The E-Drum

A Case Study for Machine Learning in New Musical Controllers

Adam R. Tindale and George Tzanetakis

Alberta College of Art + Design, University of Victoria

adam.tindale@acad.ca, gtzan@cs.uvic.ca

Phone Number of Primary Author: +1 403 481 0576

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Abstract

This paper describes a system of drum gesture acquisition via machine learning methodologies. Discussions of techniques, advantages, and previous work are discussed in the context of evaluating a new controller for musical expression. An evaluation of the machine learning mechanism is provided in the form of statistical results of classification tests. An informal evaluation of the effectiveness of the system for percussionists is provided in the form of performance reports of the first author's use of the system.

1 Background in Music Performance

The rate of advance in Music Technology has increased enormously, yet commercial electronic percussion has been stagnant for approximately 20 years. There is not even an entry for it in the standard book Percussion Instruments and their Histories Blades (1997). Commercial electronic percussion hardware has not improved and the sounds have only evolved to imitate sounds that have already become popular. Current percussion controllers only provide data on the velocity of the impact, forcing a single dimension of data to represent something as complex as musical gestures.

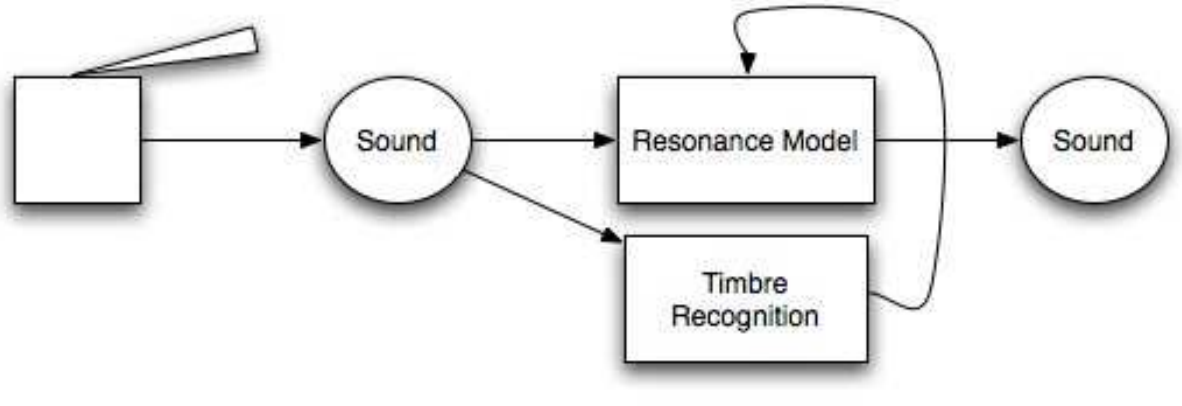

Figure 1: A diagram of the signal flow in the E-Drum software.

2 Background in Computer Science

Rebecca Fiebrink has presented numerous works on integrating machine learning into the live performance context Fiebrink et al. (2008); Wang et al. (2008). Fiebrink's system incorporates a machine learning framework with a real-time Open Sound Control interface in order to allow an agnostic system towards feature extraction systems.

Roberto Aimi received his Ph.D. from the MIT media lab where he focused on developing novel percussion interfaces Aimi (2007). Aimi's convdrum uses piezo microphone that is attached to a drum and fed into a computer where a convolution algorithm is applied to the signal. Convolution offers many advantages as a synthesis method. When one uses a high quality sample of an acoustic instrument then the it is possible to get a high quality reproduction of the acoustic instrument.

3 Aims

The E-Drum utilizes the concept of an acoustically driven physical model as the primary form of sound generation. Typically physical models are driven by synthetic excitations. By modifying the algorithms to accept audio input acoustically excited physical models are created. This model allows for the use of brushes and scraping gestures that standard drum controllers are not able to capture. See figure 1 for the general software overview of the E-Drum.

4 Main Contribution

The E-Drum software provides two methods of recognizing gestures: implicit and explicit position tracking. Explicit position tracking is achieved using machine learning to determine the timbre produced by a drum controller and then infer position based on labeled training data. The explicit position tracking can be tailored to a specific application by using different classification algorithms outlined in this chapter. Implicit position tracking is achieved by using the acoustic signal of a drum controller to allow the listener to hear to timbral variations that naturally occur when the controller is struck at different locations. The accuracy of these systems is sufficient for performance, as will be demonstrated in the following chapter.

5 Implications

The E-Drum has been used in a number of performances. In these environments there is no tolerance for noise or failure. During years of performance experience the E-Drum has proven to be a reliable concert instrument. The flexibility of the instrument is illustrated by the ability to improvise in a number of musical situations.

The Electron Orchestra Withdrawal is an exploration in expanding the prototypical rock ensemble: guitar, bass, drums, and vocals. The group consists of Clinker (aka Gary James Joynes) on bass and electronics, Les Robot on Guitar, Jackson 2Bears on turntables and electronics, and the primary author on E-Drum. The group is able to explore electronic music, rock music, ambient and metered structures through improvisation.

References

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Fiebrink, R., Wang, G., and Cook, P. R. (2008). Support for mir prototyping and real-time applications in the chuck programming language. In *ISMIR*, pages 153–158.

Wang, G., Fiebrink, R., and Cook, P. R. (2008). Music information retrieval in chuck; real-time prototyping for mir systems & performance. In *ISMIR*, page 23.

Figure 2: Performing with E-Drumset and the Electron Orchestra Withdrawal.

6 Biographies

Adam R. Tindale

Adam Tindale is an electronic drummer and digital instrument designer. He is a Permanent Instructor of Interaction Design in the Media Arts and Digital Technologies department at the Alberta College of Art and Design. Adam performs on his E-Drumset: a new electronic instrument that utilizes physical modeling and machine learning with an intuitive physical interface. He completed a Bachelor of Music at Queen's University, a Masters of Music Technology at McGill University, and an Interdisciplinary Ph.D. in Music, Computer Science and Electrical Engineering at the University of Victoria.

George Tzanetakis

George Tzanetakis is an Assistant Professor in the Department of Computer Science with cross-listed appointments in ECE and Music at the University of Victoria. He received his PhD in Computer Science at Princeton University in 2002 and was a Post-Doctoral fellow at Carnegie Mellon University in 2002-2003. His research spans all stages of audio content analysis such as feature extraction, segmentation, classification with specific emphasis on music information retrieval. He is also the primary designer and developer of Marsyas an open source framework for audio processing with specific emphasis on music information retrieval applications. His pioneering work on musical genre classification received a IEEE signal processing society young author award and is frequently cited. More recently he has been exploring new interfaces for musical expression, music robotics, computational ethnomusicology, and computer-assisted music instrument tutoring. These interdisciplinary activities combine ideas from signal processing, perception, machine learning, sensors, actuators and human-computer interaction with the connecting theme of making computers better understand music to create more effective interactions with musicians and listeners.