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** and **2**, the user interface system **100** of the preferred embodiments includes a sheet **110** that defines a surface **115** and a cavity **125**, a volume of a fluid **120** contained within the cavity **125**, a displacement device **130** that modifies the volume of the fluid **120** to expand the cavity **125** (thereby outwardly deforming a particular region **113** of the surface **115**), and a sensor **140** that detects a force applied by a user that inwardly deforms the particular region **113** of the surface **115**. As shown in FIG. **3**, the user interface system too may also include a display **150** coupled to the sheet **110** and adapted to output images to the user and a processor **160** that is preferably coupled to the sensor **140** to receive signals from the sensor **140** and coupled to the displacement device **130** to send signals to the displacement device **130**. The sensor **140** may also be located in between the sheet **110** and the display **150**. However, any other suitable arrangement of the components of the system too may be used.

[0027] The user interface system too 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 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 too may, however, be used as the user interface for any suitable device that interfaces with a user in a tactile and/or visual manner. As shown in FIG. **2**, the surface **115** of the user interface system too preferably remains flat until a tactile guidance is to be provided at 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 deform and/or expand the particular region **113** outward, preferably forming a button-like shape. With the button-like shape, the user will have tactile guidance when navigating for the expanded particular region **113** and will have tactile feedback when applying force onto the particular region **113** to provide input. The sensor **140** preferably senses the force that inwardly deforms the particular region **113**. However, any other arrangement of the user interface system **100** suitable to providing tactile guidance and/or detecting user input may be used.

1. The Sheet

[0028] As shown in FIGS. **1** and **2**, the sheet **110** of the preferred embodiment functions to provide the surface **115** that interfaces with a user in a tactile manner and to at least partially define the cavity **125**. The surface **115** is preferably continuous, such that when swiping a finger across the surface **115** a user would not feel any interruptions or seams. Alternatively, the surface **115** may include features that facilitate the user in distinguishing one region from another. The surface **115** is also preferably planar. The surface **115** is preferably arranged in a flat plane, but may alternatively be arranged in a curved or warped plane. The surface **115** also functions to deform upon an expansion of the cavity **125**, and to preferably "relax" or "un-deform" back to a normal planar state upon retraction of the cavity **125**. In one version, the sheet **110** contains a first portion that is elastic and a second portion that is relatively less elastic. In another version, sheet **110** is relatively more elastic in specific areas and relatively less elastic in other areas and is deformed by the expanded cavity **125** in the relatively more elastic areas. In another version, the sheet **110** is generally of the same elasticity. In yet another version, the sheet **110** includes or is made of a smart material, such as Nickel Titanium (commonly referred to as "Nitinol"), that has a selective and/or variable elasticity. The sheet **110** is preferably optically transparent, but may alternatively be translucent or opaque. In addition to the transparency, the sheet **110** preferably has the following properties: a high transmission, a low haze, a wide viewing angle, a minimal amount of back reflectance upon the display (if the display is included with the user interface system too), scratch resistant, chemical resistant, stain resistant, relatively smooth (not tacky) to the touch, no out-gassing, and/or relatively low degradation rate when exposed to ultraviolet light. The sheet **110** is preferably made from a suitable elastic material, including polymers and silicon-based elastomers such as poly-dimethylsiloxane (PDMS) or RTV Silicon (e.g., RTV Silicon 615). In the version wherein the sheet **110** includes a first portion that is elastic and a second portion that is relatively inelastic, the inelastic portion is preferably made from a material including polymers or glass, for example, elastomers, silicon-based organic polymers such as poly-dimethylsiloxane (PDMS), thermoset plastics such as polymethyl methacrylate (PMMA), photocurable solvent resistant elastomers such as perfluropolyethers, polyethylene terephthalate (PET), or any other suitable material. The sheet **110** may, however, be made of any suitable material that provides the surface **115** that deforms and defines a cavity **125**. The sheet **110** may be manufactured using well-known techniques for micro-fluid arrays to create one or more cavities and/or micro channels. The sheet **110** may be constructed using multiple layers from the same material or from different suitable materials, for example, the sheet **110** may include a layer portion **116** of one material that defines the surface **115** and a substrate portion **118** of a second material (as shown in FIG. **4**). The substrate portion **118** functions to support the layer portion **118** and to at least partially define the cavity **125**. However, any other suitable arrangement, material, and manufacturing method may be used to create sheet no.

[0029] As shown in FIG. **2**, the cavity **125** of the preferred embodiment functions to hold a volume of fluid **120** and to have at least two volumetric settings: a retracted volume setting (shown in FIG. **2***a*) and an extended volume setting (shown in FIG. **2***b*). The fluid **120** is preferably a substantially incompressible fluid, but may alternatively be a compressible fluid. The fluid **120** is preferably a liquid (such as water, glycerin, or ethylene glycol), but may alternatively be a gas (such as air, nitrogen, or argon) or any other substance (such as a gel or aerogel) that expands the cavity **125** and deforms the surface **115**. In the extended volume setting, the cavity **125** deforms the particular region **113** of the surface **115** above the plane of the other regions of the surface **115**. When used with a mobile phone device, the cavity **125** preferably has a diameter of 2-10 mm. When used with this or other applications, however, the cavity 125 may have any suitable dimension.

2. The Displacement Device

[0030] The displacement device **130** of the preferred embodiment functions to influence the volume of the fluid