Feel the Beat: Direct Manipulation of Sound during Playback

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Abstract

We present a tangible user interface for direct manipulation of sound during playback. The interface was inspired by observing DJs and musicians working with computers where looping of sound takes on an important role. Through exploration using hardware and software prototypes we have realized direct mapping of perceptually important sound parameters to a motorized slider, enabling users to monitor and manipulate sound during playback[1].

1. Introduction

Computers are widely used in music performance and production. DJs increasingly use computers rather than analogue turntables and mixers [1]. Musicians use sequencing software in composition and ubiquitously employ computers in their productions. Sequencing software offers the ability to arrange and transform music, primarily in an offline situation, with notable exceptions such as Ableton Live which is designed for live performance. Here we seek to develop a tangible user interface for common sequencing operations such as looping of a sound. We work with samples of duration between 1 to 8 beats corresponding to 0.5 to 8 seconds. Our interface should allow for display and modification of sound during playback and be direct in its operation [9]. The proposed interface employs a loudspeaker and a motorized slider [3, 5] (Fig. 1) offering continuous audio, visual, and haptic cues during playback. The slider handle moves according to a predefined temporal audio parameter and thus gives immediate and continuous feedback about the current playback state. When the user holds or moves the handle the audio parameter changes and the audio playback is affected accordingly.

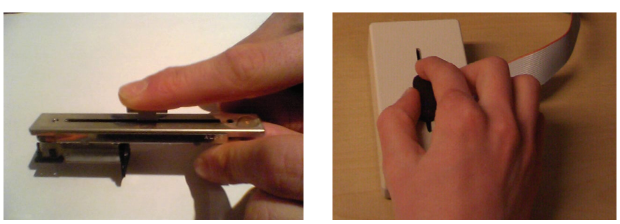

Figure 1. Motorized slider (left) and hardware used (right).

[1] This position paper is supported by a video presented at: http://www.diku.dk/~haste/feelthebeat.html

2. Tangible user interfaces

When playing a musical instrument the most important types of feedback are auditory and haptic. It is not uncommon to observe professional musicians closing their eyes while playing their instrument. For perception and manipulation of sound there seems to be a more direct coupling to haptic than to visual feedback. Interfaces employing auditory and haptic channels exist [6, 10]. The interactive elements of such interfaces are typically knobs, dials, switches, and sliders. Typical use of such interfaces has been media browsing [6].

Previous work in tangible user interfaces for music performance is based on one-dimensional interfaces such as the Q-Slider [2] and two-dimensional interfaces such as BlockJam [7] and Audiopad [8]. Here we choose to focus on a one-dimensional interaction device, the slider, since it hardly requires visual attention to operate and offers improved stability during body movement. Beamish et al. [2] investigated the use of a slider in a DJ setting. There, playback position was mapped to slider position and the slider was used for navigating sound files. Here we chose a radically different mapping using the slider to display and manipulate sound as a time varying function rather than time only.

3. Mapping sound to slider

By mapping a time varying audio parameter to the handle position the user can feel playback by touching the slider handle. When holding or moving the handle the audio parameter changes and audio playback of the loop is affected instantly. The new audio parameter value is recorded and used the next times the sample is played. In this way the slider can be used to manipulate and record a new transformation of the sound.

To couple sample playback with a motorized slider we started our exploration by mapping the time varying sound pressure level to the handle position. As the playback was carried out the handle moved up and down according to the sound pressure, this being limited to slider frequency response. However, driving or manually moving the handle up and down at audible frequencies is almost impossible; touching the handle resulted in silence.

Instead, we considered mapping of low frequency time varying sound parameters that are perceptually relevant. A parameter that proved feasible was the amplitude envelope of the sound. The amplitude envelope, a time varying function of the amplitude, was mapped to the slider handle position (Fig. 2). Changes in the envelope are easily heard and therefore it is used by musicians to manipulate sound using sequencing software or by DJs using a mixer. Other possible parameters include filters and sound effects such as echoing. Mapping a sound parameter to a higher order function of the slider handle, such as speed or acceleration, could be both intriguing and useful [4]. We also envision that additional benefit may be derived from moving the entire slider around at the tabletop which is the case in many other tangible UIs.

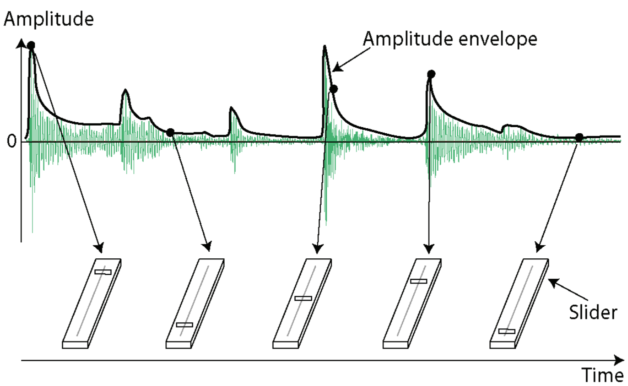

Figure 2. Amplitude envelope of sound and slider positions.

4. Realization

Using a motorized ALPS slider controlled by in-house designed hardware [3, 5], we can read and set slider force and position. Our hardware uses a modified sound card, offering AD/DA converter and audio class USB interface. Stereo sound channels are used to set and read position and force. A major challenge has been to control friction and non-linear behavior of the motorized slider. This was solved using a P-regulator, where actual position and set position are input parameters. The P-regulator is not able to eliminate the error, but this is compensated by the friction in the slider. Reading and setting position and force gives a set of control parameter combinations. The application works in two distinct modes depending on the observed force. When the observed force is above a given threshold it is interpreted as user manipulation and the position of the slider is used, otherwise ignored. In both modes the time varying position is set and a constant force is set.

The latency of the system is governed by the operating system and hardware. Using Windows XP with DirectSound the minimum latency of 64 milliseconds for reliable operation of sound hardware is required. However, with ASIO drivers it is possible to lower the latency to approximately 4 ms. To ensure stability of the slider operation, low pass filtering of the values read from the slider was needed adding a latency of 20 milliseconds. From handle manipulation to perceived sound effect this gives 148 milliseconds delay in the present prototype.

5. Discussion

In conclusion we have presented a new interface and a new parameter mapping for playback and haptic manipulation of sound. We have demonstrated the use of the interface by implementing a prototype system and tested its operation on a set of samples[1]. Using the interface it was possible to change the rhythm and musical structure of the loops. A problem is related to the two modes of force interpretation described above. When the observed force is below a given threshold it is interpreted as acceleration induced by rapid re-positioning of the handle, otherwise as user handling. To allow for a clear distinction, the slider must be operated as a relatively stiff device. Another problem was the trade-off between latency and stability where high latency was required to assure stability.

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