MULTIPLE MODE HAPTIC FEEDBACK SYSTEM

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 60/828,368 filed Oct. 5, 2006.

FIELD OF THE INVENTION

[0002] One embodiment is directed to a haptic feedback system. More particularly, one embodiment is directed to a multiple mode haptic feedback system.

BACKGROUND INFORMATION

[0003] 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." 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.

[0004] 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.

[0005] For portable devices, costs is an important driving factor. Therefore, to generate haptic effects a single low cost actuator is generally used, for example an eccentric rotating mass ("ERM") motor or an electromagnetic motor. Typically, vibrations output by standard portable electronic devices, such as PDAs and cellular telephones, are simple vibrations that are applied to the housing of the portable device, which operate as binary vibrators that are either on or off to typically create an alert. That is, the vibration capability of those devices is generally limited to a full-power vibration (a "fully on" state), or a rest state (a "fully off"). Thus, generally speaking, there is little variation in the magnitude of vibrations that can be provided by such devices.

[0006] 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. When using the touchscreen input device, a mechanical confirmation on button press or other user interface action can be simulated with haptics. In order to be effective and pleasing to a user, the haptics used to simulate the buttons should typically be applied primarily to the touchscreen rather than the housing. However, the single actuator typically provided with portable devices cannot usually generate haptic effects to generate alerts on the housing and to also generate other haptic effects to, e.g., simulate a touchscreen button, on the touchscreen. Thus, one or more additional actuators are required to create the required multiple haptic effects. Unfortunately, this increases the costs of the portable device.

[0007] Based on the foregoing, there is a need for a system and method for generating multiple haptic effects using a single actuator.

SUMMARY OF THE INVENTION

[0008] One embodiment is a haptic effect device that includes a housing and a touchscreen coupled to the housing through a suspension. An actuator is coupled to the touchscreen. The suspension is tuned so that when the actuator generates first vibrations at a first frequency, the first vibrations are substantially isolated from the housing and are applied on the touchscreen to simulate a mechanical button. Further, when the actuator generates second vibrations at a second frequency, the second vibrations are substantially passed through to the housing to create a vibratory alert.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a sectional view of a cellular telephone in accordance with one embodiment.

[0010] FIG. **2** is a graph of acceleration magnitude vs. drive signal frequency that illustrates the frequency response of the telephone after tuning a suspension in accordance with one embodiment.

[0011] FIG. **3** is a graph of acceleration magnitude vs. time for one embodiment for a click vibration frequency.

[0012] FIG. **4** is a graph of acceleration magnitude vs. time for the same embodiment of FIG. **3** for an alert vibration frequency.

DETAILED DESCRIPTION

[0013] One embodiment is a device that includes a touchscreen coupled to a device housing by a suspension. A single actuator creates a haptic effect vibration that is substantially applied only to the touchscreen in one mode, and is applied to the housing in another mode.

[0014] One type of haptic effect that is typically provided on handheld portable touchscreen devices is an "alert" vibration applied to the device housing. Alert vibrations are effective when played in the 100 Hz-200 Hz frequency range. An alert is a vibratory method to notice a user of a present, future or past event. Such an alert can be a ringtone signaling an incoming call where the ringtone has been converted to a vibratory equivalent to play on the handheld device. An alert can be to notice a user of a dropped call, for ringing, busy and call waiting. Other examples of alerts include operational cues to guide the user through an operation such as for Send/OK with a different feel for each menu and message navigation for scrolling down a screen and to feel the difference between opened and unopened messages. Further, for cellular phones with GPS tracking, a proximity sensing application to determine a distance from a designated geographic location can generate an alert.