Thesis Project Portfolio

Distributed Smart Solar Charge Controller for UVA Solar Car

(Technical Report)

To Return or Not to Return: The Shopping Cart as a Measure of Ethical Character

(STS Research Paper)

An Undergraduate Thesis

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

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Kyle Clemente

Spring, 2024

Department of Electrical Engineering

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Sociotechnical Synthesis

The technical and STS components of my thesis portfolio explore two perspectives on ethical and effective design: one centered on solar energy systems and the other on habitual moral behavior. Though these projects address distinct subject matters, they are united by a shared emphasis on understanding how design (whether of a circuit or a civic norm) reflects and influences the values of its users. In my technical project, my team and I designed a Distributed Maximum Power Point Tracking (MPPT) solar charge controller that optimizes energy extraction from mismatched solar panels. In parallel, my STS research investigates how seemingly mundane actions, such as returning a shopping cart, serve as everyday tests of moral character when viewed through the lens of virtue ethics. Both projects address the gap between idealized functionality and real-world behavior by asking what principles shape user decisions in practice.

The technical report details the design of a cost-effective, energy-efficient Distributed MPPT system. This system allows each solar panel in an array to operate at its individual maximum power point, thereby minimizing mismatch losses that occur due to partial shading or manufacturing variances. Unlike conventional systems relying on bypass diodes or centralized tracking, our design assigns a buck-boost converter to each panel, managed by a microcontroller for dynamic power optimization. Real-time performance data is collected and displayed locally to confirm system efficiency. Our solution was developed for the UVA Solar Car Team, with broader applications envisioned in solar deployments that require flexibility, modularity, and cost-sensitive implementation.

My STS research paper, titled *To Return or Not to Return: The Shopping Cart as a Measure of Ethical Character*, argues that returning a shopping cart in the absence of

surveillance or consequence serves as a unique metric of one's internal moral compass. Framed through virtue ethics, as well as drawing on Aristotle's theory of habitual virtue and MacIntyre's concept of practices, the paper contends that small, routine actions reflect deeply held values more than externally enforced behavior does. Supplementing this philosophical lens are psychological theories such as moral disengagement and self-perception theory, which reveal how individuals rationalize inaction or reinforce virtuous behavior over time. Ultimately, I argue that these mundane actions, when performed voluntarily and habitually, become meaningful indicators of one's moral identity.

Working on these projects concurrently deepened my appreciation for the ethical dimension of engineering design. The STS research encouraged me to think beyond efficiency metrics and consider how technologies invite or discourage virtue through their everyday use. Similarly, the technical project illuminated how engineering decisions (such as cost tradeoffs or modular design) shape the accessibility and sustainability of energy technologies. Going forward, I will approach future engineering work with a stronger awareness that even the most technical systems exist within moral and social worlds, and that good design must account for both.