HAPTIC FEEDBACK SYSTEM WITH STORED EFFECTS

RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 11/748,219, filed May 14, 2007, which claims priority to U.S. Provisional Patent Application No. 60/890,690, filed Feb. 20, 2007. These applications are herein incorporated by reference.

FIELD OF THE INVENTION

One embodiment of the present invention is directed to a handheld device with a touchscreen. More particularly, one embodiment of the present invention is directed to a handheld device with a touchscreen that includes a haptic feedback system.

BACKGROUND INFORMATION

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.

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.

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.

Some known devices modify or generate haptic effects in real-time or "on the fly". Although this allows a wide variety of haptic effects to be generated, it may require a substantial amount of processing power and may not facilitate rapid development of new devices because the wide variety of possible haptic effects must be compatible with the hardware interface of the device.

Based on the foregoing, there is a need for an improved system and method for generating haptic effects for a device.

SUMMARY OF THE INVENTION

One embodiment is a haptic feedback system that includes a controller, a memory coupled to the controller, an actuator drive circuit coupled to the controller, and an actuator coupled to the actuator drive circuit. The memory stores at least one haptic effect that is executed by the controller in order to create a haptic effect. The stored haptic effect, unlike real-time generated haptic effects, reduces the required processing power.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. **2** is a block diagram of the system architecture of a haptic feedback system in accordance with one embodiment.

FIG. **3** is a block diagram of the software architecture in accordance with one embodiment.

FIG. **4** is a block diagram of the file format used in one embodiment for a digitized steam envelope construct.

FIG. **5** is a block diagram of an Effect Storage Block in accordance with one embodiment.

FIG. **6** illustrates a typical short control signal or stored haptic effect where the critical data to be encoded is clearly identified in accordance with one embodiment.

DETAILED DESCRIPTION

FIG. **1** is a block diagram of a cellular telephone **10** in accordance with one embodiment. Telephone **10** includes a screen **11** and keys **13**. In one embodiment, keys **13** are mechanical type keys. In another embodiment, keys **13** can be implemented by a touchscreen or other type of touch sensitive surface so that keys **13** are touchscreen keys, or can be implemented using any method. 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 individual keys of keys **13**, whether the keys are mechanically oriented, touchscreen, or some other type of implementation.

The haptic feedback system includes a controller **12**. Coupled to controller **12** is a memory **20** and an actuator drive circuit **16**, which is coupled to a vibration actuator **18**. Although the embodiment of FIG. **1** is a cellular telephone, embodiments of the present invention can be implemented with any type of handset or mobile/portable device, or any device that uses an actuator to generate vibrations. Further, the haptic feedback system may be implemented as a development board that allows manufacturers of haptically enabled handsets to perform rapid prototypes.

Controller **12** may be any type of general purpose controller or processor, or could be a controller specifically designed to provide haptic effects, such as an application-specific integrated circuit ("ASIC"). Controller **12** may be the same controller/processor that operates the entire telephone **10**, or may be a separate controller. Controller **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.

Controller **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**).