

been applied, the deformation of the electroactive polymer material **15** maintains a steady state.

[0072] **FIG. 3F** depicts a triangle DC voltage wave form superimposed with a sinusoidal wave form being applied to the electrodes **20A**, **20B** of the dynamic graphical display device **5**. The application of a triangle DC wave form causes the electroactive polymer material **15** to deform in concert with the increasing and decreasing voltage applied to the electrodes **20A**, **20B**.

[0073] In addition, the superimposed sinusoidal wave form causes the deformation of the electroactive polymer material **15** to further vary as a time and voltage function in concert with the applied sine wave, thus rendering a “shimmering” effect to the electroactive polymer material **15** and any graphical image **10** affixed thereto. The various wave forms described above may be used to make a graphical image **10** appear to expand slowly, as if growing over time from the small size to the large size. To achieve the slow change in visual perspective, the electronic controller **35** may be programmed to slowly vary the voltage from an initial value (0 V) to a final value (500 V).

[0074] The voltage may be varied linearly or non-linearly, depending upon the desired change in visual perception. Additionally, the voltage may be varied across a dynamic function, such as a slowly growing DC voltage with a small oscillating AC signal superimposed upon a based DC voltage. This overlaid oscillating signal could be used to make the graphical image **10** appear “alive” simulating an image of a cartoon.

[0075] Referring to **FIGS. 4A and 4B**, an exemplary implementation of the invention is depicted. In this example, a graphical image **10A** is affixed to a baseball cap **400** as patch or team logo. The fabric material under or surrounding the patch could be constructed from a flexible cloth or elastomeric material to allow for the deformation of the graphical image **10A**. The electronic controller **35** and EMF generator **25** may be hidden in the back of the cap **400** or sewn into the cap’s lining. The graphical image **10A** is affixed to a dynamic graphical display device **5** as previously described. In this example, an electronic controller **35** is configured to periodically expand the graphical image **10B** and contract the graphical image **10A**. In various embodiments of the invention, such as print media images, company logos or graphics on packaging, it may be useful to include a touch sensor coupled to the local control electronics (usually via a local processor) such that when the image itself is touched the image deformations are triggered. For example, a logo on the cap **400** shown in **FIGS. 4A and 4B** include a graphical image **10A**, **10B** that performs its deformation routine when the wearer lightly touches the graphical image **10A**, **10B** with his or her finger.

[0076] Because electroactive polymer actuators may act as sensors as well as actuators the same electro-active polymer structure can be used as both the sensor for touching the image as well as the actuator for deforming the image. The sensor works by detecting a voltage and/or current produced or changed as a result of a person pressing upon the compliant material and compressing the electrodes together by a sufficient amount.

[0077] **FIGS. 4C and 4B** depict another exemplary embodiment of the invention where a dynamic graphical

display device **5** is included on packaging or provided as advertising. As previously discussed, human visual perception is far more sensitive to apparent movement than to constant images. Therefore, a dynamic graphical display device **5** added to traditional packaging, product labeling and advertising may be used as a means of attracting the attention of a prospective customer to a particular product or service.

[0078] For example, product slogans, product names, product logos, and other similar advertising information could be made to expand, contract, oscillate, and otherwise change over time as dynamic graphical images **10C**. In this example, a graphical image **10C** may be affixed to product packaging via a dynamic graphical display device **5** and may be controlled by embedded electronics to slowly oscillate between two states **10C**, **10D**, rapidly oscillate between two states **10C**, **10D**, or otherwise deform based upon a time varying voltage signal provided by a controller **35**.

[0079] **FIGS. 5A and 5B** provides an exemplary embodiment of the invention where multiple graphical images **10A-10I** may be affixed to an electroactive polymer material **15** having nine independently controllable electrode regions **5A-5H**.

[0080] In this embodiment of the invention, a single sheet of electroactive polymer material **15** includes multiple electrodes (not shown) under independent or coordinated control by the electronic controller **35**. Using such a configuration, multiple graphical images **10A-10I** can be transferred to the electroactive polymer material **15**, each of which being selectively energized by the electronic controller **35** as is depicted in **FIGS. 5C and 5D**.

[0081] In **FIG. 5C**, one graphical image **10A** is selected out of all of the graphical images **10A-10I** and energized to cause an increase in its size. In **FIG. 5D**, two graphical images **10C** and **10G** are selected out of all the graphical images **10A-10I** and energized to cause an increase in their size. This multiple graphical image **10A-10I** embodiment of the invention provides for example, diverse image control on a single page of text within a printed media. In another example, a different color, shape, number, or letter could be graphically imaged above each independently controllable electrode regions **5A-5H**. A reader of the printed media could therefore see different graphical images **10A-10I** by interacting or observing variations in the shapes, numbers, colors, or letters, which have been expanded while reading the printed media.

[0082] Referring to **FIG. 6**, another exemplary embodiment of the invention is depicted where a graphical image **10A** is affixed to an electroactive polymer device **15** that is provided with multiple electrodes **20A-20L** which may be separately and selectively energized by a controller **35**. By separately and selectively energizing one or more of the electrodes **20A-20J**, the graphical image **10A** may be transformed into various geometries. The layout of the electrodes **20A-20J** does not need to be uniform. For example, a graphical image **10** of a body or a face could have electrodes of various shapes and sizes positioned such that they fall under various body parts that can be independently activated. For instance, the example of graphical image **10A**, each eye may be controlled in size and/or shape independently by different pairs of electrodes placed under each eye