[0097] In FIG. **5***c*, a mouse **330** includes portions **332** of the housing **324** which are moveable in a split shell configuration, allowing a dedicated EAP actuator coupled to each portion **322** to drive its associated portion independently of the other portion **322**. The user's palm which contacts the moving portions **322** will feel the tactile sensations as the portions are moved, such as vibrations and the like. Alternatively, the portions **322** can be driven simultaneously or with a single EAP actuator having linkages to both sections.

[0098] FIG. **5***d* shows a mouse **340** including an upper portion **342** of the housing moveable with respect to the remaining housing portion **344** as shown by arrow **346** and driven by an EP actuator, where the user's palm contacts the moveable portion to feel the haptic contact forces. A hinge or other flexure can couple the moveable portion **342** with the base portion **344**. Differently-sized portions **342** can be provided in other embodiments.

[0099] Ball haptic feedback provides haptic forces acting on a ball, such as a trackball device, a ball used in a sensor mechanism in a mouse device, or other frictional movement device, to output haptic feedback in the degrees of freedom of motion of the interface device. For example, as shown in FIG. **6**, a ball actuation assembly **350** includes a sphere or ball **352**, an X roller **354**, A Y roller **356**, an X sensor **358**, a Y sensor **360**, an X EAP brake **362**, a Y EAP brake **364**, and a support **366** supporting the brakes. The ball **352** rolls against the cylindrical rollers **354** and **365** (the ball can be biased against the rollers by using, for example, a third roller that is spring biased against the ball). The encoder sensors **358** and **360** sense the position of the rollers, and thus the ball, in the x and y axes by providing an encoder wheel attached to a roller and an emitter-detector to detect slots or marks in the wheel, as is well known. The EAP brakes **362** and **364** each include a brake shoe **368** (which can be of any suitable material) on their ends facing the rollers **354** or **356**. The EAP brakes are provided with a control electrical signal to induce linear motion in the EAP elements and thus on brake shoes **368** to cause the brake shoes to frictionally contact the rolling members **354** and/or **356**. This frictional contact causes resistance to motion of the ball **352**, which the user feels as resistance to motion and haptic feedback. The EAP brakes **362** and **364** can be moved different distances to cause different amounts of friction on the rollers, thus causing different amounts of friction on the ball. This resistance also causes resistance to the mouse in its degrees of freedom, in such embodiments.

[0100] Some embodiments of the interface device **12** can include a wheel, such as mouse wheel **254** shown in FIG. **3**. The wheel can be rotated by the user's finger(s) to provide position signals to a computer indicating a position or motion of the wheel, and which can be used to scroll documents displayed by a host computer, move a cursor and select an item in a list, or perform other functions well known to those of skill in the art. Haptic feedback can be output in the rotational degree of freedom of the wheel, and/or on the wheel itself, using an EAP actuator. For example, FIG. **7***a* illustrates a wheel **380** which includes an EAP rotary inertial shaker **382**. The shaker includes a curved EAP element **384** and a mass **386** positioned at the end of the element **384**. The mass **386** can be oscillating using a periodic waveform as an input signal, similar to the shaker shown in FIG. **4***b*. This causes inertial sensation on the wheel **380**, which are transferred to the user's finger **388**.

[0101] In FIG. **7***b*, a wheel **400** includes number of radially expanding EAP actuators **402**. Each actuator **402**, as shown in FIG. **7***c*, can be similar to the area expansion actuator shown in FIG. **2***e* above to provide an expanding outer surface to the wheel **400**. Multiple EAP actuators are provided around the circumference of the wheel, where the expansion of each actuator can be controlled individually to provide tactile sensations to the user's finger based on the collective movement of those actuators in contact with the user's finger. Other types of EAP actuators, such as linear moving elements, can alternatively be used.

[0102] In FIG. **7***d*, an EAP brake device **410** is shown which includes an EAP brake **412** that includes an EAP linearly-moving structure **414** coupled to a brake shoe **416**. The brake shoe **416** frictionally contacts a rotating axle **418** of the wheel **420**, similar to the EAP brake of FIG. **6**, to cause resistance in the rotational degree of freedom of the wheel.

[0103] FIG. **7***e* illustrates a wheel device **430** that uses an EAP actuator to provide lateral motion or forces on the wheel, parallel to the axis of rotation of the wheel. A linearly-moving EAP actuator **432** can be coupled to the rotating axle **434** (or to a member rotatably coupled to the axle) to provide horizontal forces and motion, as indicated by arrow **436**, to wheel **438**. Also, in some embodiments, a linearly-moving EAP actuator **440** can be coupled to a member as shown to provide a vertical force or motion on the entire wheel device **430** as indicated by arrow **442**. These embodiments can also be used with a rotary control knob used in a variety of devices.

[0104] Other interface devices **12** can be provided with haptic feedback using EAP actuators. For example, in FIG. **8***a*, a "trackpoint" controller **450** is shown, which is often positioned between keys on a standard computer keyboard of a laptop or other computer and used to control a cursor or other pointing function by being moved in normal displacement directions, as shown by arrows **452**. For example, the trackpoint can be translated or rotationally moved in the two degrees of freedom. The trackpoint **450** can be provided with an EAP actuator **454**, which can be controlled to move linearly vertically (z-axis) in both directions to provide z-axis tactile feedback to the user's finger operating the trackpoint. In some embodiments, the EAP actuator **454** can also or alternatively act as a sensor to detect when the user is contacting the trackpoint and/or the amount of z-axis pressure or displacement exerted by the user on the trackpoint. The amount z-axis pressure can be used to control a value or parameter in an application program, such as a rate control function (scrolling, panning, zooming, velocity of a virtual vehicle in a game, etc.) or the position of a cursor in a representation of a third dimension. The trackpoint controller can be considered the interface device as well as a manipulandum of the interface device.

[0105] In FIG. **8***b*, a trackpoint controller **460** can include a linearly-moving EAP actuator similar to that of FIG. **8***a* but positioned within a hollow interior of a vertical post **462**. The cap **461** of the trackpoint can be textured to allow a stronger user grip and includes an aperture **465**. As shown in FIG. **8***c*, the EAP actuator **464** can be controlled to extend a poker **466** or other member that is coupled to the EAP actuator **464** through the aperture into the skin of the user's finger contacting the top of the trackpoint controller **460**. The poker can be withdrawn and extended to provide texture sensations to the user.

[0106] FIG. **8***d* shows another embodiment of a trackpoint controller **470**, where EAP actuators are used to provide haptic feedback in the normal x-y directions of control of the trackpoint controller. Four linearly-moving EAP actuators