HAPTIC STYLUS UTILIZING AN ELECTROACTIVE POLYMER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation application of U.S. patent application Ser. No. 11/711,400 filed Feb. 26, 2007 by Bruce M. Schena, entitled, "Haptic Devices Using Electroactive Polymers", which is a continuation of U.S. patent application Ser. No. 09/866,385, filed May 24, 2001 by Bruce M. Schena, entitled, "Haptic Devices Using Electroactive Polymers", now U.S. Pat. No. 7,196,688 which claims the benefit of U.S. Provisional Patent Application No. 60/206,929, filed May 24, 2000 also by Bruce M. Schena, entitled, "Haptic Feedback Devices Using Electroactive Polymers".

BACKGROUND

[0002] This description relates generally to interface devices for allowing humans to interface with computer systems, and more particularly to low-cost computer interface devices that allow the user to provide input to computer systems and allow computer systems to provide haptic feedback to the user.

[0003] A user can interact with an environment displayed by a computer to perform functions and tasks on the computer, such as playing a game, experiencing a simulation or virtual reality environment, using a computer aided design system, operating a graphical user interface (GUI), navigate web pages, etc. Common human-computer interface devices used for such interaction include a mouse, joystick, trackball, gamepad, steering wheel, stylus, tablet, pressure-sensitive sphere, or the like, that is connected to the computer system controlling the displayed environment. Typically, the computer updates the environment in response to the user's manipulation of a physical manipulandum such as a joystick handle or mouse. The computer senses the user's manipulation of the user object through sensors on the interface device that send locative signals to the computer. In other applications, interface devices such as remote controls allow a user to interface with the functions of an electronic device or appliance.

[0004] In some interface devices, force (kinesthetic) feedback and/or tactile feedback is also provided to the user, more generally known collectively herein as "haptic feedback." These types of interface devices can provide physical sensations which are felt by the user manipulating a user manipulandum of the interface device, such as a joystick handle, mouse, wheel, etc. One or more motors or other actuators are coupled to the manipulandum and are connected to the controlling computer system. The computer controls forces on the manipulandum and/or device housing in conjunction and coordinated with displayed events and interactions by sending control signals or commands to the actuators. The computer system can thus convey physical force sensations to the user in conjunction with other supplied feedback as the user is grasping or contacting the interface device or manipulatable object of the interface device.

[0005] One problem with current haptic feedback controllers in the home consumer market is the high manufacturing cost of such devices, which makes the devices expensive for the consumer. A large part of this manufacturing expense is due to the inclusion of complex and multiple actuators and corresponding control electronics in the haptic feedback device. In addition, high quality mechanical and force transmission components such as linkages and bearings further add to the cost of the device. Some low cost haptic devices exist, but are highly limited in their ability to output haptic sensations.

[0006] A need therefore exists for a haptic feedback device that is lower in cost to manufacture yet offers the user compelling haptic feedback to enhance the interaction with computer applications.

SUMMARY

[0007] The described subject matter is directed toward providing haptic feedback in an interface device using electroactive polymer (EAP) actuators, which can provide haptic sensations more efficiently and at lower cost than many existing technologies for haptic devices.

[0008] More particularly, a haptic feedback interface device is in communication with a host computer implementing a host application program and is manipulated by a user. The interface device includes a sensor device that detects the manipulation of the interface device by the user and outputs sensor signals representative of the manipulation, and an electroactive polymer actuator responsive to input signals and operative to output a force to the user caused by motion of the actuator. The output force provides a haptic sensation to the user. Haptic feedback interface devices using electroactive polymer (EAP) actuators to provide haptic sensations. A haptic feedback interface device is in communication with a host computer and includes a sensor device that detects the manipulation of the interface device by the user and an electroactive polymer actuator responsive to input signals and operative to output a force to the user caused by motion of the actuator. The output force provides a haptic sensation to the user. In an embodiment, a stylus including a body having a first end and a second end opposite from the first end, a moveable member coupled to the body and capable of being in contact with a user's hand; and an electro active polymer actuator coupled to the moveable member, wherein the electroactive polymer moves the moveable member from a first position to a second position with respect to the body upon being activated.

[0009] These and other advantages will become apparent to those skilled in the art upon a reading of the following specification and a study of the several figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a block diagram illustrating a haptic feedback system suitable for use with the described embodiments;

[0011] FIG. **2***a* is a side elevational view of an electroactive polymer element in a bending motion;

[0012] FIG. **2***b* is a top plan view of an electroactive polymer element in a bending motion;

[0013] FIG. **2***c* is a side elevational view of an electroactive polymer sandwich structure providing linear and bending motion;

[0014] FIG. **2***d* is a perspective view of an electroactive polymer element in a cylindrical configuration to provide motion in multiple degrees of freedom;

[0015] FIG. **2***e* is a perspective view of an electroactive polymer structure that provides an area expansion of the element;