Thesis Project Portfolio

Gesture-Controlled LED Matrix Display

(Technical Report)

On the Effects of Artificial Intelligence in Classroom Settings

(STS Research Paper)

An Undergraduate Thesis

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Spencer Lucas Hernandez

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Department of Electrical and Computer Engineering

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Sociotechnical Synthesis

The technical and STS portions of my thesis are loosely coupled with one another, and both focus on how technology can influence K-12 education. My technical project is on the development of a low-power, gesture-controlled Light-Emitting Diode (LED) matrix for classroom settings. LEDs tend to consume lots of energy, so using a multitude of them in a matrix is inefficient and costly. With this technical project, my capstone sought to minimize the amount of power consumed, while also developing a guide that K-12 students can understand, in order to get students more excited about Electrical and Computer Engineering (ECE). My STS project was originally on the effects of the digital divide in education since this coupled well with my technical project, which also had education in mind. However, with the rapid development of Artificial Intelligence (AI) technologies, I thought a more relevant topic would be the effects of AI in classroom settings. This research utilizes different STS frameworks and relevant literature to examine the various harmful effects of unregulated use of AI when used by K-12 students. With the loose coupling of both projects, my portfolio provides an ethical review of technology in classrooms, as well as potential new technologies that could bolster educational outcomes.

The technical portion of my thesis produced a gesture-controlled LED matrix and an educational brochure explaining the project. The matrix uses time-of-flight sensors, which emit infrared light and count how long it takes for the light to return to the sensor, in order to track the hand position of the user. This hand coordinate data is then fed into an STM microcontroller to process the data and determine which LED should be turned on. The STM then sends the led data to an Arduino microcontroller, which is responsible for toggling the individual LEDs in the system. The Arduino reads the data and will tell that LED to turn on if it is not already on.

Originally, the design utilized 500 individual LEDs that were placed on a custom Printed Circuit Board (PCB), which would turn each column of the matrix on and off very quickly, but in a way that wasn't detectable by the human eye. This significantly reduced the power consumption of the board since only one column was ever on, but unfortunately our group was unable to use this design due to design defects. Instead, we purchased programmable strips of LEDs that we cut and soldered together to make an array. As previously mentioned, the final deliverable included a K-12 brochure that broke each component down into an easy-to-digest format that was suitable for non-ECE students to understand. Since the final product is very entertaining and engaging to play with, I hope that it gets students more interested in ECE, and STEM in general.

In my STS research, I analyzed the effects that students using AI for school will have on them. I discuss how most people, when they think of AI in an educational context, think of students using ChatGPT to cheat on their assignments. Instead of focusing on this, I researched the effects AI could have on mental health and developing biases. Since social media platforms use AI recommendation systems to recommend relevant content to their users, students' mental health is suffering as a result of being led down dangerous rabbit holes. I also discuss how the effects of biased data in AI could potentially lead to adoption of harmful ideologies from young students. If AI is continued to be used in classrooms, it is crucial that steps are taken to protect students from these adverse effects.

Overall, I had a pleasant experience working on both projects. While both projects were only loosely coupled with one another, it was still a rewarding experience to complete both. With the technical project, I was able to apply the knowledge from the entirety of my undergraduate experience onto a project that I saw through to completion. It was difficult, but it taught me about deadlines, the engineering process, and deeper technical skills. The STS portion, on the

other hand, taught me more about research skills, and how to find reputable sources to back up my claims. I hope that the findings from both projects educate people on integrating technology into schools.