Thesis Project Portfolio

The Samplisizer

(Technical Report)

Residential Microgrids in the United States

(STS Research Paper)

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

Lucia Hoerr

Spring, 2023

Department of Electrical and Computer Engineering

Table of Contents

Sociotechnical Synthesis

Introduction

Although my technical project and STS research paper are unrelated, both topics allowed me to dive deeper into subjects and skills that interested me greatly. My STS research focused on community microgrids as a solution to the failing United States power grid and the positive and negative externalities of adopting more individualized sources of clean energy. For my technical project, I worked with a team of students to build a modular audio sampler and synthesizer for users of any musical skill level to create music instantly and easily from the sounds around them.

Project Summaries

In my STS research, I explored the complex causes of the struggling United States power grid as well as possible engineering solutions for how to improve the grid's stability and environmental impact. I found that the leading strains on the electric grid are the aging infrastructure, the lack of proximity to renewable energy sources, and an increasing number of natural disasters and major weather events due to climate change. After identifying the largest problems, I dove deeper into researching a range of possible solutions which eventually led me to residential and community microgrids. Microgrids are independent electricity grids within a home, business, or community that create and store energy. The electricity typically comes from renewable resources such as solar, and the energy generated can be used immediately, stored in a battery, or pumped back into the main grid if connected. Microgrids take strain off of the larger power grid and utilize green energy sources.

I completed the technical portion of my thesis through the joint Electrical and Computer Engineering capstone class in the Fall of 2022. My group created The Samplisizer: a synthesizing instrument for entry-level digital musicians looking for a simple way to sample audio. The Samplisizer differs from other sampling devices because it is modular: a brick-sized case contains and hides all the hardware with port openings for users to plug in their microphone,

speaker, and MIDI instrument. For our demonstrations, we used a 24-key piano. A user records a sound bite into the microphone, the audio is pitch-shifted up and down and mapped to the piano keys, and the resulting sounds are output through the speakers when the user plays the piano. We utilized LEDs (red for recording, yellow for processing, and green for ready for playing) to display the progress from start to finish for the user. To complete this capstone project, my group had to write software to perform the pitch shifting and audio manipulation, design and manufacture a printed circuit board, and connect all the hardware to fit inside a 3D printed case we also designed. We concluded the capstone by presenting our working prototype to students and faculty in the Engineering School.

Conclusion

These projects, while different, both taught me important research and technical skills. Through the technical portion of the project, I gained numerous electrical and computer engineering skills related to the audio synthesizing project, as well as experience writing technical reports and presenting my research in front of peers and professionals. I was able to take many of these skills and apply them when it came time to start writing my STS research paper. My engineering background also allowed me to fully understand the technology behind the power system and microgrids I was writing about.

Acknowledgments

I want to acknowledge the support from my STS professor and research advisor, Richard Jacques for all his guidance in creating this portfolio. I also want to thank my technical capstone advisor Harry Powell for his assistance and my capstone team, Cooper Grace, Frederick Scotti, and Quinn Ferguson for being incredible partners.