METHOD, APPARATUS, AND COMPUTER PROGRAM PRODUCT PROVIDING VIBRATION CONTROL INTERFACE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The teachings in accordance with the exemplary embodiments of this invention relate generally to a vibration control interface.

[0003] 2. Brief Description of Prior Developments

[0004] Mechanical vibrators are employed in conventional electronic devices for a variety of purposes. Mobile phones and pagers utilize a mechanical vibrator to provide a vibrating notification of incoming calls or messages. Game controllers utilize a mechanical vibrator to provide the user with a vibratory effect in the controller, to simulate game mechanics, for example. Conventional mechanical vibrators are generally either binary, having a vibratory effect or no vibratory effect, or have very few vibration settings, as few as two or three that vary only in the strength of the vibratory effect.

[0005] It is known to provide tactile feedback to displays of mobile devices (See, for example, "Ambient Touch: Designing Tactile Interfaces for Handheld Devices", Proceedings of CHI, Volume 4, Issue 2, by Poupyrev et al.). Current vibrators are usually driven with a simple step function voltage signal allowing only monotone vibration. Such signals typically exhibit long rise and fall times that provide poor tactile feedback. In addition, even in instances where the vibration effect length matches well the effect's authored length, as when using Immersion Studio by the Immersion Corporation of San Jose, Calif., the vibration effect envelope can deviate substantially from the designed envelope. As a result, generated effects are not in sync with the graphical elements of, for example, games. In addition, due to the inherent nature of pulse width modulation control the produced effects are lacking in sharp definition.

[0006] In addition, pulse width modulated (PWM) vibrators used for haptic and tactile purposes typically require real-time response on the order of 5 milliseconds, that cannot be provided using commonly employed mobile terminal operating systems, such as Symbian OS by Symbian Ltd. Even in instances where it is possible to produce a real time response, the resulting vibration effects are typically left blurry.

SUMMARY

[0007] In an exemplary aspect of the invention, a method includes defining a plurality of parameters for a vibration control pulse comprising a start pulse and a stop pulse, and outputting the vibration control pulse to a vibration element to provide tactile feedback.

[0008] In another exemplary aspect of the invention, a method includes defining a first plurality of parameters for a first vibration control pulse, outputting the first vibration control pulse to a vibration element to provide tactile feedback, defining a second plurality of parameters for a second vibration control pulse having a polarity opposite that of the first vibration control pulse, and outputting the second vibration control pulse to the vibration element to provide tactile feedback.

[0009] In another exemplary aspect of the invention, a mobile phone includes a processor configured to execute a program comprising an application program interface configured to define a vibration control pulse, and a vibration element configured to provide tactile feedback in response to the vibration control pulse.

[0010] In another exemplary aspect of the invention, a method includes defining at least a first intensity parameter for a first vibration control pulse comprising a first start pulse and a first stop pulse, outputting the first vibration control pulse to a vibration element to provide tactile feedback, defining at least a second intensity parameter for a second vibration control pulse comprising a second start pulse and a second stop pulse, and outputting the second vibration control pulse to the vibration element to provide tactile feedback wherein the first intensity parameter is different from the second intensity parameter.

[0011] In another exemplary aspect of the invention, a program of machine-readable instructions, tangibly embodied on an information bearing medium and executable by a digital data processor, performs actions including defining a plurality of parameters for a vibration control pulse comprising a start pulse and a stop pulse, and outputting the vibration control pulse to a vibration element to provide tactile feedback.

[0012] In another exemplary aspect of the invention, an integrated circuit includes a first circuitry operable to define a plurality of parameters for a vibration control pulse comprising a start pulse and a stop pulse, and a second circuit operable to output the vibration control pulse to a vibration element to provide tactile feedback.

[0013] In another exemplary aspect of the invention, an integrated circuit includes a first circuitry operable to define a plurality of parameters for a vibration control pulse comprising a start pulse and a stop pulse, and a second circuit operable to output the vibration control pulse to a vibra module.

[0014] In another exemplary aspect of the invention, a method includes utilizing a vibration application program interface to define a plurality of parameters for a vibration control pulse comprising a start pulse and a stop pulse, and executing the application program interface to provide tactile feedback.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The foregoing and other aspects of embodiments of this invention are made more evident in the following Detailed Description, when read in conjunction with the attached Drawing Figures, wherein:

[0016] FIG. **1** is a schematic diagram of software and hardware components for practicing exemplary embodiments of the invention;

[0017] FIG. **2** is a diagram of a vibration control pulse according to an exemplary embodiment of the invention;

[0018] FIG. **3** is a diagram of the derivation of control parameters for the vibration control pulse according to an exemplary embodiment of the invention;

[0019] FIG. **4** is a diagram of an apparatus for practicing exemplary and non-limiting embodiments of the invention;

[0020] FIG. **5** is a step diagram of a method according to another exemplary embodiment of the invention;

[0021] FIG. **6** is a diagram of two vibration control pulses having opposite rotation direction form each other according to an exemplary embodiment of the invention; and