A New Piezo-Based Instrument to Create and Perform with 10 Discrete Channels of Audio Using Non-Traditional Instrument Interaction Methods

ABSTRACT

Multi-channel music compositions are able to create interesting and exciting spatial effects that exceed the potential of music in stereo. However, capturing live audio for use beyond stereo is difficult due to the fact that most electronic instruments, such as electronic keyboards and synthesizers, only output two independent channels of audio. To capture audio in up to 10 channels, I have built a piezo-based microphone array that can be interacted with in a multitude of ways to capture 10 independent streams of audio. I have named this device the "Hexapad Controller" or "Hexapad" for short. The Hexapad allows a performer to excite up to 10 piezo microphones in non-traditional methods when compared to conventional musical instrument interaction; this can be with a brush sweeping across the piezos or any other interaction method a performer can devise. The Hexapad is modular in that it is able to incorporate different objects laser cut from wood to be placed over the piezos for different interaction methods. These include neoprene cut-outs for brushing over and birch wood cut-outs with rings screwed in for dragging wire through creating vibrations.

1. PRIOR WORK

Contact microphones have been used in experimental music for many decades. For example, John Cage has used contact microphones in a variety of compositions, dating back to [1].

The Pebble Box [2] is an example of a previously designed device to facilitate interaction between haptic and auditory sensations in response to the sonification of parameters captured by interaction with physical materials. Much like the Hexapad, the Pebble Box uses small microphones embedded into an object, in this case a box, that can be interacted with in any non-specific way to generate audio signals from interaction with the microphones.

"A Comparison of Sensor Strategies for Capturing Percussive Gestures" explores research and evaluation of the current strategies for capturing percussive gestures.[3] One of the technologies evaluated is piezo microphones. This paper concluded that piezos can be effective if they are isolated from other piezos and their impact locations to minimize the vibrations or nearby strike zones.

A paper on Augmenting an electric cello also utilized piezo microphones to capture audio from a cello to then use in MasMSP to give a performer gesture control with a digital interface. [4]

2. HEXAPAD

The main focus of the Hexapad is to have a multichannel piezo-based instrument that can generate signals at an audio sampling rate for spatial audio applications. The Hexapad accomplishes this by making use of ten piezo microphones each mounted to the device. To avoid direct contact with each microphone, a pad of neoprene sits above each piezo. The pads also aid in isolating each piezo from one another effectively reducing unwanted vibrations from neighboring piezos. Each piezo is wired to its' own individual audio output connector to be plugged into any audio device that supports audio input.

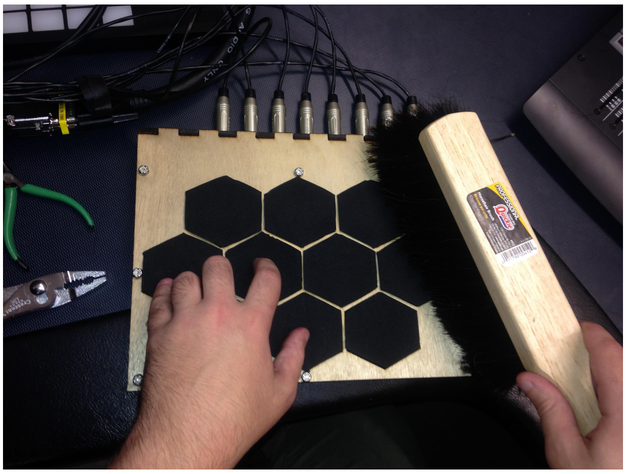

Figure 1. Performers can easily play the Hexapad using the fingers or a brush.

3. INTERACTION METHODS

3.1 Fingertips

Using one's fingertips on the pads is a percussive way of interacting with the Hexapad, similar to the percussive interaction discussed in [3].

3.2 Brush

Using a brush like the one pictured in figure 1 is the primary way that I interact with the Hexapad. Dragging the brush around creates an image in the speakers that mirrors the brush's direction of motion when multiple outputs are mapped to multiple speakers. The audio created is an interesting grinding sound similar to scraping objects along a rough surface.

3.3 Snare Cables

Using different cut-outs for the Hexapad allows for the use of snare cables as an interaction method. These cut-outs have rings drilled into birch wood that the performer can drag snare cables through to transfer vibrations to the piezos. Similar to the brush, dragging the cables through these rings creates movement of the sound sources in the speakers when the outputs are mapped to multiple speakers. The timbre of the sound is similar to metal scraping against other metal surfaces.

4. FUTURE WORK

4.1 Alternate designs

The current state of the Hexapad's design does not elegantly support the interaction of droppings objects onto the pads. The objects roll or bounce off of the pads and the surface of the Hexapad. In future designs, this problem will be addressed by adding raised perimeter dividers around the pads to capture any loose objects being used to interact with the Hexapad.

I will also include actuators to give haptic feedback to the performer like the ones discussed in[5].

4.2 Future Projects

I will evaluate the Hexapad using HCI techniques discussed in [6] to further improve upon and add features to the Hexapad.

A large scale application of this device is desired for use in the theatre that I have access to. This theatre contains a system of 92 speakers with 71 channels of audio available for routing. In this project, each piezo will represent one or more speakers for the user to send localized audio to in a massive multichannel spatial environment.

Link to demo video:

`https://drive.google.com/open?id=1XgAMMVW7XDqFWucL-dIVCY_wfzHjGLCm`

5. REFERENCES

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