Thesis Project Portfolio

Gesture-Driven Robotic Vehicle

(Technical Report)

A Sociotechnical Analysis of Service Robotics and Human Replacement

(STS Research Paper)

An Undergraduate Thesis

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Executive Summary

As engineers, we share the fundamental responsibility of improving society through the technology we develop. For my technical capstone project, my team and I designed a gesture-driven robotic vehicle paired with a wireless glove controller. The goal was to design a gadget marketed towards teenage technology enthusiasts that could foster interest in robotics. On the other hand, for my sociotechnical research paper, I dive into the topic of service robot integration, Specifically, I present an analysis on the effectiveness of human-robot replacement within the service industry from social, economic, and ethical perspectives. The goal of this research is to not only analyze the consequences of rapid robotics integration, but also debunk a unilateral rejection and fear of incorporating robotics into service. The problems addressed in the technical and STS research sections are inextricably linked. While the technical section of this prospectus deals with the development of new technology, the STS section analyzes the consequences of that technology. Furthermore, the complete profile of a technology includes both its development and its effects, and one cannot exist without considering the other.

Over the past decade, interest in applied robotics has grown significantly, especially among younger populations. Currently, many efforts are being taken to foster youth interest in robotics in interactive ways outside the traditional classroom, such as extracurricular robotics competitions. Doing so not only instills youth interest in engineering careers, but also improves teenagers' problem solving and technical skills. Thus, our project will contribute to this effort by creating a gesture-driven robotic vehicle marketed towards STEM-interested teenagers. As for methodology, the project will be developed iteratively via implementation and improvement of core features every two weeks. The project features will be planned via GANTT chart scheduling, Although this project does not directly address any real-world problems, it enables teenagers to explore applied

robotics by providing a fun and approachable entry point for developing interest. Inspiring the next generation of young engineers is critical for the continuous advancement of science and technology.

After several months of technical work and iteration, our final project successfully met all of the Capstone requirements. The glove controller remains connected to the car as long as the batteries stay charged. The connection is also decently fast, allowing users to control the car accurately and precisely using the preset gestures. Furthermore, the glove and robotic car use a Bluetooth communication protocol to transmit data wirelessly, and after experimentation, we determined a functional radius of around 150 meters. In addition to the core functionality, we also incorporated several additional features, including a haptic feedback system for obstacle detection paired with the ultrasonic sensor, and an analog camera and receiver. After testing, the haptic feedback system performs as expected within the functional radius, and the analog camera transmission radius was determined to be around 100 meters. Future iterations of this project would include implementing an array of optimizations to both the hardware and software.

However, as we enter a new age of AI and robotics, we must consider the social repercussions of the technologies we innovate. In my sociotechnical investigation, I will address the question of whether human-robot replacement within the service industry is favorable from social, economic, and ethical facets. Additionally, I will investigate the degree to which human-robot substitution is optimal and attempt to find a balance between human-robot replacement and human-robot collaboration. Overall, this is an incredibly significant STS investigation since the consequences of human-robot replacement within the service industry affects all parties involved. For one, it influences the quality of service presented to the customer. Additionally, it influences the reputation of the service industry as well as any potential human workers that were phased out.

The primary research methodology for this paper will be a thorough literature review involving all three facets. Additionally, there will be some supplemental statistical evidence to support any economic arguments. The sociotechnical research will be conducted within the context of the technological momentum framework.

Upon synthesis of the evidence gathered during the literature review, I find partial human-robot replacement paired with partial human-robot collaboration to be the most optimal conclusion to the research question for all facets. While robots do not yet have the capacity for high emotional intelligence, the evidence suggests that robot replacement is optimal for highly repetitive service settings, and robot collaboration optimal for hospitality-focused service settings. Furthermore, allocation and distribution of human and robot service workers can be done depending on the degree of repetitiveness and sociality of each role. From an economic standpoint, robot integration into the service industry is also generally viewed as a viable adaptation. However, the degree of integration should not only vary depending on the industry, but also align towards collaboration over replacement. Lastly, the evidence suggests completely replacing frontline service workers with robots is not the most ethical decision, since it not only dehumanizes the human worker being replaced, but also undermines the core customer experience. Overall, as computing and robotics continue to evolve, we will continue to observe new cases of human-robot integration. Thus, as engineers, we must be equipped to answer nuanced questions surrounding the consequences of our work.