by providing tactile sensations to the user, when interacting with the rendered visual images of these key/buttons and menu/list items.

As illustrated, for the embodiment, apparatus **100** is equipped with device drivers **140** and graphics functions **130**, incorporated with the teachings of the present invention, to enable applications **120** to exploit the capabilities of tactilely enhanced visual imaging display **106** to improve user experience.

Also, depending on the intended usage of interactive apparatus **100**, it may further include additional components such as digital signal processor (DSP), encoder/decoder, transceiver (TX/RX), network interface (NIC), and so forth.

These and other aspects of interactive apparatus **100** will be described in more detail in turn.

## Processor and Memory

Still referring to FIG. **1**, processor **102** controls the operation of apparatus **100**, by executing the binaries or instructions loaded into memory **104**.

Processor **102** may be any one of a number of processors known in the art, including but are not limited to the Pentium® processors available from Intel Corporation of Santa Clara, Calif. or the Anthlon® processors available from Advanced Micro Devices of Sunnyvale, Calif.

Memory **104** may be volatile or non-volatile memory of any kind known in the art. Typically, when non-volatile memory is employed, apparatus **100** further includes mass storage devices, such as disk drive, CDROM, DVD drives, and so forth, where a persistent copy of the binaries/instructions may be stored, or a NIC, through which the binaries/instructions may be retrieved from a remote location.

## Tactilely Enhanced Visual Imaging Display

FIG. **2** illustrates an exploded perspective view of the tactilely enhanced visual imaging display **106** of FIG. **1**, in accordance with one embodiment. As illustrated, for the embodiment, tactilely enhanced visual imaging display **106** comprises a transparent touch sensitive layer **202**, a flexible visual display layer **204** and a tactile display layer **206**, successively disposed adjacent to other as shown.

Flexible visual display layer **204** is employed to render visual images, such as the "arrow" and "select" array image **210** illustrated in FIG. **2**. Flexible visual display layer **204** comprises a matrix of pixels, and flexible visual display layer **204** has the characteristics of being particularly thin and flexible.

Tactile display layer **206** disposed on the back side of flexible visual display layer **204** is employed to tactilely enhanced visual images rendered on flexible visual display layer **204**. Tactilely display layer **206** is also employed to facilitate user interaction, i.e. touching, with the tactilely enhanced visual images.

Tactile display layer **206** comprises a number of pistons **208** and a sensor circuit (not shown). For the embodiment, pistons **208** are disposed in an effective core area of display **106**. Pistons **208** may be selectively activated/raised to push against different corresponding portions of flexible visual display layer **204**. Since visual display layer **204** is flexible, the pushing creates a raised or elevated condition for the visual images rendered on the area being pushed. The sensor circuit detects and reports any touching by a user of any of the tactilely enhanced visual images.

Transparent touch sensitive layer **202** is employed to provide conventional touch sensing for non-tactilely enhanced visual images. For the embodiment, transparent touch sensitive layer **202** has a hollowed effective area, surrounding the effective core area of tactile display layer **206**.

Tactile enhanced visual imaging display **106** is the subject matter of U.S. Pat. No. 7,138,985, entitled "Tactilely Enhanced Visual Image Display" and issued on Nov. 21, 2006, that patent having the same inventorship and being contemporaneously filed with the present application. Its specification is hereby fully incorporated by reference.

In alternate embodiments, the present invention may be practiced with an embodiment of tactilely enhanced visual image display **106** without the "top" transparent touch sensitive layer **202**.

## Dynamically Formed Non-Persistent Input Keys

FIGS. **3***a*-**3***g* illustrate various example non-persistent input keys that may be dynamically formed using the tactilely enhanced visual images of the present invention, in accordance with a number of embodiments. As illustrated in FIG. **3***a*, a number of non-persistent tactilely enhanced numeric input keys may be dynamically formed on display **106** by first rendering the visual images of these keys on the flexible visual display layer **204**, and then tactilely enhancing these visual images by selectively activating/raising the corresponding pistons **208** of tactile display layer **206**.

Similarly, as illustrated in FIG. **3***b* and **3***c*, a number of non-persistent tactilely enhanced alphabet input keys may be dynamically formed on display **106** in a like manner. Depending on the application (e.g. wireless mobile phone or email), the non-persistent tactilely enhanced alphabet input keys may be formed in a 9-key arrangement or the QWERT arrangement.

Similarly, as illustrated in FIG. **3***d* and **3***e*, a number of non-persistent tactilely enhanced punctuation and special character input keys may be dynamically formed on display **106** in a like manner.

Similarly, as illustrated in FIG. **3***f* and **3***g*, a number of non-persistent tactilely enhanced function/control keys may be dynamically formed on display **106** in a like manner. These function/control keys may be function/control of various media devices, including but are not limited to TV, VCR player, CD/DVD player, MP3 player, set-top box, and so forth.

In various embodiments, in addition to or in lieu of the above illustrated dynamically formed non-persistent tactilely enhanced keys/buttons, these keys/buttons may also include "go up", "go down", "go left", "go right", "page up", "page down" and/or device selection keys/buttons. Device selection keys/buttons may e.g. be also employed to facilitate selection of a media device, such as a TV, a VCR player, a CD/DVD player, and so forth.

In various embodiments, various tactilely enhanced input key group selection keys may also be provided. That is, various non-persistent tactilely enhanced keys may be dynamically formed to facilitate a user in causing the tactilely enhanced numeric, alphabetic or "special" keys/buttons to be dynamically formed for use by the user.

## Tactilely Enhanced Menu/List Items

FIGS. **3***h*-**3***i* illustrate various example menu and list items that may be formed using the tactilely enhanced visual images of the present invention, in accordance with a