Thesis Project Portfolio

Development of an Autonomous Campus Vehicle Platooning System

(Technical Report)

A Discussion of the Effects of Autonomous Vehicle Data Security Issues on the Widespread Implementation of this Technology

(STS Research Paper)

An Undergraduate Thesis

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Executive Summary

The internal combustion engine automobile has been one of the single most influential marvels of engineering developed over the span of human intelligence. As our world has progressively growth more conscious of external factors such as efficiency, safety, and environmental sustainability, these vehicles have accumulated innovations such as the anti-lock braking system, hybrid electric engines, and even motorized windows. The incorporation of artificial intelligence with modern vehicles has led to one of the newest iterations of this technology, autonomous vehicles. Autonomous vehicles have brought forth the potential for numerous improvements to our current mobile networks, including increased traffic efficiency, reduced vehicular emissions, and improved general roadway safety. When extended further to a college campus, an autonomous vehicle system could provide increased mobility to disabled students as well as reduce congestion on highly-trafficked roadways. The applicability of an autonomous vehicle system to a college campus will be the focus of my Technical Project. Currently, there are several issues with this developing technology which are preventing its immediate incorporation into society. Data security issues within autonomous vehicles, such as vulnerability to blinding attacks, spoofing attacks, and communications attacks, present one of the most formidable challenges when considering its use in our current society. The total effect of these data security issues on the development of autonomous vehicles will be the focus of my STS Research Paper.

On campuses such as ours here at the University of Virginia that span over a large landscape of hills and other difficult terrain, transportation can be a significant issue for both those with and without mobility issues. The journey from Engineer's Way to the Observatory Mountain Engineering Research Facility (OMERF) is one specific instance of such a navigability

problem. With limited parking options and no direct public transportation methods to travel this distance, most engineers at this lab must resort to walking this distance, which is often impractical due to severe weather and extensive travel times. To help remediate this issue, the Autonomous Campus Vehicle team is seeking to develop an autonomous golf cart system to assist OMERF researchers. As currently used in our project, one golf cart will be manually operated while additional cart(s) will follow behind using a method called platooning. Since this is an ongoing project, our efforts this semester have varied in scope, including improvement of the capabilities of the system by developing new electrical boxes using Jetson TX2 processors with NVIDIA graphics, incorporating new cameras and LIDAR sensors, and altering the current platooning code. From all of our team's progress this semester, we have successfully established a convenient and reliable alternative to assist with mobility difficulties when traveling from Engineer's Way to OMERF.

Based on analysis of several current issues with autonomous vehicles, the research question for my STS Research Paper was formulated as follows: How are data security issues affecting the development of autonomous vehicles? Using thorough documentary analysis of several sources relating to data security issues with autonomous vehicles including journal articles, periodicals, and public forums, it was determined that these data security issues leave several vulnerabilities in this technology that are negatively affecting the public's current perception of autonomous vehicles. However, using the STS concept of Mutual Shaping, I was able to conclude that the mutual shaping between the public's perception of autonomous vehicle data security and the current data security issues with this technology will ultimately lead to a successful incorporation of autonomous vehicles into our society.

Overall, my work on autonomous vehicles in both my Technical Project and STS Research Paper have helped to shed light on the current state of this technology. My Technical Project helped to solve a pressing issue affecting our engineering community, demonstrating the power of autonomous vehicles to help positively change society. Despite our success, there are still several improvements to be made to our current system, including the addition of safety message broadcasting, a cart tracking hub, improved sensor capabilities, and additional follower carts to increase our system's capacity. My STS Research has explored the current data security vulnerabilities with autonomous vehicles and how they will lead to a safer, more beneficial future for our society's transportation landscape. In order to thoroughly assure the successful use of this technology, additional limitations of this technology must be analyzed similarly to my exploration of data security issues. Examples of these other limitations include artif icial intelligence decision making, environmental sustainability, and technological reliability. Both of my projects this year have exhibited a successful culmination of my experience here in the Mechanical Engineering program at the University of Virginia.