

alert can be generated, and the file can be rejected. If the sound file is suitable to be automatically converted, then the MIDI conversion computer window **1500** can be presented to a user, each of the identified instruments being displayed with the corresponding channel and a suggested frequency map.

[0087] The MIDI conversion computer window **1500** shown in **FIG. 15** illustrates some options that can be selected to facilitate conversion from a MIDI file to a timeline haptic effect file. For example, the MIDI channel name and corresponding MIDI instruments can be identified. If automatically converting the MIDI file to a timeline haptic effect is desired, the “import” option can be selected. Options can also be selected for automatic conversion of MIDI durations to haptic effect durations, MIDI note velocity to haptic effect magnitude, MIDI note number to haptic effect frequency (which can be adjusted using the frequency map described below), and so forth. It should be recognized that additional conversions can be implemented depending upon the desired conversion to be performed by one or more embodiments of the invention.

[0088] MIDI files can be converted in several ways. For example, each instrument can be converted to haptic effects (e.g., in a haptic-effect file). Similarly, each channel of the MIDI file can be converted to haptic effects. Additionally, any instrument-channel combination defined in a MIDI file can be converted to haptic effects (e.g., using an automatic conversion technique). In many instances, conversion of all notes defined for a particular channel in a MIDI file can be selected for automatic conversion to haptic-effect signals. In some instances, conversion of notes for each instrument, or even each note within a channel, may be desirable. For example, on MIDI channel **10**, each percussion instrument corresponds to an individual note within that channel. Thus, to accurately convert certain percussion instruments to haptic effects, individual notes within channel **10** should be mapped or otherwise converted to haptic effects (e.g., by creating appropriate haptic-effect signals).

[0089] The conversion from MIDI files to files defining haptic effects can use the various events of the MIDI file. For example, MIDI files generally have “note-on-events” and “note-off-events” indicating the beginning or end of a MIDI note, respectively. Both note-on-events and note-off-events specify a MIDI channel number, a note number, and a note velocity. MIDI files can also have other events, such as a “program-change event” that indicates changes in instrumentation for a giving MIDI channels. For example, a program-change event can specify that 30 seconds into a song, the instrument used on channel **1** is to be changed from a first instrument (e.g., acoustic guitar) to a second instrument (e.g., electric guitar).

[0090] Conversion of MIDI information to haptic-effect information can occur using several techniques. For example, a duration-override command can be used to match a note-on-event with its corresponding note-off-event (i.e., the note-off-event for the same note as the note-on-event) to determine note durations. A haptic effect can then be commanded (e.g., using a basis haptic-effect signal or a timeline haptic-effect signal) to have the determined note duration, or the duration can be changed by manually overriding the automatic duration to set a desired duration. Additionally, a velocity-to-magnitude command can be used

to set the magnitude of an effect to be commanded (e.g., using a basis haptic-effect signal or a timeline haptic-effect signal) based on the velocity of a MIDI note (e.g., as specified in the note-on-event that generated the note with which the haptic effect is to be associated or synchronized). Furthermore, a note-to-speed command can set the frequency of a commanded haptic effect based on a MIDI note number (e.g., the note number for a MIDI note specified in the note-on-event for the note with which the haptic effect is to be associated or synchronized).

[0091] Additionally, components of the timeline haptic effect can be created using default parameters, or using custom parameters specified in a conversion reference file, which can be selected using the MIDI conversion computer window **1500**. The frequency map of the one or more channels can be edited by selecting one or more “edit freq. map” buttons shown on the right-hand side of the MIDI conversion computer window **1500**. Each of the options listed above can be selected on a channel-by-channel basis, an instrument-by-instrument basis, or a combination thereof.

[0092] Table 2 below shows some options for automatically converting various MIDI messages to timeline events (e.g., events of the timeline-effect definition **1000** of **FIG. 10**).

TABLE 2

| Some options for automatic conversion from MIDI to timeline events |   |
|--|---|
| MIDI messages  | Timeline events   |
| Note On  | LaunchPlayback  |
| Note Off   | Duration between a “Note On” and a “Note Off” determines the value of duration override in LaunchPlayback event |
| Program Change   | Effect ID override in LaunchPlayback event  |
| Bank Select  | Effect ID override in LaunchPlayback event<br>Effect ID is a combination of “Bank Select” and “Program Change”  |
| All Sound Off  | “All Sound Off” is treated as a “Note Off” for all pending “Note On”  |
| All Notes Off  | “All Notes Off” is treated as a “Note Off” for all pending “Note On”  |
| Set Tempo  | “Set Tempo” MIDI event determines TimeOffset properly of a given LaunchPlayback event                           |

[0093] **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. According to one or more embodiments of the invention, selecting one or more “edit freq. map” buttons shown on the right-hand side of the MIDI conversion computer window **1500** (shown in **FIG. 15**) will access the frequency map computer window **1600** shown in **FIG. 16**. The frequency map shown in the frequency map computer window **1600** plots all existing MIDI channels in a MIDI file to be converted to a timeline effect frequency. Each of the channels (shown on the horizontal axis) can be mapped to a vibration frequency of a periodic haptic effect (shown on the vertical axis) using a translation curve **1602**, with which a user can interact with using the GUI within which the window **1600** is presented (e.g., using “click-and-drag” techniques, etc.). The translation curve **1602** defines the frequencies of a haptic device that correspond to the MIDI