

ASSIGNMENT COVER PAGE



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Self-Driving Cars – Technology, Ethical and Legal Issues

Part 1: Introduction

1.1 What are they?

Self-driving or Autonomous vehicles are cars or trucks in which human drivers are not required to take complete control to operate the vehicle. These vehicles generally use various sensors, and processors integrated with specialized software and programming paradigms like machine learning and artificial intelligence to enable the automation of driving.

According to (How Do Autonomous Cars Work?) Often researchers categorize self-driving cars based on their capabilities into 5 levels. They include:

- Level 0: All major systems are controlled by humans.
- Level 1: Certain systems, such as cruise control or automatic braking, may be controlled by the car, one at a time.
- Level 2: The car offers at least two simultaneous automated functions, like acceleration and steering, but requires humans for safe operation.
- Level 3: The car can manage all safety-critical functions under certain conditions, but the driver is expected to take over when alerted.
- Level 4: The car is fully autonomous in some driving scenarios, though not all.
- Level 5: The car is completely capable of self-driving in every situation.

1.2 How do they work?

According to (How Do Autonomous Cars Work?) the basic architecture of a self-driving car includes but is not limited to modules such as:

1. Sensors – Autonomous vehicles generally are equipped with a large array of sensors to gather data:
 - Radars are used to determine the distance, and velocity of objects.
 - LiDAR is used to gather 3D information and map the surroundings of the vehicle.
 - GPS and GNSS supply high-precision real-time geographic location information.
2. Computer Vision – It is the classification and identification of objects captured using cameras and sensors. The computer onboard is generally trained with a large dataset which provides precedence for the system to accurately identify and classify objects.

However, since datasets (large volumes of information) used for training cannot possibly cover all objects and scenarios, there exists some scope for misidentification or error which could also arise due to bias in selecting the dataset often termed selection bias.

3. AI systems and algorithms are used for making decisions based on data input from the sensors and controlling the vehicle.

AI systems are often black boxes, i.e., the exact method or basis for their decisions might be transparent or perceptible.

1.3 Why do we need them?

“Today, some 56% of the world’s population – 4.4 billion inhabitants – live in cities” (worldbank.org)

As a result of this concentration and population density, congestion of the roads leads to a rise in traffic, motor accidents, and vehicular emissions which affects\ the quality of life in urban areas (longer commutes, pollution, etc.)

Also driving in the present day poses a significant challenge to elderly individuals and persons with specific disabilities.

Autonomous vehicles can help alleviate these problems:

1. Self-driving cars can be programmed to travel at constant speeds and with the advent of IOT (Internet of things) and vehicle-to-vehicle communication technologies, vehicles can effectively communicate on road thus reducing bottlenecks and allowing for a smoother flow of traffic.
2. Research shows that 90 percent of crashes are caused by human error, and driver impairment. Hence eliminating the human element from the equation with the advancement of self-driving systems with very low failure/glitches could hypothetically reduce the number of motor accidents and make the roads safer. However, our current self-driving systems in production are far from perfect as shown by several crashes involving self-driving cars where the cause was attributed to software failures. Recently, A crash involving a Tesla in 2018 was reportedly due to a failure in its sensors. (Tesla Autopilot System Found Probably at Fault in 2018 Crash)
3. Self-driving cars often drive more smoothly and at a constant pace thus decreasing fuel consumption, thereby reducing vehicular emissions. A report by SWRI indicates that AVs can lead to as much as a 20% improvement in fuel consumption (SWRI report).
4. Self-driving cars can provide greater freedom and mobility for people with disabilities and elderly individuals who may be inhibited by traditional driving methods.

Part 2: Contemporary Issues – Self-driving cars:

Self-driving cars are autonomous vehicles that use a combination of sensors, cameras, and machine-learning algorithms to operate without human intervention. However, the technology is still in its early stages and several challenges need to be addressed before self-driving cars can become a reality. Self-driving cars are a promising technology that is still in the early stages of development and deployment. Several issues are evident in the development and deployment of self-driving cars, some of which include:

1. **Technical Challenges:** Self-driving cars rely on complex and sophisticated technology that is still being developed and improved. Challenges include accurately detecting and interpreting real-world data, handling complex driving scenarios, and ensuring the safety and reliability of autonomous systems.
2. **Regulation:** There are currently few clear regulations governing the development and deployment of self-driving cars. This lack of regulatory clarity can lead to inconsistencies in testing, deployment, and safety standards, and can also hinder the commercialization of the technology.
3. **Public Acceptance:** Many people are still wary of self-driving cars, and there are concerns about the safety, reliability, and ethical implications of the technology. Building public trust will be critical to the widespread adoption of self-driving cars.
4. **Cybersecurity:** Self-driving cars rely on connected systems and networks that are vulnerable to hacking and cyberattacks. Ensuring the security of these systems will be critical to the widespread adoption of self-driving cars.
5. **Liability and Insurance:** Determining who is responsible in the event of an accident involving a self-driving car remains a significant challenge. The development of new liability and insurance models will be necessary to support the commercialization of self-driving cars.
6. **Cost:** Self-driving cars are still very expensive, both in terms of development costs and consumer costs. The cost of the technology and its components must come down for self-driving cars to become accessible to a wider range of consumers.

Despite these challenges, the potential benefits of self-driving cars are substantial, including increased road safety, reduced traffic congestion, and improved mobility for elderly and disabled individuals.

Part 3: Legal considerations – self-driving cars

Level 0: No Automation.

Level 1: Assisted Driving Automation.

Level 2: Partial Automation.

Level 3: Conditional Automation.

Level 4: High Automation.

Level 5: Full Automation.

The Geneva Convention (1949) and the Vienna Convention on Road Traffic (1968) form the basis of road traffic laws in most countries. Under both conventions, it is assumed that a driver is in control of the vehicle. Therefore, the introduction of legislation for automated cars will require a new definition of “driver.” It is commonly accepted that driver error is a factor in over 90% of road traffic accident deaths and automation is expected to reduce the level of road deaths.

The various levels of automation (0-5) present different challenges. At level 2 automation and below the driver is always in control and therefore liable for any incidents, whereas at Level 3 the driver may be requested to take back control for a critical event. International legislative changes are needed to govern self-driving vehicles, but they must cover liability issues for all vehicles on the sliding scale from assisted driving automation (level 1) to full automation (level 5) (Teare, 2014).

The most problematic issues with Level 3 automation include transitions of control and modifications to driver training and licensing for managing a partially automated car. Driver consent to having control handed back where necessary is a particularly tricky issue. If a Driver is doing something else or distracted, there may be a lag in time to readiness for driving and it may be difficult for manufacturers to prove that a satisfactory transition of control has been agreed to via an in-car digital interface. For these reasons, car manufacturers may be considered liable for level 3 incidents and some manufacturers are therefore skipping level 3 altogether (Pattinson, Chen & Basu, 2020).

A Level 4 automation taxi service is currently offered by Waymo (a google brand) in Phoenix, Arizona, and San Francisco, California. At this level of automation, the passenger does not interact with the vehicle control system and does not need to know how to drive (Waymo, 2023). At level 4 automation, the vehicle is geo-fenced (I.e., it can only drive in pre-defined areas) and can only operate in favorable weather conditions (Krishnakumar, 2022). Level 5 (I.e., full automation) is not currently in practice in public spaces. At levels 4 and 5, vehicles are likely to be owned by companies that would have responsibility for maintenance and checks of the vehicles. There are already precedents with the short-term car hire business such as go car.ie whereby users are liable for any damage caused during their rental period but not for any maintenance-related issues. There are also precedents for level 2 automation currently in use such as lane assist, and automated braking assistance, the driver is

considered “in control” of their vehicle and therefore liable for any damages under tort law, unless a gross malfunction of the technology occurs.

The question of who is liable for damage caused by a fully autonomous car is not currently clear in law, but the burden is likely to fall more towards the manufacturer with increasing levels of automation. In the absence of clear passenger interference, liability will fall on the car manufacturer and/ or leaser (Teare, 2014)

In the case of partially autonomous cars, it is critical that the point of handover between car and driver is unambiguous and clearly recorded so that is obvious at all times whether a human or a machine is in charge of the vehicle. The handover process would need to involve a request from the vehicle to the human to retake control and a backup plan (e.g., pull in safely) would need to be the fallback if the human did not take over as requested. Hacking or cybersecurity threats also need to be considered perhaps a requirement for manufacturers to have a specified minimum-security level to prevent unauthorized control of cars

Testing of control systems for driverless vehicles is also a legal and ethical minefield – the public would be put at risk if systems were tested on the road before they had been proven to be safe. Controlled testing like the current process for the pharmaceutical industry for new drugs is a suggestion, with a mandated adverse event reporting system as follow-up (Mills & Reeve, 2014)

Part 4: Ethical Considerations - Self-Driving Cars

Most people think self-driving cars can prevent accidents since they are more reliable than humans and are trained to always obey a set of instructions called an algorithm. However, there are a few ethical dilemmas that raise concerns about the use of self-driving automobiles in the future. We will look into the top 4 dilemmas,

1. Bias leading to Impartial Decision

There has always been conjecture on how the algorithm recognizes an object or person in the context of autonomous vehicles. It is extremely advised that the program does not discriminate against anyone based on their gender, age, race, or other characteristics. The Georgia Institute of Technology study demonstrated that these vehicles could recognize a light-skinned human far easier than a dark-skinned person, making a dark-skinned person more likely to be struck by a self-driving automobile. Additionally, these vehicles are programmed to make judgments that have a lower impact than others. This law for self-driving cars in Germany likewise prioritizes human lives over the lives of animals.

2. Fear of hacking

Some claim that because of the possibility of hacking, self-driving automobiles provide a greater security risk. Even though technology enables driverless cars, it also makes it possible for hackers to

hijack vehicles for malicious or amusing purposes, which can be catastrophic. Due to the GPS and programming that these vehicles use, it is simple for a hacker to steal the vehicle or even kidnap someone without their awareness. Therefore, the crucial query is how this might be prevented and who is accountable. Is this considered cybercrime? Or is the automaker or owner at fault? For instance, in 2019 the Tesla Model 3 was completely taken over by "White Hat Hackers" after they had been infiltrated. We are still unsure of the threats these vehicles provide once they are fully operating, despite the fact that we have not yet observed widespread exploitation or breaches.

3. Response during an Accident

Self-driving vehicles could help society in many ways, including time savings, simpler transportation for those who are unable to drive, and a reduction in accidents caused by human mistakes. However, one of the ongoing discussions regarding accidents is the behavior of an algorithm or software. Does it save the pedestrian or the passenger first? This can be difficult since a human makes an instinctive choice, whereas the software makes an analytical and planned reaction by following the stages. Despite the algorithm's programming to prevent problems, accidents can still happen and there may be some casualties. Who gets to make the decision on whose life is more valuable, then? A 2016 study revealed prejudice depending on gender and age, with a percentage of respondents suggesting saving. A percent of participants proposed saving as many people as possible regardless of physical characteristics, according to a 2016 survey that revealed bias based on gender and age. Another percent suggested saving women first, while another percent advocated saving the elderly first.

4. Accessibility

Self-driving cars could provide mobility for people with disabilities or those who are unable to drive. However, there must be appropriate measures in place to protect the safety and welfare of these individuals. These measures could include specialized technology and extra safety features, as well as trained personnel to ensure that passengers with disabilities are safe and comfortable. For example, the vehicles could be equipped with sensors and cameras to detect obstacles and provide feedback to the driver. The car could also be equipped with voice recognition software that can understand and respond to verbal commands. Additionally, companies developing self-driving cars could partner with organizations that advocate for the rights of people with disabilities to ensure that the vehicles are designed with their needs in mind. Finally, laws and regulations should be in place to ensure that self-driving cars are safe for everyone, regardless of their ability. It is important to ensure that the self-driving car is properly equipped to accommodate any disabilities and ensure that the individual is able to control the vehicle if necessary. Overall, self-driving cars have the potential to provide independence and mobility to people with disabilities, but it is essential that appropriate measures are taken to ensure their safety and well-being.

Part 5: The course of action to prevent future vulnerabilities

To prevent future vulnerabilities in self-driving cars, several courses of action can be taken:

1. **Security by Design:** Incorporating security measures into the design and development of self-driving cars from the outset will help to mitigate the risk of future vulnerabilities. This can include using encryption and secure communication protocols, implementing secure software development practices, and performing regular security audits and penetration testing.
2. **Regulatory Oversight:** Governments can play a critical role in ensuring the security of self-driving cars by establishing and enforcing clear regulations and standards. This can include requirements for regular security audits, mandatory reporting of security incidents, and minimum-security requirements for software and hardware.
3. **Collaboration between Industry and Government:** Collaboration between the automotive industry and government agencies can help to ensure that security is a priority throughout the development and deployment of self-driving cars. This can include sharing of information, research and best practices, and coordinated efforts to address security threats and vulnerabilities.
4. **Continuous Monitoring and Updating:** Regular monitoring and updating of self-driving car systems are necessary to ensure their continued security. This can include regular software and firmware updates, continuous monitoring for new threats and vulnerabilities, and providing ongoing security training to employees and stakeholders.
5. **Public Awareness:** Raising public awareness about the potential security risks associated with self-driving cars is important to encourage users to take steps to protect themselves. This can include education on safe usage practices, providing information on how to identify and report security incidents, and promoting the use of secure and trusted self-driving car systems.

By implementing these courses of action, the future vulnerabilities of self-driving cars can be prevented, and the widespread adoption and deployment of this technology can be facilitated. In conclusion, while self-driving cars present many challenges, the potential benefits are substantial. With continued investment in research and development and a focus on addressing the technical, regulatory, ethical, and cost-related challenges, self-driving cars have the potential to revolutionize the way we travel in the future.

Part 6: Conclusion:

Self-driving vehicles have the potential to completely change how we travel around by providing previously unheard-of levels of efficiency, convenience, and safety. Major automakers and tech companies are heavily investing in the development of autonomous vehicles, which is accelerating the advancement of the technology that underpins self-driving automobiles. While there are still obstacles to be solved before self-driving cars are a reality, the advancements that have been accomplished so far indicate that this new mode of transportation is unavoidable.

Autonomous vehicles have the ability to increase road safety, lessen traffic, and save lives. They might also provide new chances for those with restricted mobility, enabling them to move about more easily and autonomously. As people's time is freed up to pursue their creative passions, autonomous vehicles may potentially have positive economic effects. Nevertheless, it's critical to comprehend the possible dangers and moral ramifications of self-driving automobiles. Before autonomous vehicles may become widely used, concerns about liability, privacy, data security, and public trust must be resolved.

In conclusion, autonomous vehicles are destined to play a significant role in our lives in the near future. If the proper steps are taken to ensure their safety and convenience, they could provide a variety of benefits, from enhanced safety to greater convenience.

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