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(54) CUSTOMIZING HAPTIC EFFECTS ON AN END USER DEVICE

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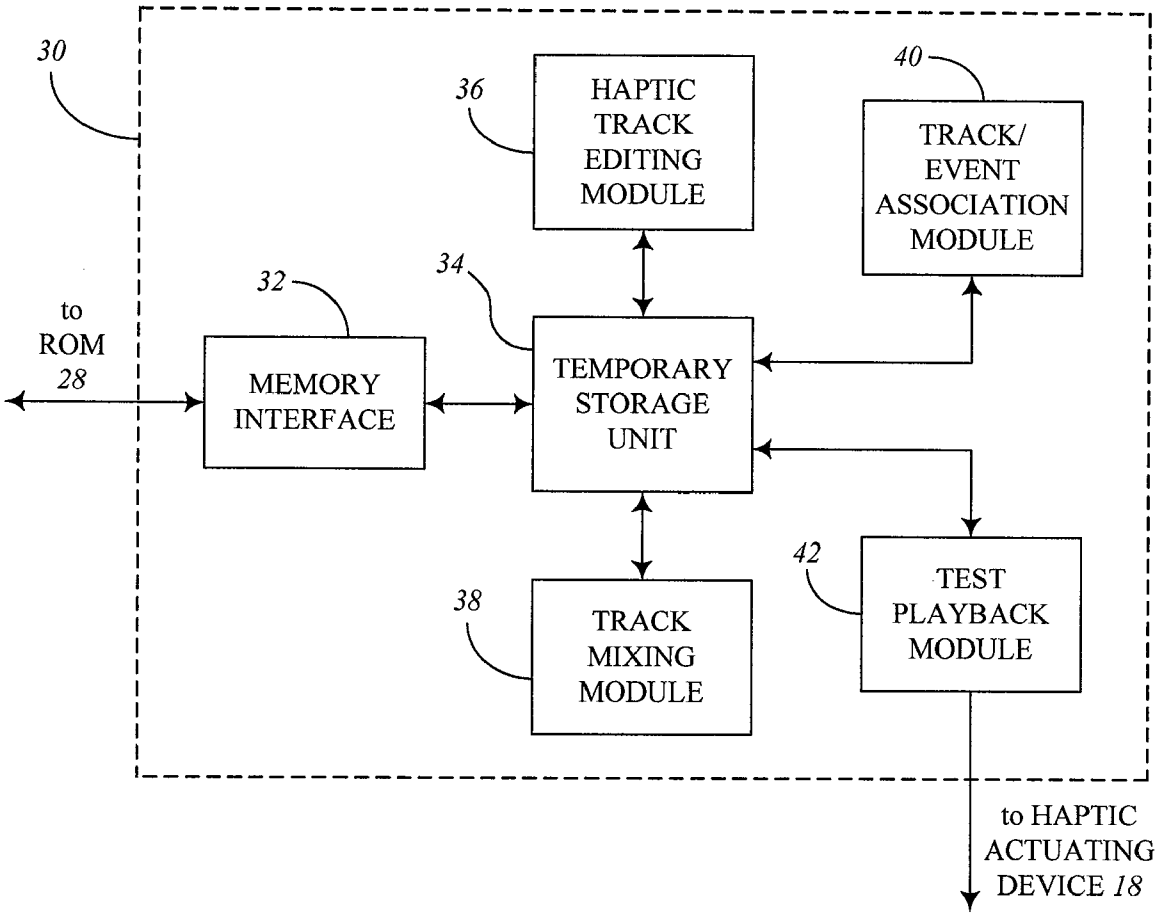
(57) **ABSTRACT**

Systems, methods, and associated software are described herein for enabling a regular user of an end user device, such as a cellular telephone, to customize parameters associated with haptic effects applied to the user by the end user device. In one implementation, among several, a method described herein includes enabling a user of an end user device to access software adapted to design or modify haptic effects of the end user device. The method further includes enabling the user to open a haptic track file and enter or modify parameters associated with the haptic effects of the opened haptic track file.



APPLE 1006

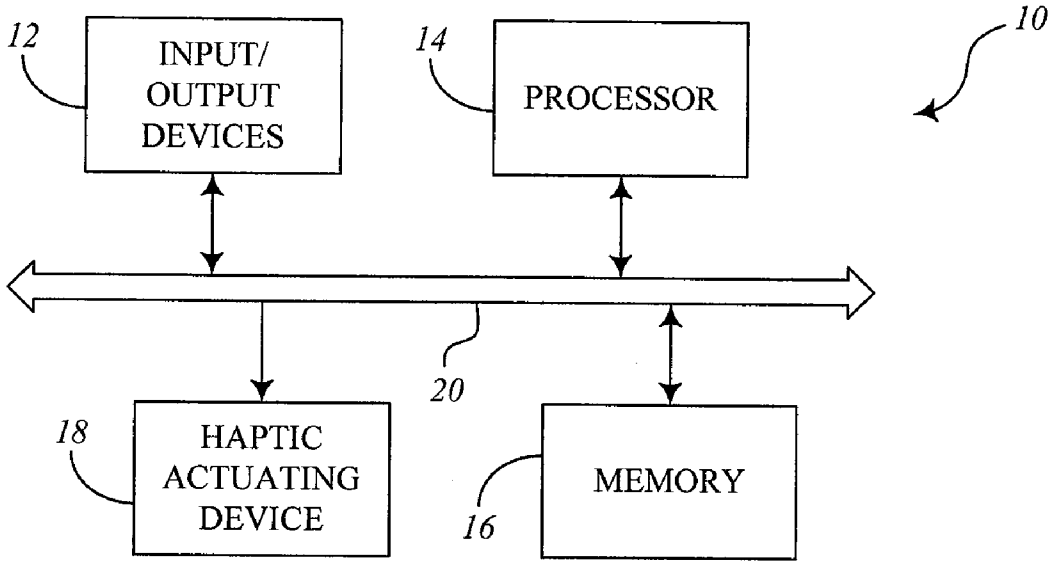

12
INPUT/
OUTPUT
DEVICES
14
PROCESSOR
10
20
18
HAPTIC
ACTUATING
DEVICE
16
MEMORY

FIG. 1

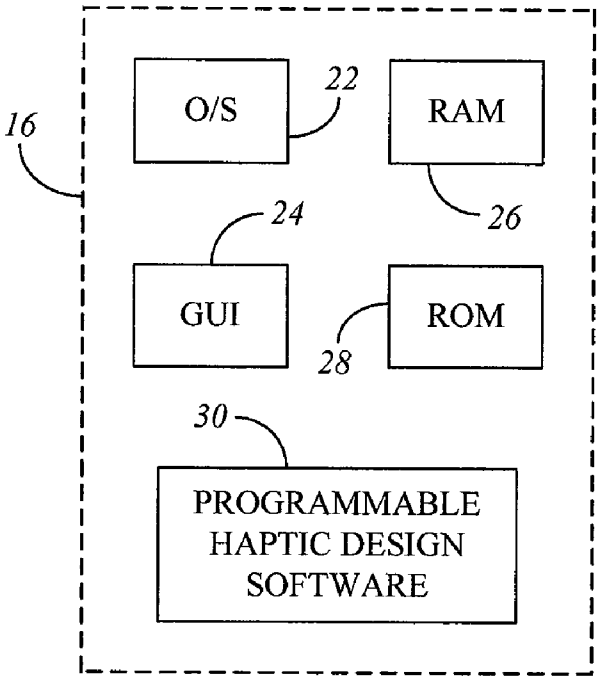

16
O/S
22
RAM
24
26
GUI
ROM
28
30
PROGRAMMABLE
HAPTIC DESIGN
SOFTWARE

FIG. 2

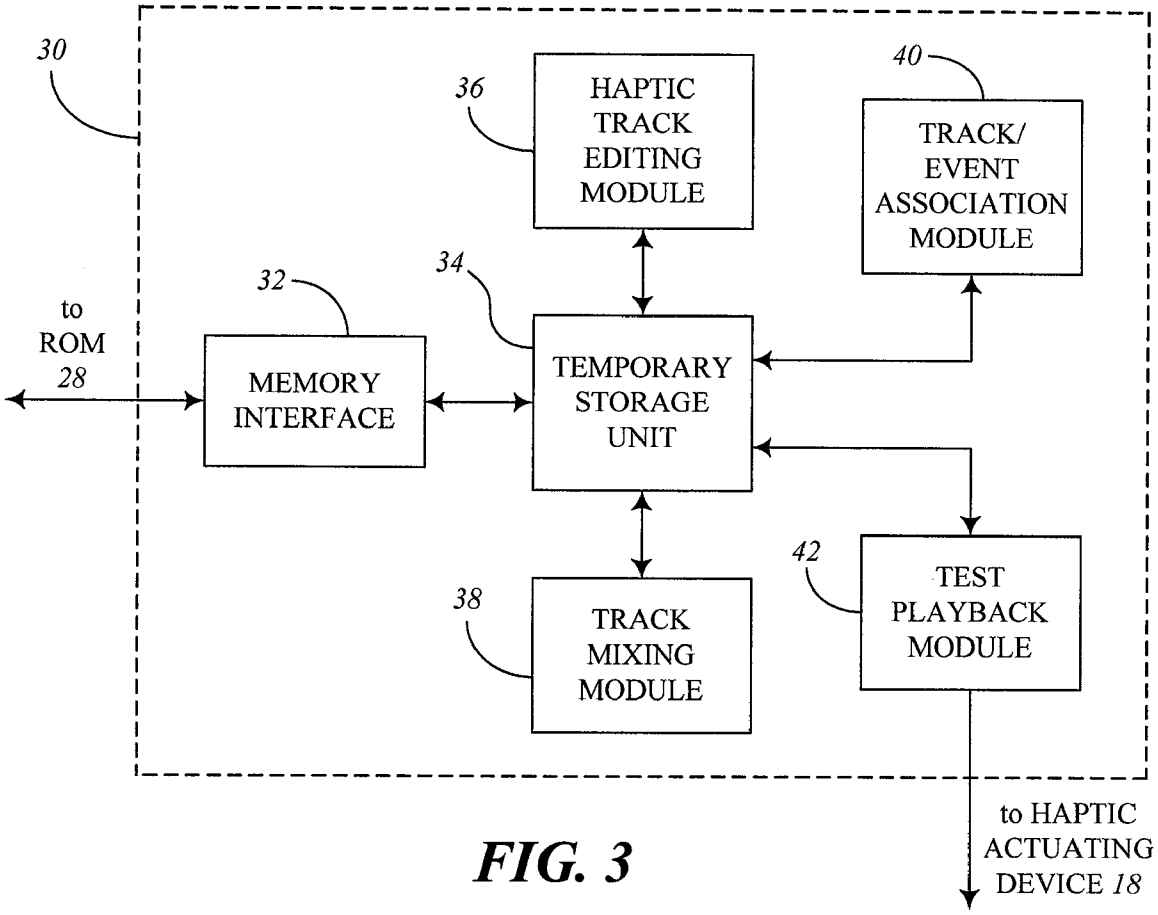

30
36
HAPTIC TRACK EDITING MODULE
40
TRACK/ EVENT ASSOCIATION MODULE
32
34
to ROM 28
MEMORY INTERFACE
TEMPORARY STORAGE UNIT
42
TEST PLAYBACK MODULE
38
TRACK MIXING MODULE
to HAPTIC ACTUATING DEVICE 18

FIG. 3

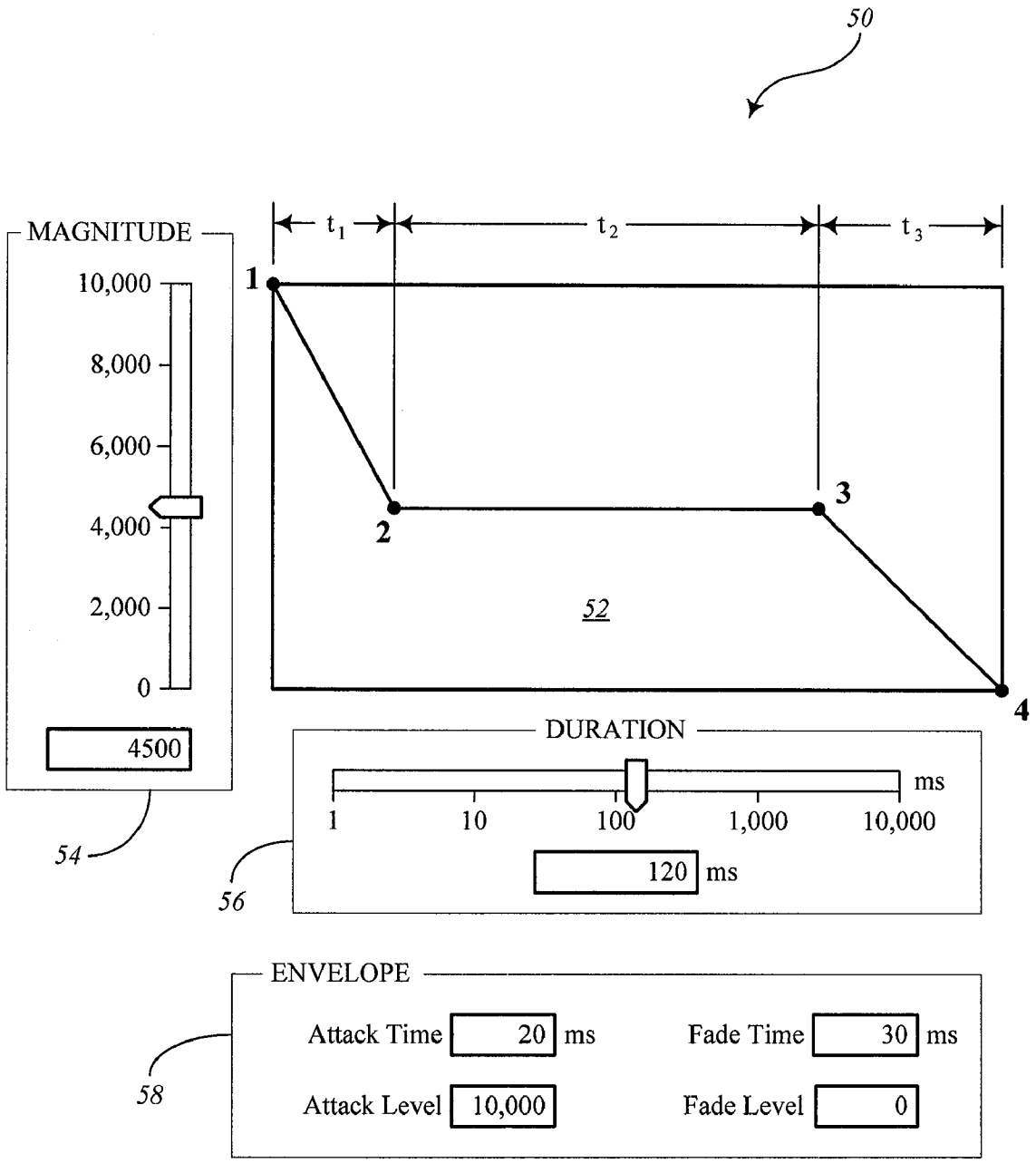

50
MAGNITUDE
10,000
8,000
6,000
4,000
2,000
0
4500
54
t1
t2
t3
1
2
3
4
52
DURATION
ms
1
10
100
1,000
10,000
120 ms
56
ENVELOPE
Attack Time 20 ms
Fade Time 30 ms
Attack Level 10,000
Fade Level 0
58

FIG. 4

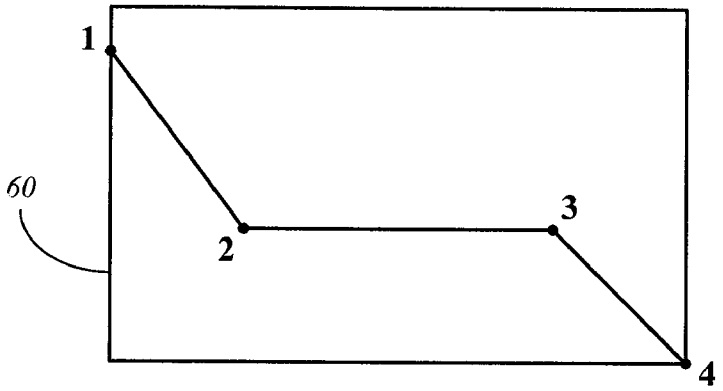


FIG. 5A

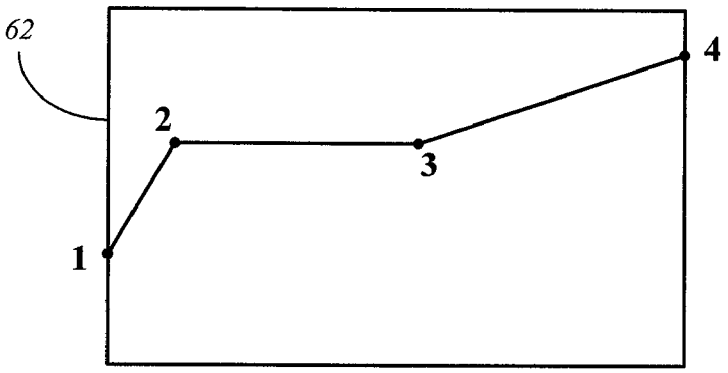


FIG. 5B

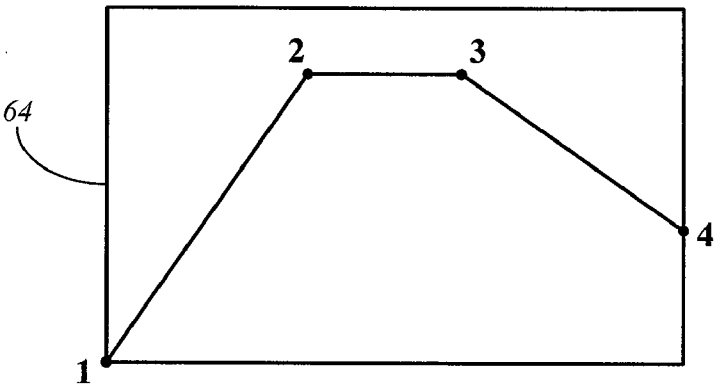


FIG. 5C

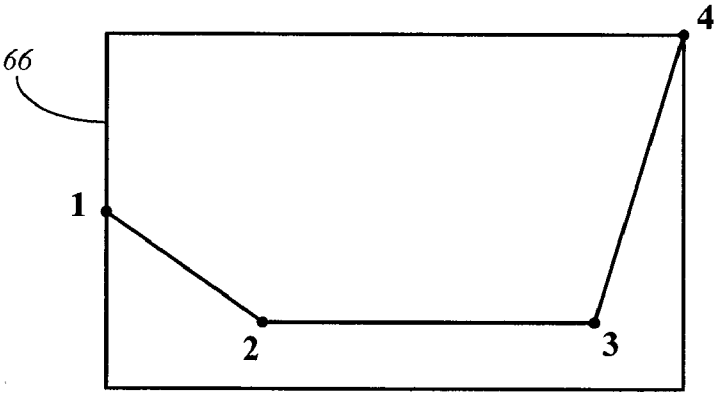


FIG. 5D

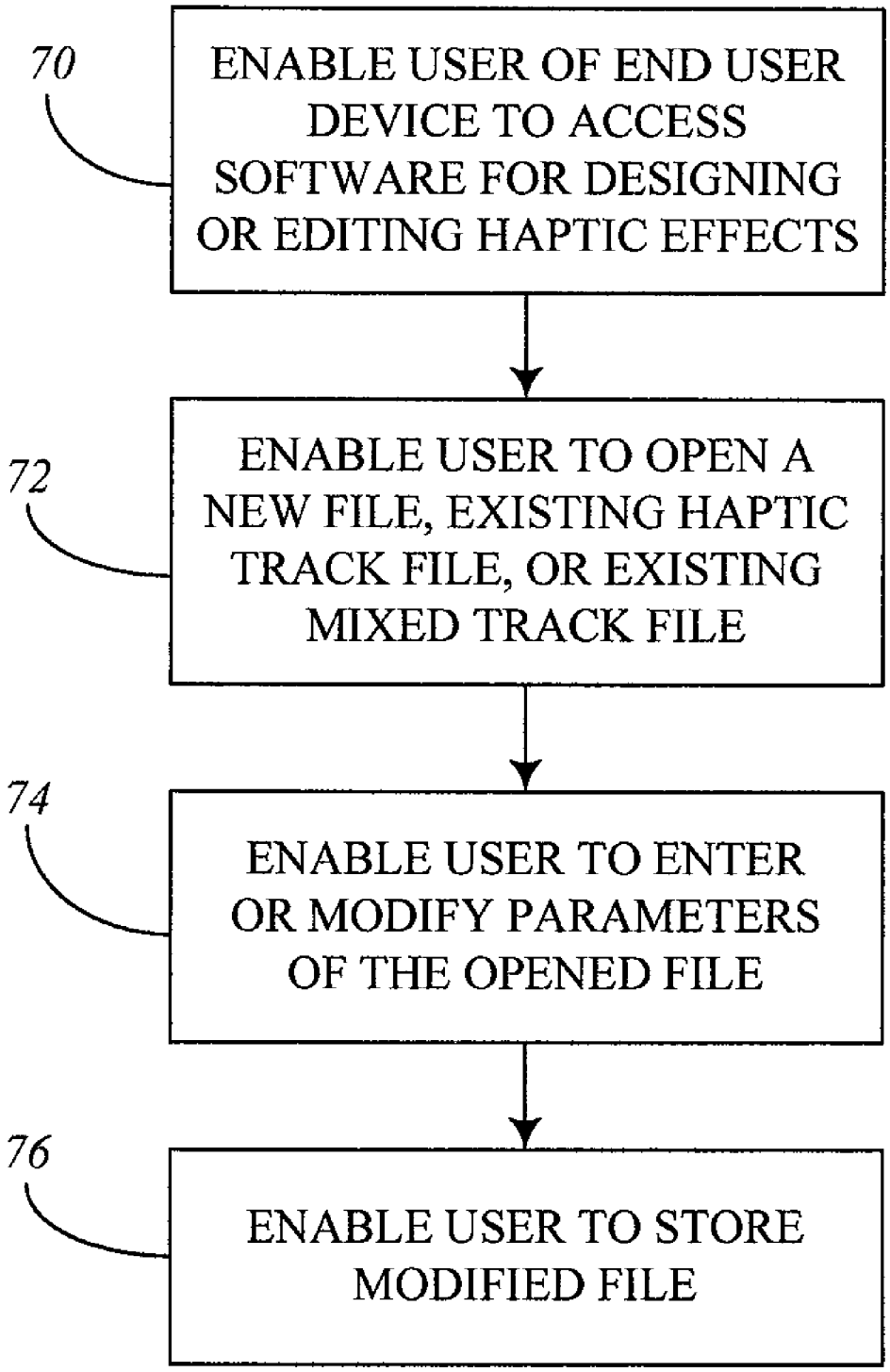

70
ENABLE USER OF END USER DEVICE TO ACCESS SOFTWARE FOR DESIGNING OR EDITING HAPTIC EFFECTS
72
ENABLE USER TO OPEN A NEW FILE, EXISTING HAPTIC TRACK FILE, OR EXISTING MIXED TRACK FILE
74
ENABLE USER TO ENTER OR MODIFY PARAMETERS OF THE OPENED FILE
76
ENABLE USER TO STORE MODIFIED FILE

FIG. 6

CUSTOMIZING HAPTIC EFFECTS ON AN END USER DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/940,227, filed May 25, 2007, the entire disclosure of which is incorporated by reference herein.

TECHNICAL FIELD

[0002] The present disclosure generally relates to devices having haptic feedback capabilities for providing haptic effects to a user. More particularly, the present disclosure relates to enabling a user to customize the haptic effects on an end user device.

BACKGROUND

[0003] Electronic device manufacturers strive to produce a rich interface for users. Conventional electronic devices typically use auditory and visual cues to provide feedback to a user. For example, cell phones are commonly equipped with auditory and visual output devices for indicating an incoming telephone call. The auditory cues, for instance, may include a series of tones, synthesized music, or digitally-recorded music. However, in some instances, auditory and visual cues may not be useful to a cell phone user. For example, in a movie theater, a user will typically have the phone's audible ringer silenced and will have the phone in a place where visual cues cannot be seen. In this case, kinesthetic and/or tactile feedback can provide a more desirable and more effective interface.

[0004] Some electronic devices are equipped to provide kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, vibrotactile feedback, texture, heat, etc.) to a user. Generally, these types of feedback are collectively known as "haptic feedback". Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, haptic effects may be useful to alert the user to specific events or to provide realistic feedback to create greater sensory immersion within a simulated or virtual environment. However, further improvements in the field of haptics can still be made to enhance the user interface of end user devices.

SUMMARY

[0005] The present disclosure describes systems and methods for allowing a user of an end user device to modify parameters associated with haptic effects that can be played on the end user device. Among several possible embodiments, a method disclosed herein comprises enabling a user of an end user device to access software adapted to design or modify haptic effects of the end user device. The method further includes enabling the user to open a haptic track file and enter or modify parameters associated with the haptic effects of the opened haptic track file.

[0006] Other features, advantages, and implementations of the present disclosure, not expressly disclosed herein, will be apparent to one of ordinary skill in the art upon examination of the following detailed description and accompanying drawings. It is intended that such implied features, advantages, and implementations of the present disclosure be included herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The components in the following figures are not necessarily drawn to scale. Instead, emphasis is placed upon clearly illustrating the general principles of the present disclosure. Reference characters designating corresponding components are repeated as necessary throughout the figures for the sake of consistency and clarity.

[0008] FIG. **1** is a block diagram illustrating an end user device according to one embodiment.

[0009] FIG. **2** is a block diagram illustrating the memory shown in FIG. **1** according to one embodiment.

[0010] FIG. **3** is a block diagram of the programmable haptic design software shown in FIG. **2** according to one embodiment.

[0011] FIG. **4** is a graphical user interface associated with an end user device allowing changes to a haptic track according to one embodiment.

[0012] FIGS. **5**A-**5**D are graphs illustrating a number of examples of possible haptic tracks that can be created using the graphical user interface of FIG. **4**.

[0013] FIG. **6** is a flow chart illustrating operations provided by a haptic design program according to one embodiment.

DETAILED DESCRIPTION

[0014] Some electronic devices are equipped with a haptic actuating device to provide haptic feedback to a user. This haptic feedback can be used to supplement auditory and visual feedback to enhance how information is provided to the user. For years, users of electronic devices have been given the option to modify various characteristics of auditory and visual outputs. For example, cell phone users can easily change ring tones if desired. However, a user typically does not have the option on the device itself to modify characteristics of haptic feedback. Normally, a professional haptics designer uses a computer system to create haptic effects or haptic tracks having parameters which are permanently set in the device during the manufacturing stage. The end user normally does not have the means to create or modify the haptic effect files directly on the device after the device is purchased.

[0015] However, in the present disclosure, systems and methods are described that allow a user to create and/or modify the parameters associated with haptic feedback on the target device itself through on-device means. In this respect, the power to create customized haptic effects is placed in the hands of a regular end user who may not be as skilled as a professional haptics designer. The end user can then create or modify the haptic effects to the user's liking using tools similar to those available to a professional haptic designer, but perhaps on a simplified scale. Software and systems can be embedded in the end user devices, according to the teachings herein, to lead a user through the process of entering and/or modify parameters and characteristics of haptic tracks.

[0016] With the ability to modify haptic tracks, a user can customize haptic effects to be associated with specific "events." For example, with respect to cell phones, a user may wish to associate certain customized haptic effects with receiving a call from a particular caller or group of callers.

Also, a user may wish to customize certain haptic effects to play during the output of specific auditory and/or visual cues. Other events associated with an end user device may include, for example, the pressing of a key on a keypad, a time-sensitive message or alarm, receiving a phone call, receiving an e-mail, etc.

[0017] Furthermore, the customized haptic effects created by a user can be stored on the device for use by the user. Once saved, customized haptic effects can also be shared with others by transmitting the haptics files to another device. In this respect, other users can play the haptic effects on these other devices as desired. Customized haptic effects can also be transmitted to another device to initiate immediate playback of a haptic track on the receiving device. In this example, customized sensations can be applied to intended recipients when they receive (or make) calls from (or to) the author of the customized haptic effects. This would be the haptic equivalent of the audio feature known as "ringback tones" and "ringtones," whereby a telephone caller and receiver, respectively, hear a specific song or message instead of the standard ringing.

[0018] Although many examples described in the present disclosure relate to cell phones, it should be understood that the teachings of the present disclosure may also include other applications in which haptic effects can be applied to a user of an end user device. Other advantages will become apparent to one of ordinary skill in the art from an understanding of the present disclosure.

[0019] FIG. **1** is a block diagram of an embodiment of an end user device **10**. At least part of end user device **10** includes regular electrical circuitry for performing tasks associated with the normal operation of end user device **10**. For example, end user device **10** may be a mobile handset, cell phone, personal digital assistant (PDA), personal navigation device, tablet PC, hand-held video gaming device, game module, game console, touch screen, touch pad, virtual reality force feedback device, or other suitable electronic device. In these examples, end user device **10** may include circuitry for performing the normal functions of these devices. The present disclosure, however, describes further components and related software of end user device **10** for allowing a user to modify haptic tracks according to the teachings herein.

[0020] In some embodiments, end user device **10** can be a haptic-enabled device that provides haptic feedback to the user during specific events. Regarding the aspect of providing haptic feedback, the user may be able to sense the haptic effects from the device when it is held in the user's hand, stored in a pocket of the user's clothing, stored in a purse, handbag, pouch, or other portable accessory, attached or clipped to the user's clothing, worn as an item of clothing, or held in any other suitable manner adjacent to or near the user. In this regard, end user device **10** can be in direct or indirect contact with at least a portion of the user's body in order that the user can experience the sensation of haptic effects provided by the device.

[0021] In addition to the regular circuitry and functionality of end user device **10**, additional elements reside in or are associated with end user device **10**, as described herein, to enable the user to create and/or modify haptic effects. The customized haptic effects can be played on end user device **10** itself, provided that end user device **10** is capable of providing haptic feedback, or can be played on a corresponding compatible device that is haptic-enabled.

[0022] End user device **10**, according to the embodiment of FIG. **1**, includes input/output devices **12**, processor **14**, memory **16**, and haptic actuating device **18**. End user device **10** further comprises a bus **20** or other suitable communication interface allowing input/output devices **12**, processor **14**, memory **16**, and haptic actuating device **18** to communicate with each other. In some embodiments, end user device **10** may further include a transceiver, such as for use in a cell phone or other wireless communication device. Such a transceiver can be used for communication within a cell phone network or within a short range network, such as is associated with Bluetooth® compatible devices. In this case, newly created or modified haptic effects can be transmitted to a device that has the capability to play the haptic effects. If end user device **10** is connected to another device via a mobile phone network, wide area network (WAN), local area network (LAN), Bluetooth® transmission, infrared transmission, etc., haptic files can be transmitted to these devices. In some embodiments, for instance, end user device **10** may use a streaming data transmission protocol for immediate playback on another user's device. When in a streaming mode, end user device **10** may stream music, video, and/or haptic data to other devices for an indefinite length of time.

[0023] In one embodiment, some elements shown in FIG. **1** can be positioned on different devices. For example, input/output devices **12**, processor **14**, and memory **16** can be used to allow a user to create or modify haptic effects. The created or modified haptic effects can be provided to or transmitted in any suitable manner to another device having haptic actuating device **18**. In this case, the one device creates or modifies the haptic effects while the other device contains the haptic actuating device **18** to be able to play the haptic effects for the user of the other device.

[0024] Input/output devices **12** consist of one or more input mechanisms, which may include any suitable combination of keyboards, keypads, cursor control devices, computer mice, voice activation mechanisms, touch screen with respective stylus or other drafting instrument, touch pads, buttons, sliders, microphones, digital cameras, etc. Input/output devices **12** also consist of one or more output mechanisms, which may include any suitable combination of computer monitors, display screens (such as touch screens), virtual reality display devices, speakers or other audio output devices, printers, etc. Some input/output devices **12** may be capable of functioning to both receive inputs and provide outputs.

[0025] Processor **14** may be a general-purpose or specific-purpose processor or microcontroller. Generally, processor **14** controls the functions of end user device **10** and can execute software stored in memory **16**. Memory **16** may include internally fixed storage and/or removable storage media for storing information, data, and/or instructions. Memory **16** may include any suitable combination of volatile memory, such as random access memory (RAM), dynamic RAM (DRAM), etc., and/or non-volatile memory, such as read only memory (ROM), electrically erasable programmable ROM (EEPROM), flash memory, etc. Memory **16** can also store a software program for enabling an end user to create and/or modify haptic effects, the software program of which can be executed by processor **14**.

[0026] Haptic actuating device **18** may include any suitable combination of electrical or electro-mechanical components for providing haptic effects to a user. In some embodiments, haptic actuating device **18** is configured as an eccentric rotating mass (ERM) actuator. Modifying the amplitude values

applied to an ERM actuator results in a change of the speed of a motor associated with the ERM actuator. In other embodiments, haptic actuating device **18** can be configured as a linear resonant actuator (LRA), whereby modifying the amplitude values applied to the LRA results in a change of vibration or pulse frequency. In still other embodiments, haptic actuating device **18** can be configured within a pressure sensing surface, such as a touch screen device, which is capable of sensing pressure applied by the user and also providing haptic feedback to the user. The pressure that is sensed by the pressure sensing surface can be translated into data related to amplitude parameters of a haptic effect as it is being modified. Regarding embodiments where haptic actuating device **18** is an accelerometer, the accelerometer can also be utilized as an input device for detecting a shaking motion from a user to record a certain vibration entry.

[0027] FIG. **2** is a block diagram of one embodiment of memory **16**, which is shown in general in FIG. **1**. Memory **16** in this implementation is configured to store programs, data, information, files, etc., including, for example, an operating system (O/S) **22**, a graphical user interface (GUI) **24**, RAM **26** or other suitable volatile memory, and ROM **28** or other suitable non-volatile memory, such as EEPROM, flash memory, etc. Files associated with haptic effects and that are stored in memory **16** can include a particular file format that is compatible with or can be understood by haptic actuating device **18** or other haptic actuating devices.

[0028] ROM **28** may be configured to store a library of preset haptic tracks that can be used as a general starting point for creating new tracks. In this case, the preset tracks can be protected from being overwritten in order to be available whenever the user wishes to create a new file. ROM **28** can also store haptic track files created or modified by the user and can also store mixed track files, which include multiple haptic tracks combined together. The user is given the capability to assign new filenames to newly created or modified haptic track files and mixed track files. ROM **28** can further store files that include association information for associating certain track files with specific events related to end user device **10**.

[0029] As shown in FIG. **2**, memory **16** also stores programmable haptic design software **30**, which is configured to allow a user to create, modify, design, and customize haptic effects as desired. Using programmable haptic design software **30**, a user can design a track or sequence of haptic outputs for playback over any length of time. Using programmable haptic design software **30**, the user is also able to associate certain haptic track files and mixed track files with specific events related to end user device **10**. For example, a haptic track can be programmed to play when one or more specific events occur, such as when an incoming cell phone call is received, or even when a call is received from a particular caller or phone number.

[0030] Certain parameters or characteristics of a haptic output or haptic track can be created, entered, changed, modified, etc. For example, the modifiable parameters may include a frequency of vibration and amplitude of vibration. Also, the frequency and amplitude can be set to change over time. In addition, the user is able to combine or mix different haptic tracks together if desired to provide a fuller haptic experience. In this way, a user is capable of programming or customizing a haptic track or track mix to one's liking.

[0031] While programming a haptic track or track mix, a user can enter a command to initiate a test playback of the haptic track or track mix in order that the user can experience upon demand how the creation may actually feel. This can be experienced, for example, using haptic actuating device **18** (FIG. **1**) located in end user device **10**. The user may also have the option to run the haptic track or track mix in the test playback in synchronization with audio and/or video outputs.

[0032] Programmable haptic design software **30** may be accessed by the user using any number of possible access techniques. In one example, the user may access programmable haptic design software **30** via GUI **24**. In this case, programmable haptic design software **30** may be opened from a menu option such as "Options", "Tools", or "Tactile Sensations" from GUI **24**. Other non-limiting techniques for accessing programmable haptic software **30** include a voice responsive system, a text interface, a Braille-type surface having either fixed or changeable components.

[0033] When initially accessed, programmable haptic design software **30** may present, via GUI **24**, options to either "Create a New Track" or "Edit an Existing Track". The term "track" used in the present disclosure can refer to parameters associated with haptic effects that can be played on a haptic-enabled device. For instance, the parameters may include frequency and amplitude characteristics of a haptic output over a certain length of time.

[0034] According to one embodiment, when "Create a New Track" is selected, programmable haptic design software **30** may provide the user with two options to either "Start with Track from Library" or "Start from Scratch". As mentioned above, ROM **28** can store the library of tracks that can be used as a starting point for certain types of haptic effects. When "Start with Track from Library" is selected, a list of track files stored in the library are displayed for the user's selection. The track files in the library may be given filenames that represent understandable characteristics of the files. For the purpose of illustration, the files may be given names such as "Regular", "Normal Alarm", "Gentle", "Rising Intensity", "Long and Steady", "Quick Pulse", "Wake Up!", "Loud and Obnoxious", among others.

[0035] When a new file or existing file is opened, the user has the opportunity to modify certain characteristics of the haptic track as desired. For example, the user may be able to set the amplitude or frequency of vibration of the haptic track. It may be desirable for the user to vary the amplitude over time. The amplitude can be changed gradually or in steps during a portion of or during the entirety of the haptic track.

[0036] Another aspect of the haptic track that can be modified by the user is the attack level, which corresponds to the initial amplitude of the signal. Attack time is another modifiable parameter that corresponds to the time that it takes for the signal to change from the attack level to a center magnitude, which is another parameter that can be set. The center magnitude corresponds to the amplitude of the haptic signal during what may be the majority of the time of the haptic track. Another parameter is fade level, which corresponds to an amplitude at the end of the track. The time that it takes for the signal to change from the center magnitude to the fade level is referred to as fade time, which can also be modified. The user also can enter a certain duration, which is another modifiable parameter. In some embodiments, the signal remains at the center magnitude for a time equal to the duration minus the attack time and fade time. In other embodiments, the duration may be associated with the time that the signal remains at the center magnitude.

[0037] The following description includes several embodiments defining ways that the parameters of a haptic track can be modified. When the user accesses programmable haptic design software **30** via GUI **24** and opens a file to be edited, the user can continue to interact with programmable haptic design software **30** by input and output mechanisms of GUI **24**.

[0038] In a first example, specific values related to parameters of the haptic track can be entered via GUI **24**. Regarding parameters such as attack level, attack time, magnitude, duration, fade level, and fade time, the user can enter values in units of Hertz, seconds, milliseconds, decibels, etc. GUI **24** may present an acceptable range of values for each of the parameters. Also, programmable haptic design software **30** can monitor the entries to check for errors, which may be a result of setting values outside the acceptable range, conflicting values among two or more parameters, etc.

[0039] Another example of how to modify haptic tracks is by presenting via GUI **24** a range of values that can be selected by the user. Alternatively, in place of values, descriptive terms can be used that might be more easily understood by a non-skilled user. For example, some descriptive terms may include the categories of "Starting Intensity" (attack level), "Intermediate Intensity" (amplitude or magnitude), and "Ending Intensity" (fade level). Other descriptive terms may include "Duration" (duration), "Start Time" (attack time), and "Ending Time" (fade time). Under the categories of Starting Intensity and Ending Intensity, descriptive terms such as "Strong", "Medium", and "Weak" may be presented to the user for selecting the desired attack level. Under the category of Intermediate Intensity, descriptive terms such as "High", "Medium", and "Low" may be presented to the user for selecting the desired magnitude. Under the Duration category, "Long", "Medium", and "Short" may be presented to the user. Under the Start Time and Ending Time categories, "Rise/Fade Quickly", "Medium Rise/Fade", and "Rise/Fade Slowly" may be presented for selection of the desired rise or fade times. As suggested above, additional entry can be made to allow the user to alter the amplitude or pulse frequency during the haptic track. It should be understood that other descriptive terms can be used to describe in layman's terms the characteristics of a haptic track. Also, it should be understood that the categories can be divided in more than three values or levels of selection.

[0040] In another example of how parameters can be entered, GUI **24** can display a graph showing some of the characteristics of the amplitude of a haptic output over time. GUI **24** may further enable the user to alter the graph as the user desires. For example, lines of the graph can be stretched, shortened, moved, slid, altered, etc., using various input device tools. In this embodiment, the user may use manipulative input devices, such as a touch screen device and stylus.

[0041] Other visual presentations may be provided to the user to allow the user to modify parameters. For example, the amplitude of a haptic track can be represented by musical notes along a musical scale. Thus, musical notes higher on the scale can represent higher amplitude or higher pulse frequency haptic output. Other embodiments for representing amplitude using musical notation include musical directions with respect to loudness. For example, ff (fortissimo) might be used for very loud or very high amplitude, f (forte) might be used for loud or high amplitude, mf (mezzo forte) for moderately loud or moderately high amplitude, m (mezzo) for moderate, mp (mezzo piano) for moderately soft or moderately low amplitude, p (piano) for soft or low amplitude, and pp (pianissimo) for very soft or very low amplitude. Duration parameters in this respect can also be represented by musical notation. For instance, musical notes may be shown as eighth notes, quarter notes, half notes, etc., to represent the duration of a haptic output.

[0042] After creation or modification of a haptic track file or mixed track file, the user can store the file using a new filename or can overwrite the original file, provided that the original file is not protected from overwriting. Particularly, as mentioned above, the files in the library can be set so that they cannot be overwritten. ROM **28** is configured to store any reasonable number of haptic track files and mixed track files according to the particular design.

[0043] Various logical instructions or commands may be included in programmable haptic design software **30**. Programmable haptic design software **30** of the present disclosure can be implemented in hardware, software, firmware, or a combination thereof. When implemented in software or firmware, the software can be stored in memory **16** and executed by processor **14**. When implemented in hardware, programmable haptic design software **30** can be implemented, for example, using discrete logic circuitry, an application specific integrated circuit (ASIC), a programmable gate array (PGA), a field programmable gate array (FPGA), etc., or any combination thereof.

[0044] FIG. **3** is a block diagram of an embodiment of programmable haptic design software **30** shown in FIG. **2**. In this embodiment, programmable haptic design software **30** includes a memory interface **32**, temporary storage unit **34**, haptic track editing module **36**, track mixing module **38**, track/event association module **40**, and test playback module **42**.

[0045] Memory interface **32** is configured to retrieve a copy of a file, either a haptic track file or a mixed track file, from ROM **28** (FIG. **2**). Memory interface **32** places the copy of the retrieved file in temporary storage unit **34**, where the file can be modified according to user's inputs. In this respect, temporary storage unit **34** can simply contain RAM or other volatile memory while the tracks are being programmed. After a user creates or modifies a file or files in temporary storage unit **34**, memory interface **32** is configured to store a copy of the file in ROM **28** as instructed by the user. Also, the user may enter a unique filename for the file for later referencing and accessing the file. Furthermore, each file can include information that associates the file with one or more specific events that may occur during normal use of end user device **10**.

[0046] While files are opened in the temporary storage unit **34**, the user may use haptic track editing module **36** to edit the opened files. In addition, the user may use track mixing module **38** to mix a combination of opened haptic tracks together. Haptic track editing module **36** allows the user to perform different types of editing of the haptic track by changing various parameters of the haptic track. The haptic tracks can be modified in any suitable manner, such as the ways described above. For example, haptic track editing module **36** enables user to modify such features as the rise time, attack level, attack time, magnitude, duration, fade time, and other characteristics related to the waveform parameters with respect to time during which the haptic track is played. In addition, haptic track editing module **36** enables the user to

enter one or more frequencies for the haptic track or even continually changing frequencies to be played along the length of the haptic track.

[0047] Temporary storage unit **34** is capable of storing more than one haptic track. Additionally, temporary storage unit **34** can even store multiple copies of the same haptic track, for example, if the user wishes to mix the same haptic track into a mixed track, such as where a second occurrence of the haptic track is offset in time from a first occurrence, in order to provide a fuller haptic output. Track mixing module **38** allows the user to combine haptic tracks to play simultaneously, to overlap in time for a portion of the time, to play end-to-end, or even to start a subsequent track after a short pause at the end of a first track. When programmed to overlap in time, two or more haptic tracks can be programmed to be simultaneous or partially overlapping in time in any desirable manner. Track mixing module **38** also allows the user to adjust the amplitude of one haptic track with respect to another to more strongly emphasize one track over another.

[0048] Track/event association module **40** allows the user to form a relationship or association between a specific event and a track file. One example of an event is receiving a cell phone call from a certain caller. When a call is received from the caller, the file having the association information added by track/event association module **40** is retrieved from memory and played along with respective audio and visual cues. Track/event association module **40** allows the user to form associations of any number of events with any number of track files. In some cases, one or more events may not be associated with a track file, while in other cases, each event may be associated with a respective track file. Other associations can be established, such as for relating haptic tracks and mixed tracks with other media or with specific auditory and/or visual output.

[0049] Test playback module **42** may reside in programmable haptic design software **30** as illustrated in FIG. **3**. In other embodiments, this element may be omitted from the programmable haptic design software **30** depending on whether or not end user device **10** includes a haptic actuating device. If end user device **10** does include a haptic actuating device, test playback module **42** can be used to play a haptic track or mixed track that is temporarily stored in temporary storage unit **34**. When the user enters a command to end user device **10** to provide a test playback, test playback module **42** sends a selected haptic track or mixed track from temporary storage unit **34** to haptic actuating device **18**, which can then play the track for the user. Test playback module **42** may be useful to provide the user with an understanding of how modification affect how a haptic track or mixed track would actually feel when played out on haptic actuating device **18**. In further implementations, test playback module **42** may be configured to playback a haptic track as changes are being made. In this case, the user may receive immediate feedback regarding how the changes affect the haptic tracks.

[0050] In other embodiments, such as where haptic actuating device **18** resides on a remote device, programmable haptic design software **30** may additionally include a transmitting module for sending an instruction to a transmitter or transceiver of end user device **10** to transmit a selected haptic track or mixed track to the remote device. Thus, a remote user can experience or test the track being modified.

[0051] Programmable haptic design software **30** may operate in conjunction with other measuring and testing devices associated with end user device **10**. For example, a temperature measuring device may be used to detect if the temperature of end user device **10** drops below a certain level. If so, one or more haptic tracks being edited by programmable haptic design software **30** may be programmed to compensate for a situation that may result in a decreased ability on the part of the user to sense haptic feedback. Cold temperatures may result in cold hands that cannot sense vibrations as easily. Also, along with cold weather, a user may be more likely to wear extra clothing, gloves, mittens, etc., which can muffle the haptic feedback from end user device **10**. Compensation in these situations may include a greater amplitude of the haptic signal, longer duration, and/or higher frequency vibrations.

[0052] Programmable haptic design software **30**, described with respect to FIGS. **2** and **3**, and other programs or software code stored in memory **16** that are associated with creating and modifying haptic effects, include executable logical instructions as described herein. Programmable haptic design software **30** can be embodied in any suitable computer-readable medium for execution by any suitable processing device. The computer-readable medium can include any physical medium that can store the programs or software code for a measurable length of time.

[0053] FIG. **4** is a diagram showing an embodiment of a graphical user interface (GUI) **50** associated with the end user device having haptic design capabilities. GUI **50** in this embodiment includes a screen **52** diagrammatically showing an output of a haptic track. In other embodiments, GUI **50** may show track mixes where two or more haptic tracks are combined together. GUI **50** also includes a magnitude adjusting mechanism **54**, duration adjusting mechanism **56**, and an envelope adjusting mechanism **58**.

[0054] Screen **52**, showing a single haptic track, includes four points that are numbered **1-4**. Point **1** represents the attack level, shown in this example having a magnitude of 10,000, which corresponds to the attack level setting in the envelope adjusting mechanism **58**. The center magnitude or intermediate magnitude is set at 4500 in this example. Screen **52** shows the center magnitude maintaining a steady magnitude from point **2** to point **3**. The attack time is set at 20 ms, which is shown in screen **52** as t_1 representing the time from point **1** to point **2**. In this example, fade level is set at 0 (point **4**) and the fade time is set at 30 ms (from point **3** to point **4**, or t_3). If desired, the names used to describe the characteristics or aspects of the haptic track can be changed to any suitable names. For example, "magnitude" may be called amplitude, intensity, volume, etc., and "duration" can alternatively be named periodicity, length, etc.

[0055] Magnitude adjusting mechanism **54** includes a slider that allows the user to adjust the center magnitude of the haptic track as desired. Magnitude adjusting mechanism **54** also includes a window in which a user can enter a value representing the magnitude. In this embodiment, the magnitude value is set at 4500, which can be seen on the slider and in the window. These and other suitable means can be used to adjust magnitude.

[0056] Duration adjusting mechanism **56** includes a slider that allows the user to adjust the duration of the haptic track as desired. GUI **50** shows the duration slider being represented on a logarithmic scale, but in other embodiments may include a linear scale. Duration adjusting mechanism **56** also includes a window in which a user can enter a duration value in milliseconds. In this embodiment, the duration can be adjusted to any time period between 1 ms and 10 seconds. However, in

other embodiments, duration adjusting mechanism **56** may be configured to allow selection of any desirable value. The duration is set at 120 ms in this example, which can be seen on slider and in window.

[0057] Envelope adjusting mechanism **58** includes windows allowing the user to enter values for attack time, attack level, fade time, and fade level. In this example, the attack time is set at 20 ms, attack level is set at 10,000, fade time is set at 30 ms, and fade level is set at 0. With attack time (t_1) set at 20 ms, fade time (t_3) set at 30 ms, and duration set at 120 ms, the time t_2 that the signal remains at the center magnitude of 4500 is equal to the total duration time minus the attack time and fade time. Specifically, t_2=duration−t_1−t_3, and, in this case, t_2 would be 70 ms.

[0058] In FIG. **4**, the parameters of the haptic track shown in screen **52** illustrates the amplitude or magnitude of the haptic track versus time, where the unit of time is illustrated on the x-axis and the unit of amplitude is illustrated on the y-axis of the graph. This graph may be illustrated on GUI **24** in embodiments where the user can manipulate the lines of the graph for modifying the haptic track. In other embodiments, certain representations or values describing the aspects of the haptic track can be stored in order to recreate haptic track **44** at a later time.

[0059] It should be understood that the particular graph of the haptic track shown on screen **52** merely represents one example of possible haptic outputs and is not intended to limit the disclosure in any way. In some embodiments, the attack time and attack level may be omitted, such that the user enters parameters with respect to magnitude, duration, fade time, and fade level. Still other embodiments may omit attack time and fade time, which can greatly simplify user interaction. Yet in other implementations, further characteristics or parameters may be included in haptic track **44** to allow tracks having even greater complexity. For instance, instead of one constant amplitude level for magnitude, the haptic track may include two or more levels. Furthermore, the haptic track may include additional attack level, attack time, fade level, and fade time characteristics between the illustrated attack and fade levels.

[0060] FIGS. **5**A-**5**D are graphs representing embodiments of screen **52** shown in FIG. **4**. Graph **60** of FIG. **5**A represents a situation where a user enters an attack level (point **1**) that is higher than the center magnitude (from point **2** to point **3**). Also, the center magnitude in graph **60** is higher fade level (point **4**). Graph **60** therefore provides an initially strong signal sloping down to a level portion and then sloping down again to the final fade level.

[0061] FIG. **5**B shows graph **62** having an upward slope to the level off portion followed by another upward slope to the final fade level. In this case, the attack level is the lowest and the fade level is the highest. Graph **64** of FIG. **5**C includes an upward slope to the level off, and then a downward slope. Graph **66** of FIG. **5**D includes a downward slope to the level off, and then an upward slope. It should also be noted from FIGS. **5**A-**5**D that the attack times, fade times, and durations include various non-limiting possibilities. It should further be noted that attack times and/or fade times can be 0 ms, such that the output will simply include the center magnitude. Further, if the attack time plus the fade time is equal to the duration, then the time of the center magnitude level will be 0 ms. Other possible arrangements using these parameters can be achieved as desired.

[0062] FIG. **6** is a flow chart illustrating an embodiment of a method for enabling a user to edit and process haptic effects and haptic tracks. The method may include operations of a haptic design program, such as programmable haptic design software **30** or other programs for enabling the creation and/or modification of haptic tracks. Block **70** of the method describes that the user of the end user device is enabled by the program to access software for designing or editing haptic effects. The end user device may be haptic-enabled device, such as a handheld device or module. The software for designing or editing haptic effects may include programmable haptic design software **30** or other programs.

[0063] In block **72**, the method enables the user to open a new file, an existing haptic track file, or an existing mixed track file. In these examples, a new file can represent a haptic track from a library having default values that can be used as guidelines or starting points for creating a new track file. Otherwise, the new file can be created with no particular guidelines if desired.

[0064] In block **74**, the user is enabled to enter or modify parameters of the opened file. Entering or modifying parameters can be accomplished using any suitable interface between the user and the end user device. Entering values may correlate to actions for new haptic files, while modifying correlates to pre-existing haptic files or values of preset files. Values can be entered directly, selections of values can be made from a range of values, lines of a graph of a haptic track can be altered to change the shape of the track, etc.

[0065] In block **76**, the user is enabled to store the modified file. In some embodiments, the user can play back a created or modified haptic track or mixture of tracks to test how the tracks might actually feel. Furthermore, the user may be able to transmit the file of one or more haptic tracks or mixed tracks to another user on a different device. In this respect, the users can share haptic effect files.

[0066] It should be understood that the steps, processes, or operations described herein may represent any module or code sequence that can be implemented in software or firmware. In this regard, these modules and code sequences can include commands or instructions for executing specific logical steps, processes, or operations within physical components. It should further be understood that one or more of the steps, processes, and/or operations described herein may be executed substantially simultaneously or in a different order than explicitly described, as would be understood by one of ordinary skill in the art.

[0067] The embodiments described herein merely represent examples of implementations and are not intended to necessarily limit the present disclosure to any specific embodiments. Instead, various modifications can be made to these embodiments as would be understood by one of ordinary skill in the art. Any such modifications are intended to be included within the spirit and scope of the present disclosure and protected by the following claims.

We claim:

1. An electronic handheld device comprising:

a haptic actuating device configured to actuate haptic effects upon a user;

memory configured to store software that enables the user to modify the haptic effects; and

a processor configured to execute the software stored in memory;

wherein the haptic actuating device is further configured to play a modified haptic effect when an event associated with the electronic handheld device occurs.

2. The electronic handheld device of claim **1**, further comprising one or more input devices allowing the user to enter information capable of modifying the haptic effects.

3. The electronic handheld device of claim **1**, wherein the haptic effects are defined by haptic track files stored in memory.

4. The electronic handheld device of claim **3**, wherein each haptic track file stores a haptic track comprising magnitude parameters with respect to time.

5. The electronic handheld device of claim **4**, wherein the memory is further configured to store one or more mixed track files, each mixed track file comprising a combination of multiple haptic track files.

6. The electronic handheld device of claim **5**, wherein at least a portion of each of the haptic track files of a respective mixed track file overlap in time.

7. The electronic handheld device of claim **1**, wherein the electronic handheld device includes one of a mobile handset, cellular telephone, personal digital assistant, personal navigation device, tablet PC, video gaming device, game module, or game console.

8. The electronic handheld device of claim **1**, wherein the memory is configured to store a library of haptic tracks that can be used as a starting point for creating haptic effects.

9. The electronic handheld device of claim **1**, wherein the event associated with the electronic handheld device is the receiving of a telephone call.

10. Programmable haptic design software stored on a computer-readable medium, the programmable haptic design software comprising:

logic adapted to enable a user to enter or modify parameters associated with a haptic track; and

logic adapted to associate the haptic track with an event of an end user device;

wherein the end user device is configured to play the haptic track when the event occurs.

11. The programmable haptic design software of claim **10**, wherein the event corresponds to a specific auditory or visual output of the end user device.

12. The programmable haptic design software of claim **10**, further comprising logic adapted to enable the user to initiate a test playback of a modified haptic track.

13. The programmable haptic design software of claim **10**, wherein the parameters associated with the haptic track comprise an attack level, attack time, magnitude, duration, fade level, and fade time.

14. The programmable haptic design software of claim **10**, further comprising logic adapted to enable the user to mix a plurality of haptic tracks to create a mixed track file.

15. The programmable haptic design software of claim **10**, wherein the logic adapted to enable the user to enter or modify parameters further enables the user to set the duration of the haptic track from about 0.001 seconds to about 10 seconds.

16. A method comprising:

enabling a user of an end user device to access software adapted to design or modify haptic effects of the end user device;

enabling the user to open a haptic track file; and

enabling the user to enter or modify parameters associated with the haptic effects of the opened haptic track file;

wherein, in response to a specific event, the end user device plays the haptic effects entered or modified by the user.

17. The method of claim **16**, further comprising:

enabling the user to store the modified haptic track file.

18. The method of claim **16**, wherein the end user device is a haptic-enabled device.

19. The method of claim **16**, wherein enabling the user to open the haptic track file comprises enabling the user to open a new file or an existing file.

20. The method of claim **19**, wherein the haptic track file includes magnitude parameters with respect to time.

21. The method of claim **19**, wherein the haptic track file is a mixed track file that includes an overlapping mix of haptic track files, each haptic track file including magnitude parameters with respect to time.

22. The method of claim **16**, further comprising:

transmitting the haptic track file to a remote device that is haptic-enabled.

23. The method of claim **22**, wherein transmitting the haptic track file initiates immediate playback of the haptic effect associated with the haptic track file on the remote device.

24. The method of claim **16**, further comprising:

measuring an ambient condition of the end user device; and

modifying the haptic effects to compensate for the measured ambient condition.

25. The method of claim **16**, wherein the specific event includes one of receiving a telephone call, receiving a telephone call from a particular caller, providing a particular audible signal, providing a particular visual signal, or pressing a key or button of a keypad or touch screen.

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