Thesis Portfolio

Autonomous Driving Simulator Design and Analysis

(Technical Report)

Navigating the Road to Autonomous Vehicles: Balancing Technological Advancements, Ethical Dilemmas, and Societal Impact

(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

Marlena Reinhard

Spring, 2024

Department of Mechanical and Aerospace Engineering

Sociotechnical Synthesis

Introduction

Autonomous vehicles hold the potential to revolutionize society by fundamentally altering the transportation world. Like any new technology, the ethical considerations are paramount to initiating this change as well as the testing and manufacturing of the vehicles themselves. These considerations encompass a range of issues from the ethics embedded in the programming to the legislative and regulatory reforms. Once surpassed, the adaptation of AVs presents clear benefits, such as minimizing energy and emissions, improving mobility and traffic patterns, and advancing public health. These benefits are unattainable unless the obstacles can be overcome and the technology can be adequately tested using driving simulators and on road tests of the systems. Autonomous driving simulators are therefore crucial for validating the efficiency and safety alongside the ethics of deploying autonomous vehicles in real-world environments.

Project Summaries

Using a series of reports regarding studies on autonomous driving, this STS research paper synthesized current findings to contrast the key challenges and benefits of adopting a full scale implementation of autonomous vehicles. Driverless cars have proved to be considerably safer, more efficient and increasingly better for the environment than manually operated vehicles. Despite the preliminary effects of job shifting, infrastructure changes, new legislation and programming risks, once overcome, the long-term positive impacts that AVs have on society greatly outweigh the initial challenges. The complete implementation of autonomous vehicles is directly dependent on the qualitative data and testing processes collected through simulators and test-track trials highlighting the importance of autonomous driving simulators.

The technical project my capstone team worked on this year helped significantly advance the manual car simulator located in the VICTOR lab at the University of Virginia. The goal of the project was to adapt the simulator so that it will be able to be used in testing and performance reviews in the technological efforts to establish a safer and more accessible world filled with autonomous vehicles. The technical report focuses on the advancements our team made towards this goal including a functioning autonomous program, successful manual operation of the simulator and a redesign on the simulator interior.

Conclusion

The symbiotic relationship between technological innovation and ethical consideration of autonomous vehicles is highlighted through both the STS research paper and the technical report. In designing and operating the autonomous vehicle simulator, the intertwinement of ethics into each component of the technological design became evident. This dual approach not only enriched our understanding of the challenges and opportunities of autonomous vehicles but also emphasized the importance of responsible innovation. Our capstone team significantly advanced the vehicle simulator in the VICTOR lab to not only be autonomous but also significantly safer and a more realistic driving experience. Through my STS research paper, the importance of these simulators was brought paramount when balancing the potential societal impacts and ethical dimensions guiding full-scale implementation of autonomous vehicles. In conclusion, the integration of ethical considerations with technological advancements, as demonstrated through both my STS research and technical projects, are imperative to ensuring the safety of the forthcoming future of transportation.

Acknowledgements

I would like to thank my capstone group members, Julia Blackin, Emma Dalkin, and Brian Luong for their help with the technical project. Additionally, I would like to thank Hudson Burke for his help with the coding aspect and mentoring on this project as well as Professor Tomonari for the funding and guidance.

Portfolio Table of Contents