Platooning Campus Vehicles in an Effort of Accessible Transportation

Social Ramifications of Safety Issues in Current Autonomous Vehicles

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction: Autonomous Vehicles as They Drive Today

The creation and usage of autonomous vehicles has risen in the past decade, and continues to rise as technology advances. Companies such as Tesla have an auto-pilot feature in their cars that allows the driver to relax control of the wheel and pedals (Pritchard, 2022). In order for this feature to work, it has to be able to create a safe driving experience. An embedded autonomous system acts as a brain, checking the surroundings and the road at all times to detect the location of cars and hazards. A fully autonomous vehicle has yet to be made, as there are many safety concerns with current designs (NHTSA, 2022).

The technical project I am working on is the implementation of several platooning campus vehicles that follow a leader cart. The leader cart will be driven manually, and the follower carts will hold passengers, moving autonomously behind the leader cart, which is known as platooning. The final plan of the project is to have a demonstration of the carts driving passengers around the university to raise awareness for the project and get people excited for future innovation.

My STS project will center around the current safety issues that are present in autonomous vehicles and the social ramifications. There are reports of crashes in vehicles such as Tesla that only support a fraction of autonomy, still requiring a driver to keep a watchful eye and continuously hold onto the steering wheel (Tesla, 2019). This feature is also recommended for limited use on highways, only when the road is mostly clear and with good weather conditions. In these regards, these vehicles are still a long way from full autonomy, and the levels they do have require careful attention and are not guaranteed to be safe. Because of this and reports of accidents, many people are concerned with the risk of driverless cars. Dangerous situations can also be created through misuse and underdevelopment (Press, 2022).

If society wishes to advance technology in this field, it has to prove that safety can be ensured and is an improvement to the levels of safety presented in real world statistics. With this in mind I seek to answer one question: what are the current safety issues involved in autonomous vehicles. This question will bring into focus the main concerns and will help build a roadmap to a new future of transportation. Even if a person does not own an autonomous vehicle, they are at risk of a related accident. Understanding this and the main ways an accident can occur will better prepare developers.

The technical and STS project are very closely related. If we wish to have a new form of semi-autonomous transportation on grounds at the university, people have to feel comfortable enough to ride in it and be around it. It is possible that people may choose to walk between follower carts when crossing the street. If there is no safety system installed on the follower carts that can detect objects moving in front of them and stop in enough time to avoid an accident, the technology will be unsafe for normal use. With the inclusion of a new system of transportation, there will be changes in traffic and how people will get to class.

In this prospectus, I will discuss my technical project in more depth, explaining the work that has already been done, and what needs to be worked on in order to make the carts safe and able to transport passengers. I will then discuss my STS project, and its importance as well as who is involved in the progression of autonomous vehicle safety.

Technical Project: From a Golf Cart to a Campus Vehicle

The main focus of the technical project is to create a reliable transportation system with the hope of someday providing a quick and effective mode of transport for people with disabilities or injuries that have a hard time commuting on grounds. Club Car, a golf cart company, provided the university with several golf carts over the years. From this, previous students have worked on the carts, modifying them. The original goal was to create a fully autonomous cart that used an array of sensors to generate a map of the road so it could travel. This goal is still unfulfilled. Over the extent of the project, the focus has shifted to incorporate the idea of platooning as opposed to full autonomy. This option is more viable, and would allow a quicker release to the public.

With this previous knowledge in mind, a note of the current state of the carts is made. There is only one cart that is able to drive, the leader cart. This cart still has some exposed wiring and internal parts that need to be covered, and it needs to be tested to make sure it is functioning the way that it should. There are two follower carts, one with more work completed, but both are in need of new parts and controls. The followers will trail behind the leader cart by using cameras reading a QR code from the leader cart. This means that the cameras and other sensors need to be added and tested to ensure they can accurately measure the distance between them and the leader. They will also be sent information over a wireless signal from the leader cart that will provide the speed they need to travel and how they should turn. Code will need to be developed so that there is a delay between each cart turning around a corner, as well as when they accelerate or brake.

In order for the signals sent from the leader cart to work, we must also add motors and some sort of connection between the motor and the wheel as well as the brake pad so that the follower carts have a way to mechanically control their motion with a digital signal. Arduinos and other computer chips will be needed to receive the control signal and translate it into an analog output so the motors can function properly. Emergency stop buttons will also need to be added so that if an accident is about to occur, the passengers have a way to stop the vehicle. In addition, the brake pedal on the follower cart must also still function when pressed down so that if the cart loses electrical function, it can still break manually. Once these additions have been made, the cart will be rigorously tested: first around the lab area, but then on side roads that have little to no average traffic. With these tests, we can tweak slow responses and ensure that safety is prioritized.

The final product will be one that can drive over hilly terrain and has an adequate battery life so that it can run a whole day without charging. Since the cart is smaller than a normal car, it will also have increased maneuverability. This will let the cart get closer to entrances and allow for easier passenger pickup and drop off. Future teams will also be able to add on to the chain of follower carts and extend the efforts of the project. In addition, they can add systems with improved reliability that will continue to increase the safety of the carts.

STS Project: Safety Issues as a result of Autonomous Systems

For this prospectus, I am examining the safety of autonomous passenger vehicles. To research this, I am asking the question: What are the current safety issues involved in autonomous vehicles? This will directly position me to answer what future concerns should be planned for and avoided with the creation of new systems.

This topic as a whole is very important to the future of transportation. As we progress in making smarter computers that can handle a wide array of tasks, we replace the need for human interaction. In cars today, many systems are automated like ABS (Automatic braking system) or even headlights to create a higher level of safety. These systems can also cause harm if they are not properly created or implemented. Therefore, new autonomous vehicles have to be carefully created and rigorously tested in order to fulfill the demand for safety that is placed on them, especially as they grow in popularity. Understanding the safety concerns can allow us to design new systems that will fix the current problems.

The main relevant group is the users of the vehicles. At first, these will be people in upper class situations that can afford the cost of an autonomous vehicle. As time moves on, and the cost decreases, more people will be inclined to purchase one. In particular, people that have held a job for a longer number of years and have the money saved are more likely to buy such a vehicle, placing the age range at a higher age. Car and large tech companies will also be big social groups. Specifically, Tesla or Google, who already have claims in semi-autonomous cars and systems, will put large amounts of money and time into perfecting their existing technology. The U.S. government will also be relevant as more regulations are placed on autonomous vehicles to define where they are allowed to drive, and who is responsible in accidents involving them.

The implementation of these vehicles on the road will mean the inevitability of crashes, as no mode of transportation can be completely safe. Therefore, anyone in the street will be relevant, whether it be pedestrians, cyclists, or other drivers. It is not reasonable to include this group as the number involved is too large, and while they are important to discuss in terms of safety, they do not hold the responsibility of the vehicle as the driver or the creator would. The consideration of relevant social groups is important because it allows one to focus on specific people, allowing for detailed safety issues as opposed to broad generalizations.

I will mainly use the actor-network framework. This framework seeks to organize technology and its connections to social groups through the use of actors (social groups or technologies) and networks (the web that connects actors). I will be able to label the transportation system as a network, and compare the main actors (vehicles, drivers, those involved in accidents) that affect the network. Looking at a technology in a purely engineering or mechanical mindset gives a picture of how that technology is made or how its different parts interact, but it does nothing to describe its purpose in society. In order to truly understand the effect of a design, it must be viewed in context with how it is actually used. Otherwise, half of the picture is missing. With this in mind, an STS framework will allow me to truly see how autonomous vehicles change the transportation system. It will show the interactions of actors in accidents: how pedestrians become involved and how the car is at fault for not detecting them. It is also possible to redescribe the network as something smaller, such as roads in a suburb or a city, and then redefining the actors to follow this network. An even more specific focus can then be created.

The framework of technological momentum can also be used. Technological momentum discusses the stages a technology goes through: invention, development, innovation, transfer and growth, competition, and consolidation (Hughes, SCOT, p. 95). It asserts that it must go through these stages before it is accepted by society. Once accepted, the technology is rooted and hard to replace. Autonomous modes of transportation are still being invented, with autonomous cars in development and innovation stages. By looking at this framework, it can be seen that there are still several stages to go before the technology can be accepted by society. This means that there are concerns and apprehension towards the idea. Therefore, by analyzing the stages that autonomous vehicles are currently in, reasons as to why people have not accepted the technology can be found, and a case can be made as to the link between them. Similar to actor-network theory, a link is discovered between technology and society.

This research will occur over the next semester. I have done preliminary research, but I will read more articles to determine common safety issues and compile a list so that I can better report on them. Articles will be the main method to gather information, as the field of autonomy is still growing, and many of the issues listed will come from tests done by designers. Articles can also be used to understand concerns shared by people, as well as what knowledge is known and common misconceptions. Surveys conducted by me and others will also give insight into how comfortable people are with autonomous vehicles, highlighting social acceptance.

Key Texts

Synthesis of Autonomous Vehicle Guideline for Public Road-Testing Sustainability by Abu Bakar et al. provides a general overview of regulations set on autonomous vehicles in different countries. It lists the guidelines for public road testing, and also discusses the differences. These differences involve safety issues such as cybersecurity threats, vehicle safety, and registration of the vehicle. This article is helpful as it gives consideration to the array of safety methods that have been implemented by certain countries. It ties in the technology to social expectations of different countries. This is important for many reasons, one of which being that cars manufactured in certain parts of the world will be sent to other countries. If regulations are not the same, safety concerns can arise, and potential accidents could occur. Therefore, this is important to learn about and understand the effect it can have on safety.

The study conducted by Kim et al., Determinants of personal concern about Autonomous Vehicles, is helpful to this prospectus as it gives an insight on the main issues people hold over autonomous vehicles. Several concerns include the reactions cars may have in different environments, the overall security of these vehicles, and who is liable when an accident occurs. It also sorts the data out through age ranges, which gives another level of results and a clearer representation of what part of society feels more concerned by this technology. This helps me because surveys create a direct connection to how people feel. It is possible to come up with concerns based on my own intuition and general observation, however a survey presents definite information, and seeks to do so in an unbiased way.

As an example of a specific technology that can be used for pedestrian detection, the work by Zhang et al. on ST CrossingPose can be referenced. This article discusses a network created to determine whether a person plans to cross in front of a vehicle. It creates a skeleton frame around a person, meaning a very minimal mesh is created to model the person as a simple object. With this being said, the technology is still able to detect the intent of a pedestrian with a

few failures. This ability demonstrates a basic yet essential function that autonomous cars need in order to prevent accidents. This research is important to the prospectus, as pedestrians are one of the biggest safety concerns. People walking across streets is very unpredictable, especially when jaywalking. Therefore, this is a very big safety issue currently. This research provides a specific example of the imperfect technology in use, and will help show a need for further improvement.

Lastly, a literature review on current artificial intelligence methods by Nascimento et al. will be helpful. It provides an overview of current AI technologies and how they are correlated to the safety of autonomous vehicles. Current vehicles rely on the driver to be alert of potential danger in order to stay safe. Autonomous vehicles remove the driver, and must have some form of intelligence to interpret signals from sensors that can avoid potential hazards. This review will give a good jumping point for me to find a more specific AI system that I can focus on. With this, I can highlight current safety issues and how that can potentially affect society. AI is a growing field of study, and it is very important to the future of autonomy.

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