ECE Capstone: Smart Solar Charge Controller
(Technical Paper)

AI's Effects on Software Engineering Jobs
(STS Paper)

A Thesis Prospects
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degrees
Bachelor of Science in Computer Engineering
Bachelor of Science in Computer Science

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November 1, 2024

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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

According to Amazon, a builder of AI models, AI is "is a technology with human-like problem-solving capabilities. AI in action appears to simulate human intelligence—it can recognize images, write poems, and make data-based predictions." (AWS). This definition begs the question, how well can AI imitate humans, and even more importantly, what will these imitations be used for? AI has gotten more powerful in recent years, with the emergence of Large Language Models, or LLMs. LLMs are AI tools that work using natural language, trained using millions of gigabytes of data from the internet (What Is a Large Language Model (LLM)?, 2022). These LLMs then use that data from the internet, run it through algorithms that learn from it, and it produces a program that can reply to text messages meaningfully (What Is a Large Language Model (LLM)?, 2022). Today, there are many different LLMs, including ChatGPT 4 by OpenAI, released in 2023 (Somoye, 2023), Claude 3 by Anthropic, released in 2024 (Anthropic, 2024), and Llama 3 by Meta, released in 2024 (Meta, 2024). As all of the models listed here were released within 2 years of the time of writing, this suggests that AI, and LLMs in particular, are a rapidly growing field.

For a society to function properly, the people in it must have jobs to support themselves and the society. According to one article, 68% of Americans don't have enough money to survive for one month without their job (Shilling, 2023). Therefore, it stands to reason that for most Americans, losing their job would be detrimental. Historically, with new automations, some people lose their jobs to automation (What the History of Automation Can Tell Us about AI's Impact on Jobs, 2024). Therefore, we must ask the question, what effect has automation via AI had on jobs, and how will it continue to affect jobs in the future? Specifically this paper explores AI's effects on software engineering as a job, which will be elaborated on later on in this paper.

Software Engineering is the field that designs, develops, tests, and maintains software programs written for various computing systems (Michigan Tech, n.d.). Computer programs are written in human readable plain text called source code (Definition of Source Code, n.d.), which makes them good candidates for automation via Large Language Models. Additionally, according to theNexus, white collar jobs, such as software engineering, are more likely to be impacted by AI (Shah, 2024).

My technical project is the design of a Maximum Power Point Tracking Solar Charge Controller, or MPPT. An MPPT is an electronic device used in tandem with solar panels to attempt to increase the power output of the solar panels (Northern Arizona Wind & Sun, 2019). Solar Energy is important because of its positive impacts on the environment, including having low greenhouse gas emissions, and thus helping to mitigate climate change (Solar Energy Technologies Office, 2021). The UVA Solar Car team is a team at the University of Virginia that builds and races an electric vehicle powered by solar panels on top of it (Solar Car Team at UVA, n.d.). My ECE capstone technical project seeks to design an MPPT to further increase the efficiency of the solar panels of the UVA Solar Car team. This relates to my STS paper as we had to program a microcontroller to design the MPPT. Therefore, the topic of this STS paper, on how software engineering is (or is not) being replaced by AI, can illuminate how tasks such as programming a microcontroller, a software engineering task, can be done by AI.

My STS paper will explore the question of how AI has, and how AI has the potential to affect Software Engineering jobs. As described earlier, there are a couple of reasons why Software Engineering is a good potential candidate for automation via LLMs, and my paper aims to further explore those in depth.

Technical Problem

The UVA Solar Car team competes in the Formula Sun Grand Prix, an event where teams from various schools race their solar cars around a track for 3 days, and all of the energy after the start of the race comes from the car's solar panels (Formula Sun Grand Prix – ASC & FSGP, n.d.). Because the Solar Car relies on Solar energy, it is critical that the maximum possible amount of power be extracted from their Solar Panels, so that they can drive further and be competitive for the Formula Sun Grand Prix. Solar car already has an MPPT design on their car, but this technical project aims to enhance their system to deliver even more power and thus better racing results.

An MPPT is a special type of DC-DC converter that changes the electrical characteristics of the solar panel circuit with the goal of maximizing the power output (Basics of Maximum Power Point Tracking (MPPT) Solar Charge Controller, n.d.). There are multiple different designs for MPPTs. Solar Car currently uses central MPPTs, which consist of an array of solar panels connected electrically in series, then to one central MPPT per solar circuit (SPW, 2019). The primary goal of these MPPTs is to maximize the power output via the IV curve, which measures the solar panel's current output versus its voltage output (What Is a PV Module IV Curve?, n.d.). The MPPT aims to find the maximum power point along the IV curve by finding where I*V (which equals power) is maximized by changing the resistance that the solar panel(s) see, which moves the system along the IV curve (What Is a PV Module IV Curve?, n.d.). However, this solution can introduce losses in certain scenarios, known as mismatching losses. According to pveducation.org, mismatching losses are caused when solar panels in series with each other have different current output conditions, which can happen for a variety of reasons, including partial shading or manufacturing differences. In the worst case, all of the panels can be

limited by the lowest performing panel (Mismatch Effects | PVEducation, n.d.). This is due to Kirchhoff's Current Law, which states that in series the current at all points must be the same, therefore the current is limited by the lowest performing panel (Kuphaldt, 2015).

My technical project seeks to solve this issue of mismatching losses for the UVA Solar Car Team by designing a different type of MPPT controller specifically for the team, a Distributed MPPT. A Distributed MPPT does the same general job of attempting to maximize solar panel power outputs, however a Distributed MPPT works on the individual panel level, rather than the level of a string of panels. This can help to mitigate mismatching effects, as all of the currents from each panel can be made to match using DC-DC converters in between each panel (Başoğlu, 2022). Our project aims to make a proof of concept Distributed MPPT design on a smaller scale, and to then provide solar car with documentation on our design so they can implement it. One of the key efforts of our design has been scalability, as we want the Solar Car team to be able to scale up and implement our designs as easily as possible.

STS Problem

My STS paper aims to explore the effect of AI, specifically LLMs, on the job market for Software Engineers. Software Engineering, like various other white collar jobs, represents a potential market for AI based automation, however there has not yet been a clear answer as to how it will be affected yet. The system of AI in the job market can be represented using the Actor Network Theory. Actor Network Theory aims to describe systems in terms of human and non-human actors, and explores the relationship between said actors (Nickerson, 2024). In the system of AI and the Software Engineering job market, there are a number of different actors. The first actor to consider are the Software Engineers. They stand to either keep or lose their

jobs, depending on whether or not AI automates them. The second actor is the AI itself, which is the tool that may potentially be used to automate away the jobs. The third actor is the makers of AI, companies such as Anthropic or OpenAI which design and procure AI models for people to use. The fourth and final actor is the companies that develop software, as they employ software engineers. Thus, these software companies decided whether or not to replace their workers with AI automations.

The STS paper will further dive into Actor Network Theory and its implications on AI in the Software Engineering job market, as well as what this analysis may mean for aspiring and current software engineers.

My key texts are listed below:

- "AI jobs negatively impacts blue and white-collar jobs" by Rajvi Shah
- "What the history of automation can tell us about AI's impact on jobs." on Eviden
- "Latour's Actor Network Theory" by Charlotte Nickerson
- "68% of Americans couldn't cover their living expenses for even a month if they lost their job, survey finds. The good news? Now is the best time in years to fix that." by Andrew Shilling

To conduct research, I plan to use multiple methods. The first will be looking throughout previously written works to find statistics about how AI is affecting software engineering jobs. The second will be to conduct interviews with actors in the network. Ideally, if I can find willing participants, interviews from both software engineer(s), and software engineering manager(s) could paint a better picture of what real companies are doing in regards to AI today.

My timeline is given below, with deadlines in parenthesis:

- Further background research (End of January 2024)

- Conduct interviews with people in various software roles (Mid March 2024)
- Compile results from the above into the final paper (Late April 2024)

Conclusion

Through my STS research and paper, I plan to shape a better understanding of how AI can affect Software Engineering jobs, such as those done in my technical project to program the MPPT. By exploring the relationships between the components of the AI-job market system using Actor Network Theory, I plan to explain what affects AI has currency had on Software Engineering jobs, and explore how it may be affected by AI in the future. I also plan to back up my findings with credible statistics describing the performance of AI in Software Engineering tasks, which will further illuminate its potential for effects.

References

Anthropic. (2024, March 4). Introducing the next generation of Claude. Www.anthropic.com. https://www.anthropic.com/news/claude-3-family

AWS. “What Is Artificial Intelligence? - Artificial Intelligence (AI) Explained - AWS.” Amazon Web Services, Inc., 2024, aws.amazon.com/what-is/artificial-intelligence/.

Basics of Maximum Power Point Tracking (MPPT) Solar Charge Controller. (n.d.). Www.leonics.com. https://www.leonics.com/support/article2_14j/articles2_14j_en.php

Başoğlu, M. E. (2022). Comprehensive review on distributed maximum power point tracking: Submodule level and module level MPPT strategies. Solar Energy, 241, 85–108. https://doi.org/10.1016/j.solener.2022.05.039

Definition of source code. (n.d.). PCMAG. https://www.pcmag.com/encyclopedia/term/source-code

Formula Sun Grand Prix – ASC & FSGP. (n.d.). American Solar Challenge. https://www.americansolarchallenge.org/about/formula-sun-grand-prix/

Kuphaldt, T. R. (2015, February 9). Kirchhoff’s Current Law (KCL). Allaboutcircuits.com; All About Circuits. https://www.allaboutcircuits.com/textbook/direct-current/chpt-6/kirchhoffs-current-law-kcl/

Meta. (2024, April 18). Introducing Meta Llama 3: The most capable openly available LLM to date. Ai.meta.com. https://ai.meta.com/blog/meta-llama-3/

Michigan Tech. (n.d.). What is Software Engineering? | Computer Science | Michigan Tech. Michigan Technological University. https://www.mtu.edu/cs/undergraduate/software/what/

Mismatch Effects | PVEducation. (n.d.). Www.pveducation.org. https://www.pveducation.org/pvcdrom/modules-and-arrays/mismatch-effects

Nickerson, C. (2024, February 13). Latour's Actor Network Theory. Simply Psychology. https://www.simplypsychology.org/actor-network-theory.html

Northern Arizona Wind & Sun. (2019). What is maximum power point tracking (MPPT). Northern Arizona Wind & Sun. https://www.solar-electric.com/learning-center/mppt-solar-charge-controllers.html/

Shah, R. (2024, March 15). AI jobs negatively impacts blue and white-collar jobs. The Nexus. https://wvnexus.org/opinions/ai-jobs-negatively-impacts-blue-and-white-collar-jobs/

Shilling, A. (2023, March 8). 68% of Americans couldn't cover their living expenses for even a month if they lost their job, survey finds. The good news? Now is the best time in years to fix that. MarketWatch. https://www.marketwatch.com/picks/68-of-americans-couldnt-cover-their-living-expenses-for-even-a-month-if-they-lost-their-job-survey-finds-the-good-news-now-is-the-best-time-in-years-to-fix-that-a9842d35

Solar Car Team at UVA. (n.d.). Www.solarcaratuva.org. https://www.solarcaratuva.org/

Solar Energy Technologies Office. (2021). Solar Energy, Wildlife, and the Environment. Energy.gov. https://www.energy.gov/eere/solar/solar-energy-wildlife-and-environment

Somoye, F. L. (2023, October 20). GPT-4 release date — When was GPT-4 released? PC Guide. https://www.pcguide.com/apps/chat-gpt-4-release-date/

SPW. (2019, December 3). MPPT: How energy harvest changes as solar projects age. Solar Power World.

https://www.solarpowerworldonline.com/2019/12/mppt-how-energy-harvest-changes-as-solar-projects-age/

What is a large language model (LLM)? (2022). Cloudflare.com. https://www.cloudflare.com/learning/ai/what-is-large-language-model/

What is a PV Module IV Curve? (n.d.). Atonometrics. https://www.atonometrics.com/applications/what-is-a-pv-module-iv-curve/

What the history of automation can tell us about AI's impact on jobs. (2024, June 12). Eviden. https://eviden.com/insights/blogs/what-the-history-of-automation-can-tell-us-about-ais-impact-on-jobs/