Analyzing the Dangers and Ethical Concerns of Autonomous Vehicles

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Emma Dalkin

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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

Signature _____ Date _____

Emma Dalkin

STS Advisor: Richard D. Jacques, Ph.D., Department of Engineering & Society

Introduction

Self-driving cars are on the move and are most likely to take over the roads in the near future. People can now have their food and groceries delivered by a self-driven car or robot and can even be taken places by companies such as Uber or Lyft in a vehicle without a human driver. Other sectors besides transportation including agriculture, mining, construction, and military/defense are also using autonomous technology such as drones to assist in areas that often require human labor; however, most of the sectors outside of transportation do not pose a large threat to human safety.

With extensive improvements in technology and the increasing use of AI, the role of human decision making, responsibility, and accountability is decreasing. This is a huge factor in the implementation of autonomous vehicles (AVs). Although AVs aim to increase road safety by helping to reduce the number of road accidents, decreasing traffic congestion, and improving transportation efficiency, there are still many concerns hindering implementation. A problem that comes to mind is the ethical trolley experiment in which the trolley driver must decide whether to save its occupants inside the trolley or the pedestrians on the track in the case of an unavoidable accident. Similarly, AVs may have to make these types of ethical and moral decisions on the roads. AI and other types of technology being utilized in AVs may be smart enough to solve logical and math-based problems, but they lack the human judgment necessary to make ethical and moral based decisions.

Whether people choose to use AVs for transportation, delivery services, or other means to make their lives easier, AVs will no doubt affect millions of people. Because of the large-scale impact of this new technology, it is necessary to implement ways to ensure their safety and effectively evaluate their performance. Furthermore, there needs to be a way to establish

communication among every system working together within the vehicle including the AI decision making algorithms, steering system, and sensor systems. The best method to evaluate autonomous vehicles and their decision-making process is through autonomous driving simulators. These simulators are able to test different environments, driving conditions, and driving scenarios to see how an autonomous car would react. Furthermore, if a car gives a "bad" reaction and causes an accident, or makes a decision that could potentially endanger people, no one will actually be injured or put at risk when testing with a simulator. Additionally, analyzing wrong or bad decisions will help to determine where improvements need to be made and the AI algorithms need to be adjusted.

Designing AVs to overcome critical ethical concerns and to reliably make decisions is essential to their full implementation into society. Moreover, their safety and trust cannot be surged. The goal of this research is to analyze the safety and reliability concerns associated with autonomous vehicles in order for self-driving cars to perform at the highest level of safety. Furthermore, this research will determine how driving simulators can be utilized to achieve this level of safety and ensure that AVs can be trusted enough to be widely used.

Literature Review

Autonomous vehicles and autonomous machines have been a long time coming. AVs were first introduced in 1925 by Francis Houdina (Tomorrow's World Today, 2021). Houdina demonstrated a radio-controlled car that could start its engine and shift gears without a driver behind the wheel. However, this idea was shut down when the operator of the vehicle lost control and crashed into another vehicle. Houdina's project provided a glimpse into the future of autonomy, but it also alluded to some of the potential dangers of AVs. Furthermore, in 1939 General Motors proposed an electric vehicle that was guided by electromagnetic fields generated

by metal spikes embedded into the road (Gringer, 2018). Although this proposition never launched, it did provide insight into the possible technology that could be used to provide autonomy. Moving farther into the future, numerous car companies today have started implementing driverless technology into their vehicles such as cruise control, blind spot warnings, and emergency brake systems. Companies such as Tesla, Mercedes, BMW, and Audi have deployed systems such as radar sensors, video cameras, Lidar sensors, and ultrasonic sensors to ensure that their systems are “better rule followers" than humans (Armstrong, 2018). Many car and tech companies believe that AVs have the potential to make roads safer so long as their systems can perform consistently and reliably. As of today, autonomous, and driverless features in vehicles suggest many of the possibilities for fully autonomous vehicles.

Autonomous driving has six levels as shown in Figure 1, where level 0 represents no automation and level 5 represents full autonomy. Right now, the newest cars stand at level 2 with partial automation by utilizing driverless technology. In the future, the goal is to have cars that reach level 5; however, it is crucial that vehicles are safe at each prior level before moving on to the next.

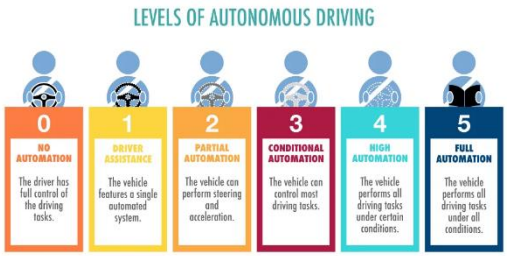

Figure 1

Some current tech companies that work with AVs include Waymo, Google, Zoox, Pony.AI, and Aurora. Most of these companies provide rideshare or delivery services and are now turning to AVs instead of human drivers. However, an Uber self-driving car killed a pedestrian in 2018 when the vehicle registered the pedestrian as a “false positive” (Field, 2018). The vehicle detected the pedestrian but decided to ignore them. As a result, Uber stopped their self-driving vehicles to allow time to perform more tests and research. This incident sheds light

on many concerns with AVs and how their decision-making algorithms are not always dependable. Other industries such as mining and agriculture have started using AVs for tedious or dangerous work that is normally done by humans. For example, autonomous tractors are now being developed to keep up with agricultural needs and allow the process of cultivating, plowing, and harvesting crops to be more efficient. A few other examples of autonomous vehicles or autonomous machines currently being developed with intentions to improve people's lives include autonomous drones for delivery services, autonomous surgical robots for healthcare purposes, small autonomous robotic vacuum cleaners, and autonomous cranes for construction.

Autonomous vehicles and machines are also portrayed in pop culture in movies such as Batman, WALL-E, and Interstellar. As early as 1966, movies such as Batman depicted self-driving cars. Batman's Batmobile was a remote-controlled car that could drive on its own to pick up Batman whenever he commanded it. In the futuristic movie WALL-E, self-driving hovercraft are used to take people from place to place. Lastly, the main character in Interstellar has an autonomous tactical robot who follows orders from the others, but it is also fully capable of making decisions and solving problems on its own (Acuna, 2015). Many sci-fi and futuristic movies or tv shows illustrate the potential of autonomous vehicles to influence people on a large platform.

Overall, autonomous vehicles are meant to benefit people's lives. From their first proposal in the early 1900s to their futuristic portrayals in movies, AVs have intended to make people's everyday lives easier. Despite some of the concerns associated with AVs, using proper testing and methods of analysis can help to ensure that their benefits far outweigh their risks.

Methodology

There are many different ways to evaluate autonomous vehicles and several methods have already been implemented. Various companies that aim to use AVs in the future have tried numerous techniques to examine self-driven vehicles based on their application. Data and results from these methods can be analyzed in order to determine the best approach to design a simulator that will accomplish our safety goals. Methods and existing technology that have been tested or used in the past include entertainment simulators, human factors simulators, engineering simulators, and real road autonomous driving simulators (RRADS). Entertainment simulators are mostly used for gaming systems on a desktop and are commonly used in commercial applications such as amusement parks. These simulators have a mock cockpit and motion system, but they generally just provide a visual feel for driving. Typically, entertainment simulators have good graphics which is important to make the driving environment realistic. Human factor simulators more closely resemble real driving experiences by utilizing a motion and visual system that work simultaneously to create virtual scenarios. These simulators are often used to measure human behavior and response. Additionally, engineering simulators are similar to human factor simulators except they measure driver or vehicle performance rather than driver behavior. They are often lightweight machines with screen graphics. An engineering simulator was the type of simulator used for this research. Lastly, RRADS are used to reveal how an autonomous vehicle feels when riding as a passenger. These are vehicles driven by a real human, but there is a partition between the driver and the passenger so that the passenger cannot see the driver. This provides a more realistic idea of a self-driven vehicle by giving the sensation of riding in a vehicle in which the passenger does not see or interact with the driver and does not have any control over the vehicle.

Overall, the uses of these simulators can all be incorporated into our research in order to provide us with the best results. Furthermore, clear graphics from an entertainment simulator can be implemented into our project to provide realistic visuals. Data analysis techniques from human factor simulators and engineering simulators can be implemented to examine how people would react in different driving scenarios, environments, and conditions. Finally, our research will only involve a driving simulator and will not include any real road vehicles; however, our aim is to provide the same feeling as an RRADS with the successful implementation of various hardware, software, and mechanical modifications to achieve full autonomy.

Discussion

Autonomous vehicles have the potential to provide numerous benefits to people's lives. To start, AVs will provide more accessible and cheaper modes of transportation, reduce the number of car accidents by eliminating human error, and they will provide new job opportunities. However, many people only look towards the obstacles AVs will face or the concerns that surround them. Although there are some bumps in the road that AVs will have to overcome, the advantages of AVs cannot be ignored once these issues are resolved.

The largest concern surrounding AVs is the algorithms and software that will be implemented to allow cars to make driving decisions in place of a human. As mentioned before with the Uber self-driving car, these algorithms can make mistakes. These algorithms must be consistent given the same scenario repeatedly and must also be able to make decisions in a variety of scenarios given different road and weather conditions, distinct levels of pedestrian traffic, and must be able to handle a variety of other types of obstacles or drivers on the road. Furthermore, the software installed for AVs must be secure. The new technology cannot be easily hacked or tampered with; it is critical that AVs are secure enough that they cannot be

taken over by foreign sources. It is imperative that AVs not only provide safety for their passengers but are also secure enough to maintain their safety.

Another obstacle faced when implementing AVs into society is the substantial number of technological advancements they require. In order for AVs to function at the highest level of safety and to actually prove to be beneficial, every system of the vehicle must work and communicate together efficiently. This includes sensor technology, coding, algorithms, steering and braking systems, and all other systems of a vehicle that already exist. Despite the time that is needed to develop these systems and assess their performance, their success will provide an entire new level of road safety by minimizing a substantial portion of human driving mistakes.

Similarly, new road infrastructure will be needed to allow AVs to communicate with each other. This will make transportation more efficient in heavily congested areas such as cities and urban environments and will also decrease traffic during busy times such as rush hour. Additionally, proper road infrastructure can allow emergency vehicles to get to their destinations faster by controlling traffic lights and communicating with other AVs to move out of their way. Package and food delivery services along with rideshare services will also become more efficient with improved traffic management and communication infrastructure.

Autonomous vehicles will most likely alter the job availability in the transportation sector by initially reducing jobs that require people such as bus driver, ride share drivers, or delivery drivers; however, they will provide new job opportunities to a vast number of people. Eventually, they will open up job opportunities in sectors such as vehicle manufacturing, software development, road construction and infrastructure, and numerous other AV related services. Also, AVs have the potential to reduce transportation costs, therefore enabling people

to get to and from their everyday jobs by providing a lower cost than how much they currently pay for public transportation or a lower cost than what they would normally pay for gas.

Overall, self-driving cars will bring a lot of change and may result in some initial and temporary drawbacks. However, the benefits far outweigh the drawbacks. Additionally, with a lot of change comes the need for acceptance. The implementation of AVs will not move forward without people accepting them and seeing their benefits and therefore their need. Further, regulations and legislation allowing self-driving cars will not be passed until people deem AVs as safe and accept that they are the future of transportation. Acceptance of AVs will only grow through the application of testing and research to ensure their safety, dependability, and consistency.

Conclusion

Self-driven vehicles will surely hit the roads soon, as some already have. However, AVs that more directly impact people's lives and are implemented for everyday use may still have a long time to go and much testing to do before becoming a societal norm. A major challenge is that the criterion for safety varies between families, businesses, and cultures. Similarly, everyone has different morals or ethical principles that they follow. Therefore, deciding what decision a vehicle should make in certain situations will vary by person. So, who is to determine when AVs are safe enough for everyday use? Should it be the manufacturers, the coders and engineers, or the consumers?

As history has seen with incidents such as the Challenger explosion in 1986, safety is a top priority and is not something that can be overlooked. AVs should not become available for

everyday use until their safety needs are met and their limitations are fully understood. Furthermore, the use of self-driven vehicles cannot be rushed. Taking the time to correctly ensure their reliability rather than urgently developing them will reduce their safety concerns and minimize the risk of incorrect human use or machine functioning. The best way to do this is through testing and research. Passing legislation for the allowance of AVs is another major obstacle. Due to safety concerns, laws and legislation regarding AVs can take extensive periods of time to pass. Some states, such as California, have more lenient legislation regarding AVs and their use for the public. As a result, many companies such as Waymo, Zoox, and Aurora are based out of California. However, these companies have a much higher risk with the public use of their vehicles. With the power and luxury of being some of the only publicly available autonomous vehicle services comes major responsibility.

Without a doubt, AVs will change people's lives. Despite the concerns, the advantages to the full implementation of safe AVs will drastically improve numerous aspects of people's everyday lives. Primarily, they will improve road safety by reducing human error. Roughly 1.3 million people are involved in car accidents each year, and AVs could help to reduce this number by eliminating imperfect human driving (Redmond, 2021). Additionally, AVs will make public transportation more efficient and accessible. Especially for people with disabilities that prevent them from being able to drive, they will now have access to a safe mode of transportation. Furthermore, there will be less traffic congestion once AVs are able to communicate with each other and with traffic infrastructure. Lastly, many jobs such as food and package delivery or ride share services will be more efficient and more available as an AV can be used at any time of day whereas delivery or rideshare drivers often need breaks during the day and at night.

In conclusion, autonomous vehicles will change the future of driving. Currently, AVs have a lot of safety concerns and are not reliable enough for their full implementation into society. Consequently, driving simulators are a great solution to recognizing and improving areas of safety without putting lives at risk. Autonomous driving simulators are an ideal tool to test the functioning and consistency of multiple systems that will be working simultaneously in an AV and to analyze how these systems respond to different driving conditions or make decisions in given scenarios. Driving simulators provide an approach that ensures AVs are fully reliable and meet society's needs and expectations without compromising the safety of those who use them. Further, they offer a method of testing that can be done in a controlled environment. Most problems posed by AVs can be recognized early on through the use of driving simulators. Moreover, ethical challenges posed by AVs and the use of their decision-making algorithms can be more easily studied and addressed on a simulator. Ultimately, it is unclear how soon in the future autonomous vehicles will hit the roads, but it is clear that methods exist to ensure their highest level of safety and dependability.

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