008] FIG. **2** is a cross-sectional view illustrating the operation of a button array in accordance to the preferred embodiments.

[0009] FIGS. **3***a* and **3***b* are cross-sectional views of the layer, the substrate, the cavity, the touch sensor, and the display of the preferred embodiments, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0010] FIGS. **4***a* and **4***b* are cross-sectional views of the touch sensor located above the substrate, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0011] FIGS. **5***a* and **5***b* are cross-sectional views of the layer and the substrate combined as a singular structure, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0012] FIGS. **6***a* and **6***b* are cross-sectional views of a support member between the layer and the substrate, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0013] FIG. **6***c* is a top view of the support member.

[0014] FIG. **6***d* is a cross-sectional view of an alternative support member that partially defines the cavity.

[0015] FIGS. **7***a* and **7***b* are cross-sectional views of the layer, the substrate, the cavity, the touch sensor, the display, and a displacement device that modifies the existing fluid in the cavity, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0016] FIG. **8** is a schematic view of the layer, the substrate, the cavity, the touch sensor, the display, and a displacement device of a first example that displaces additional fluid into the cavity.

[0017] FIG. **9** is a schematic view of the layer, the substrate, the cavity, the touch sensor, the display, and a displacement device of a second example that displaces additional fluid into the cavity.

[0018] FIGS. **10***a* and **10***b* are schematic views of the layer, the substrate, the cavity, the touch sensor, the display, and a displacement device of a third example that displaces additional fluid into and out of the cavity, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0019] FIGS. **11**, **12**, **13**, **14**, and **15** are top and side views of a button deformation, a slider deformation, a slider ring deformation, a guide deformation, and a pointing stick deformation, respectively.

[0020] FIG. **16** is a flow chart of the different operation modes of the preferred embodiments.

[0021] FIG. **17** is a schematic of the different input graphics, different cavity settings, and different user touches of the preferred embodiments.

[0022] FIGS. **18***a* and **18***b* are schematic views of the cavity and the second cavity connected to a single displacement device, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0023] FIGS. **19***a* and **19***b* are schematic views of the cavity and the second cavity connected to a separate displacement devices, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0024] FIGS. **20***a*, **20***b*, and **20***c* are schematic views of the cavity and the second cavity connected to a linear actuator, with the cavity in the expanded volume setting and the second cavity in the retracted volume setting, the cavity and the second cavity in the retracted volume setting, and the cavity in the retracted volume setting and the second cavity in the expanded volume setting, respectively.

[0025] FIG. **21***a* is a schematic view of a first cavity array arranged in a dial pad and a second cavity array arranged in a QWERTY keyboard on the same device.