rendering flexible visual display layer **102** to be flexible, as illustrated in FIG. **2**, where layer **102** is illustrated in a flexed position.

Referring back to FIG. **1**, tactile display layer **104** is employed to tactilely enhance the visual images rendered on flexible visual display layer **102**. As alluded to earlier, tactile display later **104** includes a number of pistons **106**, which may be selectively activated or raised, as illustrated in FIG. **3**.

As described earlier, flexible visual display layer **102** and tactile display layer **104** are disposed adjacent to each other. More specifically, flexible visual display layer **102** has a viewing side **103***a* and a back side **103***b*, and tactile display layer **104** is disposed adjacent to flexible visual display layer **102** on the back side **103***b* of flexible visual display layer **102**. Depending on the intended usage or orientation of the final assembly, viewing side **103***a* may also be referred as the top side or the front side, whereas back side **103***b* may also be referred as the bottom side.

Thus, as pistons **106** of tactile display layer **104** are selectively activated or raised, different portions or areas of flexible visual display **102** are being pushed against by the activated/raised pistons. Since, flexible visual display **102** is designed to be flexible, the corresponding areas being pushed by the selectively activated/raised pistons **106**, present to the user a raised condition, as illustrated by FIG. **5**.

Therefore, if a key or button image, or a menu or list item is rendered on the area of flexible visual display layer **102** being pushed by the selectively activated/raised pistons **106**, the user perceives a raised key or button, or raised menu or list item.

In various embodiments, pistons **106** may be further provided with different degree of resistance to a user touching or pushing against them. Accordingly, depending on the application and the desire of the designer, different degree of hardness may be manifested for the user.

As a result, the present invention enables a designer to present to a user with an interface on demand, where the interface may include keys, buttons, menu/list items that are dynamically formed, and non-persistent, and yet these dynamically formed non-persistent keys, buttons, and menu/list items may provide an interacting user with some degrees of tactile sensations that approximate permanently formed “hard” keys/buttons.

Still referring to FIG. **1**, in various embodiments, flexible visual display layer **102** has a thickness in the range of 0.1 mm to 1.0 mm. In alternate embodiments, flexible visual display layer **102** may be thicker or thinner.

Further, in alternate embodiments, other circuit technology beside plastic thin-film transistors may be employed to provide the visual image rendering capability of sub-assembly **100** with the desired thinness and flexible attribute.

FIGS. **4***a*–**4***b* illustrate the alignment relationships between the pixels of the flexible visual display layer **102** and pistons **106** of tactile display layer **104**, in accordance with two embodiments. In various embodiments, flexible visual display layer **102** comprises m×n pixels **105**. Typically, although not necessarily, m and n are integers, and equal to a power of 2. Similarly, tactile display layer **104** comprises p×q pistons **106**. Typically, although also not necessarily, p and q are integers, and also equal to a power of 2.

For the embodiment of FIG. **4***a*, the pixels of flexible visual display layer **102** and the pistons **106** of tactile display layer **104** are 1:1 aligned. That is, the size of each pixel **105** and the size of the each piston **106** is approximately the same. In one embodiment, m and n equal p and q respectively.

For the embodiment of FIG. **4***b*, each piston **106** is aligned with a group of pixels **105**. That is, the size of each piston **106** is approximately that of the size of the group of pixels **105** to which it corresponds. In one embodiment, m and n are multiples of p and q respectively, i.e. 2×, 3× and so forth.

FIG. **6** illustrates an architectural view of the pistons **106** of the tactile display layer **104** and the companion elements, in accordance with one embodiment. As illustrated, for the embodiment, pistons **106** are connected to a servo mechanism **602** that is responsible for activating or raising pistons **106** as earlier described. Further, for the embodiment, servo mechanism **602** is also responsible for providing resistance to pistons **106** to simulate various degrees of hardness for a user.

For the embodiment, tactile display layer **104** is also provided with sensor **604** coupled to servo mechanism **602** as shown. Sensor **604** is employed to sense a user's interaction with the tactilely enhanced visual image, which as described earlier, may be “emulating” an input key/button.

Sensor **604** enables the sub-assembly **100** to be touch sensitive, in addition to rendering tactilely enhanced visual images.

For the embodiment, both servo mechanism **602** and sensor **604** are controlled by controller **606**. In various embodiments, controller **606** is in turn coupled to and controlled by a processor of a host device, e.g. a PDA.

Any one of a number of known servo mechanisms, sensor circuits and controllers may be employed to practice the present invention.

Thus, from the foregoing description, it can be seen that tactilely enhanced visual images may be advantageously provided to improve user experience, by providing a user with tactile sensation when interacting with an interface element of a user interface. The tactilely enhanced visual image display may also be touch sensitive.

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.

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**.

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.

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**.