engine interface allows host software to send a variety of commands to define, redefine, modify, select or read haptic profile information that is stored/used in the haptic device.

[0049] FIG. **9** illustrates an example schematic, combined with FIG. **11**, of the high-side and low-side switches used to drive the actuator. The components, including the optoisolators, constitute but one implementation. Accordingly, other implementations can be utilized without departing from the spirit and scope of the claimed subject matter.

[0050] FIG. **10** illustrates an example schematic of a microcontroller and supporting hardware used to implement the haptic customization engine, the haptic engine, the USB interface, the key scan circuitry, and the EEPROM. Other circuitry can be used without departing from the spirit and scope of the claimed subject matter.

[0051] FIG. **11** illustrates the details of FIG. **9**. This schematic is an example implementation of a solid state switch stacking scheme that allows inexpensive, low voltage parts to be used together in order to switch high voltage. This particular stacking scheme utilizes capacitor coupled MOSFET gates and is uniquely designed for this switching application to be very power efficient during idle and active state due to the elimination of resistors while providing reliable switching function to capacitive loads which include many electrically-deformable devices such as, by way of example and not limitation, electroactive polymers, piezo materials, and electrostatic actuators. It is to be appreciated and understood that capacitive coupling is not the only way to stack switches for increased voltage handling, nor are stacked switches the only way to handle switching of high voltage.

Example Touch Surfaces

[0052] In the discussion above, an example touch surface was illustrated in the form of a single touch surface. It is to be appreciated and understood that multiple different touch surfaces can be provided on a single device.

[0053] As an example, consider FIG. **12***a* which illustrates an example touch surface layout for a device **1200** which may reside in the form of a hand-held device. In this example, multiple different touch surfaces are provided including a display surface **1202** and a typing surface **1204**. The display surface **1202** can be utilized to display images for the user such as, for example, webpages to which a user may browse. Typing surface **1204** can be used to render a virtual keyboard or other type of virtual input mechanism for a user to provide input to the device. Both the display surface **1202** and the typing surface **1204** can be configured to provide haptic feedback as described above. For example, each individual surface may have its own actuator array to provide individualized haptic feedback to the user.

[0054] FIG. **12***b* illustrates an example touch surface layout for a device that includes a control panel **1250**. The device can be any suitable type of device such as, by way of example and not limitation, a printer, a copier, a multifunction peripheral device, a vending machine, an ATM machine, appliance white goods, GPS devices, portable gaming consoles, touch pads, mouse buttons, portable media players (MP3), Medical equipment, personal computing devices, automotive dash boards, and the like.

[0055] In this particular example, control panel **1250** includes display surface **1252**, typing surface **1254**, display surface **1256**, and typing surface **1258**. Any suitable number of surfaces can be provided and can operate as described above.

Example Method

[0056] FIG. **13** is a flow diagram that describes steps a method in accordance with one embodiment. The method can be implemented in connection with any suitable hardware, software, firmware or combination thereof. In at least some embodiments, the method can be implemented by a system, such as those systems shown and described above. It is to be appreciated and understood that the described method can be implemented by systems other than those described above without departing from the spirit and scope of the claimed subject matter.

[0057] Step **1300** detects user movement or physical engagement of a touch surface. An example of how user movement can be detected is provided above. In addition, various examples of touch surfaces are provided above as well. Step **1302** activates electrically-deformable material responsive to detecting the user movement or physical engagement. Examples of electrically-deformable material are provided above. Step **1304** moves the touch surface responsive to activation of the electrically-deformable material. Examples of how a touch surface can be moved are provided above. It is to be appreciated and understood that any suitable movement of the touch surface can occur. For example, the touch surface can be moved in a single direction. Alternately or additionally, the touch surface can be moved in multiple different directions along different movement vectors. For example, one movement vector can be away from the user and another movement vector can be toward the user.

[0058] By moving the touch surface in accordance with the embodiments described above, haptic feedback can be provided to the user to provide the user with a realistic-feeling that enhances the user's experience.

CONCLUSION

[0059] In one or more embodiments, an electronic device includes a touch surface that can be physically engaged by a user. The touch surface is operably connected to an actuator arm which, in turn, is connected to an actuator array. Drive electronics sense a user's movement relative to the touch surface and, responsively, drive the actuator array effective to move the actuator arm and, in turn, provide haptic feedback to the user through the touch surface.

[0060] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed is:

1. A device comprising:

a touch surface that can be physically engaged by a user, the touch surface comprising a generally planar top surface;

an actuator array operably coupled to the touch surface, wherein the actuator array comprises an electrically-deformable material; and

drive electronics operably coupled to the actuator array and configured to electrically drive the electrically-deformable material, responsive to sensing a user's movement