

## USER INTERFACE SYSTEM

### CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a continuation of prior U.S. application Ser. No. 12/652,704, filed on 05 Jan. 2010, which is a continuation-in-part of prior U.S. application Ser. No. 12/319,334, filed on 05 Jan. 2009, which is a continuation-in-part of prior U.S. application Ser. No. 11/969,848, filed on 04 Jan. 2008, all of which are incorporated in their entirety by this reference. U.S. application Ser. No. 12/497,622 is also a continuation-in-part of prior U.S. application Ser. No. 11/969,848, filed on 04 Jan. 2008.

**[0002]** This application is also a continuation-in-part of prior U.S. application Ser. No. 13/414,589, filed on 07 Mar. 2012, which is a continuation of U.S. application Ser. No. 12/319,334, filed on 05 Jan. 2009, which is a continuation-in-part of prior U.S. application Ser. No. 11/969,848, filed on 04 Jan. 2008, all of which are incorporated in their entirety by this reference.

**[0003]** This application is also a continuation-in-part of prior U.S. application Ser. No. 11/969,848, filed on 04 Jan. 2008, which is incorporated in its entirety by this reference.

### BRIEF DESCRIPTION OF THE FIGURES

**[0004]** FIG. 1 is a top view of the user interface system of a preferred embodiment.

**[0005]** FIG. 2 is a cross-sectional view of the operation of a button array in accordance to the preferred embodiments.

**[0006]** FIGS. 3a, 3b, and 3c are cross-sectional views of the retracted, extended, and user actuated modes of the preferred embodiments, respectively.

**[0007]** FIGS. 4a and 4b 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.

**[0008]** FIGS. 5a, 5b, and 5c are schematic views of the sheet, the cavity, and a displacement device of a first example, second, and third variation, respectively.

**[0009]** FIGS. 6a and 6b are schematic views of the retracted and extended modes of the cavities of the first preferred embodiment, respectively.

**[0010]** FIGS. 7a and 7b are schematic views of geometric variations of the first preferred embodiment.

**[0011]** FIGS. 8a, 8b, 8c, and 8d are schematic views of the different expansion modes of the cavities of the second preferred embodiment.

**[0012]** FIGS. 9a, 9b, and 9c are schematic views of the different expansion modes of the cavities of a variation of the second preferred embodiment.

**[0013]** FIGS. 10a and 10b are schematic representations of a first variation of the valve of the preferred embodiments.

**[0014]** FIG. 10c is a schematic representation of a second variation of the valve of the preferred embodiments.

**[0015]** FIGS. 11a and 11b, 12a and 12b, and 13a and 13b are schematic representations of the OPEN and CLOSED states of a first, second, and third example of the valve of the preferred embodiments, respectively.

**[0016]** FIG. 14 is a schematic view of the expansion of the cavities of the third preferred embodiment.

**[0017]** FIGS. 15a and 15b are schematic representations of two examples of groups of cavities.

**[0018]** FIG. 16 is a schematic representation of channels arranged at different height levels within the sheet of the preferred embodiments.

**[0019]** FIG. 17 is a schematic representation of groups of cavities with shared cavities.

**[0020]** FIG. 18 is a schematic view of an arrangement of a cavity belonging to more than one group of FIG. 17.

**[0021]** FIGS. 19a, 19b, 19c, and 19d are schematic representations of the different expansion modes of the cavities of the fourth preferred embodiment.

**[0022]** FIGS. 20a and 20b 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.

**[0023]** FIG. 20c is a top view of the support member.

**[0024]** FIG. 20d is a cross-sectional view of an alternative support member that partially defines the cavity.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0025]** 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.

**[0026]** As shown in FIGS. 1-4, the user interface system 100 of the preferred embodiment includes: a sheet in 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 111 and adapted to output images to the user. As shown in FIGS. 4a and 4b, the preferred embodiments may also include a processor 300 that controls the expansion of the cavities 125.

**[0027]** 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