Undergraduate Research Award Proposal: Composing Electronic Music Controlled by Physiological Input

Nicholas Shaheed

For Spring 2015

1 Project Description

1.1 Project Summary

I intend to compose a multi-movement piece of music for solo flute, computer, and heart rate monitor. My intent with this composition is to create a piece of music that is significant in its scope while also creating a more intimate connection between the performer and the generated electronic sounds. This will be accomplished by utilizing a computer to analyze the real-time physiological data of the flautist to control a number of aspects of the music, including, but not limited to, the tempo, dynamics, texture, and overall structure of the music itself. The result will be a piece of music with two "performers," the flautist and the electronic sounds generated by the computer. Because of the connection made between the two "performers" through the real-time heart rate data, the result will be a product that is more organic in its realization than the typical approach to this format, where a live performer is accompanied by a prerecorded backing track that is strict in its tempo and limited in its ability to adapt to the live performer.

1.2 Background

Using non-musical data as a means of organizing or generating music has been explored since the emerging years of electro-acoustic music. One notable example is Charles Dodge's *Earth's Magnetic Field* (1970). For this piece, Dodge took a years worth of data measuring Earth's magnetic activity and mapped that data to musical pitches to create a lighthearted, synthesizer laden journey through the the geological data. Additionally, there is Alvin Lucier's *Music for Solo Performer* (1965), a piece which uses amplified alpha waves generated by the performer's brain to vibrate percussion instruments, creating a contemplative, minimal texture. Another, more recent, work is Jon P. Bellona's master's thesis *Running Expressions* (2011-12) which uses a heart rate monitor, two wii-remotes (video game controllers with accelerometers) to narrate the emotional journey of an athlete participating in a long distance run. All of these pieces will inform me on different means of utilizing the physiological data I will acquire, and on different ways to approach the piece both musically and technically.

1.3 Methods and Timeline

The creation of this piece will require three stages: Creating and applying the technology to gather and send real-time heart rate data to the computer program, the composition of the piece - including creating the musical portion of the electronics, and the creation of a polished, publishable finished product for use by a performer.

1.3.1 Collecting Heart Rate Data

The first process in the project is to construct a means of gathering heart rate data and transmitting that data to the computer program in a usable form. Accomplishing this will require two pieces of hardware: the Polar T31 Coded Transmitter and the Polar Heart Rate Monitor Interface. The T31 is what actually measures the heart rate. The device is strapped to the performer's chest and wirelessly transmits the data to the receiver: the Polar Heart Rate Monitor Interface. The Interface is a small, specialized computer that gathers data, converts the data into a format that is readable by other devices, and sends the data through USB to the main computer. What I need to do is create a program that connects the hardware and the software: a program that reads the data sent over USB, and transmits it to the rest of the electronics for processing.

The next step is to create a calibration tool that will configure the incoming heart rate data - maximum/minimum/average heart rates must be set, error detection, and value scaling must all be adjusted in order to tailor the electronics to the specific performer.

The program connecting the hardware and software, and the calibration tool will be designed and tested over the winter break, and some final adjustments made with the consultation of the flautist during the beginning of the spring semester.

1.3.2 Composing

The actual composition of the piece will be a back-and-forth process, where I will constantly be moving between writing for the flute and writing with electronics. An idea may begin with a melody or motive for the flute, or some concept or process in the electronics (such as recording the flute and playing the recording backwards). I will then expand on that idea by moving into the other medium, where new possibilities will open up. This constant exchange between the acoustic and synthetic allows the two to intertwine, creating a coherent whole.

I will continue to use the process to develop a number of sections and ideas to be used throughout the composition. Once I have a sufficient number of these, I will begin planning the overall form of the music. Because this work will be multiple movements, the form is a paramount aspect of composing - the music needs to be a single piece with multiple parts, not several unrelated pieces of music put together. Therefore, the relationship between the movements must be given careful thought - how will they relate dynamically? What notes will each movement use? Is there a story to be told? Every detail must be worked out, first broadly, then going back and refining each part. Eventually a clear template emerges, outlining the progression of the piece.

All throughout the composing of this piece, I will be collaborating with a the flautist David Ramirez - a graduate student in flute performance who is attending the University of Kansas on a Fulbright grant - to ensure that I am being both idiomatic with my writing for the instrument and utilizing it to its fullest potential. Additionally, he has agreed to perform my music, ensuring a high quality performance of my piece once it is finished.

The composing of the piece is, of course, the most important and time consuming aspect of the project, I will begin this process during the winter break and plan on finishing approximately halfway into the semester.

1.3.3 Finished Product

The finished product of the piece - the package that will be given to performers - will consist of the sheet music and an easy to use computer program containing the electronics. My goal is to create a finished product that is at a publishable level of quality.

The sheet music is how the composer communicates their ideas and intentions to the performer. Therefore, it is necessary that the sheet music be constructed in such a way that

conveys these ideas in a fashion that is also readable, so that the sheet music does not become a hindrance during a performance.

The program must also be as little of a hindrance as possible. The interface must be designed such that it is easily usable even for a performer who is not intimately familiar with technology. My goal as the programmer is to minimize the amount of rehearsal time that has to be spent troubleshooting. This includes making the set up of the hardware as simple as putting on the monitor and plugging the Interface into the computer.

I intend to begin working on these two components during the middle of the semester, and finishing them in the two to three weeks following.

2 Significance to Applicant

2.1 Exploring Ways to Integrate Electronic Music with Live Performers

The mixing of electronic music with acoustic instruments is a topic that greatly interests me. I have found that the rich, organic, and sonically complex sound of acoustic instruments wonderfully complements the infinite textural possibilities of electronic music. The nuance afforded by a skilled performer and the presence of having someone putting a physical effort into the creation of the music are important facets of a live performance that can be lost when everything is handled from behind a computer screen. This piece would allow me to further push my ability to integrate the two and expand the boundaries of what can be done to connect the performer with the computer.

2.2 Graduate Applications

Ultimately my goal is find a career that allows me to merge my interests in composition and computer science. An important step in achieving that goal is to attend graduate school, and I intend to pursue a graduate degree in composition/electronic music. The most important aspect of a graduate application for composition is the portfolio - a collection of original compositions that demonstrate a candidate's creativity, skill, and diversity of output. A piece such as this, being both ambitious in its length and unique in its concept, would be a memorable addition that will help my application stand out.

2.3 Performance Opportunity

Having and organizing public performance of your pieces is an important part of any composer's career - this is where exposure and feedback of the full realization of your music is obtained. Thus, being able to get as many quality performances of your music as possible is important skill to develop. This piece is conducive to this need, it only requires a single performer, a laptop, a couple of small pieces of equipment, and speakers. Aside from the heart rate monitor, which is small and can be easily mailed to the performer, this is all equipment that is easily available to most performers. This portability allows for a minimal amount of obstructions between composing and performance. The piece's small overhead also makes it an attractive candidate for a number of types of composition competitions and call for scores.

In addition, as mentioned in the *Composing* section, I already have a flautist who agreed to premiere this piece, so a performance is assured, not just possibility.

2.4 Computer Science Relevance

Because of the interdisciplinary nature of this project, the computer will take on many roles in this piece (monitoring heart rate, sound playback/generation, interface, etc.). The creation of the electronics will touch on a number of different areas in computer science. With the use of

a heart rate monitor, the most immediately apparent field is human-computer interaction: the study of how humans and computers connect and interface with one another. This interaction, particularly in relation to music, is something that has interested me since I have started composing electronic music. However, I have never had an opportunity to explore it in depth. This composition provides an excellent introduction to the field with a real world application.

Another topic that the piece will utilize is systems programming. Systems programming is a type of subject of creating programs that interact with the hardware, as opposed to a program that interacts with a user or a program that processes data. The hardware that the program would be interfacing with would, of course, be the heart rate monitor and the Heart Rate Monitor Interface.

Additionally, reactive programming is a style of programming that will be used heavily. Reactive programming a style of programming that centers around the flow of data, such as a heart rate or audio signal. This style of programming is, in fact, immediately relevant to my job as an undergraduate research assistant. The approach that is being applied to animation and sound - two topics currently being researched - utilizes a number of elements of reactive programming.

The wide range of topics in computer science that this piece will cover provides me with relevant experience to a number of fields. This will prove useful when applying to a wide variety of jobs within the fields of computer science and software development.

3   Technical Skills and Qualifications

3.1   Background in Programming

Creating a musical system that has several variables being controlled by a stream of real-time data from an external piece of hardware is a complex undertaking that requires a sizable amount of skill and experience with programming. As a computer science major, I have taken, and excelled in, a number of classes meant to develop such skills: Programming I & II, Digital Logic Design, and Programming Language Paradigms. In addition to these classes I am currently employed as an undergraduate research assistant to create tools to enable the creation of animation and sound using the Haskell programming language. I am also currently enrolled in Embedded Systems, a class that specifically focuses on interfacing and programming micro-controllers such as the heart rate monitor that will be used.

3.2   Experience Composing Electronic Music

The majority, if not the entirety, of the electronics for the piece will be made using the visual programming language Max/MSP, a popular tool for creating electronic music. I have taken an independent study with the electronic music professor Kip Haaheim over using this language for the creation of electronic music, have further studied about it in the class Electro-Acoustic Composition I, and have completed and are currently working on a number of compositions and projects that utilize Max/MSP as the primary means of creating electronic sounds - including compositions for solo euphonium and electronics and a tuba-euphoinum choir with electronics.

References

[1] Bellona, Jon P. (2011). *RUNNING EXPRESSIONS: PHYSIOLOGICAL MONITORS AND MOTION SENSORS MAPPED FOR MUSICAL PERFORMANCE* (Master's thesis). Retrieved from http://deecerecords.com/music/

[2] Dodge, Charles (1970). [Liner Notes]. *Earth's Magnetic Field*, Nonesuch LP H-71250

[3] Julio, Dan, *Heart Rate Monitor Interface User Manual*, danjuliodesign, LLC. Boulder, Colorado, 2010.

[4] Lucier, Alvin (1965). [Liner Notes]. *Music for Solo Performer*, Lovely Music, New York, 1982.