element of a user interface. The tactilely enhanced visual image display may also be touch sensitive.

[0044] **FIG. 7** illustrates an exploded perspective view of the relevant elements of tactilely enhanced visual image display sub-assembly **100'** of the present invention, in accordance with another embodiment. The embodiment advantageously provides tactilely enhanced visual image display with touch sensing, as well as conventional touch sensing of non-tactilely enhanced visual images.

[0045] Similar to the embodiment of **FIG. 1**, sub-assembly **100'** also includes flexible visual display layer **102** and tactile display layer **104** adjacently disposed and complement each other as earlier described. Except, for the embodiment of **FIG. 7**, sub-assembly **100'** also includes a transparent touch sensitive layer **120** disposed also adjacent to the flexible visual display layer **102**, on the viewing side of flexible visual display layer **102**. Further, for the embodiment, tactile display layer **104** comprises pistons **106** only in a core area to tactilely enhance visual images rendered on a corresponding core area of flexible visual display layer **102**. This core area is also referred to as the effective area of tactile display layer **104**.

[0046] Transparent touch sensitive layer **120** is provided to equip sub-assembly **100'** with conventional touch sensing capability, i.e. for conventional non-tactilely enhanced visual images.

[0047] As its name suggests, touch sensitive layer **120** is transparent, such that the visual images rendered on flexible visual display layer **102** remain visible to a user, notwithstanding the fact that touch sensitive layer **120** is disposed on the viewing side of flexible visual display layer **102**.

[0048] As illustrated in **FIG. 8**, in one embodiment, transparent touch sensitive layer **120** comprises two transparent spaced sub-layers **122**. The facing inside surfaces of the spaced sub-layers **122** are at least partially coated with transparent (see through) conductive materials **128**. An example of a suitable substantially transparent conductive material is indium-tin oxide.

[0049] Each sub-layer **122** also includes a number of leads **124** to facilitate determination of the contact point, i.e. the point touched by a user.

[0050] For the embodiment, both sub-layers **122** are flexible, such that when pistons **106** are selectively activated to tactilely enhanced a visual image rendered in a corresponding area on flexible visual display **102**, the tactile enhancement will "show through" the added transparent touch sensitive layer **120**.

[0051] For the embodiment, the two facing inside surfaces of sub-layers **122** are coated with the transparent conductive materials in the perimeter area surrounding the core effective area of tactile display layer **104** only. Thus, when pistons **106** of tactile display layer **104** are employed to tactilely enhanced visual images rendered in the corresponding core area of flexible visual display layer **102**, pushing against flexible visual display layer **102** and transparent touch sensitive layer **120**, touch sensitive layer **120** would not report touching by the user. For the core area, touching by the user will continue be reported by tactile display layer **104**.

[0052] Thus, for devices employing sub-assembly **100**, conventional touching sensing for the area surrounding the effective area of tactile display layer **104** may also be provided. In other words, conventional touch sensing for sub-assembly **100'** has essentially a hollowed effective area, surrounding the effective core area of tactile display layer **104**.

[0053] In alternate embodiments, the facing inside surfaces of sub-layers **122** may be fully coated with transparent conductive materials as conventional touch sensitive layer, but complemented with a limiting circuit to exclude the reporting of user touching for the effective core area of tactile display layer **106**.

[0054] For these embodiments, the electrical models of touch sensing are re-calibrated for the various activations of pistons **106**, and detection of user touching by touch sensitive layer **120** further factors into consideration whether any of pistons **106** are activated.

[0055] In other words, for these embodiments, transparent touch sensitive layer **120** has a nominal effective area with an area size equals to the total surface of the layer. This size of this effective area is larger than the size of the effective core area of tactile display layer **104**. However, the limiting circuit modifies the nominal effective area to a hollowed effective area surrounding the effective core area of tactile display layer **104**.

[0056] In other alternate embodiments, touch sensitive layer **120** is capacitance based instead. That is, touch sensitive layer **120** is a "field sensitive" touch layer instead.

[0057] An example limiting circuit suitable for practicing with these embodiments of the present invention is illustrated in **FIG. 9**. Limiting circuit **140** includes a number of comparison circuits **142**, an OR gate **144** and a number of AND gates **146**.

[0058] Comparison circuits **142** are employed to determine whether the location of a sensed contact is within the effective core area of tactile display layer **104**. Preferably, the coordinates of the effective core area of tactile display layer **104** are configurable. The results of the comparisons are provided to OR gate **144**.

[0059] OR gate **144** is employed to combine the two signals together, producing a true signal if at least one of the x or y coordinate of the sensed contact point is within the effective core area of tactile display layer **104**. For the embodiment, the invert of the true signal is provided to AND gates **146**.

[0060] AND gates **146** are employed to negate any reporting, if it is determined that at least one of the coordinate values is within the effective core area of tactile display layer **104**.

[0061] Thus, it can be seen from the foregoing further description that tactilely enhanced visual image display with touch sensing may also be provided with conventional touch sensing for non-tactilely enhanced visual images.

[0062] **FIG. 10** illustrates an assembled perspective view of a tactilely enhanced visual image display device of the present invention, in accordance with one embodiment. As illustrated, display **160** includes either the tactilely enhanced visual image sub-assembly **100** of **FIG. 1** or the tactilely