Thesis Project Portfolio

Development of an Autonomous Driving Simulator

Fiscal Policies and the EV Transition: Why the United States fell behind in Electrification

An Undergraduate Thesis

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Executive Summary

The emergence of autonomous vehicles (AVs) has ushered in a new era of transportation, promising a plethora of benefits but also presenting a host of challenges. Autonomous vehicles have the capacity to significantly minimize the number of accidents and improve safety, which will result in fewer road fatalities and injuries. However, despite these promising advantages, the widespread adoption of autonomous vehicles has been impeded. Since these concepts are very novel, much more research must be done to develop a full understanding of their benefits and potential consequences. In particular, being able to test AV software will significantly improve safety and efficiency. This is an area that can be improved by autonomous driving simulators (ADS). In the real world, beta testing has already been implemented in electric and next generation vehicles, to collect data as well as understand public perception with the technology. Electric vehicles (EVs) have been closely linked to autonomous self-driving, with companies like Tesla increasing popularity and adoption for EVs. Both technologies promise to revolutionize the future of transportation, and developing a more complete understanding of the way they are perceived, adopted, and regulated can help to formulate a better understanding of the efficacy of certain strategies in the push for electrification and sustainable transportation.

My technical project focused on improving the University of Virginia's Virginia Cooperative Autonomous Robotics lab's hyper-immersive driving simulator by implementing autonomous driving and self-driving testing software. Since autonomous driving is a very novel technology that has not been thoroughly researched, many states have restrictions on the level of autonomous driving that is allowed on public roads. With the use of the "Car Learning How to Act" (CARLA) open-source program, we will be able to develop a platform that can interface with autonomous driving software for the purpose of performance analyses and studies on the public perception of AVs. The second objective is to improve the realism of the simulator by creating a new enclosure and improving graphics. To accomplish this, our team first set out by defining the technical specifications required for the system and identifying a suitable methodology for implementing the software. With this in mind, we built a new computer that can run the software and autonomous algorithms using high-end components. To integrate CARLA, we migrated all the python code used to control the simulator to ROS 2 where it is optimized to run and also allows future sensors to be easily implemented. For mechanical improvements, the team relocated the simulator and securely fastened it to the ground. This had been a major concern in past years due to excess vibration and movement during high-speed tests. A curved screen was also built and implemented, increasing the field of vision and realism. With the progress made this year, the simulator can implement and test autonomous driving software in a safe and controlled environment.

The main research question driving the STS report is: *in what ways are fiscal policies on EVs between the US, Europe, and China different and how do these policies affect the EV transition?* Specifically, I seek to understand why some countries are at different stages in the EV transition and how this is a byproduct of the kinds of fiscal policies they implement. By analyzing the efficacy of each country's fiscal policies in making EVs competitive in the auto market, successful policies can be adapted to countries that seek to enter into the EV transition and help to usher in a more sustainable and innovative future. To do this, I compare the total fiscal burden placed on the consumer when buying an EV versus a hybrid electric vehicle (HEV) after applying all relevant fiscal policies in the USA, Norway, and China. These countries were chosen because they each offer a unique perspective on EV legislation, allowing comparison of fiscal policies and the effect of different levels of government involvement in the EV industry. From the analysis, it was shown that EVs have less of a fiscal burden in Norway and China but are still more expensive in the US. This supports the claim that countries that have had the most success in the EV transition utilize strong fiscal measures to either make EVs more competitive in price to HEVs and ICEs or disincentivizing ICEs. It was also found that as countries progress along the EV transition, different policies are enacted that are effective in certain phases. With this in mind, successful policies can be adapted to work in the most unique situations to support the global push for electrification.

In conclusion, the work I did this semester helped to further our understanding of the regulatory frameworks and testing required for the development of fully autonomous driving software and the importance of understanding how fiscal policies can impact the EV transition. Since EVs and AVs are very new technologies, the research I accomplished will contribute to addressing key challenges that affect these technologies in the economic, political, and cultural realms. Despite this, further work can be done to improve the ADS by integrating additional sensors and algorithms to refine the simulator, and well as conducting studies on the public perception of autonomous driving technology. A more inclusive policy analysis that includes more countries can also improve my research, as well as a more detailed study analyzing additional factors that affect the EV market, such as competition from other EV companies and the supply chain for EV components. As these technologies become more advanced, the sociotechnical system will continually adapt to changes in the technical, political, and economic landscapes and will require frequent revisions in the current research to include the most accurate information.