

TACTILE SURFACE

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 61/143,203 filed on Jan. 8, 2009, and to U.S. Provisional Application No. 61/171,646 filed on Apr. 22, 2009, the disclosures of which are incorporated by reference herein.

BACKGROUND

[0002] Today there are a limited number of options that allow touch pads or touch screens to possess and provide tactile feedback to their users. Some of these options include using electromechanical linear or rotary motors which consume a significant amount of power, have a slow response time, and do not provide “point of touch” or localized tactile feedback. That is, they typically vibrate the entire device. Other options include using piezo elements, which are generally fragile and expensive and provide very little movement back to the user; or, using large electro-magnetic solenoid type actuators that consume a significant amount of power and require complex mechanical assembly.

SUMMARY

[0003] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The same numbers are used throughout the drawings to reference like features.

[0009] FIG. 1 illustrates an example device in accordance with one or more embodiments.

[0010] FIG. 2 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

[0011] FIG. 3 illustrates some example components in accordance with one or more embodiments.

[0012] FIG. 4a illustrates a high-level block diagram of example system in accordance with one or more embodiments.

[0013] FIG. 4b illustrates an example voltage regulator in accordance with one or more embodiments.

[0014] FIG. 4c illustrates a USB interface that can allow real-time changes of haptic profiles in accordance with one or more embodiments.

[0015] FIG. 4d illustrates an electronic circuit in accordance with one or more embodiments.

[0016] FIG. 4e illustrates an electronic circuit in accordance with one or more embodiments.

[0017] FIG. 4f illustrates an electronic circuit in accordance with one or more embodiments.

[0018] FIG. 5a illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

[0019] FIG. 5b illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

[0020] FIG. 6 is a flow diagram that describes steps in a method in accordance with one or more embodiments.

[0021] FIG. 7 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

[0022] FIG. 8 illustrates a side sectional view of the FIG. 7 material assembly in accordance with one or more embodiments.

[0023] FIG. 9 is a flow diagram that describes steps in a method in accordance with one or more embodiments.

[0024] FIG. 10 illustrates the device of FIG. 1 in accordance with another embodiment.