Automated Word Search Solver

(Technical Paper)

Industrial Ethics Regarding Autonomous Cars

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Wade Hisiro
Fall 2019

Technical Project Team Members
Josh Laney
Nick Mohammad
Christopher Truong
Sean Wolfe

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

Signature_____   Date_____
     Wade Hisiro

Approved_____   Date_____
     Harry Powell, Department of Electrical and Computer
     Engineering

                                             Date_____
Approved_____
     Kent Wayland, Department of Engineering and Society

General Research Problem

How concerned should workers be that robots and machines are being built in order to complete increasingly complex tasks more efficiently than humans? In recent years, automation and autonomy have become increasingly prevalent and sophisticated, thereby leading to fear that robots will displace human workers. Because machines are more consistent than human labor and typically cheaper in the long-term, employers and businesses prefer using them (Ivanov & Webster, 2017). In the past, the fear was based only around automation of repetitious tasks as the machines were only being designed for some limited functions. However, with recent advancements in fields such as machine learning and computer intelligence, the capabilities of these machines have been greatly increased. They are now capable of self-learning and achieving tasks as complex as driving. Roles that were typically seen as too advanced to be automated are now threatened. This paper will address the issue by first describing a technical project and then describing research about a society and technology (STS) problem that both deal with automation and autonomy. The technical project will explore an attempt aimed at automating the simple task of solving a word search puzzle. This project is an example of using computer vision to make a robot more robust and capable of adapting to different input conditions. The STS problem being researched deals with the employers of workers who might lose their jobs due to autonomous vehicles and how much they should be concerned about the impact the job loss will have on their employees. As mentioned previously, these autonomous vehicles demonstrate the amount of progress that has been made, which allows robots to achieve complex tasks and are capable of displacing drivers whose jobs were previously considered to be safe from automation.

Automated Word Search Solver

How can embedded programming be combined with mechatronics and computer vision to create a mechanical system that can locate and highlight all the words in a word search puzzle? This problem is a great learning opportunity for these various technical fields and for gaining experience designing and manufacturing a working real-world product. The skills and knowledge gained through completion of the project can help build practical knowledge useful for future career aspirations such as graduate school or industry. The first step to designing a solution involved developing a high-level idea of how things would work together before narrowing down the specifics through iteration, research, and assistance from technical advisors. Next, the design had to actually be implemented by selecting parts, a thorough testing process, and tweaking the design as needed to solve any issues that might arise. By the end of the process, the automated word search solver should be built and capable of solving the puzzle in software and then using mechanical parts such as motors to physically highlight all of the words in the appropriate spots.

In the process of deciding on a capstone, inspiration was found through a project seen in a previous semester - the Scrabble playing robot. Such a project was intriguing since it presented challenges across the spectrum of engineering, as robotics problems tend to do.

Because this idea captures the essence of computer engineering in a project that was feasible to complete in a single semester, a project idea was generated that was similar in principle, but less burdening in the mechanical aspects.

While this project is a derivative of other puzzle-playing robots, the particular task chosen seems to be unique, at least in the scope of things that have been published on the internet and scraped by Google. Speculatively, the reason that this task has not been done is that it is either too trivial or too useless a task; more advanced robots have been created in the past, but that would be outside the scope of the Capstone. However, this robot is a demonstration of what can be accomplished fairly quickly with limited prior experience and resources using robotics and advanced computer science fields like computer vision.

This project draws on concepts from various coursework at UVA such as embedded topics from Intro to Embedded/Advanced Embedded, Computer Vision for identifying the word search characters, and electrical concepts in the Fundamentals of Electrical Engineering series. Embedded programming techniques, a fast word search algorithm implemented in CS 2150, concepts from computer vision, and circuit design methods learned in FUN 1 through FUN 3 will be utilized to create the project.

As the primary method of computation, a small computing board will be utilized in order to conduct the computer vision aspects of the project and find the locations of the words. A separate board will be employed to handle the highlighting of the words by controlling stepper motors to move the pen, limit switches to set the XY-axes, and a solenoid used for picking up and dropping the highlighter. The main board will direct the other to the correct locations. At the end of the project, the main deliverable will be a structure that is capable of solving a variety of word searches and highlighting the found words.

Industrial Ethics Regarding Autonomous Cars

How much should driving companies factor in the loss of jobs caused by technology when they consider adopting autonomous vehicles? As automation and autonomy have become increasingly widespread, so too has the fear that robots will displace human workers. There is much apprehension that their continuation will put people out of work and take a toll on the economy. However, those in favor of autonomous vehicles say that they can increase convenience, streamline processes, and strengthen businesses by reducing operating and insurance costs. An effective case study for this is the autonomous vehicle as it presents both points of view. If autonomous vehicles truly do end up becoming omnipresent, then the need for human drivers could be greatly reduced and put bus, Uber, truck drivers, *etc.* out of work. According to a White House report, it is estimated that up to 3.1 million American jobs are threatened by autonomous vehicles (Artificial Intelligence, Automation, and the Economy, 2016). With all these benefits, it has to be questioned if these cars should still be developed if it could cause a large number of people to be unemployed. The goal of this paper is to study the ethics of companies wanting to utilize these cars and what responsibilities they have to the employees that risk losing their jobs because of them.

In business, the debate between profits and people is one with which most people are

familiar. In fact, these two ideas are also typically at odds with each other in the shareholder vs. stakeholder debate. It has been argued that a business's job is to increase profits and that doing something for a general social interest "would be spending someone else's money" (Friedman, 1970, 3). Stakeholder theory, however, argues that a business should manage the needs of its stakeholders, which includes its employees, customers, and local communities according to a white paper published by Edalys, a sustainable development company in France (Fontaine, 2006). Essentially, the theory argues that businesses must consider the needs of others and try to balance them. When developing new technologies like the autonomous car, it is advantageous to study stakeholder and shareholder theories to help determine the extent to which different factors such as employee well-being should be considered when designing and planning said technology. Doing so will help provide insight into whether profit should still be the main consideration when the technology has the potential to eliminate millions of jobs and impact millions of families.

Background

   Autonomous vehicles have an abundance of benefits in addition to the ones listed previously. For example, their development has created many jobs for skilled specialists like computer scientists. Additionally, they would most likely benefit people, such as mail carriers and firefighters, who drive as a side function of their job (Reinickle, 2018). Not only that, but these cars lead to more convenience and free time which could consequently increase productivity of other workers because they can accomplish more work while traveling or catch up on sleep. Proponents of autonomous vehicles also argue that they provide more societal benefit because they greatly increase the safety of roads since they have a lower accident rate and are not prone to human error. On the other hand, however, the loss of jobs is a potential major turnoff. Creating machines that can do the work of humans results in less humans doing that work, thereby reducing the opportunity to earn a living from it. As such, the autonomous vehicle's potential to put several million people out of work could very negatively affect those displaced workers and their families. As everyday tasks become more automated, the controversy of whether or not this trend should continue has been raised and has an increasing number of people fearing for their future.

Methods: Data Collection

   In order to start considering the proposed question, some research must be conducted in order to gain insight and collect evidence. Data can be collected by looking at relevant court cases and by examining the statements of the people involved, which could include statements from unions or other representatives of the employees. This data will be useful to see what the people close to the situation believe and to have a more complete picture of the situation. Additionally, research on different philosophies regarding business ethics and responsibility can be conducted. In particular, the shareholder vs. stakeholder debate will be a useful starting point as the businesses are trying to balance improving technology and profits (shareholders) against employee interests (stakeholders). Exploring these theories will be valuable in figuring

out what factors might need to be considered such as profits and employee well-being. Research and projections from economists and experts can also give a clearer picture of the impact that the cars will have on the employees' careers and well-being. This is important to understand the full impact the cars will have on the job market and the workers. For instance, a situation that has either a low chance of widescale job displacement or a high probability of displaced workers quickly finding new employment is very different than one where many people lose their jobs and do not recover for a while.

Methods: Analysis

Once the data is collected, it will be analyzed with respect to business, societal, and legal ethics. For the initial purpose of this paper, each individual perspective will be considered a separate area and will consequently be examined independently. Therefore, a lack of legal responsibility does not denote a lack of total responsibility as there could still be societal, ethical, or business obligations. However, regarding material that is in direct conflict such as two disagreeing theories in the business and social realms, a different approach will need to be taken. For these cases, social construction of technology will be used to break down the connections between the technology and society, which is useful since technology is not created in a vacuum. By analyzing how the technology and society relate and shape each other, a clearer picture of the whole situation should emerge and possibly reveal societal benefits and drawbacks of the technology. The goal of this analysis will not be to argue a specific claim, but instead thoroughly investigate the involved parties and to explore the underlying issues so that the reader can walk away with a better understanding of the situation.

Wrap-up of the STS Research Project

By the end of this research, there should be a better understanding of the proposed question. Businesses should have a better idea of what different frameworks say they should take into account regarding employee decisions and whether or not they would be justified in potentially putting profits ahead of people. They should also have knowledge of the shareholder/stakeholder debate and should consider both sides. In the same vein, this paper hopes to persuade employees of these companies and even the general public to think about the impact these increasingly complex machines might have on their jobs or on society as a whole. While no formal suggestions or opinions will be offered, the knowledge gained should help shed some light on the issue.

Overall Conclusion

From these technical and STS projects, it should be clear how emergent autonomy has become in our present day. The technical section shows how a simple task like solving a word search can be automated and achieved without unnecessary human intervention. While this is a seemingly modest task, it illustrates what can be achieved when several components that can easily be translated to larger tasks are utilized. The STS section studies the impact autonomous vehicles could have on society and brings to light potential issues with job displacement. When

taken together, these two projects illustrate the degree to which automation and autonomy have been integrated into our society, and while solving some problems, they still introduce some of their own. Increasingly complex machines are being created that can eliminate the need for human workers in areas that were previously thought of as safe from automation. Anticipating further progress, it might be startling to see how advanced automation and autonomy become in the future and causes one to wonder about what it means not only for jobs, but society as a whole as we move forward.

Bibliography

Artificial Intelligence, Automation, and the Economy. (2016). Executive Office of the
President. Retrieved from
https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/documents/Artificial-
Intelligence-Automation-Economy.PDF

Fontaine, C., Haarman, A., & Schmid, S. (2006). *The Stakeholder Theory*. Retrieved from
https://pdfs.semanticscholar.org/606a/828294dafd62aeda92a77bd7e5d0a39af56f.pdf.
Manuscript.

Friedman, M. (1970, September 13). The Social Responsibility of Business is to Increase its
Profits. *The New York Times Magazine*.

Ivanov, S., & Webster, C. (2017). *Adoption of robots, artificial intelligence and service
automation by travel, tourism and hospitality companies – a cost-benefit
analysis*. Paper presented at the International Scientific Conference "Contemporary
tourism – traditions and innovations", Sofia, Bulgaria. Retrieved
from: https://ssrn.com/abstract=3007577

Reinickle, C. (2018, August 11). Autonomous vehicles won't only kill jobs. They will create
them, too. Retrieved from CNBC: https://www.cnbc.com/2018/08/10/autonomous-
vehicles-are-creating-jobs-heres-where.html