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## TACTILELY ENHANCED VISUAL IMAGE DISPLAY

### FIELD OF THE INVENTION

The present invention relates to the field of visual displays. More specifically, the present invention relates to a tactilely enhanced visual image display.

### BACKGROUND OF THE INVENTION

Human-machine interface has long been a subject of interest to designers of human operated machinery, particularly for machines or devices intended for “unskilled” novice users, such as personal devices of various kinds, remote controls, palm-sized computing devices (also referred to as personal digital assistants (PDA)), laptop computers, and so forth. Improved ease-of-use, in general, improves user satisfactions.

Increasingly, as a result of advances in microprocessor and other related technologies, more and more personal devices are processor based and multi-functional. For example, today one can acquire a PDA that can also serve as a wireless mobile phone, a MP3 player and so forth.

Typically, the appropriate end user interfaces, i.e. the interfaces for operating one of these devices as a PDA, a wireless mobile phone, or a MP3 player and so forth, are presented on a touch sensitive screen on an as needed basis. A user would interact with the interface by touching the appropriate interface element, a visual image, e.g. a key or button image, or a menu or list item image.

Many of these graphical interfaces are intuitive, and easy-to-use. However, as friendly as these graphical interfaces are, there is no tactile feel to the touching of the key or button image (i.e. a user does not feel the clicking of a real key/button). The same applies to the selection of menu or list items. The lack of tactile feedback is “difficult” or “less satisfying” for some user.

Thus, it is desirable if the user experience may be further enhanced by providing the user with tactile sensations when interacting with at least some of the interface elements.

### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

FIG. 1 illustrates an exploded perspective view of the relevant elements of the tactilely enhanced visual image display sub-assembly of the present invention, in accordance with one embodiment;

FIG. 2 illustrates a perspective view of the flexible visual display layer of FIG. 1 in a flexed position, in accordance with one embodiment;

FIG. 3 illustrates a perspective view of the tactile display layer of FIG. 1 with a number of its pistons in an activated or raised position, in accordance with one embodiment;

FIGS. 4a-4b illustrate the alignment relationships between the pixels of the flexible visual display layer and the pistons of the tactile display layer, in accordance with two embodiments;

FIG. 5 illustrates a cross-section side view of the flexible visual display layer and the tactile display layer, with a number of pistons of the tactile display layer in an activated or raised position, pushing against the flexible visual display layer, in accordance with one embodiment;

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FIG. 6 illustrates an architectural view of the pistons of the tactile display layer and companion elements, in accordance with one embodiment;

FIG. 7 illustrates an exploded perspective view of the relevant elements of the tactilely enhanced visual image display sub-assembly of the present invention, in accordance with another embodiment;

FIG. 8 illustrates the transparent touch sensitive layer of FIG. 7 in further details, in accordance with one embodiment;

FIG. 9 illustrates a companion limiting circuit of the transparent touch sensitive layer, in accordance with another embodiment; and

FIG. 10 illustrates an assembled perspective view of a tactilely enhanced visual image display device of the present invention, in accordance with one embodiment.

### DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The present invention includes a tactilely enhanced visual image display.

In the following description, various aspects of the present invention will be described. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some or all aspects of the present invention. For purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well-known features are omitted or simplified in order not to obscure the present invention.

Parts of the description will be presented in terms, such as pixels, active matrix, pistons, and so forth, consistent with the manner commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art.

The phrase “in one embodiment” is used repeatedly. The phrase generally does not refer to the same embodiment, however, it may. The terms “comprising”, “having” and “including” are synonymous, unless the context dictates otherwise.

Section headings are merely employed to improve readability, and they are not to be construed to restrict or narrow the present invention.

FIG. 1 illustrates an exploded perspective view of the relevant elements of the tactilely enhanced visual image display sub-assembly **100** of the present invention, in accordance with one embodiment. As illustrated, for the embodiment, tactilely enhanced visual image display sub-assembly **100** includes flexible visual display layer **102** and tactile display layer **104**, disposed adjacent to each other. Tactile display layer **104** or more specifically, its pistons **106**, are advantageously employed to tactilely enhance visual images rendered on flexible visual display layer **102**, to further improve user experience, by providing the user with tactile sensations when interacting with the rendered visual images.

More specifically, flexible visual display layer **102** is employed for rendering visual images, such as the example “arrow” and “select” key array image **108** depicted.

For the embodiment, similar to conventional flat panel displays, flexible visual display layer **102** comprises a number of thin-film transistors forming a matrix of pixels (not shown) to facilitate visual image rendering.

However, unlike conventional flat panel displays, the thin-film transistors are plastic thin-film transistors, thus