as tactile sensations by the user. For example, a vibration can be output having a particular frequency and magnitude. Other types of actuators can also be used, as explained for the above embodiments.

FIG. **6** is a perspective view of a different embodiment **170** of the direction pad **18** of the present invention, where a direction pad **18** includes a portion **172** that extends below the direction pad. A coil **174** can be wound around the portion **172** as in a voice coil actuator. A number of magnets **176** can be fixed in position relative to the direction pad **18** (such as being coupled to the housing **14** of the device **10**). In the described embodiment, four magnets are shown, each spaced under a corresponding extension **20** of the direction pad **18**. Different numbers of magnets can be used in other embodiments. When a current is flowed through the coil **174**, a force is produced based on the interaction of the magnetic fields from the magnets **176** and the electrical current, as is well known to those skilled in the art. Since there is a single main coil **174**, a force from each magnet **176** is produced on the direction pad **18** in the same direction, thus causing all portions of the pad **18** to move up or down along the z-axis, where the force can be controlled in direction and magnitude by controlling the direction and magnitude of current. In other embodiments, additional coils can be provided. For example, a coil loop can be coupled to the pad **18** above each magnet **176**, in effect providing several voice coil actuators. The current in each such coil can then be controlled independently, allowing different magnitude and directional forces to be provided from each magnet **176** and its associated coil. This would allow the direction pad **18** to be tilted or be provided with rotational degrees of freedom **173** about a pivot point. Alternatively, the pad **18** could be translated along the z-axis by causing the same magnitude and direction of force from each magnet **176** and associated coil. Or, the coil **174** can be replaced with a single magnet (or multiple magnets) and the magnets **176** can be replaced with coils to allow similar translation and pivoting abilities. Support structures for the directional pad **18** allowing it to move relative to the housing also can be included (not shown).

FIG. **7** is a side elevational view of another embodiment **190** of the direction pad **18** of the present invention. In this embodiment, direction pad **18** is directly coupled to a piezoelectric actuator **192**, which operates as described above with reference to FIG. **5** to produce a force when an electrical signal is input to the actuator. Since the direction pad **18** is directly coupled to the actuator, any produced forces are directly applied to the direction pad **18**. The actuator **192** is coupled to the raised portions **198** of an elastomeric layer **194**, which functions to detect extension presses of the direction pad **18** as described in the embodiments above. Since the actuator **192** is coupled to the flexible raised portions **198**, the direction pad is able to flex and rotate to allow the user to press on different directions of the pad, and the raised portions **198** provide enough springiness to return the direction pad **18** to its rest position when pressure from the user is removed. The conductive portions of the raised portions **198** engage contacts on the surface of a printed circuit board **196** or other substrate similar to the embodiments described above.

While this invention has been described in terms of several preferred embodiments, it is contemplated that alterations, permutations, and equivalents thereof will become apparent to those skilled in the art upon a reading of the specification and study of the drawings. For example, many different types of actuators can be used to output tactile sensations to the user. Furthermore, many of the features described in one embodiment can be used interchangeably with other embodiments. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the present invention.

What is claimed is:

**1**. A tactile feedback control device for inputting control signals to a computer and for outputting forces to a user of the control device, the control device comprising:

a housing, said housing capable of being held and operated by a user in one or more hands of said user;

a direction pad coupled to said housing, said direction pad capable of being contacted by said user in at least two different locations to provide two different directional signals to said host computer, each directional signal corresponding to one of said locations on said direction pad; and

a computer-controlled actuator coupled to said direction pad, said actuator outputting a force directly on said direction pad to cause said direction pad to move with respect to said housing.

**2**. A control device as recited in claim **1** further comprising a microprocessor separate from said computer and providing control signals to control said actuator.

**3**. A control device as recited in claim **1** wherein each of said locations on said direction pad is an extension of said direction pad, said extensions being part of a unitary member, wherein said unitary member tilts approximately about a pivot point when said user presses one of said locations.

**4**. A control device as recited in claim **1** wherein each of said locations on said direction pad is a button separate from a central portion of said direction pad.

**5**. A control device as recited in claim **1** further comprising a sensor that detects when said locations of said direction pad have been contacted by said user.

**6**. A control device as recited in claim **5** wherein said sensor includes a plurality of contact switches.

**7**. A control device as recited in claim **6** further comprising an elastometric layer positioned under said direction pad, said elastomeric layer providing conductive portions to engage said contact switches.

**8**. A control device as recited in claim **1** wherein said direction pad is capable of being contacted by said user in four different locations, each location providing a different directional signal to said host computer.

**9**. A control device as recited in claim **1** wherein said force is a linear force output approximately perpendicularly to a plane of a top surface of said direction pad.

**10**. A control device as recited in claim **9** wherein said actuator is a linear actuator that provides an output force in a linear degree of freedom.

**11**. A control device as recited in claim **1** wherein said actuator is a rotary actuator that provides an output force in a rotary degree of freedom.

**12**. A control device as recited in claim **11** further comprising at least one member coupling said actuator to said directional pad which converts said rotary output force to an approximately linear output force imparted on said direction, said linear output force being approximately perpendicular to a top surface of said direction pad.

**13**. A control device as recited in claim **1** wherein said actuator includes a voice coil actuator.

**14**. A control device as recited in claim **1** wherein said actuator includes a piezo-electric actuator.

**15**. A control device as recited in claim **1** wherein said actuator includes a pager motor.

**16**. A control device as recited in claim **1** wherein said actuator includes a solenoid.