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How Infrastructures, Social and Ethical issues and Governments are Affecting the Expansion of Autonomous Vehicles?

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ABSTRACT

Autonomous Vehicles (AVs) are expected to considerably reduce pollution, energy consumption as well as car accidents in the very near future. In spite of all these promising perspectives, the expansion of such technology is encountering significant obstacles going beyond the simple technical difficulties. In this paper the issues dealing with car insurance, regulations, cybersecurity, real world poorly regular environments and technical limitations are treated aiming at giving an overview about such revolutionary technology.

Introduction

A fully autonomous vehicle can be defined as a car which is able to perceive its environment, decide which route to take to its destination, and drive it[1], [2]. In other words we can say autonomous vehicles are smart cars or robo cars which uses a variety of sensors, computer processors, and data bases such as maps to take over some or all of the functions of driving from human operators. Cars equipped with this technology will have its own benefits. It will likely reduce crashes, energy consumption, and considerably pollution. Recently major Original Equipment Manufacturer (OEM)'s has announced their plans to begin selling such vehicles in a few years from now.

The introduction of completely autonomous cars onto American streets in the coming years will revolutionize how people drive, perhaps cut traffic deaths, and raise a slew of legal concerns. How, for example, should they be regulated? Over 37,100 individuals were killed in car accidents in the United States in 2017. According to the US Department of Transportation, 94 percent of those deadly incidents were caused by human mistake while driving. According to one research, deploying an early type of autonomous car technology onto American highways might cut traffic deaths by 10%[2],[5]. Once totally autonomous cars are on the road, traffic deaths might be cut by up to 90%[3]. However, given the AV industry's infancy, it is difficult to predict to what extent autonomous cars would minimize the number of yearly deaths. Despite this, both industry experts and the federal government concur that AVs will continue to save lives. As the reliance on human decision making while driving reduces, so increases the lifesaving potential of AV technology. In 2017, an estimated 25,000 road deaths were caused by impaired driving, distraction, speeding or illegal manoeuvres, and drinking while driving. Computer programming is immune to the forces that influence human decision making.

Private and government testing of driverless cars has risen dramatically in recent years. However, widespread usage of self-driving vehicles, where no human attention required, is likely to be several years away. The 2018 fatality in Arizona of a pedestrian struck by an autonomous car halted the speed of commercialization, highlighting the problems of artificial intelligence mimicking human decision making. The National Transportation Safety Board ruled that the tragedy was caused by a "inadequate safety culture" at Uber, which was testing the vehicle, as well as flaws in state and federal regulation. Two fatalities in a Tesla car that was driving with no one in the driver's seat in April 2021 generated new concerns about autonomous technology.

The notion of self-driving automobiles is around to stay. America is engaged in a worldwide race to make driverless cars the norm, and, as expected, virtually all major automakers already offer vehicles with different degrees of autonomy. What's not to love about this? Today, it appears that more people want self-driving cars.

Unfortunately, although the worldwide autonomous vehicle market is expected to be worth $556.67 billion by 2026, still there is very minimal law governing the business[16].

While the National Highway Traffic Safety Administration (NHTSA) has classified driver-assist technology into six degrees of autonomy, most customers are ignorant of the distinction. Because of the absence of industry norms and laws, manufacturers' marketing tends to blur the distinction.

An active and engaged driver is necessary if a vehicle has Level 0, Level 1, or Level 2 driver assistance systems. He is constantly in charge of the vehicle's functioning, has to keep an eye on the technology at all times, and may assume entire control of the vehicle if required.

If a vehicle is equipped with Level 3, Level 4, or Level 5 autonomous, the technology will assume the entire control of the driving without the need for human intervention. If the car warns the driver and demands that he takes charge of the vehicle, he must be prepared and capable of doing so.

Stage 5 AVs (Fig.1), or totally self-automobiles (aka autonomous vehicles), are planned to travel without a human operator by combining powerful AI software, LiDAR, and RADAR sensor equipment[4].

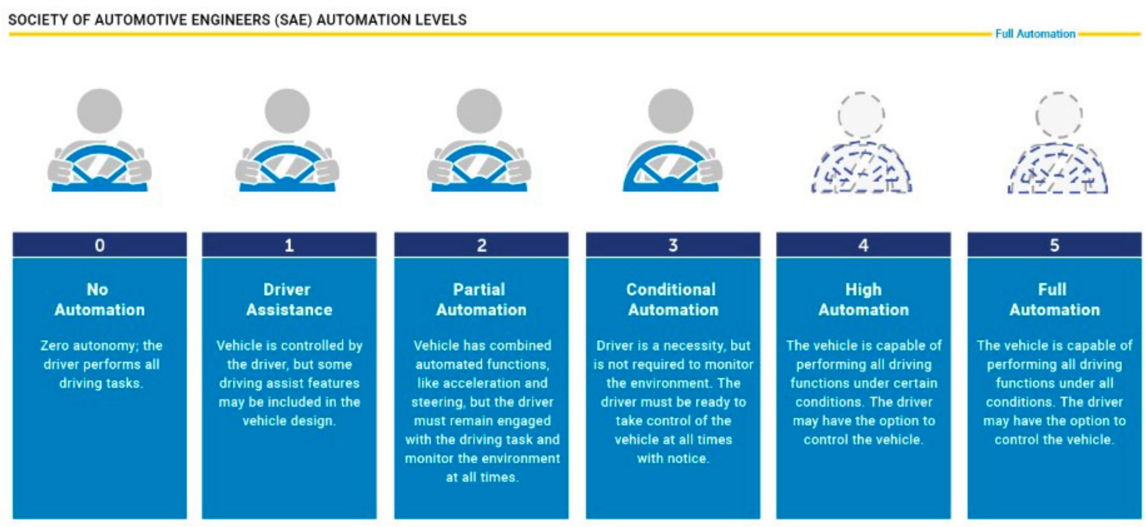

Fig 1: National Highway Traffic Safety Administration (NHTSA) driver-assist technology classification

Is it any surprise that these level 5 AVs are frequently billed as "driverless," and that human drivers behave more like passive passengers when operating them? Because none of these driverless vehicles are completely self-driving, calling them "driverless" is at best deceptive. The great majority of incidents involving self-driving cars appear to be the consequence of the human driver being distracted, as is often the case in a car with no technology.

Yes, drivers are expected to be vigilant and ready to take control at any time, but how probable is that given the driverless car was designed to be, well, driverless? To reach such condition, technology is evolving in the expectation of making "self-driving" automobiles better and safer.

Dangers of self-driving cars

Several dangers are intimately linked with the deploy of AVs, such as error due to the self-driving system itself, cyber threats, infrastructure poor reliability, adverse weather conditions, physical limitations[4]. Because autonomous cars rely on network connectivity, they will be subject to cyber threats. Furthermore, because they will be linked to Cooperative Intelligent Transport Systems (C-ITS), a cyber security compromise might have disastrous effects for all networked transportation infrastructure, not just autonomous automobiles.

The construction of an autonomous car, which relies on a variety of third-party vendors for hardware and software elements, might pose a cyber risk. It can also happen when the vehicle is in motion and a hostile actor gains control of the vehicle or nearby infrastructure. Another worry is that a hacker will get unauthorized access to confidential data generated by automated cars and C-ITS.

Cybercrime is now governed under Australia's Criminal Code Act 1995 (Cth) (Criminal Code), which includes cybercrime offenses such as unauthorized access to computer systems (section 478.1) and denial of service attacks (s 477.3). In an increasingly linked society, the extent of criminal offenses and associated consequences may have to be reconsidered.

In recent years, Australia has also implemented laws and recommendations to address critical infrastructure security. Owners and operators of critical infrastructure assets (including some power, gas, water, and port assets) are required under the Security of Critical Infrastructure Act 2018 (Cth) (SCI Act) to disclose specific facts to the Secretary to the Department of Home Affairs. This permits the Critical Infrastructure Centre to acquire detailed information from owners and operators of key infrastructure assets under specific circumstances, and it authorizes the Minister to intervene if national security concerns exist.
One of the most discussed elements of developing self-driving automobiles is safety.

The most recent tragedy involving a driverless Tesla happened on Saturday, April 17 2021, in Texas, when it crashed, killing both occupants and burning for four hours. According to the Washington Post, the National Transportation Safety Board (NTSB) is investigating the collision, although no one was operating the car, according to authorities.

Simply put, when a motorist slams on the brakes to avoid colliding with a pedestrian who has crossed the road unlawfully, he is making a moral judgment that shifts the danger from the pedestrian to the passengers in the car. Self-driving cars may eventually be required to make ethical decisions on their own, but establishing an uniform moral code for the vehicles, according to a study of 2.3 million individuals from around the world, might be a difficult assignment.

The pro-self-driving vehicle lobby is continually emphasizing the increased safety and lives that automated driving can provide. However, poor weather conditions, such as rain, sleet, and snow, continue to be a barrier for self-driving automobiles[4].

Will a self-driving car be able to transport people safely to their destination in such weather? It may take several years to receive a definitive solution to this topic. When it comes to dealing with bad weather, the technology utilized in self-driving cars today have significant shortcomings. Heavy rain and snow lower LiDAR's effectiveness, while fog might impair the camera's view.

Engineers are working tirelessly to devise novel solutions to this challenge. In 2016, for example, researchers at the University of Michigan and Ford conducted what is thought to be the industry's first test of autonomous vehicles in winter conditions. The approach entails employing high-resolution 3D maps to collect and analyse data about the road and what's above it, such as road markings, signage, geography, landmarks, and terrain. However, it will require more time to operate such cars organically and securely under adverse weather situations.

Cars are heavy, fast moving objects in public spaces. Safety is largely the responsibility of the driver, who must constantly observe, analyze, decide and act. Drivers not only need to obey the rules of the road, but they also need to communicate with each other and with other road users to navigate unclear or disputed situations; Think about how you greet or nod your head to signal "You go first."

The autopilot system must perform all of these functions, and do so with accuracy, reliability and safety, in a wide variety of situations and conditions. Currently, the technology works better in some situations than others.

Using sensors and detailed mapping software, systems build representations of their environment and update them several times per second. They categorize the objects they see and predict possible behavior before choosing appropriate responses. The speed and accuracy of these systems have exceeded human response in many situations. The laser is visible in the dark. The reaction time can be almost instantaneous.

But certain conditions still limit them. The camera is challenged by strong low-angle sunlight (important for reading traffic lights), and the laser can be confused by fog and snowfall. It can be difficult to classify unusual, unfamiliar, and unstructured situations (known as edge cases), such as accidents, road works, or rapid-access emergency vehicles. And self-driving systems aren't very good at detecting and interpreting human cues, such as gestures and eye contact, that help coordinate cars on the road.

It is far easier to automate well-structured processes and environments than it is to automate poorly-structured processes and surroundings. Automated systems must gather, categorize, and respond to data. Such process is simpler to accomplish in a clean and clear environment, that is also the less probable to incur. Self-driving system designers simply cannot anticipate every conceivable combination of variables that may arise on the road. Though some businesses are attempting to do so: The Waymo team at Google purposefully puts its cars in "pathological circumstances" that are unlikely to occur, such as persons hiding in bags and then jumping in front of the car[11].

Narrow streets are also a barrier for autonomous vehicles, according to several of the businesses who are now testing their vehicles on public roads. When two cars had to pass side-by-side on some particularly tiny streets in Boston, NuTonomy's AVs encountered some trouble, according to the company. During AV testing in Phoenix, Waymo's self-driving vehicles reportedly struggled on tight streets due to a lack of room to satisfy its space cushion or "bubble" around it. Human drivers have also claimed that Waymo vans travel in the middle of a two-lane, two-way road with no lane markings and don't swerve to their side of the road until a car approaching from the other direction comes quite near.

Bad or narrow roads are a problem for self-driving cars because they complicate the driving environment and make it more difficult for them to operate. This is because, in order to automate a process, it must be defined in a logical algorithm, and the more orderly the process, the easier it is to define. When a process is intricate, messy, or difficult to explain, programming it into code or automating it becomes significantly more challenging, even for self-learning systems. And this is the case when an autonomous vehicle must operate in a cluttered environment, whether owing to infrastructural or non-infrastructural factors such as inclement weather.

While some technical challenges are currently being encountered during public road testing in several locations, even in more or less ideal conditions (good road, good weather, light traffic, well-mapped area, good network strength, etc.) such as on the road below in Fairview, there are even greater challenges abound in more difficult terrains and road conditions around the world.

Regulatory Issues

The legislation is among the most important features of self-driving. The majority of state and federal legislation do not define who would be held accountable for fatal accidents by such vehicles[16]. When it comes to personal injuries resulting from a routine vehicle accident, identifying who is at fault is difficult enough. In the case of self-driving cars, there is no clear definition of who the driver is, making it more difficult to decide who is to blame for the accident and the repercussions of it.

Who is ultimately liable in the event of an automobile accident? Traditionally, it is the driver, unless the accident is caused by a product flaw. However, as automobiles grow more autonomous, it is likely (and reasonable) that liability will transfer to the manufacturer, because the producer's product - the car – is "driving" itself.

Software is the primary decision maker and operator in the majority of self-driving automobiles. However, the design may differ based on the manufacturer. Some self-driving vehicles lack a steering wheel. In such circumstances, should the burden of proof shift from individuals to manufacturers?

Things become more problematic if the self-driving car has a manual override in the event of an emergency. Because of the nature of self-driving cars, passengers are more prone to be distracted. As a result, by the time they act, it could be too late to avert the emergency[16]. In such cases, will the driver or the manufacturer be held liable for the accident? Can the driver be held liable if the car makes a faulty "judgment," whether due to a product flaw or the inherent limits of the technology?

The problem of liability often generates concerns about insurance. Under the "user-liability paradigm," the driver/operator of the vehicle is now obliged to obtain insurance. However, if a vehicle is controlled by a

computer or automated system, it seems logical to extend that need to the manufacturer. But to what extent? Insurance legislation is anticipated to expand obligations beyond the driver, with numerous parties paying to the insurance. Questions to be settled include whether automobile owners would still be needed to carry third-party liability insurance and if car manufacturers will be required to carry product liability insurance.
Another point of contention in this respect is who would be responsible for insurance. Should the insurance be paid for by all parties involved, including the owner and the manufacturer? Or is it just one of them? Will incidents involving self-driving cars be subject to product liability laws? Who is responsible for the property and physical harm caused by an accident?

A big problem is the rising threat of cybersecurity, as already anticipated before. Vehicles that are more autonomous and "connected" will function in the environment of the "Internet of Things "(IoT), in which data is constantly shared across a network of connections. To work properly, the cars will need to collect significant amounts of data (through cameras, radar, and ultrasonic detections, for example) and exchange that data with the wider mobility infrastructure. Vehicles may capture data on how, when, and where people drive, which might pose privacy issues if the data is stolen or misused. As there is more data, there is a bigger possibility of hacking, therefore cyber security is becoming increasingly crucial. Because hacking is a criminal offense in many countries, the hacker bears responsibility. However, it is clearly the obligation of automobile makers to ensure that proper steps are taken to prevent illegal access or usage. And maybe with drivers, if they are demonstrated to have failed to deploy a required software "patch" or upgrade, for example.

Who will pay for the losses caused by a cyber-attack on the vehicle's computer system? In this instance, will the maker or the owner be held liable? Legislators must handle this area of the law as thoroughly as possible. Self-driving cars are less likely to be accepted by the general public if there are no clear laws and regulations governing the safe usage of autonomous vehicles.

Benefits of AVs

Almost all of the major automobile manufacturers are now working to develop autonomous vehicles (AVs). Automakers and suppliers are more and more purchasing or licensing a wide range of technology that is not traditionally associated with the automotive industry, and the number of patent applications filed by these companies for technologies (including radar/LIDAR, telematics, collision avoidance, artificial intelligence, and machine learning) is rapidly increasing. All of this can be beneficial for economy and work opportunities.
Furthermore, this advanced technologies is expected to significantly reduce road traffic accidents, which are currently the eighth leading cause of death worldwide, according to the World Health Organization, by eliminating human errors caused by factors such as distracted driving, drunk driving, and drowsy driving, among others.
They are also predicted to have far-reaching societal implications. Automation has the potential to help reduce the amount of collisions on our roadways.

Driver conduct or mistake is a role in 94 percent of crashes, according to government data, and self-driving cars can help decrease driver error.

Increased autonomy has the ability to eliminate unsafe and harmful driving habits. Reduced devastation from intoxicated driving, narcotic driving, unbelted car occupants, speeding, and distraction may hold the most potential.

Conclusion

Despite the great potentialities of AVs technology and the accomplishments reached by OEMs, a totally AVs-managed transportation era is very far to be reached for the more disparate reasons. Surely, the most discussed aspect is the safety of these vehicles. The AVs self-driving efficiency and security is linked to environment conditions, the clearer and the simpler leads to safer. However, the occurrence of perfect environment conditions are difficult to be met in the real world. For instance, environment characterized by poor weather conditions, incident light saturating the cameras, unpredicted shapes surroundings the car, unexpected obstacles on the road can dramatically affect the AVs safety.

Another aspect is the lack of understanding of what autonomous means. On such regard, degrees from 0 to 5 of AVs were defined by NHTSA, where 5 means totally self-driving car. Nevertheless, the lack of proper market rules are aiding manufacturers to mislead people in properly understanding the main figures of each of these degrees.

Interestingly, one of the main aspect is about liability. To assert who is responsible in case of accident involving AV is very difficult since decisions are taken by a software and not by an human. Furthermore, a software is sensitive to cyber threats, hence proper countermeasures must be taken by manufacturers to prevent accidents. Moreover, the question about how insurances have to be defined in order to legally intervene in case of AVs involved in car crashes is utterly opened.

All these aspects need to be faced and quickly solved otherwise, despite all the fascinating improvements AVs can generate in terms of reduction of deaths or energy consumption, the acceptance of the same by the general public will dramatically plummet and, perhaps, become the biggest obstacle.

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