similar to a pulse force, but depends on the position of the user's finger on the area of the touchpad and/or on the location of the cursor in a graphical environment. Thus, texture bumps can be output depending on whether the cursor has moved over a location of a bump in a graphical object. This type of force is spatially-dependent, i.e. a force is output depending on the location of the cursor as it moves over a designated textured area; when the cursor is positioned between "bumps" of the texture, no force is output, and when the cursor moves over a bump, a force is output. This can be achieved by host control (e.g., the host sends the pulse signals as the cursor is dragged over the grating). In some embodiments, a separate touchpad microprocessor can be dedicated for haptic feedback with the touchpad, and the texture effect and be achieved using local control (e.g., the host sends a high level command with texture parameters and the sensation is directly controlled by the touchpad processor). In other cases a texture can be performed by presenting a vibration to a user, the vibration being dependent upon the current velocity of the user's finger (or other object) on the touchpad. When the finger is stationary, the vibration is deactivated; as the finger is moved faster, the frequency and magnitude of the vibration is increased. This sensation can be controlled locally by the touchpad processor (if present), or be controlled by the host. Such texture sensations are described in copending application Ser. No. 09/504,201, which is incorporated herein by reference. Other spatial force sensations can also be output. In addition, any of the described force sensations herein can be output simultaneously or otherwise combined as desired.

[0187] Different types of graphical objects can be associated with haptic sensations. Haptic sensations can output on the touchpad based on interaction between a cursor and a window, menu, icon, web page link, etc. For example, a "bump" or pulse can be output on the touchpad to signal the user of the location of the cursor when the cursor is moved over a border of a window. In other related interactions, when a rate control or scrolling function is performed with the touchpad (through use of the cursor), sensations can be output related to the rate control functions. Furthermore, the magnitude of output forces on the touchpad can depend on the event or interaction in the graphical environment, including user-independent events. These force sensations can also be used in games or simulations. These and other haptic sensations are described in U.S. Pat. No. 6,211,861 and copending patent application Ser. No. 09/585,741, both incorporated herein by reference. Other control devices or grips that can include a touchpad 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.

[0188] Some forms of touchpads and touchscreens allow the amount of pressure the user is exerting on the touchpad to be sensed. This allows a variety of haptic sensations to be determined based at least in part on the sensed pressure. For example, a periodic vibration can be output having a frequency that depends on the sensed pressure. Or, the gain (magnitude) of output haptic sensations can be adjusted based on the sensed pressure. Those users that always tend to use the touchpad with more pressure can be allowed to select an automatic magnitude increase that would be in effect constantly.

[0189] Other embodiments of touchpads and touchscreens allow the user to enter "gestures" or shortcuts by tracing a symbol on the cursor control region or other region, which is recognized as a command or data by a processor. Haptic sensations can be associated with or dependent on particular gestures. For example, a confirmation of modes can be conveyed haptically with a particular haptic sensation when a mode confirmation gesture is recognized. Characters recognized from gestures also may each have a particular haptic sensation associated with them. In most touchpad embodiments, a user can select a graphical object or menu item by "tapping" the touchpad. Some touchpads may recognize a "tap-and-a-half" or double tap, which is the user doing a tap and then again touching the pad and maintaining the finger or object on the pad while moving the finger. For example, such a gesture can provide a "drag" mode in which objects may be moved with the cursor. When the user is in such a drag mode, a vibration or other haptic sensation can be output to indicate to the user that this mode is active.

[0190] As stated above, the touchpad **450** can also be provided with different control regions that provide separate input from the main cursor control region **452**. In some embodiments, the different regions can be physically marked with lines, borders, or textures on the surface of the touchpad **450** (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 touchpad.

[0191] For example, scroll or rate control regions **454***a* and **454***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 simulation. Region **454***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 touchpad, 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 **454***b* can similarly be used for horizontal (left/right) scrolling or rate control adjustment of a different value, view, etc.

[0192] Particular haptic effects can be associated with the control regions **454***a* and **454***b*. For example, when using the rate control region **454***a* or **454***b*, a vibration of a particular frequency can be output on the touchpad. In those embodiments having multiple actuators, an actuator placed directly under the region **454***a* or **454***b* can be activated to provide a more localized tactile sensation for the "active" (currently used) region. As a portion of a region **454** is pressed for rate control, pulses can be output on the touchpad (or region of the touchpad) 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 **454***a* or **454***b*.

[0193] Other regions **456** can also be positioned on the touchpad **450**. For example, each of regions **456** can be 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 **456** can initiate such computer functions as running a program, opening or closing a window, going "forward" or "back" in a queue of web pages