

TONGUE DRIVE SYSTEM FOR ASSISTIVE CONTROL
COMPARING PERCEPTIONS OF DISABILITY THROUGH A
CHARACTERIZATION OF ATTITUDES TOWARDS ASSISTIVE TECHNOLOGY

A Thesis Prospectus
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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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Investigating the impact of AI-based automation on jobs with low barrier to entry

Overview:

As a part of the inquisitive mindset I have as an engineer I am led to question the efficiency of different tasks that I observe myself and others undertaking. This of course has led me down the rabbit hole that is automation. Especially with the emergence of more effective and accessible AI-based technologies that have expanded the possibilities of what can be automated; I have decided to investigate how AI-based automation will impact the landscape of the labor market particularly when it comes to jobs with low barrier to entry - whether that be financial means, education, or social capital. The methodology taken to answer this question will be an analysis of classifications of jobs to determine what can and cannot be automated, to what extent, and lastly how will these changes impact the workers currently in those positions. Designers of these emergent technologies have claimed that AI-based technologies will transform jobs rather than replace them so this claim will be challenged across this paper to determine whether it holds true and if so in what industries and circumstances.

Problematization:

AI-based technologies have grown capable and accessible enough to the point where they will soon begin to change many sectors of industry. These changes will impact the people that drive these industries - their jobs may be replaced or completely transformed.

Guiding Question:

What are the characteristics of jobs that make them susceptible to automation and how can the impacts of automation be mitigated?

Projected Outcomes:

The examination of the parties most affected by the advancing capabilities of artificial intelligence as well as what those effects are will better help policymakers determine how they can change aspects of society to mitigate those effects. These changes may take the form of regulation, support systems, accessibility initiatives, or changing educational priorities. They should aim to simultaneously foster the development of indispensable skills and traits in students while aiding those displaced from their jobs in finding a new career and staying financially secure.

Technical Project Description:

Quadriplegia is the inability to move your limbs or your head - a condition often caused by spinal injury or muscular dystrophy. Individuals with this disability are forced to use prohibitively expensive assistive devices to move around. The prototype attachment I will be building for my technical project can be attached on top of any motorized wheelchair to allow it to be controlled using tongue-tracking to give these individuals the freedom of movement at a fraction of the cost. This invention uses artificial intelligence so it is important that human-conscious design is used to ensure that the project is empowering people rather than harming them. The research conducted towards answering the guiding question will better allow me to analyze unintended consequences that as a designer it is my responsibility to consider.

Preliminary Literature Review & Findings:

According to an initial analysis done by Arntz et al. (2017, p.157-160) the percentage of the United States population exposed to a more than 70% risk of having their job automated is 9%. This estimate helps set a scope for how big of a challenge mitigating the effects of automation

will be. Initial research done by a multitude of authors has discovered traits that make a job more or less likely to be automated.

Agrawal et al. (2019) suggest that jobs heavy on making predictions and Frey (2017, pg. 254-280) adds that jobs heavy on pattern recognition will be automated in the near future. This suggests the future of work will be focused more on making decisions based on generated predictions and recognized patterns. According to Autor (2015), repetitive jobs are likely to be entirely replaced and the future of work will be centered around characteristics such as creativity and adaptability. In the opinion of Goyal et al. (2020), as shown by the decline of repetitive jobs in India as a result of the automation revolution, this will lead to mass employment displacement as the number of low-medium skill jobs shrinks. Jobs will be created as a result of automation but the majority of these will be medium-high-skill jobs. Lastly, Elliot (2018) posits that the required literacy level for jobs will rise as artificial intelligence advances.

By examining the traits of the careers most likely to be automated it is clear that those from a less financially fortunate background who may struggle to acquire a higher degree of education will be most affected by job displacement. A few suggested solutions include government-sponsored vocational training programs and safety nets to assist those switching careers (Lanchester, 2019). In regards to preparing future students for these changes, it has been suggested that curriculum can be changed to encourage lifelong learning and flexibility (Grose, 2017) as well as improving literacy and digital skills (Chen et al., 2022).

STS Project Proposal:

Science and technology studies (STS) relates to how technology is developed and used as well as the ramifications of these decisions. This investigation is an STS project because it highlights the

effect of AI-based technologies on the people whose livelihoods have been impacted. More specifically, this investigation focuses on discussing the impacts on those it will hit hardest, people who lack the financial, educational, or social capital resources to easily get back on their feet. The examination of the relationship between technology and people makes it an STS project by definition.

The perspective from which analysis will be conducted is the effects of automation specifically on jobs with a low barrier to entry. For the most part, this will mean financial and educational. Considering the ecosystems of knowledge that was developed during a preliminary literature review the following are the core authors that will be used while addressing the guiding question and how they fit into the overall picture. Arntz et al. (2017, p.157-160) primarily sets the scope for how big of an issue automation will be for job displacement. Agrawal et al. (2019), Autor (2015), Elliot (2018), Frey et al. (2017), and Goyal et al. (2020) will primarily be used as starting points for examining traits that are more or less likely to lead to job displacement. Planning for future generations and thinking about how reform can be used to make the next workforce more resilient to automation comes from authors such as Chen et al. (2022), Graesser et al. (2019), Grose (2017), and Fernandes et al. (2020). Solutions as to how the current workforce can be empowered to handle higher skills jobs or be assisted into finding new careers can be found through authors such as Goyal et al. (2020), Lanchester (2019), and Rampersad (2020).

The analysis will consist of two parts to address the core questions posed - What are the characteristics of jobs that make them susceptible to automation and how can the effects be mitigated? The first part will be accomplished by examining a dataset of careers that have been evaluated by experts and includes the likelihood of said career being replaced by automation. The dataset will be manually tagged for each career with the different characteristics that make a

job more or less likely to be automated as found through literature reviews such as repetitive nature or requiring creativity, adaptability, or literacy. Then using machine learning models such as a decision tree, patterns can be found to determine which traits, or lack thereof, are most likely to correlate to a higher likelihood of susceptibility to automation.

The second part of the analysis builds off the first. By consulting the dataset which lists how likely specific jobs are to be automated, the top few jobs most likely to be automated can be identified. From there, discourse analysis can be used with the goal of identifying what the people whose jobs are most susceptible to automation think were the leading factors that caused this to be the case and whether they agree with the previously identified traits from part one of the analysis. Another goal would be to get their thoughts on how they and those like them can best be helped as they transition to new careers and what changes they would like to see in order to prevent future generations from befalling the same fate as them.

Discourse analysis is the study of language. The idea behind it is to examine communication and analyze it for patterns and insights while keeping in mind the context behind said communication. This generating of conclusions regarding technology with the people being impacted at the forefront of analysis goes back to the definition of STS. In order to conduct a discourse analysis; online forums and social media of the target demographic will be examined and interviews and a literature review will be conducted.

The preliminary literature review revealed a few existing theories for mitigating the effects of automation-based job displacement and skill development. By collecting data through interviews and document analysis, theories can be formed on how to aid best those who are most lacking in the traits found in the first part of the analysis as well as how to develop said skills in future generations.

Barriers & Boons

Certain limitations and biases must be acknowledged regarding the analysis. Internal bias may skew the attribution of characteristics and traits for specific careers. For example, as someone who is deeply engrossed in Science, Technology, and Engineering, I may be more conservative in assigning perceived positive characteristics to careers outside that sphere. To limit the effects of bias within assigning traits, a survey can be used for the assignment of traits. Ideally, by sampling a set of opinions from a diverse group of people of different backgrounds, ages, and genders, bias can be limited. Another limitation is finding people to interview for the second part of the analysis. To learn about the efficacy of solutions such as different educational programs or public policies I must find people who have experienced them and are willing to speak about their experiences. A way I can potentially find more people to interview is by posting on online message boards looking for people with desired experiences and providing an incentive for those who undergo a quick interview. Lastly, this will be the first time I am conducting an investigation based on discourse analysis. However, by looking at examples of what other investigations and by talking with research experts such as librarians, I am confident my examination will still be able to be complete and provide insight into my guiding question.

References

- Agrawal, A., Gans, J. S., & Goldfarb, A. (2019). Artificial Intelligence: The Ambiguous Labor Market Impact of Automating Prediction. *The Journal of Economic Perspectives*, 33(2), 31–50. <https://www.jstor.org/stable/26621238>
- Arntz, M., Gregory, T., & Zierahn, U. (2017, October 1). Revisiting the risk of automation. *Economics Letters*, 159, 157 - 160.
- Autor, D. H. (2015, July 1). Why Are There Still So Many Jobs? The History and Future of Workplace Automation. *The Journal of Economic Perspectives*, 29(3), 3 - 2.
- Chen, N., Li, Z., & Tang, B. (2022). Can digital skill protect against job displacement risk caused by artificial intelligence? Empirical evidence from 701 detailed occupations. *PLoS ONE*, 17(11), 1–13. <https://doi.org/10.1371/journal.pone.0277280>
- ELLIOTT, STUART W. “Artificial Intelligence, Robots, and Work: Is This Time Different?” *Issues in Science and Technology*, vol. 35, no. 1, 2018, pp. 40–44. *JSTOR*, <https://www.jstor.org/stable/26594285>. Accessed 16 Mar. 2023.
- Fernandes, P. M., Santos, F. C., & Lopes, M. (2020). Norms for beneficial A.I.: A computational analysis of the societal value alignment problem. *AI Communications*, 33(5–6), 155–171. <https://doi.org/10.3233/AIC-201502>
- Frey, Carl Benedikt, and Michael A. Osborne. "The Future of Employment: How Susceptible Are Jobs to Computerisation?." *Technological Forecasting & Social Change*, vol. 114, 1 Jan. 2017, pp. 254 - 280.
- Goyal, A., & Aneja, R. (2020). Artificial intelligence and income inequality: Do technological changes and worker’s position matter? *Journal of Public Affairs* (14723891), 20(4), 1–10. <https://doi.org/10.1002/pa.2326>

Graesser, A. C., Wolter, S. C., Schokker, T., Reininga, T., & Goroff, D. L. (2019). SKILLS FOR FUTURE WORKERS. *Issues in Science and Technology*, 35(2), 10–13.

<https://www.jstor.org/stable/26948977>

Grose, T. K. (2017). REPLACED BY MACHINES. *ASEE Prism*, 26(7), 30–33.

<http://www.jstor.org/stable/44160964>

Lanchester, J. (2019, February 4). Leveling the Playing Field. *TIME Magazine*, 193(4/5), 75 - 77.

Rampersad, G. (2020, August 1). Robot will take your job: Innovation for an era of artificial intelligence. *Journal of Business Research*, 116, 68 - 74.