SOUND DATA OUTPUT AND MANIPULATION USING HAPTIC FEEDBACK

BACKGROUND OF THE INVENTION

The present invention relates generally to systems allowing humans to interface with computer systems, and more particularly to methods for providing haptic feedback to the user in computer sound editing and playback environments.

Computers have become widely-used tools in the creation and editing of music and other audio-related data. Digital data representing a musical or other type of auditory composition or recording can be easily created and/or manipulated using available editing software, such as ProTools from Digidesign® and others. A musician can playback any portion of a sound file or sound data, and copy, edit or otherwise manipulate any section of the data using such software. Graphical controls in a graphical user interface, such as sliders, knobs, buttons, pointer or cursor, etc., are typically displayed on a computer screen which the user can manipulate to control sound data playback and editing. A visual representation of the sound data is typically displayed as one or more time vs. amplitude graphs which the user can customize to a desired scale. Some more elaborate systems provide a hardware control such as a jog-shuttle wheel, which is a spring-centered knob which the user can rotate to playback a sound selection in forward or reverse.

However, one of the challenges in contemporary computer-manipulated music is to allow musicians to relate to computers in a way that is conducive to natural and instinctive music composition and editing. Much of the editing and composition process resides in the way people relate to the physical interfaces used to control computers. Traditionally, musicians have learned to work with instruments that directly bind physical manipulation to sound production (e.g., the action of a piano, or a trumpet as a resonator for lip vibrations). However, this type of physical relationship is difficult to reproduce with computers. In most cases today, the interaction with computers occurs through a keyboard and a mouse or, in less frequent circumstances, specialized hardware such as custom-developed electronic musical controllers. These types of interfaces are unidirectional, allowing the musician or other user to send physical input to the computer, but do not allow for the reception of physical feedback.

Current sound editing systems require the musician to use input devices such as keyboards and mice, passive scroll wheels, or passive joysticks while editing sounds. In these cases the musician must rely on auditory and visual feedback. However, the musician or user often performs repetitive editing tasks requiring precision, such as navigating through a musical or speech selection to find particular areas that are to be edited or manipulated. The standard input devices and auditory and visual feedback may sometimes be awkward, inefficient, or insufficiently precise at such navigation and editing tasks, thus causing frustration in the musician's creative efforts.

SUMMARY OF THE INVENTION

The present invention is directed toward outputting haptic sensations in conjunction with the output of audio. Haptic sensations are associated with audio output to allow the user more accurate and efficient control over the playback and editing of sound data.

More particularly, a method of the present invention associates haptic sensations with sound data to assist in navigating through and editing said sound data. At least a portion of sound data is loaded into a memory of a computer, and the sound data is played such that an audio signal is generated and used for outputting sound from an audio device. The playing of the sound is controlled by user input received by the computer from a user for navigation through the sound data. Haptic commands are generated based on the sound data and are used to output haptic sensations to the user by a haptic feedback device manipulated by the user. The haptic sensations correspond to one or more characteristics of the sound data to assist the user in discerning features of the sound data during the navigation through and editing of the sound data.

Preferably, the user can control a speed and/or direction of the playing of the sound data, using rate control or position control paradigms. The haptic sensations can be continuously output during the playing of the sound data and have a magnitude based on an amplitude of the sound data currently being played; or, the haptic sensations can be output only when features of the sound data having predetermined characteristics are played.

One embodiment pre-processes sound data to allow the haptic sensations associated with the sound data to be output when the sound data is played to a user. The sound data in memory is processed to find a sound feature having one or more predetermined characteristics. When a sound characteristic is found, a marker is stored in a list of markers, where the marker indicates a location of the associated sound characteristic in the sound data. The location is to be associated with at least one haptic sensation such that when the sound data is played, the associated haptic sensation is output to a user when the marker is reached during the playing of the sound data.

In another real-time embodiment, a portion of the sound data is stored in a secondary buffer and the portion of the sound data is processed to find the characteristics in the sound data real-time during the playing of the sound data. A visual representation of the sound data and a moving cursor to indicate a current part of the sound data that is being played can be displayed by the computer in any of the embodiments.

The present invention advantageously allows haptic feedback to be experienced by the user as coordinated with sound output. For example, haptic feedback can be integrated into a digital audio editing system to allow the user to feel haptic sensations that are directly related to the playback of the audio data and related to manipulations performed on the audio data. The user can navigate through sound data to find specific points in the data, and the haptic sensations can better inform the user when significant features are played. This greatly assists the user in navigation and editing tasks. This results in better user performance, higher levels of gratification, and an overall improvement in user experience.

These and other advantages of the present invention will become apparent to those skilled in the art upon a reading of the following specification of the invention and a study of the several figures of the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a system for providing sound data manipulation capabilities for the user enhanced with haptic feedback;

FIG. **2** is a block diagram illustrating one embodiment of the haptic feedback system of FIG. **1** including a haptic feedback interface device in communication with a host computer;