User-independent events can also be relayed to the user using haptic sensations on the touchpad. An event occurring within the graphical environment, such as an appointment reminder, receipt of email, explosion in a game, etc., can be signified using a vibration, pulse, or other time-based force. The force sensation can be varied to signify different events of the same type. For example, vibrations of different frequency can each be used to differentiate different events or different characteristics of events, such as particular users sending email, the priority of an event, or the initiation or conclusion of particular tasks (e.g. the downloading of a document or data over a network). When the host system is "thinking," requiring the user to wait while a function is being performed or accessed (usually when a timer is displayed by the host) it is often a surprise when the function is complete. If the user takes his or her eyes off the screen, he or she may not be aware that the function is complete. A pulse sensation can be sent to indicate that the "thinking" is over.

A software designer may want to allow a user to be able to select options or a software function by positioning a cursor over an area on the screen using the touchpad, but not require pressing a physical button or tapping the touchpad to actually select the option. Currently, it is problematic to allow such selection because a user has physical confirmation of execution when pressing a physical button. A pulse sent to the touchpad of the present invention can act as that physical confirmation without the user having to press a button or other control for selection. For example, a user can position a cursor over a web page element, and once the cursor is within the desired region for a given period of time, an associated function can be executed. This is indicated to the user through a tactile pulse sent to the pad **16**.

The above-described force sensations can also be used in games or simulations. For example, a vibration can be output when a user-controlled racing car is driving on a dirt shoulder of a displayed road, a pulse can be output when the car collides with another object, and a varying-frequency vibration can be output when a vehicle engine starts and rumbles. The magnitude of pulses can be based on the severity of a collision or explosion, the size of the controlled graphical object or entity (and/or the size of a different graphical object/entity that is interacted with), etc. Force sensations can also be output based on user-independent events in the game or simulation, such as pulses when bullets are fired at the user's character.

The above haptic sensations can be similar to those described in copending patent application Ser. No. 09/253,132, and application Ser. No. 09/456,887 entitled, "Tactile Mouse Device," filed Dec. 7, 1999, which are both incorporated herein by reference. Other control devices or grips that can include a touchpad **16** of the present invention in its housing include a gamepad, mouse or trackball device for manipulating a cursor or other graphical objects in a computer-generated environment; or a pressure sphere or the like. For example, the touchpad **16** can be provided on the housing of a computer mouse to provide additional input to the host computer. Furthermore, selective disturbance filtering of forces, as described in copending patent application Ser. No. 08/839,249, and shaping of force signals to drive the touchpad with impulse waves as described in U.S. Pat. No. 5,959,613, can be used with the present invention, both disclosures incorporated herein by reference. Such impulses are also effective when driven with stored power in a battery on the computer **10** or from a bus such as USB connected to a host computer.

The touchpad **16** can also be provided with different control regions that provide separate input from the main cursor control region **70**. In some embodiments, the different regions can be physically marked with lines, borders, or textures on the surface of the pad **16** (and/or sounds from the computer **10**) so that the user can visually, audibly, and/or or tactilely tell which region he or she is contacting on the pad.

For example, scroll or rate control regions **62***a* and **62***b* can be used to provide input to perform a rate control task, such as scrolling documents, adjusting a value (such as audio volume, speaker balance, monitor display brightness, etc.), or panning/tilting the view in a game or virtual reality simulation. Region **62***a* can be used by placing a finger (or other object) within the region, where the upper portion of the region will increase the value, scroll up, etc., and the lower portion of the region will decrease the value, scroll down, etc. In embodiments that can read the amount of pressure placed on the pad **16**, the amount of pressure can directly control the rate of adjustment; e.g., a greater pressure will cause a document to scroll faster. The region **62***b* can similarly be used for horizontal (left/right) scrolling or rate control adjustment of a different value, view, etc.

Particular haptic effects can be associated with the control regions **62***a* and **62***b*. For example, when using the rate control region **62***a* or **62***b*, a vibration of a particular frequency can be output on the pad **16**. In those embodiments having multiple actuators, an actuator placed directly under the region **62***a* or **62***b* can be activated to provide a more localized tactile sensation for the "active" (currently used) region. As a portion of a region **62** is pressed for rate control, pulses can be output on the pad (or region of the pad) to indicate when a page has scroll by, a particular value has passed, etc. A vibration can also be continually output while the user contacts the region **62***a* or **62***b*.

Other regions **64** can also be positioned on the touchpad **16**. For example, each of regions **64** provides a small rectangular area, like a button, which the user can point to in order to initiate a function associated with the pointed-to region. The regions **64** can initiate such computer functions as running a program, opening or closing a window, going "forward" or "back" in a queue of web pages in a web browser, powering the computer **10** or initiating a "sleep" mode, checking mail, firing a gun in a game, cutting or pasting data from a buffer, selecting a font, etc. The regions **64** can duplicate functions and buttons provided in an application program or provide new, different functions.

Similarly to regions **62**, the regions **64** an each be associated with haptic sensations; for example, a region **64** can provide a pulse sensation when it has been selected by the user, providing instant feedback that the function has been selected. Furthermore, the same types of regions can be associated with similar-feeling haptic sensations. For example, each word-processor related region **64** can, when pointed to, cause a pulse of a particular strength, while each game-related region can provide a pulse of different strength or a vibration. Furthermore, when the user moves the pointing object from one region **62** or **64** to another, a haptic sensation (such as a pulse) can be output on the pad **16** to signify that a region border has been crossed.

In addition, the regions are preferably programmable in size and shape as well as in the function with which they are associated. Thus, the functions for regions **64** can change based on an active application program in the graphical environment and/or based on user preferences input to and/or stored on the computer **10**. Preferably, the size and location of each of the regions can be adjusted by the user or by an application program, and any or all of the regions can be completely removed if desired. Furthermore, the user is preferably able to assign particular haptic sensations to particular