Fast, Safe, and Proactive Runtime Planning and Control of Autonomous Ground Vehicles in Changing Environments
(Technical Paper)

The Introduction of Autonomous Vehicles into Society: Encoding Morals into the Machine
(STS Paper)

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Socio-Technical Synthesis

In the technical research component of this portfolio, we worked under the guidance of the Autonomous Mobile Robot's lab at the University of Virginia to develop a policy that dynamically adjusts the speed of an Unmanned Ground Vehicle (UGV) to stay within a safe deviation from the path at all times, to avoid collision with any obstacle, and to successfully reach the final goal. In order to do this, we implemented a neural network based approach in which we took into account several aspects of the environment such as the frictional coefficient, the turning angle, the presence of ramps, and the maximum safe distance the robot was allowed to deviate from the path. For the STS research paper, I investigated how the emergence of autonomous technologies, like the ones in the technical paper, will influence, and be influenced by, society. This is a quickly growing industry and its impact is expected to be tremendous. Therefore, an analysis of this transformative technology is important to help inform those who are developing it.

The uses for unmanned ground vehicles are vast including search and rescue, firefighting, cave exploration, package delivery, and many more. In each of these applications, successful and safe completion of the mission is important, but efficiency is another crucial metric. In normal conditions, maintaining a constant speed, or maximizing the speed of the robot, may result in a timely journey, but when traversing through complex terrains such as an icy road or a sharp turn the UGV could crash. Choosing a minimum speed to maintain over the entire path could guarantee safety, but potentially at the cost of efficiency. Therefore, we focused our work on maximizing the speed while maintaining safety by dynamically choosing the velocity based on the environmental factors. In order to accomplish this we leveraged learning-based methods to create a system of neural networks that work together to find the maximum safe velocity while taking into account all major environmental conditions. Another important aspect of our work was the consideration of uncertainty. When operating from imperfect information and sensor data, the dynamic velocity predictions need to be adjusted to mitigate risk and ensure safety. In our work we model uncertainty by applying Gaussian noise to the neural network inputs, simulating the inaccuracies that could occur with imperfect sensors.

The STS research paper is an analysis of the increasingly large autonomous vehicles industry (with a focus on passenger vehicles), and the affects of it on society, and vice versa. For this analysis, I split it into two sections: how autonomous vehicles will influence the world around then and how society will impact their development and implementation. For the first component I use the STS framework actor-network theory (ANT), which views autonomous vehicles as agents in their network. This perspective is important because with autonomous technology and artificial intelligence, these cars will be making decisions in highly complex scenarios, often involving the safety of humans. In particular, subjective decisions not guided by logic or reasoning are particularly hard to program, yet that encompasses so many decisions made by human drivers. The second component is just as important as many different groups of stakeholders will be affected by autonomous vehicles. This list includes, but is not limited to, the general public, the developers of this technology, the government and lawmakers, and transportation industry workers and employees. Not only will this technology impact these groups, but ultimately they will also shape the way the technology is developed and how its introduction into society will go.

Both of these topics are about autonomous vehicle technology and advancements in the field. Our technical project focuses on small, unmanned robots, used widely today for the uses mentioned above. In contrast, my STS research paper focuses on self-driving cars and passenger vehicles, which have long been in development but has yet to be ready for market and mass use. The biggest difference between the two is that self-driving cars interact more directly with humans and have a greater impact on their safety compared to smaller UGVs. However, our technical project focuses on ways to ensure safety of autonomous vehicles, which is the main consideration with self-driving cars. Therefore, understanding the technology in my capstone project has allowed me to see the challenges that self-driving cars will face in the future.