THE AUGMENTED DRUM KIT: AN INTUITIVE APPROACH TO LIVE ELECTRONIC PERCUSSION PERFORMANCE

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ABSTRACT

This paper aims to outline some aspects of ongoing research towards the development of a computer-mediated electronic augmentation of a traditional four-piece jazz drum kit. The highly customised instrument consists of a traditional drum kit mounted with triggers, contact microphones, speakers, and bespoke software. The acoustic kit becomes part of the control interface of the electronics with the use of various machine listening techniques, and mapping strategies. Firstly, I will present an introduction to the history of the drum-kit as a constantly evolving instrument, supported by examples, and I will also discuss its relationship with the computer. Secondly, I will expound the aims of the research and the technical details of the setup, along with some of the modes of interaction methods for sound transformations through examples. Finally, I will evaluate the success of the system and its use so far, along with possible future directions.

1. INTRODUCTION

"Percussion music is a contemporary transition from keyboard-influenced music to the all-sound music of the future." - John Cage[1]

The drum kit as an instrument has two very distinct characteristics: firstly, anything can be considered to be percussion. From gongs and cowbells, to a prepared snare drum, any sound making object can be incorporated into the percussionist's sound palette. Secondly, the evolution of the drum kit tells of a history of inventions and augmentations, in order to make a single percussionist capable of having at their disposal a wider range of sounds simultaneously. The hi-hat, the snares of the snare drum, the bass drum pedal and the cymbal stands are a few obvious examples. Also, within orchestras, the percussion section has been one of the first places for sonic experimentations, with pieces such as Edgard Varèse's *Ionisation* [4] incorporating anvils and sirens. In the free improvisation scene, some of the best examples of instrumental expansions come from percussionists, such as Chris Cuttler[2] and Tony Oxley[3]. These improvisers were also among the first to use amplification and real-time electronic sound transformations as part of their setup.

In this respect, it could be argued that the drum kit has some similarities with the computer as a performance instrument. The two share the fact that they can be highly customised and adapted to the specific needs of the performer. As with the percussionist, the laptop artist builds their instrument by assembling different modules and instruments that fit their aesthetic, programming their own effects or modifying existing ones. Custom-made cymbals and bespoke software environments, paint cans used as drums, or noise-gate modules used with extreme values as real-time sound processing effects, can all be seen as different applications of the same ideas of customisation and repurposing.

2. AIMS OF THE RESEARCH

This research aims to develop a highly personalised electronically augmented drum kit, making use of the computer as the main augmentation device. In contrast to simple sample triggering (as employed by conventional electronic drum kits) the electronic part of the kit is designed to interact with *all* performance elements and variations, maintaining the responsive qualities of the acoustic instrument. Previous work towards electronically augmenting percussion was taken into consideration, for example *An Augmented Snare Drum*[4] and *The Augmented Djembe Drum*[5], as well as recent commercial products such as the *Korg Wavedrum*[6]. It was decided, however, that the system would be purely based on an acoustic drum kit, using mostly live audio for the extraction of control data. Although continually a work in progress, this required lengthy periods of time dedicated to practice and improvisation, without changing the system, in order to learn its extended capabilities intuitively. As jazz saxophonist Ronnie Scott put it, there was an effort to "become as close to the instrument, as familiar with it, as possible. The ideal thing would be to be able to play the instrument as one would play a kazoo" [1]. Performing with an augmented instrument, or indeed with any acoustic instrument and live electronics, can be challenging, mostly due to the need to learn new gestures which are often alien to the

[1] The Future of Music: Credo (1937)
[2] Chris Cutler's kit description: http://www.ccutler.com/ccutler/
[3] Audio Example: Tony Oxley - Ichnos: http://www.discogs.com/Tony-Oxley-Ichnos/release/659887

[4] http://www.icsrim.org.uk/augdrum
[5] http://recherche.ircam.fr/equipes/temps-reel/nime06/proc/nime2006_364.pdf
[6] http://www.korg.co.uk/products/wavedrum/wdx/

acoustic instrument. Pauline Oliveros describing the rise of complexity of her setup wrote "I experienced a new kind of performance frustration - how could I control multiple performance parameters spontaneously during improvisation when my hands and feet were too busy to access other controls?" [3]. Even though such problems can be considered during the design stages of the hardware setup (for example, the use of a rubber electronic pad would be more natural to a drummer for the input of control data instead of a slider), many control processes can be designed to be managed in the *software* realm with the use of machine listening techniques, partially eliminating the need for the use of MIDI controllers for all parameters.

A central point in the development of the augmented drum kit was its use and evaluation in different improvisational contexts. Being able to quickly access any sound or texture produced by the instrument in order to be able to improvise spontaneously with other musicians was one of the main tests for the system to be considered *successful*. Another important aspect was to make the electronics aesthetically relevant to acoustic percussion, and gesturally connected to the physical performance. The audience should be able to sense the relationship between the drummer's gestures and electronics to some extent, by keeping the physical cause and sonic effect not always entirely, but usually fairly obviously connected. The electronic sound was designed to enhance the drum-kit's acoustic properties, as well as to contrast them, always attempting to maintain one coherent electroacoustic instrument.

3. TECHNICAL ASPECTS

This section describes some of the basic hardware and software details of the augmented drum kit, along with some of the modes of interaction.

3.1 General Description

The software is programmed in Max/MSP and consists of ten distinct sound processing modules. These can be roughly divided into 1) Live sampling and buffer manipulation 2) Performance based sound synthesis 3) Spectral Morphing. The patch can work in three different modes: 1) Free: in this case the performer can turn modules ON and OFF on the fly with the use of a nanoPad[1] MIDI controller. 2) Listening: here the patch listens for acoustic elements that will turn processes ON or OFF, for example pitched material coming from a bowed cymbal will turn ON spectral morphing modules. 3) Cues: the percussionist initiates the start of the performance and processes turn automatically ON and OFF after predetermined amounts of time. The performer has the option to pause the time line in order to stay longer within a section. The third mode was combined with vibrotactile feedback and a local network between two performers, leading to the development of *NeVIS* [2], a networked cueing system for improvisation. It was used most notably for the performance of *Socks and Ammo* at NIME[2] 2011, a work for hybrid piano and the augmented drum kit.

3.1 Inputs

The signal inputs of the patch can be generally divided into two categories 1) inputs used only for control data; 2) inputs used for sound processing and some control data. Controllers and microphones used include:

- 4 drum triggers[3] mounted on each individual drum (Figure 1), 1 contact microphone attached on a cymbal or metallic spring (Figure 4), 1 drum pad, 1 Korg nanoPad MIDI controller, 1 expression pedal and 1 switch pedal.
- 2 DPA microphones attached on the drummer's wrists, *or* up to 4 x AKG clip microphones.

Figure 1. Triggers attached on the drum frames

Each of the control data inputs can affect each of the electronic sound modules in different ways. However, every set of inputs has a specific type of acoustic sound behaviour in mind. The drum triggers are used for onset attack detection on the individual drums, and envelope following with a quick attacks and decays. The contact microphone attached on the cymbal or spring is used for longer amplitude envelopes as the spring can keep vibrating for a longer period of time after its excitation. The same applies to the cymbal. These are used for producing longer amplitude envelopes for certain processing modules, making the spring and cymbal themselves physical amplitude controllers.

A specific example encompassing all of the features described above is the granular synthesis module[4]. The drum triggers provide information on the density of the physical performance, affecting the granular grain density. Also, when hits on the snare drum exceed a

[1] http://www.korg.co.uk

[2] http://www.nime.org
[3] http://www.ddrum.co.uk/ddrum/drumtriggers.html
[4] based on Michael Edwards' mdeGranular~ object: http://people.ace.ed.ac.uk/staff/medward2/software/mdegranular/

certain level, the granular density is maximized for a few milliseconds creating bursts of grain clouds with every hit. Finally the *type* of drum (bass drum, snare drum, etc.) determines the grain pitch. The piezo microphone acts as the amplitude envelope for the module, so in order for the aforementioned effects to be audible, one needs to keep exciting the cymbal or spring. Similar mappings and controls are applied to all the modules. Thus in combination, even though it is not entirely obvious how the electronic sound is affected, it is clear to the uninitiated observer that there is a strong connection with the acoustic performance.

The drum pad is used to freeze all of the control data of the active modules. This was employed to solve the problem of maintaining constant interaction between the acoustic performance and electronic sound. During improvisations, I often required the electronic sound to stay at the *same place* while the acoustic performance could go elsewhere, or move around for a while without affecting the electronics. The term *freeze* here does not refer to spectral freezing, but to unchanged control data, retaining the current character of the electronic sound. A hit on the pad would make the active modules stop responding to the acoustic performance (for example keeping very dense granular synthesis grains regardless of the acoustic performance). After this, if new modules are initiated, they will be responsive until the detection of a new hit on the pad, making them unresponsive too. Any hit on the drums exceeding a certain level will make all modules in this mode go back to listening mode, resuming responsiveness.

Despite the use of triggers for expressive control over the electronic sound, there was a need for specific control over certain parameters where the outcome could not rely on machine listening processes or combinations of gestures. For example, being able to force the volume of the overall sound to zero, and starting or stopping sampling processes at specific points of the performance would have to be controlled more directly. For such reasons, an expression pedal and a foot switch were incorporated into to the system. The sustain pedal was used in multiple ways (above simple mapping of its 0-127 expressive range), according to its value and speed of value change: Action A (Boolean), when its value is 0; Action B (Boolean) when its value is 127; Action C (Boolean) when the pedal is idle for more than 300 milliseconds; the actual value of the pedal.

After extensive experimentation with mappings and rehearsals it is now possible to control a very significant amount of data intuitively with a single pedal. For example, Action C is used to turn the overall sound volume to zero (with ramps) when there is no new incoming data from the pedal. Whenever I want a very sudden cessation of the electronic sound, I simply have to take my foot off the pedal. This gives a significant sense of control when performing. If I need to access other controls, and *have* to take my foot of the pedal but do not want the electronic sound to stop, I can hit the pad as described above, and the current control data (which includes the pedal) will freeze, making it possible to maintain the desired amplitude while moving away from the pedal.

The switch pedal is used mostly for sampling, and can be perceived as a *functional* gesture. Even though it affects the overall electronic sound, this does not happen directly (as in the case of the drum triggers). The effects only become apparent through the direct controls, such as the expression pedal, triggers or piezo. This could be likened to functional gestures of the acoustic performance such as changing drumsticks, turning the drum snares on, or changing the tuning of the floor tom during the performance. The fact that I change drumsticks will not affect the sound *unless* I hit the drum.

3.2 Sound diffusion

After discussions with Swiss percussionist, composer and improviser using live electronics, Christophe Fellay, in March 2011, I decided to adopt a localised speaker approach, rather than sending the sound to a wider stage PA which dislocates the electronic sound from the direct acoustic sound. The idea being that the electronic sound is a part of the instrument, and thus it should be close to the acoustic source. Of course, depending on the venue, the whole electroacoustic sound could be reinforced further by a pair of overhead microphones, but this should be something to be decided according to the needs of each performance. This approach also helps to have a sonic experience closer to that of the audience. Being able to perform comfortably while feeling *inside* the electronic sound is one of the most important aspects when improvising with an augmented acoustic instrument. Expanding this idea further, I placed a third speaker below the floor tom that would create feedback and resonate the tom membranes (Figure 2).

Figure 2. Feedback floor tom

By placing objects on top of the vibrating tom, such as small rocks, rice, twigs or chopsticks, it became possible to create slowly evolving organic textures produced by the bounces. Also, by pressing the skin with different amounts of force and on different positions, different feedback overtones and amplitudes are generated. Apart from the range of sounds being produced, one of the most important features is the physical control of the electronic sound. Performing on the feedback floor tom could be described as a physical struggle to maintain a balance between complete feedback and complete dampness. Placing too many objects or damping the top skin of the tom with an open palm will stop the resonance and thus also the feedback, providing a direct way to mute the feedback generated sound without the use of a MIDI controller.

3.3 Graphical User Interface

All mappings and controls were designed to prevent me from having to look at the laptop screen while performing. Theoretically, I should be able to close my eyes and reach the desired electronic "places" with the same ease as hitting a cymbal by remembering intuitively where it is located. Nevertheless, I decided to design a performance GUI anyway as a point of reference, if ever required (Figure 3). The most important consideration was to visually access all relevant information as quickly as possible without having to read text or control values. The interface was designed based on the Korg NanoPad and includes the following:

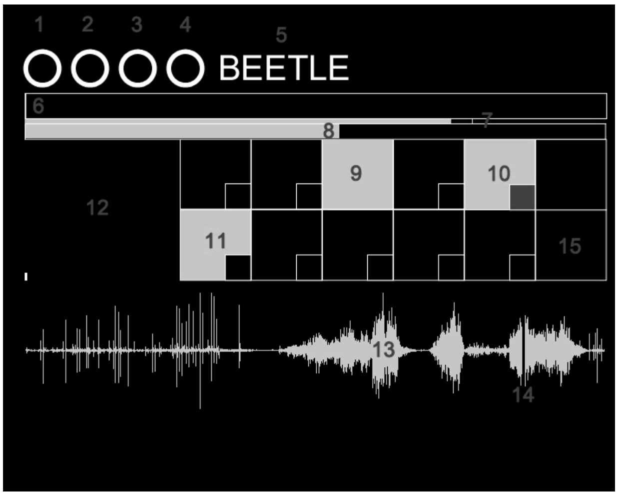

Figure 3. Performance Graphical User Interface

1. Start (in cue following mode)
2. Stop (in cue following mode)
3. Pause (in cue following mode)
4. Edit Cues (in cue following mode)
5. Current cue section name as assigned by 4
6. Overall sound density
7. Master audio level
8. Current cue section bar: time elapsed
9. Processing module active
10. Processing module active with control data *frozen* as specified by bottom greyed square
11. Processing module active with controls responding to the acoustic performance as specified by the non-greyed bottom square
12. X-Y Control from the Korg NanoPad
13. Current sampled buffer visualisation
14. The black vertical line represents the present loop playback position
15. Processing module inactive.

4. CONCLUSIONS

The augmented drum kit (Figure 4) was presented both in solo and collaborative settings in numerous festivals, most notably: Sonorities, NIME, BEAM, Dialogues, Soundings, and Network Music Festival. It was also used for the recording of a live solo improvisational album, *Frrriction*[1].

Although always a work in progress, the modes of interaction and control have remained successfully unchanged for a significant period of time and there are no plans to change the framework in the near future. Even though the actual sound processing modules may change (in the same way that a cymbal can be replaced), or be expanded on by the addition of more features, or indeed become more efficient, the control system is not likely to change soon. Having developed the augmented drum kit over several years, the instrument feels extremely intuitive and allows me to perform in a wide variety of situations with the same expressiveness and response as I would have with a purely acoustic instrument.

Figure 4. The Augmented Drum Kit

5. REFERENCES

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