FORCE FEEDBACK COMPUTER INPUT AND OUTPUT DEVICE WITH COORDINATED HAPTIC ELEMENTS

CROSS-REFERENCES

[0001] This application is related to Disclosure Document No. 431794 entitled "ACTIVE MULTI-TOUCH INPUT SURFACE (AMTIS)," having D. E. Fish as inventor. This disclosure document is hereby incorporated by reference herein, in its entirety and for all purposes.

BACKGROUND

[0002] 1. Field of Invention

[0003] This invention relates to computer input and output devices, specifically to those which provide force feedback, and to those which can be used as a pointing device for graphical user interfaces.

[0004] 2. Description of Prior Art

[0005] Computers are becoming increasingly important as a productivity tool. They continue to improve dramatically in terms of computational speed, memory, storage and display. However, the interface between users and the computer has not changed significantly since the introduction of the mouse and the graphical user interface. The human-computer interface must be improved for users to increase their productivity and take better advantage of the new capabilities computers provide.

[0006] Many common computer interface operations are best performed with a direct manipulation interface. For example, when using a drawing application, it is easier for the user to point at the object they wish to select, rather than use a voice recognition interface in which they must describe the object they wish to select. Typically, direct manipulation interfaces combine a high-resolution pointing device, used to move a cursor on the screen, with some way to initiate an action at the current location. For example, a mouse may employ rotary optical encoders to measure the distance moved, and one or more buttons for "clicking" on the object beneath the cursor (e.g., selecting, actuating, dragging, or otherwise manipulating an on-screen object.).

[0007] While this was a significant improvement over previous devices, such an interface does not come close to fully exploiting the abilities people have to manipulate objects with their hands. Existing devices have one or more of the following drawbacks:

No direct mapping between the hand and the display

[0008] Direct mapping is used herein to describe the case where a one-to-one correspondence exists between the position of a cursor on a screen and the position of a user's hand, and also implies that there is a unique hand position for every cursor position. Input devices which do not move, such as trackballs, joysticks, the IBM TrackPoint® and the Synaptics TouchPad, lack such a direct mapping. No matter where the cursor is, the user's hand is in essentially the same location. A mouse also lacks a direct mapping, for at least two reasons. First, there is a non-linear relationship between the speed of the mouse and the speed of the cursor on the screen. This results in a different position depending on how quickly the mouse is moved from one location to another. Second, the mouse is often picked up and moved during use, particularly if the working area is limited.

[0009] Direct mapping is important because it better leverages a user's spatial skills. Humans have a keen sense of the position of their hands in relationship to their body and their environment. Taking advantage of these spatial skills is valuable because the cognitive load placed on the user by the computer interface is decreased, leaving the user's attention available for performing work. For example, when dragging an object from one point on the screen to another, a user must pay close attention to a cursor's position and look for visual feedback indicating the cursor is positioned properly, in order to manipulate an on-screen object. During this process, the user's attention is not available for other tasks (e.g., reviewing files, program output, and the like). Some existing input devices have a direct mapping between the hand and the screen, such as touch screens and digitizing tablets. These devices suffer from other infirmities, as described below.

Lack of dynamic haptic feedback

[0010] Haptic feedback is a preferable characteristic for input devices. The term haptic feedback as used herein means communicating information to a user through forces applied to the user's body. Typically, the position of some portion of an input device changes along at least one degree of freedom depending on the force applied by the user. For example, when pressing a button on a mouse, the button does not move until the applied force reaches a certain threshold, at which point the button moves downward with relative ease and then stops (e.g., the sensation of "clicking" a button). The change in the position of the button communicates to the user through their sense of touch that the mouse click was successful. Note that a device with haptic feedback can be an input device (initiating an action) and an output device (giving haptic feedback indicating that the action was initiated) simultaneously.

[0011] Input devices that are completely devoid of haptic feedback, such as membrane keyboards and touch screens, have not gained widespread acceptance for desktop computers as a result of this deficiency. Thus when using such input devices, users are uncertain whether a finger press was registered by the computer and so must pay special attention to visual or auditory feedback to get this confirmation. This decreases data entry rates, making users less productive and the computer interface less enjoyable to use.

[0012] Mice, trackballs, joysticks, and other devices often provide buttons for initiating actions that provide haptic feedback. For example, the stylus used with a graphics tablet has a spring in its tip so the position of the pen relative to the tablet can vary depending on the applied force. However, such devices have the same haptic response regardless of the state of the user interface. For example, if a user clicks the mouse on a graphical button that is disabled, the haptic response of the mouse button is no different from that of clicking a button that is enabled, and so is misleading to the user because no action will result from the click. What is needed is an input device which provides dynamic haptic feedback. Haptic feedback is termed herein as being dynamic to indicate that the haptic feedback can be altered over time (e.g. by means a software application) in order to provide additional information to a user.