[0014] **FIG. 2A** is a schematic side view of a touch panel of an image display device in which a polymer is inserted;

[0015] **FIG. 2B** is a view illustrating expansion/contraction of a single electro-active polymer by an electrical activation;

[0016] **FIG. 2C** is a view illustrating vertical movement of electro-active polymers by an electrical activation;

[0017] **FIG. 3** is a flowchart of a method of providing fingertip haptics of visual information using an electro-active polymer, according to an exemplary embodiment of the present invention;

[0018] **FIG. 4** is a flowchart illustrating a polymer movement operation of S**320** depicted in **FIG. 3**; and

[0019] **FIG. 5** is a flowchart illustrating a polymer deforming operation of S**340** and a pattern generating operation of S**330**, which are illustrated in **FIG. 3**.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS OF THE PRESENT INVENTION

[0020] Exemplary embodiments of the present invention will be described more in detail hereinafter with reference to the accompanying drawings.

[0021] **FIG. 1** shows a schematic block diagram of a device for providing fingertip haptics of visual information, according to an exemplary embodiment of the present invention.

[0022] The inventive device includes a control unit **100**, a sensing unit **130**, an electro-active polymer (hereinafter referred to as "polymer") **140**, a pattern generating unit **150**, and a database **160**.

[0023] The control unit **100** is designed to move the polymer **140** based on a detecting signal from the sensing unit **130** and deform the polymer **140** based on a pattern signal generated from visual information. The control unit **100** is comprised of a polymer movement control unit **110** and a polymer deformation control unit **120**. The polymer movement control unit **110** moves a contacting point by applying a first driving voltage to the polymer **140** based on location information of the touch point of the detecting signal. The polymer deformation control unit **120** expands and contracts the polymer by applying a second driving voltage to the polymer **140** based on the pattern signal from the pattern generating unit **150**.

[0024] The sensing unit **130** outputs the detecting signal to the control unit **100** by detecting the user's finger contact on the touch panel.

[0025] The pattern generating unit **150** outputs the pattern signal to the control unit **100** by generating a pattern of haptic information from the visual information based on the detecting signal. In **FIG. 1**, the pattern generating unit **150** is formed to be independent from the control unit **100**; however, it can be formed with the control unit **100** in a single chip.

[0026] The polymer **140** is moved or deformed by being electrically activated under the control of the control unit **100**, thereby providing the fingertip haptics of the visual information to the user. That is, when the polymer **140** is activated by a driving voltage (or a driving current), it may be physically moved or deformed. The polymer **140** may be selected from the group consisting of gel, an ionic polymer, a conducting polymer, and an electro-restrictive polymer. However, the present invention is not limited to these polymers.

[0027] The polymer **140** may be formed of a single electro-active polymer or a plurality of electro-active polymers. If using a plurality of electro-active polymers, it is possible to more accurately transmit the haptics to the user, but the manufacturing cost is increased. **FIGS. 2B and 2C** show exemplary embodiments using a single electro-active polymer and a plurality of electro-active polymers, respectively.

[0028] **FIG. 2A** shows a schematic side view of a touch panel of an image display device in which a polymer is inserted. The touch panel includes an indium tin oxide (ITO) layer **200**, a spacer **210** and a panel unit **220**. **FIG. 2B** illustrates expansion/contraction of a single electro-active polymer by an electrical activation. **FIG. 2C** illustrates a vertical movement of a plurality of electro-active polymers by an electrical activation.

[0029] Referring again to **FIG. 1**, the database **160** stores visual information including haptic information. The visual information stored in the database **160** includes geometric information (e.g., a width, a length, a height, etc.) and physical information (e.g., a friction coefficient, an elastic coefficient, a mass, etc.) of an object such as a button, an icon and the like that are displayed on the panel unit **220**. Such visual information may be actual information obtained based on actual data (e.g., from Computerized Axial Tomography (CT) or Magnetic Resonance Imaging (MRI) visual information data) or may be artificial information generated by a predetermined pattern.

[0030] **FIG. 3** shows a method of providing fingertip haptics of visual information using an electro-active polymer, according to an exemplary embodiment of the present invention.

[0031] The method illustrated in **FIG. 3** will be described hereinafter in conjunction with **FIGS. 1 and 2**.

[0032] Referring to **FIGS. 1 through 3**, In S**300**, the user touches the ITO layer **200** of the touch panel. In S**310**, the sensing unit **130** detects a touch point (i.e., a point of contact) of the user's finger on the touch panel. Here, the touch point is not necessarily limited to a single point where the user's finger touches the touch panel. That is, the touch point may include, for example, a line or a surface. At this point, the sensing unit **130** detects a touch state (i.e., touch pressure) as well as the touch point and transmits this information in a detecting signal to the control unit **100**. In S**320**, the polymer movement control unit **110** moves the polymer **140** to the touch point by applying a first driving voltage to the polymer **140** based on location information of the touch point in the detecting signal. In the case of the single electro-active polymer, the polymer moves only in a horizontal direction. However, in the case of the plurality of electro-active polymers, the polymer moves in both the horizontal and vertical directions. The operation S**320** will be described more in detail with reference to **FIG. 4**.

[0033] In S**330**, the pattern generating unit **150** generates a pattern of the haptic information from the visual informa-