sensing element, the metal diaphragm contacting the spacer. A spring element provides a spring restoring force to the planar sensing element.

[0012] In another aspect of the present invention, a method for providing haptic feedback to a touch input device includes receiving a position signal from the touch input device indicating a contact location on a surface where said user is pressing, and determining in which of a plurality of regions on the surface the contact location is positioned. Force information is provided to cause an actuator to output a force to the user, the force associated with the user moving an object on or over the surface of the touch input device. A function can be associated with the region in which the contact location is positioned, such as rate control function of a value or moving a displayed cursor. The can be output when the user moves the object over a boundary to the contacted region from a different region of the touch input device.

[0013] The present invention advantageously provides haptic feedback to a planar touch control device of a computer, such as a touchpad or touch screen. The haptic feedback can assist and inform the user of interactions and events within a graphical user interface or other environment and ease cursor targeting tasks. Furthermore, the invention allows portable computer devices having such touch controls to take advantage of existing haptic feedback enabled software. The haptic touch devices disclosed herein are also inexpensive, compact and consume low power, allowing them to be easily incorporated into a wide variety of portable and desktop computers and electronic devices.

[0014] These and other advantages of the present invention will become apparent to those skilled in the art upon a reading of the following specification of the invention and a study of the several figures of the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a perspective view of a laptop computer device including a haptic touchpad of the present invention;

[0016] **FIG. 2** is a perspective view of a remote control device including a touchpad of the present invention;

[0017] **FIG. 3** is a top plan view of a haptic touchscreen embodiment of the present invention;

[0018] **FIG. 4** is a block diagram of a haptic system suitable for use in the present invention;

[0019] **FIG. 5** is a perspective view of one embodiment of an actuator assembly suitable for use in an inertial embodiment of the present invention;

[0020] **FIG. 6** is a perspective view of the actuator assembly of **FIG. 5** coupled to a touchpad;

[0021] **FIG. 7** is a perspective view of a separate palm surface providing inertial tactile sensations adjacent to a touchpad;

[0022] **FIG. 8***a* is a perspective view of a piezoelectric transducer suitable for use in providing inertial sensations in the present invention;

[0023] **FIG. 8***b* is a side elevational view of a piezoelectric transducer and structure of the present invention suitable for providing haptic sensations with a touch device;

[0024] **FIG. 9** is a perspective view of one embodiment of a translating surface member driven by linear actuators;

[0025] **FIG. 10** is a top plan view of another embodiment of a translating surface member driven by a rotary actuator;

[0026] **FIG. 11** is a perspective view of another embodiment of a translating surface member driven by a voice coil actuator;

[0027] **FIG. 12** is a perspective view of an embodiment of a translating surface adjacent to a touchpad;

[0028] **FIG. 13** is a perspective view of an embodiment of a touchpad translated in one direction by a rotary actuator;

[0029] **FIG. 14** is a perspective view of an embodiment of a touchpad translated in two directions by rotary actuators;

[0030] **FIGS. 15***a* and **15***b* are perspective views of a first embodiment of a flat E-core actuator of the present invention suitable for translating a touchpad or a separate surface;

[0031] **FIG. 15***c* is a side view of the actuator of **FIGS. 15***a*-**15***b;*

[0032] **FIG. 15***d* is a perspective view of the actuator of **FIGS. 15***a*-**15***b* coupled to a touchpad;

[0033] **FIGS. 16***a* and **16***b* are top and bottom perspective views of another embodiment of a flat E-core actuator of the present invention;

[0034] **FIGS. 17***a*-**17***b* are perspective and top views of surface-mounted E-core actuators of the present invention;

[0035] **FIGS. 17***c*-**17***g* are perspective and side views of the E-core actuators of **FIGS. 17***a*-**17***b;* and

[0036] **FIG. 18** is a top plan view of an example of a haptic touchpad of the present invention having different control regions.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0037] **FIG. 1** is a perspective view of a portable computer **10** including a haptic touchpad of the present invention. Computer **10** can be a portable or "laptop" computer that can be carried or otherwise transported by the user and may be powered by batteries or other portable energy source in addition to other more stationary power sources. Computer **10** preferably runs one or more host application programs with which a user is interacting via peripherals.

[0038] Computer **10** may include the various input and output devices as shown, including a display device **12** for outputting graphical images to the user, a keyboard **14** for providing character or toggle input from the user to the computer, and a touchpad **16** of the present invention. Display device **12** can be any of a variety of types of display devices; flat-panel displays are most common on portable computers. Display device **12** can display a graphical environment **18** based on application programs and/or operating systems that are running on the CPU of computer **10**, such as a graphical user interface (GUI), that can include a cursor **20** that can be moved by user input, as well as windows **22**, icons **24**, and other graphical objects well known in GUI environments. Other graphical environments or images may also be displayed, e.g. a game, movie or other presentation, spreadsheet or other application program, etc.