SYSTEM AND METHODS FOR RAISED TOUCH SCREENS

BACKGROUND OF THE INVENTION

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

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 large pieces of industrial equipment.

While it is 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 control "button(s)". Instead, touch sensitive displays rely on visual guidance for user input.

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 lack of tactile guidance is especially critical in industrial settings where potentially dangerous machines and parts are in constant motion such as an automobile assembly line, and also when operating the controls of a moving vehicle such as making a cellular telephone call while driving.

It is therefore apparent that an urgent need exists for an improved touch sensitive display which provides tactile guidance to the user that is easy to manufacture, easy to retrofit, shock resistant, impact resistant, remains compact and portable, cost effective, and durable.

SUMMARY OF THE INVENTION

To achieve the foregoing and in accordance with the present invention, systems and methods for tactile guidance in touch sensitive screens are provided. Such touch screens can be operated very effectively and more safely without substantially increasing cost.

In one embodiment of the invention, a touch sensitive display assembly includes a touch screen and a button array. The touch screen is configured to display one or more input keys. The button array includes one or more buttons corresponding to the one or more input keys. The button array is formed by a substrate attached to a button membrane thereby creating a set of button cavities corresponding to the input keys.

The button cavities are configured to be inflated and deflated by a pump coupled to a fluid reservoir. The cavities can be inflated/deflated together, in subsets, and/or individually. In some embodiments, the button array is sandwiched between a touch sensing layer and a display of the touch screen. In other embodiments, the button array can be located either above or below the touch screen.

These and other features of the present invention will be described in more detail below in the detailed description of the invention and in conjunction with the following figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the present invention may be more clearly ascertained, one embodiment will now be described, by way of example, with reference to the accompanying drawings, in which:

FIGS. **1**A and **1**B are cross-sectional views illustrating the operation of a button array in accordance with the present invention;

FIG. **2** is a cross-sectional view of one embodiment of the present invention;

FIGS. **3**A, **3**B and **4** are cross-sectional views of alternate embodiments of the present invention;

FIGS. **5** and **6** are top views showing a button array and an exemplary touch screen which can be combined to form an exemplary input and output (I/O) user interface suitable for telephone-based communication applications;

FIG. **7** is a block diagram illustrating one exemplary implementation of a device incorporating the touch sensitive user interface of the button array in accordance with the present invention; and

FIG. **8** is a flowchart illustrating the operation of touch screen assemblies of the present invention, including the embodiments shown in FIGS. **2**, **3**A, **3**B and **4**.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described in detail with reference to several embodiments thereof as illustrated in the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without some or all of these specific details. In other instances, well known process steps and/or structures have not been described in detail in order to not unnecessarily obscure the present invention. The features and advantages of the present invention may be better understood with reference to the drawings and discussions that follow.

FIGS. **1**A and **1**B are cross-sectional views illustrating the operation of a button array **100**, useful in association with a touch sensitive display, in accordance with the present invention. Although only one button is shown, button array can include one or more buttons. In the following discussion and in the claims, touch sensitive display is used interchangeably with touch screen. Referring first to FIG. **1**A, button array **100** includes a substrate **130** and a membrane **110** which are coupled to each other to form one or more enclosed cavities, e.g., enclosed cavity **120**.

Substrate **130** can be made from a suitable optically transparent material including polymers or glass, for example, elastomers, silicon-based organic polymers such as poly-dimethylsiloxane (PDMS), thermoset plastics such as poly-methyl methacrylate (PMMA), and photocurable solvent resistant elastomers such as perfluropolyethers. In some embodiments, substrate **130** is a single homogenous layer approximately 1 mm to 0.1 mm thick and can be manufactured using well-known techniques for micro-fluid arrays to create one or more cavities and/or micro channels. It is also possible to construct substrate **130** using multiple layers from the same material or from different suitable materials.

Membrane **110** can be made from a suitable optically transparent and elastic material including polymers or silicon-based elastomers such as poly-dimethylsiloxane (PDMS) or polyethylene terephthalate (PET). In some embodiments, membrane is a single homogeneous layer less than 1 mm