USER INTERFACE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. application Ser. No. 12/319,334 filed on 5 Jan. 2009 and entitled "User Interface System", which is incorporated in its entirety by this reference.

[0002] This application also claims the benefit of U.S. Provisional Application No. 61/223,001 filed 3 Jul. 2009, and of U.S. Provisional Application No. 61/226,286, filed 17 Jul. 2009, which are incorporated in their entirety by this reference.

BRIEF DESCRIPTION OF THE FIGURES

[0003] FIG. **1** is a top view of the user interface system of a preferred embodiment.

[0004] FIG. **2** is a cross-sectional view of the operation of a button array in accordance to the preferred embodiments.

[0005] FIGS. **3***a*, **3***b*, and **3***c* are cross-sectional views of the retracted, extended, and user actuated modes of the preferred embodiments, respectively.

[0006] FIGS. **4***a* and **4***b* are cross-sectional views of the layer, the substrate, the cavity, the touch sensor, the display, a processor, and a displacement device that modifies the volume of fluid in the cavity, with the cavity in a retracted volume setting and an expanded volume setting, respectively.

[0007] FIGS. **5***a*, **5***b*, and **5***c* are schematic views of the sheet, the cavity, and a displacement device of a first example, second, and third variation, respectively.

[0008] FIGS. **6***a* and **6***b* are schematic views of the retracted and extended modes of the cavities of the first preferred embodiment, respectively.

[0009] FIGS. **7***a* and **7***b* are schematic views of geometric variations of the first preferred embodiment.

[0010] FIGS. **8***a*, **8***b*, **8***c*, and **8***d* are schematic views of the different expansion modes of the cavities of the second preferred embodiment.

[0011] FIGS. **9***a*, **9***b*, and **9***c* are schematic views of the different expansion modes of the cavities of a variation of the second preferred embodiment.

[0012] FIGS. **10***a* and **10***b* are schematic representations of a first variation of the valve of the preferred embodiments.

[0013] FIG. **10***c* is a schematic representation of a second variation of the valve of the preferred embodiments.

[0014] FIGS. **11***a* and **11***b*, **12***a* and **12***b*, and **13***a* and **13***b* are schematic representations of the OPEN and CLOSED states of a first, second, and third example of the valve of the preferred embodiments, respectively.

[0015] FIG. **14** is a schematic view of the expansion of the cavities of the third preferred embodiment.

[0016] FIGS. **15***a* and **15***b* are schematic representations of two examples of groups of cavities.

[0017] FIG. **16** is a schematic representation of channels arranged at different height levels within the sheet of the preferred embodiments.

[0018] FIG. **17** is a schematic representation of groups of cavities with shared cavities.

[0019] FIG. **18** is a schematic view of an arrangement of a cavity belonging to more than one group of FIG. **17**.

[0020] FIGS. **19***a*, **19***b*, **19***c*, and **19***d* are schematic representations of the different expansion modes of the cavities of the fourth preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] The following description of the preferred embodiments of the invention is not intended to limit the invention to these preferred embodiments, but rather to enable any person skilled in the art to make and use this invention.

[0022] As shown in FIGS. **1-4**, the user interface system **100** of the preferred embodiment includes: a sheet **111** that defines a surface **115** on one side and at least partially defines a plurality of cavities **125** on an opposite side, a fluid network **200** coupled to the plurality of cavities **125**, a displacement device **130** that is coupled to the fluid network **200** and displaces fluid within the fluid network **200** and expands at least one the plurality of cavities **125** to deform a particular region **113** of the surface **115**. The user interface system **100** preferably also includes a sensor **140** that senses a user input at the particular region **113**. The touch sensor **140** preferably functions to detect the presence of a user input proximate to the particular region **113** of the surface **115**. The touch sensor **140** preferably detects the presence of a user touch by detecting a force that inwardly deforms the deformed particular region **113** or any other portion of the surface **115**, but may alternatively detect the presence of a user touch by detecting the presence of the finger at a location proximate to the particular region **113**. The touch sensor **140** may be a capacitive sensor, a resistive sensor, a pressure sensor, or any other suitable type of sensor. The user interface system **100** may also include a display (that may or may not be integrated with the touch sensor **140**) coupled to the sheet in and adapted to output images to the user. As shown in FIGS. **4***a* and **4***b*, the preferred embodiments may also include a processor **300** that controls the expansion of the cavities **125**.

[0023] The user interface system **100** of the preferred embodiments has been specifically designed to be used as the user interface for an electronic device, more preferably in an electronic device that benefits from an adaptive user interface. The electronic device, which may or may not include a display, may be incorporated into an automotive console, a desktop computer, a laptop computer, a tablet computer, a television, a radio, a desk phone, a mobile phone, a PDA, a personal navigation device, a personal media player, a camera, a watch, a remote, a mouse, a trackpad, or a keyboard. The user interface system **100** may, however, be used as the user interface for any suitable device that interfaces with a user in a tactile and/or visual manner. The user interface system **100** is preferably used on a planar surface, but may also be used on a non-planar surface, for example, around the rounded grip of a steering wheel or around the edge rim of a cellular phone. The surface **115** of the user interface system **100** preferably remains flat until a tactile guidance is to be provided at or in substantial proximity to the location of the particular region **113**. The surface **115** of the user interface system **100** may also be deformed when a user input is required. At that time, the displacement device **130** expands the cavity **125** to expand a particular region **113** outward, forming a deformation that may be felt by a user, and providing tactile guidance for the user. The expanded particular region **113** preferably also provides tactile feedback to the user when they apply force onto the particular region **113** to provide input. However, any other