

## HAPTIC FEEDBACK FOR DIRECTIONAL CONTROL PADS

### CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of parent patent applications:

Application Ser. No. 09/156,802, now U.S. Pat. No. 6,184,868, filed Sep. 17, 1998 entitled, "Haptic Feedback Control Devices,"

Application Ser. No. 09/103,281, now U.S. Pat. No. 6,088,019, filed Jun. 23, 1998 entitled, "Low Cost Force Feedback Device with Actuator for Non-Primary Axis," and

Application Ser. No. 09/253,132, now U.S. Pat. No. 6,243,078, filed Feb. 18, 1999 on behalf of Louis Rosenberg, entitled, "Pointing Device with Forced Feedback Button,"

all assigned to the assignee of this present application, and all of which are incorporated herein by reference in their entirety.

### BACKGROUND OF THE INVENTION

The present invention relates generally to the interfacing with computer and mechanical devices by a user, and more particularly to devices used to interface with computer systems and electronic devices and which provide haptic feedback to the user.

Humans interface with electronic and mechanical devices in a variety of applications, and the need for a more natural, easy-to-use, and informative interface is a constant concern. In the context of the present invention, humans interface with computer devices for a variety of applications. One such application is interacting with computer-generated environments such as games, simulations, and application programs. Computer devices such as game consoles (e.g. available from Nintendo, Sony, and Sega), personal computers, portable computers, and internet appliances are typically used to provided these environments, although a wide variety of devices can be used.

For many computer generated environments, users interface with the environment using an interface device having controls such as a joystick, gamepad, mouse, trackball, buttons, steering wheel, or other device physically contacted and manipulated by the user. The user manipulates the controls which provides position or other related input data to the computer, and the computer updates the environment or program in response, such as a game program.

In some interface devices, force feedback or tactile feedback is also provided to the user, more generally known herein as "haptic feedback." In the game console market, haptic feedback interface devices such as "gamepad" controllers (or add-on hardware for gamepad controllers) for game consoles include the Dual Shock from Sony, the Rumble Pack from Nintendo, and the Jump Pack from Sega. These devices are vibrotactile-feedback controllers which employ one or more motors coupled to the housing of the controller to shake the housing and thus provide output vibrations to the user which are correlated to game events and interactions. Typically, an eccentric rotating mass (ERM) motor is used to generate vibration on the controller housing and thus to the user.

One problem with existing vibrotactile controllers is that the vibrations produced are generalized in location to the entire housing of the control device. Thus the user cannot

experience localized tactile sensations that are specific to a portion of the gamepad controller or to a control on the controller, such as a button or direction pad ("D-pad"). Thus, only one type of tactile sensation can be experienced at one time by the user, which limits the immersive experience for the user when interacting with the computer.

### SUMMARY OF THE INVENTION

The present invention is directed to a low-cost haptic feedback control on an interface device connected to a computer system, where the control is a directional pad provided with haptic sensations for enhancing interactions and manipulations in a displayed graphical environment or when controlling an electronic device.

More specifically, the present invention relates to a haptic feedback control device coupled to a host computer and outputting forces to a user of the control device, the control device including a housing that can in some embodiments be held and operated by a user in one or more hands. A direction pad is coupled to the housing and is capable of being contacted by the user in at least two different locations to provide two different directional signals to the host computer, each directional signal corresponding to one of the locations on the direction pad. A computer-controlled actuator is coupled to the direction pad and outputs a force directly on the pad.

In one embodiment, each of the locations on the direction pad is an extension of the direction pad, the extensions being part of a unitary member, wherein the unitary member tilts approximately about a pivot point when the user presses one of the locations. In other embodiments, each of the locations on the direction pad is a button separate from a central portion of the direction pad. A sensor, such as one or more contact switches, detects when the locations of the direction pad have been contacted or pressed by the user. An elastomeric layer positioned under the direction pad can provide conductive portions to engage the contact switches. The direction pad is preferably capable of being contacted by the user in four different locations, each location providing a different directional signal to the host computer.

The actuator can be a linear actuator that provides an output force in a linear degree of freedom, e.g. approximately perpendicular to the top surface of the direction pad, or a rotary actuator that provides an output force in a rotary degree of freedom, where at least one member couples the actuator to the directional pad which converts the rotary output force to an approximately linear output force imparted on the direction pad. The actuator can be a voice coil actuator, a piezo-electric actuator, a pager motor, a solenoid, or other type. The actuator can output a vibration or a pulse tactile sensation on the direction pad. The computer displays a graphical environment which with the user interacts using the control device, and the control device can be a game controller, a mouse, a remote control device, or other type of device.

A microprocessor separate from the computer can receive force information from the host computer and provide control signals based on the force information to control the actuator. The user can interact with a graphical environment using said control device, such as a game, web page, or graphical user interface. In some embodiments, a sensor can be used to detect motion or position of the direction pad approximately perpendicularly to a top surface of the direction pad, wherein an input signal based on the detected motion or position is sent to the computer. In some embodiments, the direction pad is caused to move to a lower