

MULTI-TOUCH DEVICE HAVING DYNAMIC HAPTIC EFFECTS

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 haptic effects for a multi-touch touchscreen device.

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. When using the touchscreen input device, a mechanical confirmation on button press or other user interface action can be simulated with haptic effects. Further, many devices are now capable of multi-touch in which a touchscreen recognizes multiple simultaneous touch points and includes software to interpret simultaneous touches.

[0005] Based on the foregoing, there is a need for a system and method for generating haptic effects for a multi-touch device.

SUMMARY OF THE INVENTION

[0006] One embodiment is a system for generating haptic effects. The system senses at least two generally simultaneous touches on a touchscreen and, in response, generates a dynamic haptic effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a block diagram of a cellular telephone in accordance with one embodiment.

[0008] FIG. 2 is a block diagram of a touchscreen and indicates two contact points where a multi-touch contact has occurred.

[0009] FIG. 3 is a flow diagram of the functionality performed by the telephone of FIG. 1 in response to multi-touch contact on the touchscreen.

DETAILED DESCRIPTION

[0010] One embodiment is touchscreen multi-touch device that includes a haptic feedback system for generating dynamic haptic effects in response to multi-touches.

[0011] 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.

[0012] 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.

[0013] 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 executed by processor 12. Memory 20 may also be located internal to processor 12, or any combination of internal and external memory.

[0014] Touchscreen 11 recognizes touches, as well as the position and magnitude of touches on a touch sensitive surface. The data corresponding to the touches is sent to processor 12, or another processor within telephone 10, and processor 12 interprets the touches and in response generates haptic