

housing portion causes the fluid to be pumped into the fluid chambers. In one example, the pump is controlled to reverse fluid flow when the flip portion is closed. As such, there may be a fluid pump operative to move fluid into the fluid passages (and out of the passages) and a movable housing portion that is coupled with the fluid pump such that mechanical movement of the housing portion causes the fluid pump to pump fluid in at least one fluid passage. The movement of the movable housing portion in another direction may serve to remove fluid from the one or more respective chambers and return it to an internal reservoir.

[0061] FIG. 14 illustrates another embodiment of a hydraulic actuation structure and flexible skin structure that in this example, shows fluid channels 1400 with additional fluid channels 1402 connected with specific chambers that are molded into a rear surface of the flexible skin structure 1100. The flexible skin structure includes multiple features wherein movement of each of the features is controlled independently. The fluid channels 1400 are in fluid communication with the manifold 1404 whereas other chambers 1401 are in fluid communication with manifold 1406. As also shown, suitable pump inlets 1408 and 1410 are shown that are in fluid communication with pumps (not shown). In addition, light sources 1412 and 1414 are positioned in proximity to the respective manifold 1404 and 1406 to serve as a light source (such as one or more colored LEDs) and a clear fluid may be used to act as a light guide to direct the light from the internal light sources to, for example, translucent flexible portions of the flexible skin structure. Alternatively, the fluid itself may be colored so as to make the raised texture elements visually distinct by the change in color due to the color fluid contained therein. Any other suitable combination may also be employed if desired. The light sources may be suitably controlled to turn on and off as desired based on an incoming call, user programmed sequence, be activated by a ring tone, or may be controlled in any other suitable manner by the control logic.

[0062] FIG. 15 illustrates one example of the portable electronic device 1500 with the appearance of a 3D pattern with five tactile surfaces being actuated. Unactuated portions 1502 are shown to be flat in this particular example.

[0063] FIG. 16 illustrates an alternative embodiment wherein the flexible skin structure 1600 includes molded pocket patterns 1602 in an under portion thereof to receive fluid. A rigid substrate 1604 includes the suitably positioned fluid channels 1606 that are in fluid communication with one or more manifolds 1608 and also include a pump inlet. The manifold 1608 is attached to a rear side of the rigid substrate 1604 and is in fluid communication with channels 1606 through openings 1610. Each of the microchannels include, for example, openings 1610 to allow fluid to pass from the manifold into the channel 1606 as described above. One or more pumps may also be used as noted above to raise and lower the pattern 1602 by passing fluid in or out of the channel 1606. As such, in this example, if the pattern 1602 is placed, for example, on the back of a cell phone or on the face of a cell phone, the outer skin of the cell phone may be activated to give a three dimensional texture that may be suitably activated and deactivated as desired. The channels 1606 may be positioned with sufficiently fine spacing that they provide any suitable texture pattern to be actuated. It will also be recognized that the skin texture may have one or more cover layers to protect the skin texture from damage from ultraviolet radiation, physical scratches, or any other potential hazards.

[0064] FIG. 17 is a block diagram illustrating one example of the structure 1700 for controlling the hydraulic controllable skin texture surface examples noted above. The device may include one or more fluid pumps 1702 which provide fluid 1704 to and from the controllable skin texture surface. Control logic, in one example, shown as 200 provides suitable control information 1708 in the form of analog or digital signals, for example, to control the one or more fluid pumps 1702 to provide the fluid 1704 in a controlled manner to actuate and deactuate one or more portions of a flexible skin to provide a three dimensional tactile configuration as desired. It will also be recognized that instead of a fluid, a pressurized gas could be employed.

[0065] FIGS. 18a and 18b illustrate another embodiment wherein, instead of a sliding ramp structure (for example as shown in FIGS. 6 and 7), a plurality of hinged elements 1830 that have an anchored portion 1832 attached to the flexible skin structure 320 through a suitable adhesive or through any other suitable attachment mechanism. Each of the hinged elements 1830 also have a movable section 1834. The flexible skin structure 320 includes pins 1836 which are, for example, longer than those shown in FIG. 6.

[0066] The device further includes a substrate 1840 such as, for example, a printed circuit board which has attached thereto, dome switches 1842 as known in the art. The dome switches 1842 are positioned to align under the pins. A flexible sliding member 1846 is interposed between the substrate 1840 and the anchored portion 1832 underneath the flexible skin surface 320. The flexible sliding member 1846 may be made from, for example, nylon or polypropylene sheet, or other suitably flexible material that allows motion of the movable section of the hinged element 1834 to be transferred to the dome switch 1842. Holes 1850 in the flexible sliding member 1846 allow the movable sections of hinged elements 1834 to rotate downward toward the substrate 1840, as shown in FIG. 18a. It can be seen that when the flexible sliding member 1846 is in the position shown in FIG. 18a, the end of the movable section of the hinged element 1834 may be designed so as to come in contact with the substrate 1840 such that pressing the flexible surface 320 will not actuate the dome switch 1842.

[0067] As shown in FIG. 18b, the flexible sliding member 1846 is moved, as described above based on any suitable structure to activate and in this case, raise portions of the flexible skin structure 320. However, since the material is compressible, when a user presses on a top surface of the flexible skin structure 320, the pin causes the moving portion 1834 to press down upon the flexible material of the flexible sliding member 1846 and depress the dome switch 1842. As such, in this embodiment, a user may activate the dome switch only when the flexible skin texture is actuated. It will be recognized that the geometry of the movable section of the hinged element 1834 may also be designed such that the dome switch may be actuated by pressing the flexible skin 320 whether the skin is in either the actuated or unactuated state (FIGS. 18b and 18a, respectively). Among other advantages, this embodiment may allow the flexible sliding member 1846 to be stamped rather than, for example, molded and also uses conventional dome switches in combination thereby providing a potentially lower cost structure. The hinged elements 1830 may be made of any suitable material such as nylon, polypropylene sheet or any other suitable material as desired. As also noted above, the flexible sliding member may be configured as a sliding member that slides along rails formed