

ELECTRO-OSMOTIC TACTILE DISPLAY

BACKGROUND

[0001] Information may be communicated to recipients through electronic means, such as a computer, mobile device, and/or simulator, for example. Electronic information, as well as virtually any information communicated from a distance, has traditionally been provided to recipients through audio and visual channels.

BRIEF DESCRIPTION OF THE FIGURES

[0002] The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several examples in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings.

[0003] In the drawings:

[0004] FIG. 1 depicts a tactile display device;

[0005] FIG. 2 depicts an enlarged view of the tactile display device of FIG. 1;

[0006] FIG. 3 depicts a front view of the tactile display device of FIGS. 1 and 2;

[0007] FIG. 4 depicts a block diagram of an example system configured for use with the tactile display device of FIGS. 1-3;

[0008] FIG. 5 depicts a flow diagram of an example procedure for using the tactile display device of FIGS. 1-3, all arranged in accordance with at least some implementations of the present disclosure; and

[0009] FIG. 6 depicts an enlarged view of the layers of an example of a tactile display.

DETAILED DESCRIPTION

[0010] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative examples described in the detailed description, drawings, and claims are not meant to be limiting. Other examples may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

[0011] The present disclosure is generally drawn to devices, apparatuses, methods, and systems related to tactile display. Adding data channels other than visual and audio channels to communicate data through interfaces is generally desirable. Users of interfaces, as well as designers, manufacturers, and suppliers of interfaces may benefit from the addition of other data channels. Touch data, for instance, may provide heightened data to a user in terms of the type and quantity of information that may be communicated to a user of a suitable device or apparatus. In some examples, tactile display devices may be arranged to effectively communicate touch data in a selective, targeted and/or rapid manner so as to

meaningfully and usefully stimulate a person's sense of touch. In some examples, the tactile displays may be scalable and cost effective so as to properly address existing and anticipated applications with which they may be used. Example uses may include, but are not limited to, 3-dimensional world and immersion situations, training simulators, medical rehabilitation, and educational applications.

[0012] Examples in accordance with the present disclosure may provide a touch sense display to a person's skin using, for example, a glove, article of clothing and/or device having a body-touching layer. Such example devices may be worn or otherwise disposed such that the body-touching layer may contact a person's skin. Some examples may not come in direct contact with a person's skin, but rather may be disposed for indirect contact, for example, via contact with clothing that the user may be wearing.

[0013] FIG. 1 depicts a tactile display device arranged in accordance with at least some implementations of the present disclosure. The tactile display device 100 may include a zone 112, an enlarged view of which is depicted in FIG. 1. In this example, the tactile display device is configured as a wearable glove, though other examples may include displays such as full body suits, upper body suits, lower body suits, head covers, and the like, or any combination thereof. The tactile display device 100 may include outer surface layer 121, reservoir layer 122, pump member 123, and toxel layer 124. The outer surface layer 121 may include a receiver (not shown). The toxel layer 124 may include toxels 130, 131, 133, 134, 135, 136, 137, 138, 139. Bubbles 143, 144, 145 and corresponding bubble cavities 153, 154, 155 may be formed by the toxels 133, 134, 135 during use of the tactile display device 100. The tactile display device 100 may include channels 163, 164, 165 through which a liquid 126 may flow between the reservoir layer 122 and the toxel layer 124.

[0014] The tactile display device 100 may be configured for electro-osmotic flow (EOF), which may be described as the motion of a liquid through narrow channels under a low applied electric field. Electro-osmotic flow may occur in natural unfiltered water, as well as in buffered solutions. Liquid 126 may be disposed in reservoir layer 122, which may be configured so that the liquid 126 may be pumped by the pump member 123 by electro-osmosis when a low electric field is applied across the pump member 123. The liquid 126 thus may be pumped by the pump member 123 to flow through the channels 163, 164, 165 from the reservoir layer 122 to the toxel layer 124 and form bubbles 143, 144, 145 and corresponding bubble cavities 153, 154, 155. The liquid 126 being pumped to the toxel layer may cause bubbles 143, 144, 145 to form, expand, and protrude so as to make physical contact with a user of the tactile display device 100 and thereby communicate tactile information. Bubbles 143, 144, 145 may be constructed of an elastic material so that when the low electric field is no longer applied across the pump member 123, the liquid 126 may be forced by the elasticity of the material from which the bubbles 143, 144, 145 may be arranged, to flow through the channels 163, 164, 165 from the toxel layer 124 back to the reservoir layer 122. This action may cause the bubbles 143, 144, 145 to deflate so as to no longer protrude and make physical contact, or cause physical contact to be made, with a user of the tactile display device 100.

[0015] As depicted in FIG. 1, layers 121, 122, 123, 124 may be a series of layers, each of which may comprise a member. In various examples, more or fewer layers than shown in