

[0020] FIG. 11 is a timeline diagram illustrating the execution of multiple, basis haptic effects, according to an embodiment of the invention.

[0021] FIG. 12 is block diagram of memory addresses for multiple, basis haptic effects, according to an embodiment of the invention.

[0022] FIG. 13 is a diagram of a computer window of an application for modifying a periodic haptic effect, according to an embodiment of the invention.

[0023] FIG. 14 is a diagram of a computer window of an application for ordering multiple, basis haptic effects to form a timeline haptic effect, according to an embodiment of the invention.

[0024] FIG. 15 is a diagram of a computer window of an application for creating a haptic effect from a sound file, according to an embodiment of the invention.

[0025] FIG. 16 is a diagram of a computer window of an application for editing a frequency mapping of a haptic effect from a sound file, according to an embodiment of the invention.

DETAILED DESCRIPTION

[0026] Systems and methods for ordering haptic effects are described. More specifically, an embodiment of the invention is described in the context of a system and method configured to output a series of “basis,” or fundamental, haptic effects based on a time slot associated with each of the basis haptic effects. Basis haptic effects are output in response to basis haptic-effect signals. The basis haptic-effect signals are each associated with one of several effect slots based on the time slot associated with that basis haptic effect. The series of basis haptic effects output according to one or more embodiments of the invention is capable of conveying additional information to users that has not been possible using known devices. Moreover, the series of basis haptic effects output according to one or more embodiments of the invention is also capable of providing a user with an enhanced experience while using a device, such as a portable electronic device.

[0027] As used herein, the term “basis haptic effect” refers to an elemental haptic effect that can be used as a component or “building block” of more complex haptic effects. A “basis haptic-effect signal” is a signal that causes a basis haptic effect to be output (e.g., via a haptic device). Basis haptic effects are also sometimes referred to herein as “haptic effects” for the sake of simplicity.

[0028] According to one or more embodiments of the invention, basis haptic effects can include many types of effects, such as periodic haptic effects and magnitude-sweep haptic effects. These basis haptic effects can be used as components or “building blocks,” for example, to form a timeline haptic effect. Each of the components of the timeline effect can be ordered in such a way to provide a specific, desired tactile output to a user. The ordering of these components (e.g., basis haptic effects) can occur, for example, based on a time slot associated therewith.

[0029] An event-driven scheme, similar to schemes used for MIDI files, or the like, can be used to output timeline haptic effects. Timeline haptic effects can be created by way of an interactive software-authoring tool, which allows a

developer to specify the nature, order, and timing of basis haptic effects used to create a timeline haptic effect. Additionally, or alternatively, timeline haptic effects can be created by automatically converting information from files having an event-driven scheme (e.g., MIDI files, etc.).

[0030] According to one or more embodiments of the invention, an architecture (which can include software, firmware, hardware, or any combination thereof) is provided. The architecture can include an ordering component configured to associate each basis haptic effect from multiple basis haptic effects with a time slot during which that basis haptic effect is to be output. This can be accomplished, for example, based on one or more control signals received by the ordering component (e.g., from an interface component). The ordering component can, for example, provide an ordered haptic-effect signal (e.g., a timeline haptic-effect signal) to a driver, which is configured to cause all basis haptic effects associated with the timeline haptic-effect signal to be output via a haptic device. The output component is configured to associate each basis haptic effect with an effect slot from multiple effect slots. The output component is also configured to cause each basis haptic effect to be output during its associated time slot.

[0031] Advantageously, one or more embodiments of the invention allow haptic effects to be output based on information obtained from, converted from, or otherwise associated with a corresponding output (e.g., as defined by a MIDI file, etc.). For example, in the case of event-driven files, such as MIDI files, haptic effects can be output based on the notes, channels, or any combination thereof, defined in the MIDI file. This allows haptic effects to be output synchronously with such event-driven files (e.g., synchronized with the beat of music created by a MIDI file). Following this example, a different haptic effect can be defined for each MIDI instrument and/or channel, or combination thereof, such that a great variety of haptic effects is available (e.g., each haptic effect can correspond to one of over 200 MIDI instruments). Moreover, haptic effects can be commanded to correspond to parameters of MIDI files (e.g., corresponding to notes in length, speed, strength, duration, etc.), or can be based on such parameters, but tailored as desired, according to one or more other embodiments of the invention. Editing such parameters can be carried out prior to, during, or after selection of corresponding features in the MIDI file.

[0032] FIG. 1 is a block diagram of a processor system, according to an embodiment of the invention. The processor system 110 illustrated in FIG. 1 can be, for example, a commercially available personal computer, portable electronic device, or a less complex computing or processing device (e.g., a device that is dedicated to performing one or more specific tasks). For example, the processor system can be a cellular telephone, a PDA, a portable gaming system, or the like. Alternatively, the processor system 110 can be a terminal dedicated to providing an interactive virtual reality environment, such as a gaming system, or the like. Although each component of the processor system 110 is shown as being a single component in FIG. 1, the processor system 110 can include multiple numbers of any components illustrated in FIG. 1. Additionally, multiple components of the processor system 110 can be combined as a single component.