Thesis Project Portfolio

Use of Frequency Domain Analysis with Microcontrollers for a Beat Detection Device

Analysis of Electronic Music in the Space of Both Natural and Public Perception

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Davis Lydon
Spring, 2023
Department of Electrical and Computer Engineering

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Executive Summary

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My sociotechnical project examines how music as a whole has grown with us as a civilization, using electronic music as an example of music changing with us as much as we change what we produce and make. Electronic music is a vast amount of actors acting out previous symptoms of musical understanding in the past, such as jazz and rock/metal, combined with social media and the rise of technology creating a fast growing genre that is only just now becoming mainstream. It highlights in the most perfect way just how we understand the music around us, what humans are comfortable with, and how exactly we perceive sounds that don't sound "real". As technology has improved over the years, it was only natural that we would apply these new forms of technology to our forms of entertainment, which include music. Due to electronic signals and music signals bearing a striking resemblance, it was even easier to apply our newfound knowledge of electronic signal processing to music. Musical production tools, such as the synthesizer, came into being and became dominant at the same time, while musical listening tools, from the record player to the radio, and more current items such as the MP3 player and streaming platforms, reform our ideas of music listening and ownership. Musical genres are not only defined by their sound and timbre, but by the culture surrounding them and their cultural impact. Electronic music is reaching the mainstream point where its culture becomes less defined and it becomes less of a genre and more of a "sound" used in others, but that doesn't mean that its culture is basic or poorly defined. Electronic music culture is tied in with club culture, characterized by the same features found in its music: harsh, loud, and uncaring to the individual. For some, this is the type of environment that is exactly what they want, somewhere they want to get lost in. For others, this is a modern symptom of our ideas of music becoming muddied and encouraging of other debaucherous activities often found with clubbing, heavy drinking and hard drug use. My paper rounds out these ideas with extrapolation on how exactly this genre expanded, with the dominance of internet culture, forum use, and music sharing sites naturally allowing electronically-created music to become the most easily shared form of music.

My technical project worked on merging my interest in digital signal processing with music to create a beat-detecting robot that additionally played the beat of the song to a drum. I did a majority of the coding for the project, including both sending signals to the servos for moving the drum sticks and on extrapolating the beat of a song. I used my experience with signal processing to find the beat to a given song using Fourier transformation and analysis techniques. I worked together with other computer and electrical engineers with different areas of expertise to put the main microcontroller together and work on servo code, in addition to music input. We developed this device for a variety of reasons, including more basic functions. It could very easily be used as a visual and physical metronome if given a proper normal beat, a function it could serve if the user did not have a metronome handy or if the user wanted to have a drum beat to accompany them playing. For more important social uses, this was also meant to allow users of a lower socioeconomic class to have access to a drum playing device in this way. The design of it was meant to be both compact and cheap enough for it to be easily buyable regardless of your wealth. Opening up the initial musical experience towards those of a lower socioeconomic status is so important to broadening the greater musical experience for any enjoyer of music. It allows those of so many backgrounds to contribute to the greater musical sound, something that is never bad. Because the design only requires a simple headphone jack design and some other device that can play music, very little other things are required outside of our system to use it. It also has a very easy to use design, such that it can very easily immediately be used out of the box once the power and music cords are connected. As a whole, this design allowed me to use my understanding of digital signal processing techniques to help broaden my interest in music to those that are unable to do so currently.

I want to thank Professor Earle and Professor Powell for their assistance in forming my ideas for both my technical and socio technical paper.