

Thesis Project Portfolio

Gesture-Controlled LED Matrix Display

(Technical Report)

Impacts of Artificial Intelligence on Language Learning

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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Mitchell Bryce Taylor

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Charles L. Brown Department of Electrical and Computer Engineering

Table of Contents

Sociotechnical Synthesis

Gesture-Controlled LED Matrix Display

Impacts of Artificial Intelligence on Language Learning

Prospectus

Sociotechnical Synthesis

The technical report was written about the Capstone project completed by *The Pack* in Fall 2023 to complete the requirements for the undergraduate electrical engineering degree at the University of Virginia. The goal of the project was to create an engaging learning resource about electrical engineering for adolescent students. This was accomplished through the creation of an interactive gesture-controlled LED matrix that could be broken down into key components as an exciting introduction to electrical engineering. The project used infrared sensors to track hand motion and map the location of the hand to a specific point on the LED grid, which was operated by the microcontroller utilized in the project to allow the user's hand to affect the operation of the matrix. There were also other critical circuitry systems in the project that provided signal routing and allowed the project to be plugged into a standard wall outlet. The most novel feature of the project was the capability to recognize hand gestures and implement them as the condition of activation for a function on the grid such as changing colors or erasing. The project was successful and managed to meet all of the requirements set forth in the initial project proposal.

The technical report begins by summarizing the project for the reader and providing background to justify the project. The next section then details the constraints of the project, both societal and physical. Following that section, there is a listing of engineering safety standards that were required to be met for the project and then a brief description of intellectual property issues that could arise from the matrix through an overview of several patents for similar products. This is followed by the project description which provides the technical details for the project and how each of the individual components fit together to create a cohesive project. Then the report discusses the project timeline, both the initial proposed timeline and the actual timeline of development over the course of the project. The report touches on the budget of the project as

well as the actual spending done by the group before concluding with the summary of final results of the project. Finally, the technical report concludes with a description of future work focused on methods to improve the project.

For the STS research paper, the topic differed from the focus on creating educational resources of the technical project to analyzing the effects that AI can have on education. With this in mind, the topic of Artificial Intelligence was narrowed to a focus on its effects on language learning. With AI like ChatGPT experiencing significant growth and increasing usage in recent years, the effects of these AI on education is relatively unknown. With newer AI having increased linguistic capabilities across multiple languages and providing an availability of multilingual resources, the effects of the AI on language learning and acquisition is a particularly sensitive area of research. AI has the potential to revolutionize the field of language education, but it also has the ability to severely disrupt the traditionally established process. This paper seeks to explore these aforementioned effects and determine the severity of their impact as well as their potential benefits.

The research paper begins with an introduction to Artificial Intelligence, explaining what the technology is and how it works, while also discussing some of the broad well-known effects of AI. From that point, the paper discusses the methods used to analyze AI, with most data being collected from academic papers and further evidence pulled from case studies concerning the topic. The STS methodology utilized in this paper is the Social Construction of Technology, which will serve to demonstrate how human behavior and interests has shaped the development and implementation of AI in the modern world. Following the methods portion of the paper, the results are presented to the reader, starting with an explanation of AI-free machine translation to lay a foundation for future comparison with AI translation. The subsequent data presented from

academic papers concerns the role of AI on language acquisition, mainly through the comparison of the speed and quality of acquisition between AI and traditional methods. Once these contexts have been provided, the paper presents case studies of AI in language learning as the final pieces of evidence needed to analyze the societal impacts of the technology. With these results presented to the reader, the paper then analyzes the data to determine the impacts of AI on language learning. The paper then concludes with discussion of the observed impacts and how they should be addressed by all concerned parties going forward.