Dissertation outline/paragraphs: use this until I have the up-to-date latex template.

# Title page

CYBERINET: INTEGRATED SEMI-MODULAR SENSORS FOR THE  
COMPUTER-AUGMENTED CLARINET  
A Dissertation  
Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Doctor of Philosophy  
in  
The School of Music  
by  
Matthew A. Bardin  
B.M., Stetson University, 2017  
M.M., The Boston Conservatory at Berklee, 2019

# Acknowledgements

First, I would like to thank my family. Without their continued support, I would not have been able to make it into grad school, let alone be finishing my dissertation project. Thank you from the bottom of my heart Mom, Dad, Michael, Melanie, and everyone else. [If I listed everyone, this would have to be its own chapter]

I would also like to thank my various professors and mentors that I have had the pleasure of working with over the past decade. From building a general approach to music and technology in my undergraduate studies, to finding my passion while finishing my Master’s degree in Boston, to the guidance I received on this project; the advice I have received from these people has helped me to not only build a strong knowledge base, but achieve the confidence to present my work and my art to the world. [name drop here?]

Lastly, I would like to thank my cat, Bean. Regardless of whether she was in the way; she always made a spot on my desk to join me while I was writing. When in doubt, I would always defer to her expert opinion on any matters related to eat-scratches, pets, and wet food. Thank you, Bean.

[picture of bean]

# Abstract

# Introduction

# Chapter 1: AUGMENTED INSTRUMENT DESIGN AND PERFORMANCE: AN INTRODUCTION AND LITERATURE REVIEW

# Sensors used in the Cyberinet

At its core, the Cyberinet contains a small collection of sensors build into the hardware. These include: [list of sensor names and what they do]. In addition to these sensors, the unit contain two USB-C connectors on its side. [show picture] The first one is intended for the button board expansion, which gives the performer access to two buttons positioned on the thumb rest of their instrument. The functionality of these buttons can then be programmed using Max or another audio programming environment. The second USB-C port is designed to connect to a variety of other sensors, allowing for the performer to adjust their setup for whatever is needed for a particular performance. This is the origin of the phrase “semi-modular” in the project title. At the time of writing, one expansion sensor has been created and tested. This is the [figure something out, a mic that will respond to volume and transmit a bang.] Additional expansions have been planned and explored in more detail in the “Further Directions” section of this document.

ESP-32

MPU-6050

TP-4056-C

SDP-31

All these chips were selected for their ability to be dropped into the main board without an extensive need for the user to solder many components, and their use of standard 0.1 inch spacing. [fix this sentence]

# Optional Expansions

These attachments are optional and not needed for the Cyberinet main unit to be functional and are intended to only be connected when needed for a particular performance. All the expansions connect utilizing a standard USB-C connector. However, these units do not utilize the USB protocol, so both the main unit and expansions cannot be connected to a computer via these ports. Because the Cyberinet does not communicate to these using USB protocol, not all USB-C cables can be used for this, however the vast majority can. [make this true] While a set of USB-C cables that are functional is included with the full Cyberinet set of hardware, The main reason for utilizing this connector is for the end-user to be able to supply their own cables of various lengths depending on their needs.

Button Board

This board, while optional, is incredibly useful for a performer on stage. They can access the buttons using their right thumb when performing. This maneuver is easier when utilizing a neck strap, so the performer can place the buttons elsewhere if they like using a longer connector cable. Each button also contains a single, colored LED built into it to provide feedback to the performer. By default, the lights are only illuminated when the button is pressed. [investigate a way to change that perhaps?] The Cyberinet simply detects whether a button has been pressed and transmits that data as a Boolean value to the computer. Using a program such as Max, the user can have the buttons achieve functions from near limitless hypothetical list of options. For this project, the buttons were used to trigger microphone recording and buffer playback, however objects that take the button input and move between various presets, trigger DSP, and turn pages of a score have also been developed and included in the software bundle for this project.

# Software

Arduino code

Max Library

# Works written for the Cyberinet

In addition to creating the hardware and software for this dissertation, I have also created a handful of musical compositions that show off various features of the Cyberinet. These three compositions as listed below, show a gradient from simpler to more complex uses of the Cyberinet’s features.

Puzzle of a Park:

At its core, this work is the simplest of the three written especially for this project. *Puzzle of a Park* functions as a work written for a loop pedal, but without the pedal. The performer plays through the material from beginning to end, periodically pressing one of the two buttons on the button board accessory. Looking at the max patch we can see that one button will trigger the computer to record a microphone input into a buffer while the second triggers the synchronized playback of all recorded buffers.

[show patch snapshot]

This functionality allows for multiple recordings to be saved and layered, much like loop pedals such as the Boss RC line of pedals. [do I talk about multi tracking?]

When writing this work, I viewed the musical content as a quartet, with four unique voices rather than a single voice repeated several times. This allowed the musical content to flow and feel more organic once the final layer was added.

Once I had completed the short musical section, it was simply a matter of repeating the sequence of time signature and meter changes so that the score would form a repeating pattern. From there I had to decide exactly how to organize the sounds in time. Because I wanted this to be the simplest of the works in terms of performance and programming, I refrained from breaking down the recordings into smaller chunks and assembling them in Max. Instead, I choose the loop pedal approach and had the performer play through each voice before starting the playback and recording for the following voice.

When ordering the voices, I began with one of the middle voices as the opening to the solo part. When comparing the voices in the score, these helped to provide a large amount of the background and a steady, albeit syncopated, pulse to the music. Something that helps to give the following bass voice more context during the measures where it is simply holding a pedal tone during the second section. Looking at the large-scale musical form of the solo, I would describe it as ABAC since the third and first voice are often coordinated, providing harmonic content. I viewed them like a horn part in a Sousa march in this regard. When combined, the first three voices provide a complete backing track to the main melodic line. Like fitting together, the pieces of a puzzle, it is this final line that helps to give context to all the phrases we have heard so far. Down beats become upbeats, harmonic implications shift with the addition of new chord tones, and the texture is filled out to include the full range of the instrument.

Ethereal Presence

The second work created for this project begins to utilize the more complicated sensors present in the Cyberinet. These primarily include the gyroscope and airflow meter. Once received, the Max patch for the composition utilizes the values to control two different synthesizers and their parameters.

[chart showing the value and parameter mapping]

The first synthesizer outputs a single tone with the goal of harmonizing with the soloist. This is the Ethereal Presence as mentioned in the title. [add more when this synth is done]

Accompanied by this is a more textural synthesizer designed to help support and fill out the atmosphere of the composition. This synthesizer outputs noise before being run through an FFT, based filter created by Dr. Austin Franklin [ how much info on the project do I need?]. This filter takes the incoming noise and performs an FFT operation on it to determine the frequency content, then based on the values received from the Cyberinet, filters out certain frequency bins.

Raindrops on a Tin Roof