DETAILED DESCRIPTION

Overview

[0025] In one or more embodiments, two conductive surfaces are utilized and suitably driven to provide movement of at least one of the surfaces through attractive and/or repellant forces. The movement of the surfaces can be harnessed or utilized to provide a variety of functionality. Any suitable type of material can be used for the conductive surfaces. For example, the conductive surfaces can be formed as part of a transparent substrate. Alternately or additionally, the conductive surfaces can be formed from material that is not transparent, e.g., a metal material.

[0026] In one or more embodiments, a device includes a surface and an actuator mechanism operably associated with the surface. The actuator mechanism is configured to provide tactile feedback to a user in contact with the surface. In at least some embodiments, the actuator mechanism comprises a pair of spaced-apart substrates each of which supports a conductive layer of material. In at least some embodiments, a dielectric material and an adjacent air gap are interposed between the substrates. The device also includes drive circuitry operably connected to the spaced-apart substrates. The drive circuitry is configured to drive the conductive layers of material with an electrical signal. Driving the conductive layers with the electrical signal causes one or more of the corresponding substrates to be moved either or both of towards one another or away from one another. In some embodiments, the drive circuitry can use different drive profiles to drive the conductive layers to provide various tactile or audio feedback to the user.

[0027] In other embodiments, a device includes an actuator mechanism that is configured to provide tactile or audio feedback to a user. In at least some embodiments, the actuator mechanism comprises a pair of spaced-apart substrates each of which supports a conductive layer of material. At least one of the substrates supports, either directly or indirectly, or is otherwise in operative contact with a user input mechanism by which a user can provide input to the device. In at least some embodiments, a dielectric material and an adjacent air gap are interposed between the substrates. The device also includes drive circuitry operably connected to the spaced-apart substrates. The drive circuitry is configured to drive the conductive layers of material with an electrical signal. Driving the conductive layers with an electrical signal causes movement of one or both of the substrates. In some embodiments, the drive circuitry can use different drive profiles to drive the conductive layers to provide various tactile feedback to the user through the user input mechanism.

[0028] In at least some embodiments, the electrical signal that drives the conductive layers can be generated responsive to: user input or interaction, software events, and/or external triggers such as interaction with others, alerts, messages, reminders and the like. With respect to user interaction, such can occur through, for example, a touch screen, touch pad, keyboard, key pad, discrete switches (mechanical or digital), linear or rotary motion sensing, proximity, interactive content, invalid entry, limits and the like. In the discussion that follows, a section entitled "Example Device" is provided and gives but one example of a device that can utilize the inventive principles described herein. After this, a section entitled "Example Material Assembly" describes a material assembly, including an actuator mechanism, in accordance with one or more embodiments. Following this, a section entitled "Example Components" describes example components in accordance with one or more embodiments. Next, a section entitled "Embodiment with User Input Mechanism" describes an alternate embodiment. Following this, a section entitled "Example Method" describes a method in accordance with one or more embodiments. Next, a section entitled "Varying Feedback Based upon User Interface Element" describes embodiments in which feedback is varied based upon the type of user interface element engaged by user.

[0029] Example Device

[0030] FIG. **1** illustrates an example device in accordance with one or more embodiments generally at **100**. Device **100** includes a housing **102** and a surface **104** supported by the housing. Surface **104** can comprise any suitable type of surface. In this particular example, surface **104** comprises a touch surface that is configured to receive user input via touch. It is to be appreciated and understood, however, that surfaces other than touch surfaces can be utilized in connection with the principles described herein.

[0031] Touch surface **104** can comprise any suitable type of touch surface that can be physically engaged or touched by a user. In this particular example, touch surface **104** is embodied as a touch screen on a hand-held device. The touch screen can be formed from any suitable type of material such as glass or plastic and can be any suitable size. For example, a suitable touch screen may form part of a larger display device, such as a desktop monitor. Alternately or additionally, the touch screen may form part of a device on a vehicle such as, by way of example and not limitation, a user interface associated with a vehicle radio, climate control, navigation system, and/or a navigation instrumentality such as a GPS-supported navigation aid, and the like.

[0032] Alternately or additionally, in at least some other embodiments, the touch surface **104** can be embodied as a touch pad, such as one would find on a laptop computer, keyboard or button panel.

[0033] Having considered an example device, consider now an example material assembly that can provide the actuator mechanism described above and below.

[0034] Example Material Assembly

[0035] FIG. **2** illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at **200**. In this example, material assembly **200** includes a surface in the form of a screen **202** and a display **204** such as, for example, a liquid crystal display. Any suitable type of display can, however, be used.

[0036] Material assembly **200** also includes an actuator mechanism **206** operably associated with the screen **202**. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen **202**. In at least some embodiments, the actuator mechanism **206** comprises a pair of spaced-apart substrates **208**, **210** each of which supports a conductive layer of material **212**, **214** respectively. It is to be appreciated and understood, however, that substrates **208**, **210** may individually be comprised of conductive material.

[0037] Display **204** is disposed operably adjacent substrate **210**. In at least some embodiments, a dielectric material **216** and an adjacent air gap **218** are interposed between the substrates **208**, **210**. In addition, actuator mechanism **206** may also include a spring mechanism **220**, **222**. Any suitable type of spring mechanism can be utilized such as various types of mechanical springs, rubberized springs, rubberized stoppers, elastomeric material, resilient gasket material, and the like.