

Undergraduate Thesis Prospectus

The Competing Place of Public Transportation and Autonomous Vehicles in Traffic Mitigation in
the United States

(technical research project in Mechanical Engineering)

Robotic Vehicles and the Quest for Traffic Congestion Relief in the United States

(sociotechnical research project)

by

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On my honor as a University student I have neither given nor received unauthorized aid
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General Research Problem

What are the implications and potential contributions of public transportation systems and autonomous vehicles in mitigating traffic congestion in the United States?

Traffic has been an issue for dozens of years, costing the United States economy nearly \$87 billion in 2018, according to the World Economic Forum (2019). Meanwhile, autonomous vehicles (AVs) have come into the market as a new tool to curb traffic. In the near future, AVs will be able to communicate with each other to reduce accidents and decrease traffic (NHTSA, 2014). Another long-standing tool for traffic reduction is public transportation, notably subways. In a 2013 study of a Los Angeles subway worker strike it was observed that highway delays increased by 47% (Anderson). A proposed tool for traffic mitigation is to fund a ride-sharing public transportation program in which AVs can be summoned and used on demand. However, this would increase the need for mobility hubs, in which the AVs would park themselves, otherwise the cars would drive on the roads between bookings, prompting gridlock (Duvall et al., 2019). In a simulation of Berlin, which is widely known to have one of the best public transportation systems in the world (Reinhold, 2008), the introduction of on-demand AVs were simulated in a variety of scenarios. The model showed significant congestion and emission decreases in the case of a private car ban including the use of public transportation and on-demand AVs, while mixed use with private cars brought economic costs without said benefits (Carreyre, 2023).

Autonomous Driving Simulators as a Means of Safely Testing Autonomous Vehicle

Algorithms

Can Autonomous Driving Simulators be used to test autonomous vehicles?

The department for this project is Mechanical Engineering and the technical advisor is Tomonari Furukawa. This is a capstone project for Mechanical Design in collaboration with Emma Dalkin, Brian Luong, and Marlee Reinhard. The number of autonomous vehicles (AVs) on the road has grown exponentially in recent years, and is expected to keep growing with an estimated 3.5 million on the road by 2025 (NAIC, 2022). This growth is not without traffic accidents, sparking questions about the safety of testing AVs on public roads. In tandem with the rise of AVs, autonomous driving simulators (ADSs) have come to market for entertainment and driving safety training purposes. Additionally, ADSs are being used to test AV algorithms within a virtual environment, providing control and safety. An example of a robust driving simulator is the NADS-1 Simulator from the University of Iowa, which is mounted on a series of tracks to simulate motion, has a 360° field of view, and interchangeable vehicles (Iowa University, 2022). The objectives of this project are to provide realistic and challenging traffic environments for AVs to navigate as well as equip the virtual car with sensors to maximize its vehicle identification abilities. If successful, the project will produce a prototype of an AV testing simulator that can be used by AV designers to test their algorithms. The next capstone team will likely have to improve upon the realism of the ADS virtual environment as well. Additionally, as AV technology improves in the future, ADS designers will need to incorporate the new technology onto their virtual vehicle. A constraint of this project is that the platform that the ADS is on is a steel grate above a pit, which causes the system to shake when the motion platform moves.

Analyzing the Interplay of Autonomous Vehicles and Public Transportation in Traffic Congestion Mitigation

How are proponents and critics of autonomous vehicles competing to influence their part in efforts to relieve traffic congestion in the United States?

As the integration of AVs into daily life becomes more of a reality in America, there is a growing need for extensive research and legislation. According to a Pew Research Poll (2022), 44% of Americans think that AVs would be bad for society, with only 26% thinking they would be a good idea. The number of people who believe it would be a good idea grew as they learned more about AVs, with those who have heard “a lot” about them being far more likely to say they are a good idea as opposed to those who had just heard “a little” or “not at all”. Because of the growth in AV deployment, 35 states have enacted or are in the process of researching legislation related to autonomous vehicles (IIHS, 2023). Proponents of AVs such as the Coalition for Future Mobility believe that they will bring greater road safety, independence for the elderly and disabled, and increase productivity during travel. Groups such as the Autonomous Vehicle Industry Association, a coalition of AV companies, cite that 90% of accidents are caused by human error such as impaired and reckless driving, which would be eliminated by AVs. However, to maximize the benefits of AVs, significant investment in AV communication technology as well as standardized road markings and signs will be necessary, falling to state and municipal transportation sectors. Monash University (2023), a major developer and proponent of AVs in Singapore, recommended these improvements and also found that AVs may increase the number of trips taken by users and exacerbate urban sprawl due to the convenience. Supporters of AVs believe that they will reduce traffic, but a model of California from UC Davis (2021) reveals that AV adoption will decrease public transportation use while increasing total vehicle miles driven, recommending the use of shared and electric AVs. Additionally, a study by the

Insurance Institute of Highway Safety (2023) suggests that current AVs are not ready for driverless operation and have mixed findings on their safety beyond crash avoidance technology.

One major opponent group is the Safe Street Rebels of San Francisco who want to move away from dependence on cars and oppose AVs due to the predicted increase in vehicle use. San Francisco is an epicenter of AV testing, including driverless ride-share vehicles that have caused traffic disruptions in recent years without legal punishment (Dave, 2023). The Human Driving Association is another group that opposes AVs, but unlike the Safe Street Rebels, who are against car dependence altogether, believe that driving is a personal freedom (HDS). Both groups also believe that the growth of AV usage will eliminate numerous jobs. In fact, drivers make up the majority of the working population in nearly 30 states, with the number of drivers being at an all-time high (Census Bureau, 2019). In San Francisco, two AV companies, Waymo and Cruise, have been deployed for ride-sharing and testing. However, as of October 24, 2023, Cruise has been suspended from testing and deployment by the California DMV due to its performance being deemed unsafe for public operation (CA DMV, 2023).

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