Artificial Intelligence in Autonomous Vehicles.

Persuasive Paper.

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CMPT 105W: Soc. Issues & Cmns. Strategies

April 4, 2025

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Every year, over 1.19 million people lose their lives in road traffic accidents all over the world (World Health Organization [WHO], 2023, p. 4-5). According to a study conducted by the National Highway Traffic Safety Administration (NHTSA, 2021, p. 5) in the United States, nearly 94% of these fatal incidents are caused by human error, demonstrating just how influential human behavior is when it comes to road safety. Speeding, reckless driving, as well as operating a vehicle under the influence of alcohol or while experiencing fatigue or sleepiness, are often recognized as the primary causes behind the most severe traffic accidents. Although strict regulations and heavy penalties have been effective in reducing the overall number of accidents to some extent, these measures are not enough to completely eliminate the risks caused by human error (NHTSA, 2021, p. 8). The influence of human behavior on driving remains significant, as previous trends have shown, and a lot of studies have affirmed. This evidence suggests that, despite all efforts, laws and regulations alone are unlikely to bring a major change to this problem.

The concept of autonomous vehicles (AVs), which are equipped with a variety of advanced sensors and technologies, relies on artificial intelligence to enable the vehicles to navigate and make decisions with almost no external intervention (Yusuf Syed et al., 2024, p. 1-2; Mankodiya et al., 2022, p. 1). By continuously observing their surroundings and adapting to changing conditions, these vehicles have the

potential to significantly reduce the number of traffic accidents caused by human error. Furthermore, the general use of such cars could lead to a reduction in traffic congestion, as these vehicles can share information with one another and optimize routes in real-time (Zheng et al., 2023, p. 1). This work aims to inform and persuade not only students in the field of computer science, but also policymakers, technology developers, and the general public who may be skeptical about the industry of autonomous vehicles. In this paper we will argue that AI-powered autonomous vehicles show great promise for the future of transportation, particularly in improving safety, reducing environmental impact, and offering economic efficiencies. By addressing concerns such as ethical dilemmas, technical challenges, and public skepticism, we can argue with those who consider autonomous vehicles unsafe, and consequently, create a path toward a transportation system that is safer and more efficient.

Overview of Autonomous Vehicles

Autonomous vehicles, or self-driving cars, are vehicles that can move and operate without human intervention. They are equipped with artificial intelligence, sensors, cameras, radars and lidars to sense the environment, make decisions and control movement (Omeiza et al., 2022, p. 10142; Yanase et al., 2022, p. 2). The idea of self-driving cars appeared back in the 1920s, but serious progress began in the 1980s with research by Navlab at Carnegie Mellon University (Pomerleau, 1997,

p. 54). In the 2000s, Google (now Waymo) and Tesla pioneered the idea of modern autonomous driving systems.

Currently, self-driving cars are displayed in ranks from 0 to 5, depending on the degree of autonomy (SAE International, 2021). Most new models fall on the 2 or 3 level, where partial control by the human is necessary. Fully autonomous cars (level 5) are still in development stages. Companies like Waymo, Tesla and Cruise are testing autonomous vehicles in controlled environments but concerns over safety and regulation remain central challenges. Despite this, autonomous vehicles have enormous potential.

Safety Benefits of AI in Autonomous Vehicles

Many people have the feeling that if there is no human intervention, then something can definitely go wrong, and therefore many do not trust the work of AI in AVs. In fact, as studies of Zheng et al. (2023) show, in addition to the fact that autonomy makes driving both much easier and more enjoyable, it is also much safer. With the ability to process vast amounts of data in real-time, self-driving vehicles are able to make faster and more precise decisions than human drivers, offering a promising solution to improving road security (Shladover, 2018, p. 54). Referring to Tesla's Safety Report (Figure 1), which shows the number of miles driven before an accident occurred in 2023 and 2024, it is evident that cars using Autopilot, on

average, traveled 5-6 times farther without an accident compared to those not using it (Tesla, 2024).

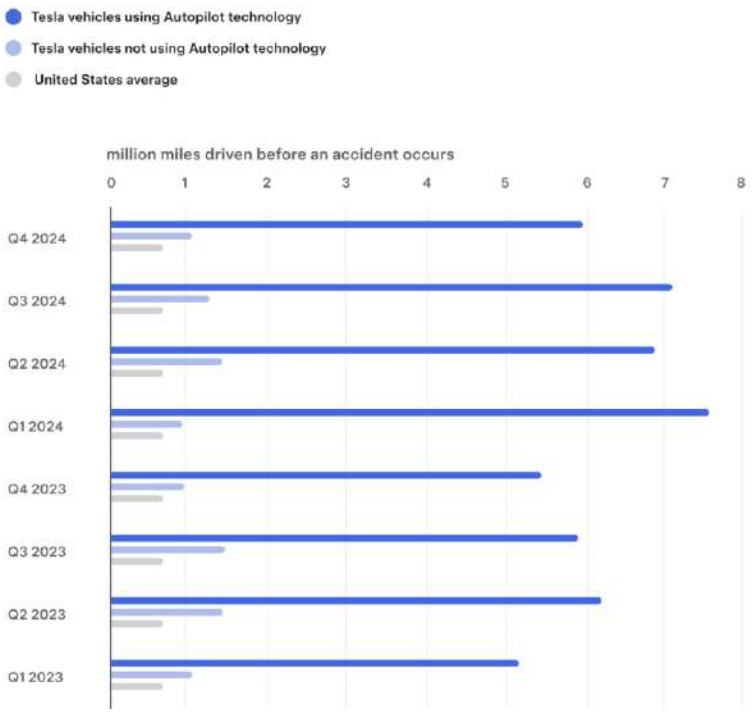

Figure 1.

And this seems obvious, as human drivers may be affected by a range of factors, including inattention, distraction, drowsiness, and the negative effects of substances such as alcohol or drugs, all of which can significantly reduce a driver's ability to maintain concentration and focus on the road (NHTSA, 2021, p. 39-52, 67-69). Consequently, these conditions can play a major role in determining a driver's capability to drive safely. In contrast, an autonomous vehicle, relying on a broad array of sensors and artificial intelligence systems, is always attentive and responsive (Mankodiya et al., 2022, p. 7-9). The vehicle's systems continuously monitor the

surrounding environment, processing data within fractions of a second (Shivam, 2023, p. 211-213). Using advanced machine learning algorithms, founded on vast databases and previous experience, the vehicle can identify the type of objects in its vicinity, calculate the distance to them, detect potential obstacles, and predict the behavior of pedestrians and other objects with a high degree of accuracy (Shivam, 2023, p. 213; Singh, 2023, p. 3304). However, while these systems work perfectly only under well understood, close to ideal conditions, their performance may be impaired in situations that differ from typical patterns. For instance, during inclement weather conditions such as dense rain, snow, or mist, the sensors may struggle to accurately process environmental data, leading to errors in decision-making (Fridman et al., 2019, p. 2851). As a result, the system could make incorrect judgments, and in some situations, these errors could have catastrophic outcomes, underlining the limitations of current autonomous technology.

Despite all these technological failures, progress continues to move forward at a rapid pace, with technology evolving faster than ever before. Machine learning and sensor fusion technologies, which are a foundation of artificial intelligence systems, are continuously improving (Hasanujjaman et al., 2023, p. 1; Shivam, 2023, p. 215). These developments are contributing to the capabilities of autonomous vehicles, allowing them to better understand and handle complex situations more effectively, making them more reliable and efficient in the long term. But even today, self-driving cars have safety performance that is several times better than that of human

drivers (Shladover, 2018, p. 54). As technology progresses, the gap between human and autonomous driving performance is expected to widen in the future, with autonomous vehicles becoming increasingly reliable and safer than their human-operated systems. According to Tesla's reports (Tesla, 2024), there was one accident for every 4.41 million miles driven with Autopilot engaged in 2020, compared to one accident for every 500,000 miles driven by human drivers.

Reduction of Traffic Congestion and Environmental Benefits

Autonomous vehicles have the potential to improve traffic conditions by reducing congestion and minimizing road conflicts (Levin et al., 2015, p. 29). Thanks to artificial intelligence, they can independently select and create optimal routes. They consciously adhere to traffic rules, never exceeding speed limits and strictly following road markings and signs, making them not only much safer but also significantly reducing the number of accidents (Fagnant et al., 2015, pp. 172-173). Due to the wide-scale adoption of 5G technology, autonomous cars are able to share information virtually in an instant (Bagheri et al., 2021, pp. 52-53; Sperling, 2018, p. 91). Therefore, for example, if there is an accident on a specific stretch of the road, the vehicle would already know about it in advance and could divert onto a quicker route. Also, such continuous connectivity makes it feasible to track the number of cars in different courses so that the vehicle can choose the most optimal

path. Research of Levin et al. has shown that even a minute percentage of self-driving cars on the road would reduce traffic congestion by up to 40% (2015, p. 32).

Moreover, most autonomous vehicles are either fully electric or hybrid, and that is they very friendly to the environment since they produce less harmful emissions. Such vehicles do not release toxic metals, helping to improve air quality and reduce pollution, which in turn means reduced global warming. This shift toward utilizing electric and hybrid cars not only promotes cleaner air but also reduces fossil fuel dependency and thus reduces transportation's environmental footprint (Sperling, 2018, p. 89).

However, there are arguments that the development and convenience of autonomous vehicles might lead to the increased numbers of cars on the roads, creating even more congestion in the traffic (Levin et al., 2015, pp. 29-30). Contrariwise, the number of vehicles on the roads continues to grow yearly either way irrespective of the rise of autonomous drive technology. Therefore, it would be better to have a higher proportion of eco-friendly automobiles because this would supposedly reduce the negative impact from increased traffic.

Additionally, autonomous vehicles can be programmed to use energy as efficiently as possible, and the continued use of electric vehicles will decrease emissions even more (Sperling, 2018, pp. 89-90). Reduced traffic congestion associated with autonomous vehicles will result in travel time and fuel consumption

decreasing, even when the number of vehicles is on the rise. Overall environmental impacts of AVs are expected to be positive, especially when renewable energy sources are becoming more prevalent.

Economic and Social Benefits

From the said above, it can be concluded that the global adoption of autonomous vehicles will be beneficial, not only from an environmental perspective but also economically. Thanks to optimized routes and strict adherence to traffic rules, less fuel will be consumed, and since most AVs are electric, there will be no need to rely on gasoline, as electricity is much cheaper. Additionally, the need for human drivers will disappear, making transportation and mobility cheaper and, as a result, more accessible (Sperling, 2018, pp. 85-89). Moreover, these vehicles will assist people with disabilities, the elderly, or individuals with physical limitations to travel without the need for assistance, ultimately improving their quality of life.

Addressing Ethical and Technical Challenges

Despite the proven safety of autonomous vehicles and the significantly lower number of accidents involving them compared to human-driven cars, every incident involving artificial intelligence is likely to receive widespread media coverage (Fleetwood, 2017, p. 534). Such attention not only undermines public confidence in the industry but also fuels skepticism toward the adoption of these technologies. According to surveys conducted among drivers in the United States *(Figure 2)*, more

than 55% of respondents express concerns about the presence of autonomous vehicles on the roads, while around 30% remain uncertain about their safety. Moreover, as Hudson et al. note (2019) these numbers continue to grow, reflecting increasing public skepticism and hesitation toward the global adoption of self-driving technologies (p. 165). While it is true that the technology has not yet reached perfection, in most cases and under the majority of circumstances, autonomous systems are already capable of performing more accurately and safely than human drivers (Shladover, 2016, p. 55).

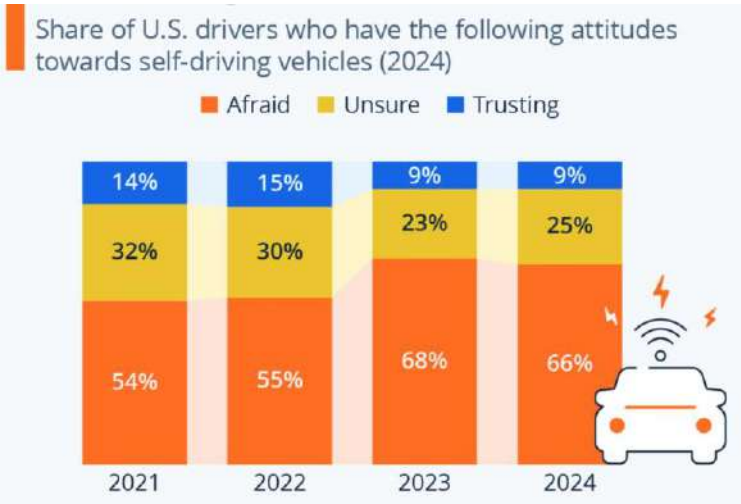

Figure 2.

For example, in poor weather conditions, sensors may struggle to accurately read environmental data, misidentify objects, or face challenges in assessing the surroundings. Similarly, in complex traffic situations where pedestrians, animals, or other drivers behave unpredictably, the system may encounter difficulties in making precise decisions (Zheng et al., 2023, pp. 14-17). However, even in these challenging

scenarios, autonomous systems are capable of performing just as well as human drivers — and often even better. Unlike humans, who are prone to distractions, fatigue, emotional reactions, or delayed responses, autonomous systems remain fully focused and react within milliseconds (Waymo, 2024). As a result, their decisions in critical situations tend to be more consistent and less influenced by the errors or irrational behavior that frequently lead to accidents caused by human drivers.

On the other hand, autonomous vehicles raise a number of ethical issues that are still the subject of debate. Fleetwood (2017) notes that one of the main issues remains the situation in which the vehicle must choose between two unfavorable outcomes (p. 534). For instance, if an accident is imminent, should the AI sacrifice the pedestrian's life to save the passengers, or vice versa? Hudson et al. (2019) also note the following issues:

• Responsibility for decisions (p. 170) — Who should be responsible for the decisions made by AI? Car manufacturer, algorithm developer, or vehicle owner?

• The value of human life (p. 168) — How should AI assess the value of life in critical situations? For example, should it take into account age, social status, or the number of people involved in an accident?

Additionally, AVs generate and process vast amounts of data, raising concerns about privacy and cybersecurity. Ensuring the security of AI systems is critical to prevent hacking and unauthorized access to sensitive information (Badue et al., 2021,

p. 14). These questions do not clear distinct answers, making them one of the most controversial areas in the development of autonomous cars.

Conclusion

To conclude, the future of autonomous vehicles looks promising. With the technology advancing, and AI algorithms being improved, we can expect AVs to be more comfortable, safe and affordable. Technologies like 5G connectivity or quantum computing will ensure faster data processing, thus improved decision-making (Bagheri et al., 2021, p. 53). By eliminating the human factor, which is prone to distraction, emotions, fatigue, and other forms of errors, autonomous technologies help eliminate the risks that are typically associated with human driving behaviors (Zheng et al., 2023, p. 2). In doing so, they are capable of significantly lowering the number of fatal accidents on the road. Moreover, the extensive use of autonomous vehicles has the potential to create a safer, more efficient, and more comfortable transportation system, with streamlined traffic flows and improved overall road safety for everyone (Chen et al., 2020, p. 4965). Already nowadays, manufacturers like Tesla or Waymo are actively testing and applying autonomous technologies. Artificial intelligence is at the center of self-driven vehicles, allowing them to perceive the environment, make decisions, and move safely without any human intervention. Despite existing challenges being experienced such as technical

difficulties, ethical and regulatory issues, autonomous cars have a great potential in improving the safety and efficiency of transport.

If current challenges are addressed, AVs could become a regular part of everyday transportation — offering improvements in safety, efficiency, and accessibility. However, in order for this to become a reality, significant investments need to be made in the research of this field, with particular emphasis on the development of artificial intelligence technologies (Badue et al., 2021, pp. 21-22). Instead of putting restrictions and regulations that are harmful for the development and only serve to increase public distrust, governments should focus on supporting these advancements through grants, providing job opportunities, and encouraging innovation. It is only through the collaboration of efforts on the part of all sectors, including government institutions, industry, and society as a whole, that we can achieve a significantly safer, more reliable, and more comfortable transportation system for everyone.

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