**Thesis Project Portfolio**

# Designing an Efficient Distributed Maximum Power Point Tracking System for the UVA Solar Car Team

(Technical Report)

# The Ethics of Artificial Intelligence: Risks, Policy Considerations, and Suggestions.

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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Bachelor of Science, School of Engineering

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## Sociotechnical Synthesis

My technical capstone team was building a Distributed Smart Solar Charge Controller (DSSCC) for the UVA Solar Car Team to enhance the efficiency and flexibility of their solar energy system. The system uses a Distributed Maximum Power Point Tracking (MPPT) architecture, where individual buck/boost converters are placed on each solar panel to minimize mismatch losses and ensure that even partially shaded panels contribute power. Our design addresses limitations in the current MPPT solution, which uses bypass diodes that fully disengage shaded panels, leading to reduced overall efficiency.

Our project was a scaled down version of what the Solar Car team needs. It includes three solar panels and a smaller battery, making it easy to replicate and scale as needed. The DSSCC is designed for superior power gain, easier repairability, and lower cost, which was estimated at $500 compared to the Solar Car Team's current $3000 MPPT system. To develop this project, we used simulation, hardware testing, and field validation under different lighting conditions. Some key features of our project include real time data logging, UART communication, and heat testing. To ensure that our design met the UVA Solar Car Team's requirements, we iteratively tested the algorithm and hardware components. We also aimed to demonstrate that the distributed MPPT not only improves energy efficiency, but it also provides a more resilient and cost effective solution for solar cars.

My STS thesis explores the ethical and social risks posed by emotional attachment to autonomous systems. As AI becomes increasingly integrated into everyday life, from chatbots to caregiving robots, users form unidirectional emotional bonds that blur ethical boundaries. My

research question asks: How might emotional attachments to automated tools and services give rise to ethical issues, especially when those tools and services are relied upon for decisions that impact human well-being, and how can we protect ourselves?

To answer this question, I identify and analyze three primary ethical concerns: Anthropomorphism and Misinformation, Bias and the Perpetuation of Harmful Stereotypes, and Surveillance Capitalism and Data Exploitation. Each section defines the specific issue, presents case studies, and explains the consequences of unchecked emotional reliance on AI. For instance, I examine how anthropomorphic design choices such as emotionally responsive chatbots encourage overtrust and diminish critical thinking, and how AI-generated misinformation can manipulate user beliefs. I also explore the dangers of biased training data and discriminatory outcomes in decision-making tools, discussing how these systems can reinforce existing inequalities. Additionally, I investigate how user data, when taken under the guise of personalization, is exploited to manipulate behavior and generate profit without informed consent.

After discussing these issues, I also present counterarguments that discuss the genuine benefits AI can offer like companionship for the elderly, support in education, and content customization. I do not argue that AI is inherently harmful. Rather, I show that without ethical design and regulation, the harms can easily outweigh the benefits.

To pave the way for a solution, I use the Ethical, Legal, and Social Implications (ELSI) framework to assess existing regulatory efforts and recommend policy improvements. I analyze current U.S. and global AI governance, including the AI Bill of Rights and President Biden’s Executive Order on Trustworthy AI, noting their limitations in enforceability and scope. I suggest the need for legally binding regulations, stronger consumer protections, mandatory bias

audits, and incentives for ethical innovation. My thesis argues that we must address these risks proactively to ensure that emotional bonds with AI do not come at the cost of human autonomy, safety, and democratic accountability.

Although my technical and STS projects focus on different applications of technology, they are united by the following theme: how to integrate autonomous systems into society responsibly. In my technical project, we aimed to optimize energy efficiency for the UVA Solar Car Team using autonomous, distributed control of solar panel outputs. This allowed machines to make fast and adaptive decisions without human intervention. In my STS research paper, I explore the ethical risks that occur when we form emotional attachments to autonomous systems, especially in areas like mental health where user well being is at stake.

These projects together reflect two sides of the same coin. My technical project shows how automation can make systems more efficient and reliable. My STS thesis highlights how these optimizations in machines can come with social risks, particularly when systems are designed to mimic human traits and foster emotional dependence. In both cases, autonomy shifts the decision making from humans to machines. Through both of these projects, I aim to promote responsible technological advancement that prioritizes performance as well as responsibility. This way, the systems we build serve people without compromising autonomy, privacy, or trust.