Incoming Object Detection Wearable using Ultrasonic Sensing and Haptic Feedback
(Technical Paper)

The Future Effects of Artificial Intelligence on the Economy and Society
(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Will machines ever completely replace humans? Originally, the possibility that machines would replace humans only appeared in science fiction stories; however, with the recent developments in artificial intelligence, it becomes questionable to many people just how fictional the concept really is. Artificial intelligence is essentially the task of teaching computers how to think and act like humans. Especially in the past decade, artificial intelligence has experienced rapid growth. More recently, it has been used to identify images more accurately than humans, defeat world champion go players, and even create algorithms for self-driving vehicles (Dormehl, 2017). Because artificial intelligence can be used to automate or accelerate many tasks, it has the potential to significantly increase economic productivity for businesses (Brynjolfsson, Rock, & Syverson, 2017). However, with these impressive feats comes a large concern that computers will eventually displace humans in the job market (Reisinger, 2019).

The STS research component of this paper investigates to what extent the concern of human job displacement by computers is a valid concern, specifically considering whether the economic benefits of machine learning will offset or alleviate this concern. More specifically, it focuses on comparing the potential economic implications of machine learning advancements to the economic implications from other emergent technologies in the past.

The technical component details the design and implementation of a wearable device which can notify users of incoming objects in their blind spots. The primary purpose of this device is to help people who require extended spatial awareness, such as people who are visually impaired and soldiers in the field. While not directly related to the STS research component, this project was inspired by the development of autonomous vehicles which depends heavily on AI.

The idea of creating a device which can detect objects through sensors is inspired by the object detection capabilities of autonomous vehicle systems.

Technical Topic

Disabilities of any form can be a significant hindrance to performing simple tasks on a day-to-day basis. They also put those who are afflicted in the undesirable position of being deficient in capabilities compared to the average healthy person, which can lead to feelings of inferiority. As such, there is great motivation to address this topic. Especially within the realm of disabilities, visual impairment is particularly grievous due to its alienating nature and how it affects physical mobility. With this prevalent issue at hand, the team was inspired to start a project that aims to ameliorate the lives of those who are visually impaired.

As precedent for this project, one may consider the growth of the field of autonomous vehicles, and how such a topic necessitates the study of obstacle detection. For instance, engineering has seen the development of robots with the ability to identify objects as well as humans, for the purpose of navigating office and work settings and performing basic tasks. An example of such a robotic system is an autonomous system that can aid nurses in hospitals by helping with bed transports (Kovala, 2015). Similarly, engineers create electromechanical surveillance systems that likewise need to deploy object recognition techniques, even if the systems are not mobile. In military applications, the continuous tracking of those objects is a key part, which involves significant image processing efforts (Gade & Wanare, 2014). An example of such image processing algorithms involves hyperspectral imaging, which finds anomalies in order to detect objects of significance that “stand out from the cluttered background” (Ke, 2018).

While there have undoubtedly been a lot of projects produced around the world that even produce wearable systems to aid the visually impaired (Dionisi, Sardini, & Serpelloni, 2012), this particular project is significantly simpler and more straightforward to use. Even though many engineers have produced smart systems that can do a lot more than just detect objects, the aim of this project is solely to prevent object collision. Furthermore, what sets this project apart from previous projects is the use of haptic feedback that responds not to human touch, but rather to object detection. More specifically, if an object is coming towards the user, the wearable device will use haptics to communicate the upcoming collision. The device will rely on detecting ultrasonic signals, which will detect approaching objects within the sensor's range of 0 to 6.45 meters away. Moving objects within a projected minimum distance threshold of 30 centimeters, calculated using an algorithm programmed in the microcontroller, will trigger the vibration motor to draw attention to the potential collision. Figure 1 shows a summary of the subsystems present in the project's design. These include the ultrasonic sensor, microcontroller, power supply, and haptic feedback subsystems.

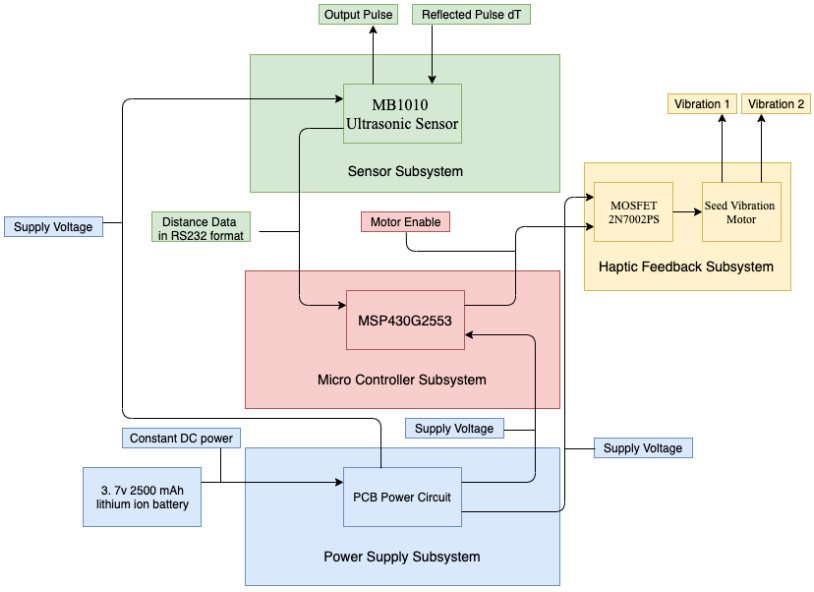

Figure 1. Overview of Project Subsystems. Created by J. Arabit.

In short, the proposed device increases awareness in the user's blind spots, and involves the design, development, and production of a wearable device that communicates with the user using haptic feedback concerning incoming or approaching objects in the user's environment. The driving microcontroller will perform the necessary calculations and power the embedded system. Users will be able to wear this device while during their daily routines to be informed of such dangers in their environment, creating an increase in situational awareness. The device, along with a poster presentation and final technical report, will be finished by the end of the fall 2019 semester. The project will be finished within a group of four people and advised by Professor Harry Powell. Renée Mitchell will be in charge of the printed circuit board design, Joshua Arabit will be in charge of system integration and assist with the circuit design, Jazlene Rae Guevarra will be in charge of the test plan and overall device design, and William Zhang (the author) will be in charge of the software and algorithm design.

STS Topic

Economic analysts have predicted that 40% of jobs are at risk of being replaced by AI in the future (Reisinger). If we take into account the recent breakthroughs of AI and their ability to surpass humans in tasks like image recognition and game playing, this figure seems even more intimidating and concerning for the economy and society as a whole (Dormehl, 2017). To better understand the potential societal impacts of AI, my STS research will focus on analyzing to how impactful AI will be on the future job market, focusing on whether the economic benefits of AI will offset any negative impacts such as job displacement. More specifically, the research will attempt to predict the potential economic implications of AI advancements by considering the

economic outcomes of previous emergent technologies and analyzing the differences and similarities between the situations.

The STS topic will be studied in the context of the technological momentum framework. The technological momentum asserts that in early stages of an emergent technology, society is the primary influence on how the technology continues to develop; however, once the technology becomes more and more widespread and advanced, it gains a technological "inertia" which makes it the primary influence on how society develops (Hughes, 1969). Essentially, the amount of influence one factor has on the other changes over time. This theory presents a middle ground for the extreme views of technological determinism, which asserts technology as the dominant force over society, and social construction, which asserts the exact opposite (Smitn, 1994; Klein & Kleinman, 2002). Critics of the idea of technological momentum frequently believe that technological momentum, although less extreme and more practical than technological determinism, still draws too heavily from determinism. They believe the idea that technology and society are inherently equal influences on each other and that even in late stages of technological development, society can still have an impact; a popular STS theory which states exactly this is co-production (Jasanoff, 2004). While these are legitimate critiques of the theory, my STS topic will be framed using technological momentum primarily because many people have a legitimate fear that machines will replace human labor within a few decades. This fear fundamentally stems from the belief that artificial intelligence will eventually become too widespread to control, supporting the idea that artificial intelligence will gain a sort of technological "inertia." At the same time, however, in its early stages, it is clear to see that government policies and overall societal views still have a large impact on the development and

adoption of new artificial intelligence models. Both of these ideas together contribute nicely to the idea of technological momentum.

Artificial intelligence is at the stage where it is considered the future of technology, but where it has not developed to the point where society is unable to significantly influence the direction in which it develops. As such, it is important to research exactly what effects the development of artificial intelligence will have on society so that we can anticipate and mitigate any potential problems it may bring. Additionally, this research is meant to alleviate some concerns regarding the potential for job displacement which this technology brings.

Research Question and Methods

The primary research question for the STS portion will be the following: to what extent is the concern of job displacement from AI valid and will the economic benefits of AI outweigh the economic costs? To answer this question, the research will involve the use of historical case studies, discourse analysis, and policy analysis. Historical case studies will be used to analyze the economic effects of previous emergent technologies, drawing conclusions based on how similar or different their situations are from our current situation with AI. One such emergent technology would be the internet, which impacted how the entire world operates. Discourse analysis will be used to analyze the various arguments made by the sources that are cited and briefly described in the next paragraph. Finally, policy analysis will be used to examine the current and upcoming policies regarding AI to better understand how society is trying to exert its influence on this technology while it has not yet gained technological inertia. For example, some states, like Nevada, have passed laws regarding the testing requirements for autonomous vehicles (Soares et al., 2019).

Some of the selected sources will be used to provide background on the overall topics of AI, ethics of AI, and economic growth (Bostrom & Yudkowsky, 2014; Kuznets, 1973; Marr, 2018). Aghion, Jones, & Jones (2017) compare AI to other forms of automation, such as electricity, to predict the future impact of AI on economic growth. Similarly, a few other selected sources also provide existing arguments regarding the topic, and will used to help shape the final thesis argument (Autor, 2015; Boyd & Holton, 2018; Chui, Manyika, & Miremadi, 2015; Hill & Rothaermel, 2003). Kim, Kim, & Lee (2017) perform simulation experiments to project how many jobs are at risk of replacement by AI. The rest of the sources will provide similar empirical results to be used as supporting evidence and examples for the argument to be made in the STS thesis (Kreickemeier & Nelson, 2006; Mills, 2018; Wilson, Daugherty, & Morini-Bianzino, 2017). The majority of research will be done during the first half of the spring 2020 semester and the majority of writing will be done during the second half.

Conclusion

The STS research component of this paper will analyze how valid the fear of machines replacing human labor is, focusing on its potential economic benefits and drawbacks and how they compare to the economic effects of previous emergent technologies. The technical component describes a wearable device which notifies users of incoming objects in their blind spots using ultrasonic sensing and haptic feedback. The device is meant to aid those in need of increased spatial awareness, such as people who are visually impaired and field soldiers. In addition to the device, a final report and poster presentation will be prepared to be presented at the end of the fall 2019 semester.

The primary problem in this paper is the fear that machines will replace human labor. While this is bound to happen to some extent, we cannot ignore the positive impacts machines have on society. Artificial intelligence will likely create a large amount of new jobs, leading to a period of economic growth and overall increased standard of living. The ultrasonic object detection wearable is also arguably a technology meant to automate, which will hopefully increase the standard of living for those visually impaired and even decrease casualty rates in war applications. The anticipated outcome is that this paper will show that technology can be intimidating, but often leads to significant benefits which often outweigh the costs.

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