HAPTICALLY ENABLED USER INTERFACE

FIELD OF THE INVENTION

[0001] One embodiment of the present invention is directed to haptic effects. More particularly, one embodiment of the present invention is directed to a user interface having haptic effects.

BACKGROUND INFORMATION

[0002] Electronic device manufacturers strive to produce a rich interface for users. Conventional devices use visual and auditory cues to provide feedback to a user. In some interface devices, kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, texture, and heat) is also provided to the user, more generally known collectively as "haptic feedback" or "haptic effects". Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, vibration effects, or vibrotactile haptic effects, may be useful in providing cues to users of electronic devices to alert the user to specific events, or provide realistic feedback to create greater sensory immersion within a simulated or virtual environment.

[0003] Haptic feedback has also been increasingly incorporated in portable electronic devices, such as cellular telephones, personal digital assistants (PDAs), portable gaming devices, and a variety of other portable electronic devices. For example, some portable gaming applications are capable of vibrating in a manner similar to control devices (e.g., joysticks, etc.) used with larger-scale gaming systems that are configured to provide haptic feedback. Additionally, devices such as cellular telephones and PDAs are capable of providing various alerts to users by way of vibrations. For example, a cellular telephone can alert a user to an incoming telephone call by vibrating. Similarly, a PDA can alert a user to a scheduled calendar item or provide a user with a reminder for a "to do" list item or calendar appointment.

[0004] Increasingly, portable devices are moving away from physical buttons in favor of touchscreen-only interfaces. This shift allows increased flexibility, reduced parts count, and reduced dependence on failure-prone mechanical buttons and is in line with emerging trends in product design. Many of these touchscreen devices include sophisticated user interfaces that convert user gestures, including multi-touch gestures, into input commands.

SUMMARY OF THE INVENTION

[0005] One embodiment is a device having a user interface that generates a haptic effect in response to user inputs or gestures. In one embodiment, the device receives an indication that the user is scrolling through a list of elements and an indication that an element is selected. The device determines the scroll rate and generates a haptic effect that has a magnitude that is based on the scroll rate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** is a block diagram of a cellular telephone in accordance with one embodiment.

[0007] FIG. **2** is a block diagram of a user interface that includes a list of elements that can be scrolled through the interaction of a scroll bar in accordance with one embodiment.

[0008] FIG. **3** is a flow diagram of the functionality performed by the telephone of FIG. **1** in accordance with one embodiment in response to a scrolling of elements through a user interface.

[0009] FIG. **4** is a flow diagram of the functionality performed by the telephone of FIG. **1** in accordance with one embodiment in response to a flicked object.

[0010] FIG. **5** is a user interface for a touchscreen that provides a virtual slider for controlling volume.

[0011] FIG. **6** is a flow diagram of the functionality performed by the telephone of FIG. **1** in accordance with one embodiment in response to the movement of a slider.

DETAILED DESCRIPTION

[0012] One embodiment is a haptically enabled user interface that provides haptic confirmation to a user in response to various user inputs and gestures or device activity.

[0013] FIG. **1** is a block diagram of a cellular telephone **10** in accordance with one embodiment. Telephone **10** includes a touchscreen **11** and may include mechanical keys/buttons **13**. Internal to telephone **10** is a haptic feedback system that generates vibrations on telephone **10**. In one embodiment, the vibrations are generated on the entire telephone **10**. In other embodiments, specific portions of telephone **10** can be haptically enabled by the haptic feedback system, including the entire touchscreen **11** or individual portions of touchscreen **11**.

[0014] The haptic feedback system includes a processor **12**. Coupled to processor **12** is a memory **20** and an actuator drive circuit **16**, which is coupled to a vibration actuator **18**. Processor **12** may be any type of general purpose processor, or could be a processor specifically designed to provide haptic effects, such as an application-specific integrated circuit ("ASIC"). Processor **12** may be the same processor that operates the entire telephone **10**, or may be a separate processor. Processor **12** can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters. In general, the high level parameters that define a particular haptic effect include magnitude, frequency and duration. Low level parameters such as streaming motor commands could also be used to determine a particular haptic effect. A haptic effect may be considered "dynamic" if it includes some variation of these parameters when the haptic effect is generated or a variation of these parameters based on a user's interaction.

[0015] Processor **12** outputs the control signals to drive circuit **16** which includes electronic components and circuitry used to supply actuator **18** with the required electrical current and voltage to cause the desired haptic effects. Actuator **18** is a haptic device that generates a vibration on telephone **10**. Actuator **18** can include one or more force applying mechanisms which are capable of applying a vibrotactile force to a user of telephone **10** (e.g., via the housing of telephone **10**). Actuator **18** may be, for example, an electromagnetic actuator, an Eccentric Rotating Mass ("ERM") in which an eccentric mass is moved by a motor, a Linear Resonant Actuator ("LRA") in which a mass attached to a spring is driven back and forth, or a "smart material" such as piezoelectric, electroactive polymers or shape memory alloys. Memory device **20** can be any type of storage device or computer-readable medium, such as random access memory ("RAM") or read-only memory ("ROM"). Memory **20** stores instructions