number of embodiments. As illustrated in FIG. **3***h*, in like manner, as earlier described for tactilely enhanced input keys, user selectable menu items may likewise be tactilely enhanced to improve user experience in interacting with these user interface elements.

In like manner, as illustrated in FIG. **3***i*, user selectable list items may also be tactilely enhanced to improve user experience in interacting with these user interface elements.

Tactilely Enhanced Visual Image Specification and Graphics Function Call

FIG. **4** illustrates a tactilely enhanced visual image specification of the present invention and a companion graphics function call to render the tactilely enhanced visual image specified, in accordance with one embodiment. As illustrated, for the embodiment, an application, such as application **120** of FIG. **1**, in source form, may specify a tactilely enhanced visual image to provide a non-persistent tactilely enhanced input key in a manner similar to the manner icon/image is conventional specified in a source program.

Example key specification **402** may include a reference **404** to the visual image to be rendered. Reference **404** may e.g. be in the form of a path name of a file system or a URL, identifying a local or remote location from which the visual image to be rendered may be obtained.

Example key specification **402** may further include the location the visual image is to be rendered, e.g. in the form of the x, y coordinates **406** of an invisible "control box" containing the visual image to be rendered, and the extents in the x and y directions **408-410**, also referred to as the width and height of the visual image.

Example key specification **402** may further include various tactile attribute specifications **412** specifying the tactile enhancements for the visual image. These tactile attributes may e.g. include the height, the medium height or the maximum height of the pistons to be activated or raised **414**, a pattern of the pistons to be employed **416**, and the hardness to be simulated **418**.

In various embodiments, the specified height is resolved to be the maximum height of the centroid piston of the group of pistons to be activated.

In various embodiments, different patterns may be employed to tactilely enhance a visual image. For examples, the group of pistons to be employed may form a square pattern, a rectangular pattern, a parallelogram pattern, a rhombus pattern, a circular pattern, a triangle pattern, a pentagon/hexagon pattern, a star pattern, and so forth.

In various embodiments, the hardness specification provides the specification for the resistance to be provided by the associated servo mechanism of the pistons, against a user pushing or touching the activated/raised pistons.

Accordingly, for the embodiment, a developer of application **120** may cause the desired tactilely enhanced visual image to be rendered calling **420** (see also **122** of FIG. **1**) a graphics function/service (**132** of FIG. **1**) of a graphic function/service library (**130** of FIG. **1**) of the execution environment, similar to other conventional graphics calls.

Graphics Function

FIG. **5** illustrates the operational flow of the relevant aspects a graphics function of the present invention, in accordance with one embodiment. As illustrated, upon receipt of a draw request or a graphics operation request of the like, based on the parameters and information supplied, the graphics function first generates the pixel data, block **502**. Then, the graphics function determines if the visual image to be rendered is to be tactilely enhanced or not (based on the parameters or information provided with the call), block **504**.

If the visual image to be rendered is also to be tactilely enhanced, the graphics function also generates the piston data, block **506**.

Upon generating the pixel and the piston data (if applicable), the graphics function performs other application dependent processing as in the prior art, block **506**.

Thereafter, the graphics function invokes the appropriate functions of a device driver or appropriate device drivers, to drive the flexible visual display layer **204** to render the visual image, using the pixel data generated, and to drive the tactile display layer **206** to selectively activate/raise the applicable pistons, to tactilely enhance the corresponding visual image rendered, using the piston data generated, block **510**.

In one embodiment, different device drivers **140**, one each, are provided to control the corresponding layers **202-206** of display **106**. In another embodiment, different functions of a single device driver **140**, are provided to control the corresponding layers **202-206** of display **106**. In yet another embodiment, a combination hybrid approach is employed.

Date Structure and Format

FIGS. **6-7** illustrate a data structure and a data format suitable for use to store the pixel and piston data of a tactilely enhanced visual image of the present invention, in accordance with one embodiment. As illustrated in FIG. **6**, the pixel and piston data of a tactilely enhanced visual image are organized as an object hierarchy **600**, with the identity and global attributes of the tactilely enhanced visual image being stored in a root object **602** of the object hierarchy **600**.

The pixel data are stored in a children pixel data object **604** of root object **602**, and the piston data are stored in a children piston data object **606** of root object **602**.

As illustrated in FIG. **7**, the piston data of each piston is stored in a 32-bit word **700**, with the value of four tactile attributes occupying four corresponding bytes **702**.

In alternate embodiments, the present invention may be practiced employing other data organizations and/or other data formats.

Example Applications

FIGS. **8***a*-**8***f* illustrate various example devices that may be incorporated with the teachings of the present invention, in accordance with various embodiments. As illustrated in FIG. **8***a*, the present invention may be applied and practiced on a "universal" remote control for controlling a wide range of media devices, including but are not limited to TV, VCR, CD/DVD players, and so forth. The control/function keys of these devices are dynamically formed employing tactilely enhanced visual images as earlier described.

As illustrated in FIG. **8***f*, the present invention may be applied and practiced on these media devices themselves, i.e. TV, VCR, CD/DVD players and so forth.

Similarly, as illustrated in FIG. **8***b*, the present invention may also be applied and practiced on a rich function wireless mobile phone, or as illustrated in FIG. **8***c*, a PDA.

Likewise, the present invention may also be applied and practiced on a palm-sized computing device (not shown), a tablet computing device (not shown), a laptop computing device, FIG. **8***d*, and a desktop computing device, FIG. **8***e*.