Granular Synthesis: Experiments In Live Performance

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Photo 1: Timothy Opie & Fish

Abstract

This paper describes current research into Granular synthesis. It outlines the design and performance of a musical instrument based upon this Synthesis method. The instrument, design, process and products are used as a research tool for examining granular synthesis in real-time performance on a low budget.

1 Introduction

Granular synthesis has been used in composition for many years now, but is still not widely used as a performance tool. The intention of this paper is to give an overview of the making of a real-time granular synthesis instrument that can be used for live performances and improvisation with other instruments including traditional acoustic instruments. This paper gives a description of some of the goals and specifications, how these were met, and how the instrument performed in a live setting. It also addresses some future development for the instrument. The paper also outlines the building of a low budget granular synthesis instrument.

2 Background

Granular synthesis is perceived as a relatively recent development in sound synthesis, but it can also be seen as a reflection of long-standing ideas about the nature of sound. Quantum physics has shown that sound can be atomically reduced to physical particles (Wiener 1964). This physical form of sound was first envisioned by the Dutch scientist Isaac Beeckman (Cohen 1984). He explained that sound travels through the air as globules of sonic data. Later works including those by Gabor (Gabor 1946) and more recently Xenakis (Xenakis 1971), Roads (Roads 1988), and Truax (Truax 1990) has evolved the particle theory of sound into a synthesis method whereby the natural sound particle is imitated and magnified. The particle is then layered with other imitation particles, either cloned or extracted through a similar process as the original to create different sounds.

3 Design Specification

My study of granular synthesis is focused on making an instrument for both research and live performance. The research element will examine and catalogue a large range of sounds produced using pure granular synthesis techniques. It will also look at ways that this can be notated for musical scores. The performance element focused on creating an easy to use instrument that can be played live on stage and interact with other instruments.

As a musical instrument, I wanted to create something that could be used alongside traditional acoustic instruments for both improvisation and scored compositions. It was also important to have a control interface that was easy to learn, but which allowed the musician virtuosic control over the instrument. A major design consideration of the instrument was budget. It needed to be inexpensive to create and use.

Another major goal of the instrument was that it had to be the focal point for performance. It had to be visually interesting and give the audience a clear association between the sound and the instrument. The computer that actually generated the sounds as dictated by the instrument interface was to be invisible to the audience.

The actual granule producing protocol was a major concern. I wanted it to be portable and open source. Portable in the sense that people could download it to any kind of computer and just run it without having to recompile it.

The first place of exhibition for the instrument was to be at the REV festival in the Brisbane Powerhouse. This was a public event for the whole family to come and try out different ways of producing sound. With this in mind, I had to create an instrument shape that would be appealing to an entire family, young and old, which would encourage them to hold the instrument and try playing it.

4 Methods

The two key elements in working with granular synthesis are the method chosen to extract the sound grains and the method by which to layer them. Bowcott (1989), Keller & Truax (1998) and Hamman (1991) have researched various mathematical and scientific algorithms that have been used for the layering process. Many of these methods were not useful for this instrument design, as they are automated. Initially I examined and produced ways of incorporating mathematical algorithms in order to reduce the number of controllers needed, but eventually decided to incorporate a direct parameter control to the instrument interface. This was done to assist in the research element of the instrument design. I wanted to work from basics and then build from that. For the basic design, I mapped 10 sliders to 10 parameters that I thought were most sonically interesting. These parameters were:

Grain duration & random offset
Grain density & random offset
Grain frequency & random offset
Grain amplitude & random offset
Grain panning & random offset

During implementation this evolved slightly, and I am working on grain envelope shape control, sound source selection, and a more refined grain frequency control with a brass instrument based fingering style.

I decided that in order to make the instrument as versatile as possible I would get it to generate the parameters in the MIDI protocol. I used a CV to MIDI converter designed by Angelo Fraietto. I just bought a basic unit consisting of a circuit board and a pre-programmed PIC chip. I soldered all the sliders and other control devices to the circuit board and then placed the circuitry inside a large 1kg Nestle Quik tin, with the controllers protruding through holes drilled in it. Wooden panels were added around the controllers to ensure there were no sharp edges. This was an important feature considering it would be open for public use.

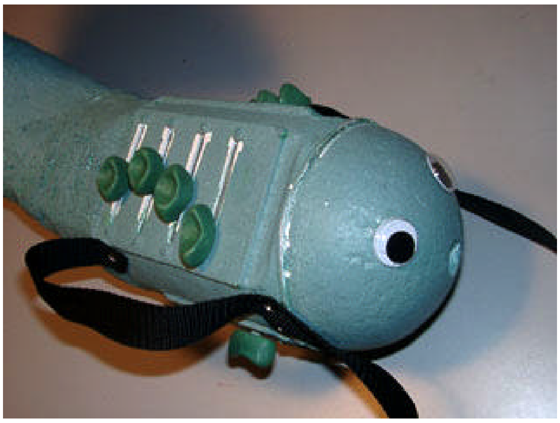

Photo 2: Close up of controls

Photo 3: Close up of MIDI, power and MIC sockets

I was concerned about the feel of the controllers so I made the finger controls out of hard setting plasticine and shaped them to each finger.

Once all of the components were installed in the tin, I then had to make a shape for the instrument. The shape was chosen in relation to a saxophone, but I knew that many children would be playing it at the exhibition, so I added more character to it. I made it a saxophone shaped fish complete with googly eyes. I made the shape out of Bostik gap filling foam by creating a mould around the tin and then spraying the gap filler into the mould. I chose the gap filler because I knew it would set quite hard but be extremely light. Lastly, I painted the instrument a marble green/blue colour.

Photo 4: The full instrument interface

The granular engine running inside the computer was done in two stages. First a prototype was made using Csound. This was primarily to check the interface as it was being made to ensure it worked correctly, and to set a benchmark. The final product was written in jMusic. jMusic is a java based sound synthesis and compositional tool written by Andrew Brown and Andrew Sorenson. Being Java-based allowed me to develop the instrument on a number of different computer platforms. jMusic has adopted the GNU Public License which my instrument also inherited making it open source, so that others may develop it further and modify it as they like.

The software development in jMusic went through a number of stages. I started by looking at different ways of creating grains of sound in jMusic. One very simple method was to create notes with lengths of only 20-30ms. This gave a good result, but the computation involved was too intense and was not suitable for a real-time instrument. I then started looking at creating a Java audio object to integrate into jMusic. Andrew Sorenson helped by creating a base, which I modified to suite the granular synthesis process and the instrument interface. The final part of the project involved getting the whole process running in real-time without any lag or unpredictable events.

The jMusic component is still being refined to include more features, as mentioned previously, envelope shape control, sound source control, and more refined frequency control which I am integrating through the use of a brass instrument based fingering style. This will include adding four buttons to the instrument the first three will follow the standard three valve brass instrument fingering style from C4 to B4, whilst the forth will be used as a substitute for the lack of breath control the musician has over the pitch. For example the note E4 and A4 have the same fingering, but the fourth button will differentiate between the two notes. There will also be a slider to control the octave. It will also retain the current frequency controlling slider, which can be used to offset the current pitch. Another feature that is being worked on is microphone input. I specifically want to incorporate microphone input because it adds a large array of sound sources and control that can be changed as quickly as the performer can create a vocal sound. In previous experiments, the microphone was found to lag when the whole process started working in real-time. This latency issue is something I wish to resolve in the near future.

Another main component to the instrument was the actual computer it ran on. Despite the computer being kept hidden away, it still would have been impractical to use a large powerful computer, or network of computers. Itagaki, Manning and Purvis suggested a live real-time granular synthesis process using 53-networked computers that could control nine voices at once [Itagaki, Manning, Purvis 1996]. Whilst this opens up a fantastic range of options, it poses many problems that would negate some primary objectives of this instrument. These include primarily cost, and computer visibility. The instrument was designed with only one voice, so in order to have multiple voices you would need more performers, each playing an instrument in a granular synthesis orchestra. The program ran on just a single computer of reasonable speed, which reduced costs a lot. Due to the nature of Java, I was able to test and run the instrument on a number of different machines and operating systems. For the REV performance I chose to use Windows 2000 on a Pentium 4 based computer. This gave the fastest Java results, with the least hassles, and at a less expensive cost than a Macintosh or other non-i386 based computer. Using BSD or Linux as the main operating system would decrease the cost even more, but the MIDI-IN support required for the sound card was not adequate. I am currently in the process of improving the MIDI-IN support for FreeBSD as this will add to the stability of the instrument.

5 Performance

The first public exhibition of this instrument was held at the REV festival in Brisbane in April 2002. For the most part the instrument was located in the elevator, with an accompanying performer. The location of the instrument had some positive and negative results. On the positive side, it gave the performer and the listeners an intimate space where they could absorb many of the sounds without being distracted by other exhibitions at the festival. On the negative side many people missed out on seeing it because they weren’t expecting anything to be in the elevator, and most of the displays were on the split ground level, for which an elevator was not required. It was also cramped in the elevator meaning that many people didn’t want to take the time to stay and learn more about the instrument. The elevator broke down on the final day of the exhibition. The worst part was traveling on the elevator so long gave me motion sickness, although the other two performers handled it much better.

As expected, children loved it. They were curious about the shape of the instrument and of what the different controllers did. The two students who helped me with performances, Rafe Sholer and Joel Joslin, both picked up the instrument playing techniques very quickly. Within half an hour, they were already picking out certain finger combinations that worked together and gave pleasing aural results. They could both see a lot of potential with the instrument and enjoyed working with it. Joel said “the instrument definitely has virtuosic potential, but at the same time it is very easy to create interesting sounds without much instruction”.

One highlight of the exhibition was to do a live performance with Benn Woods, Andrew Kettle and Greg Jenkins. We improvised music for a silent experimental Russian film. This performance really allowed me to try out the different sounds I could create in a large space and a large sound system. The effect was vastly different from that of the elevator performances. We will be doing some future performances together as a result.

The main reason I am now working on ways to modify the frequency control of the instrument is because I found it too restrictive being limited to sliders. I could jump quickly from one frequency to another with very little slide, but it was inaccurate. With a slider and preset frequencies, I could play more accurately. This would enhance performance especially when being played as part of an ensemble. For the generation of soundscapes the slider method proved to be adequate.

I found that using a physical interface shaped like a more conventional instrument helped the audience to become more involved with the music, and I was likewise more able to interact with the audience. I could watch the audience at all times and not have to look at the instrument. If I was to perform the exact same music but with the computer sitting on the desk, and myself in front of it playing with a mouse, or even a mixing panel, the audience participation would be decreased, as I would be interacting with the computer rather than with the intended audience. This restriction applies to all computer-based music. The shape and lightness of the instrument helped with the performances. As seen in Photo 1, the performer can hold the instrument quite comfortably and play, without even needing to watch the instrument. It also includes a strap to go around the neck so the performer is freer with their actions and body movements. The shape suited my hand very well. For a small child it was too large, but as I was the main performer, it was more suitable to shape it to my hand size. Joel and Rafe also had similar sized hands, so they also found it easy to hold and maneuver.

Another finding I made was that the audience did not expect such a wide range of sounds to come from one instrument. I was able to create sounds from growly rumbles that vibrated the floor, right up to bursts of high pitched flutters.

I found the granular synthesis real-time instrument to be very useful and very flexible in performance. Even though it was created on a small budget it provides the performer with a wide range of instantly variable sounds to explore.

One last performance issue of exceptional worth was the fact that the program did not crash once in the 3 days that it was running.

6 Conclusion

This paper has discussed my method of creating the instrument, and some of the issues I addressed whilst making it. I have shown that a small budget can be used to create an instrument that is visually as well as gesturally and aurally stimulating. I have briefly explored the experiences of other performers and the audience in relation to the instrument.

Granular synthesis has been used as an effects mechanism in many recent live performances, but this instrument shows that it can be used as a pure sound generation and music-performing instrument. Whilst this has been done before, it has not been used as just an instrument with the expectation of performing with other instruments.

The instrument met most of the design specifications. It still has a large area that can be worked on and refined to increase the versatility and playability of the instrument, as have been noted.

This instrument allows quick observations to be made and documented which will help with the planned research into notational conventions.

Most importantly, this instrument entertained audiences with its visual characteristics and sound qualities.

7 Acknowledgments

These people have helped me with my project in some way: Andrew Brown, Andrew Sorenson, Gabriel Maldonado, Angelo Fraietto, Craig Fisher, Stuart Favilla, Aaron Veryard, Steve Langton, Steve Adams, Steve Dillon, Paul Cohen, Adam Kirby, Rene Wooller, Joel Joslin, and Rafe Sholer.

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There will be some sound samples of this instrument available at: http://zor.org/synthesis