

[0042] 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.

[0043] 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.

[0044] Tactilely Enhanced Menu/List Items

[0045] FIGS. 3*h-3i* 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 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.

[0046] 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.

[0047] Tactilely Enhanced Visual Image Specification and Graphics Function Call

[0048] 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.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] Graphics Function

[0057] 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.

[0058] If the visual image to be rendered is also to be tactilely enhanced, the graphics function also generates the piston data, block 506.

[0059] 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.

[0060] 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.

[0061] In one embodiment, different device drivers 140, one each, is provided to control the corresponding layers 202-206 of display 106. In another embodiment, different functions of a single device drivers 140, one each, is provided to control the corresponding layers 202-206 of display 106. In yet another embodiment, a combination hybrid approach is employed.

[0062] Data Structure and Format

[0063] 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.