The elBo and footPad: Toward Personalized Hardware for Audio Manipulation

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Abstract

We describe initial prototypes and a design strategy for new, user-customized audio-manipulation and editing tools. These tools are designed to enable intuitive control of audio-processing tasks while anthropomorphically matching the target user.

Keywords: user modeling, user customization

1. Introduction

In recent years, software-based Digital Audio Workstations (DAWs) have all but replaced exclusively hardware based recording studios. This phenomenon has led to a reduction of the recording engineer's role in the production of music: many musicians now simply record themselves in project studios. This rapid transition to software-based DAW systems has led many to lament the loss of the tactile nature of hardware recording consoles. Graspable controllers [1] are uniquely suited to address this issue.

Furthermore, most musicians possess an entirely different vocabulary than trained engineers and producers. Musicians who use commercial DAW software are generally forced to work within the rubric of a fixed mixing-console-based model, in which each software knob controls a specific physical feature of a sound (amplitude, 1 kHz gain). By contrast, our work, conducted in conjunction with colleagues at Northwestern University [2], focuses on the creation of technology that controls perceptual features of sound and is adaptable to musicians on an individual basis.

2. Previous Work

The impetus behind this project is not particularly new; several recent projects have created new metaphors for editing and mixing sound. Tools like the AudioPad [3] and reacTable [4] are particularly of interest in that they use physical objects in the manipulation of sound. The Soundstone [5] and Squeezables [6] represent other remarkable controllers along these lines, although they prioritize generality over user-centricity. Commercial applications such as Ableton, Tracktion, and FL Studio tend to impose certain restrictions on musical style.

Our tools must be stylistically neutral, allowing user-customization on several levels. Specifically, our tools must meet two criteria: they must match the target user with maximum ergonomic specificity, and they must translate the desired terminology of the user into a gestural mapping that controls appropriate signal-processing algorithms. For example, we should first learn through a training phase precisely what the user means by the terms "brighter" and "darker," then learn what gesture they want to use to control the process by which sounds are made "brighter" or "darker." We must then successfully map these semantic descriptors along a continuum into a processing algorithm and gestural handle.

3. Design Approach

Our user-centered design approach involves three initial steps. First, the user is asked to develop a clay model of their desired controller. Next, this clay model is scanned three dimensionally or parametrically modeled in software. Finally, rapid prototyping methods (see, e.g., [7]) are employed to construct the physical object.

The desired sensors and electronics are then mounted in the controller, enabling the user to start controlling various features of the DAW software immediately. Next, through a software system prototype described in [2], a machine-learning phase matches user terminology with various DSP effects (e.g., equalization curves, reverberation parameters, etc.). Finally, the user is asked to "teach" the controller what gestures invoked upon it should control which processes.

4. The elBo Controller

Our first controller designed under this strategy, the elBo (Figure 1), is based on a joystick-like shape that is customized to the user's unique hand shape. It has been used as a controller for live sound diffusion in sound-

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reinforcement settings, for example in performances of electronic music in which a two-channel composition of pre-recorded music must be upmixed in real time into a large array of loudspeakers (typically eight, sixteen, or more) spaced around a concert hall.

Figure 1. The elBo controller prototype.

The controller features a number of force-sensing resistors, linear potentiometers, accelerometers, gyroscopes, and pushbuttons that translate desired gestural motions into sound-diffusion parameters (e.g., point-source location, multichannel spread, etc.; see [8] for further discussion). We have made two prototypes and are currently working on our third, which now uses the open-source Arduino microcontroller [10]; we chose the Arduino platform for its ease of use, robust features, and low cost. The most recent prototype of the elBo began as a clay model shaped by the first author's hand. It has since been printed on a 3D printer, and we are currently installing the sensors, electronics, and microcontroller to test the validity of this production method.

5. The footPad Controller

One of the most frustrating aspects of editing sound with a software-based DAW for many musicians is the lack of easy and intuitive transport control (the ability to quickly fast-forward, scrub, stop, play, etc.). The footPad controller (Figure 2) applies the central concepts of our project to a learnable, foot-operated transport.

Figure 2. The footPad audio-editing tool.

Placed directly under the user's feet while the user is in a normal sitting position, the footPad maps foot-weight distribution, brushing/sliding movements, and chording tap-patterns to various audio-transport tasks. This controller can be used with a number of commercial audio applications and digital audio workstation applications.

6. Ongoing and Future Work

We are currently incorporating work from our colleagues [2] to imbue each controller with machine-learned vocabulary that corresponds to the user's intent. We must then perform user-evaluation tests, like those described in [11], to gauge the efficacy of each tool for a number of musicians. Central to our philosophy, each controller must be quickly usable by musicians to edit, mix, and shape sound using terminology and gestures with which they are already familiar and comfortable.

7. Acknowledgments

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