European Journal of Law and Public Administration
ISSN: 2360-6754 | e-ISSN: 2559-7671
Covered in: Erih Plus; HeinOnline; CEEOL; RePEc; CrossRef; Google Scholar; KVK; WorldCat; ICI Journals Master List - Index Copernicus; EBSCO

2022, Volume 9, Issue 2, pages: 74-87 | https://doi.org/10.18662/eljpa/9.2/184

Self-Driving Vehicles. A Perspective on Ethics

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Abstract: At the time of writing this paper there are already some implementations of autonomous vehicles. This paper approaches this subject from a different perspective by defining what automation means in other areas of transportation as well as ethical problems regarding the operation of this kind of vehicle. In the later part although of equal importance discuss the operation of the autonomous vehicle from a security and data privacy point of view. This paper tries to define autonomous vehicles by comparison with other ways of transportation which have a higher degree of automation and defines what autonomous vehicles might impact our lives and our privacy.

Keywords: *automation; autonomous; ethics; legality; morality vehicle; privacy.*

How to cite: Croitoru, I., Anisie, L., & Zăgan, P.A. (2022). Self-Driving Vehicles. A Perspective on Ethics. *European Journal of Law and Public Administration*, *9*(2), 74-87. https://doi.org/10.18662/eljpa/9.2/184

1. Introduction

Defining Transportation

Let's start by defining a transportation method. Any way of transporting goods or people is considered to be a transportation method (Editors of Encyclopaedia Britannica, 2022). As such we would like to refer to the autonomous vehicles that carry people rather than all the transportation methods. Some references to other ways of transportation that are implemented in airborne transportation or watercraft transportation will be referred to in this article.

Defining Vehicle

According to the Oxford Dictionary a vehicle in a broader meaning is a way of carrying or transporting goods or people from one place to another (Oxford Learner's Dictionary, n.d.). So, it's not that far-fetched to think of vehicles as any means of transportation.

Defining the modes of transportation

There are three mediums in which any vehicle can be transported. That's air, sea or land vehicles. If we think about air, there is a definite winner and that's airplanes (Brodsky, 2016; Dolgov, 2021). Although in recent years drones, usually four-bladed, and rockets have taken a big step in being more used, with help from big companies like Amazon which implemented deliveries by air (Amazon, n.d.). Another way of transportation by air is rockets or jet packs (Blackmore, 2016). Although in rockets we see a decent amount of automation where discarding those as for the moment they are a niche product which is used either by the military or for some sort of space mission.

Regarding the water medium and sea, we have above water vehicles (watercraft) like boats and underwater vehicles like submarines as the main ways of transportation, with some odd ones like surfboarding which is more like an entertainment activity that requires some accessories like the surfboard and Jet skis that are also discarded for the same reasons.

Regarding the land ways of transportation, we can split them into road vehicles, rail vehicles, and snow vehicles. If we think about road vehicles there are:

- two-wheeled vehicles like bikes, bicycles and scooters,
- four wheels like cars and buses and heavy-duty like lories.

• rail vehicles can be split into two categories: caring people like tram underground subway systems, and multi carriage trains used in transporting goods.

As with jet skis, any relevant ways of transportation by Snow is a niche product.

Is it relevant?

If you want to start a discussion regarding autonomous vehicles we might as well, take a look at anyways of transportation because in air and by Sea we have a higher degree of automation which is relevant when thinking about autonomous cars in perspective.

II. Perspective

Brief history

To understand the concepts we need to look back to the earliest implementation of autonomous vehicles (Morar, 2010). Of course in the first stages, we can't really talk about autonomous vehicles but more in terms of automation.

The first-ever recorded automation in a vehicle was in Da Vinci's self-propelled cart which could be programmed to follow a specific route by programmed steering (Herman, 1998; Schäffner, 2020), which is considered the precursor to the modern robot cars.

Another step in developing autonomous vehicles was with the Whitehead torpedo which was an underwater vehicle used in military applications which can maintain a stable course and depth using a gyroscope (Malnig, 2018).

In 1903 Orville Wright managed to fly a heavier than air apparatus (Kevill, 2016) for 59 seconds. According to James E. Tomayko (2020), the apparatus which we now call an airplane, was very unstable and hard to control (Padfield & Laurence, 2016). In this context in 1914, Lawrence B. Sperry managed to introduce something that we call today a mechanical airplane stabilizer and managed to fly almost hands-free because only the steering had to be controlled (Tomayko, 2000). Also at the same time, John Hays Hammond managed to tackle the problem of automated steering with his automatic course stabilization (Kröger, 2016). Both these inventions paved the way for what we now call autopilot.

Regarding the terrestrial vehicles that were self-driving, history brings us to the first decades of the 1900s, when there were more than a

couple of cars that implemented some sort of automation but there were still controlled remotely via radio waves (Maurer et al., 2016).

Another important way of transportation that is relevant for this paper is the train. In this regard automation in trains has been implemented since the early 1900s and at this moment there is full automation. But automation in trains is really important because if we take a look at the first ways of automation they were applied to the tracks and not to the actual vehicle (Tomayko, 2000).

Latest technologies

Taking the same methods of transportation aforementioned and taking a look at today's level of automation, airborne vehicles are fully automated (Mobility Insider, 2020).

Regarding the watercraft's automation, we can also see fully automated cargo ships survey boats and some submarines used in researching and mapping the Ocean floor (Kim & Mallam, 2020).

Regarding trains, there are several fully functional metro systems that are autonomous and even in high-speed trains (Kent et al., 2010).

When it comes to cars which have some sort of automation but nothing that is fully functional at the moment. Of course, there are several prototypes from different companies that try to tackle this problem each with various levels of automation.

Levels of automation

In the car industry there is a set of standards regarding the level at which a car is automated. This ranges from 0 to 5. Level 0 is not automated at all while level 5 means no human interaction at all.

Same kind of levels we can see in the training industry and in watercraft vehicles but with only 4 levels.

The first automation in aviation was just years after the first successful flight of the Wright brothers which is considered to be the beginning of aviation as we know it.

Table no. 1: Level of Automation

Level	**Cars**	**Trains**	**Watercrafts**
Level 0	No automation	On-sight	
Level 1	Drive Automation	Manual	Ships with automated processes and decision

			making
Level 2	Partial Automation	Semi-automatic(STO)	Remotely-Controlled with seafarers onboard
Level 3	Conditional Automation	Driverless (DTO)	Remotely-Controlled without seafarers onboard
Level 4	High Automation	Unattended train operation (UTO)	Fully Autonomous
Level 5	Full Automation		

Source: Revised 2018 edition of SAE J3016 automated driving level definitions SAE INTERNATIONAL

If we correlate current levels of automation amongst different Ways of transportation we can conclude that cars are behind. Turn the standard gap, let's look in perspective. What are crafts, airborne vehicles and trains they all have to worry about in terms of the environment? Trains travel over a specific set of rails and when it comes to crossing roadways there are more than often over passages for under passages to help and not interfere with the flow of traffic or that of trains. That means that the complexity of automating a train is reduced because there is reduced interaction with the environment other than in stations.

If you think about the Subway system, interactions with the environment are actually reduced to zero during the movement of the train, and in some cases reduced to a minimum while the train is stopped.

Boats and other watercraft have open space to work with while sailing and given the vastness of water and the fact that you can move sideways from a set course makes it possible to automate. Of course in sports and other high traffic areas, the captain of the ship will take control to maneuver and avoid collisions with other ships, docks etc.

Regarding the airplanes they have the same set of advantages as the watercraft with the added bonus of having a third dimension to work with. Under set conditions, an airplane can successfully fly from one destination to another only with some coordinates input from the pilots. Most state-of-the-art autopilots feature takeoff and landing automation.

Matt with that in mind given the high stakes of countless lives or the money involved in a plane crash rules are put in place that takeoff and

landing should be carried out by qualified personnel. The same goes for watercraft.

Cars, on the other hand, have set pathways that they usually need to follow and given the number of cars, interaction with other cars is unavoidable. By analogy we can say that the highway is like some sort of open space vehicles.

III. Legal and moral issues regarding autonomous vehicles

Driving automation is in a constant evolution process. It began in the early 70s with the anti-lock braking system and continues to this day.

According to Google, Nissan, Ford and others consider fully developed self-driving cars are around the corner and could emerge in the next 5 to 10 years.

When it comes to autonomous vehicles, a series of sensors gather data from the environment. The list of services includes video cameras, ultrasound, radar and lidar among others.

In case of an accident, according to the law, sensor data must be recorded and provided to the police to aid in understanding the circumstances and help with the scene reconstruction. Therefore, using sensor recorded information, engineers are able to reconstruct events and study the decision making process and other alternatives that it might have had (Goodall, 2016).

Thus, it will be possible to recap how the computer acted in the same way as in the case of humans. These requests could be the basis of the accusation as well as the defense for the way the vehicle acted.

Autonomous vehicles use what you might consider being by decision making in that it can break the law under certain conditions. Google admitted to the claim that its automation exceeds the speed limit in order to keep up with traffic, justifying that in set conditions driving slowly might be dangerous. Most people would justify exceeding speed limits in situations when time is of the essence like an emergency trip to the hospital.

Even when obeying the law, autonomous vehicles can make decisions and take subtle actions that impact traffic safety.

The AI might take decisions based on:

- the value of the object with which it could collide
- the value of its occupant.

Unlike people who make these decisions instinctively, an automated vehicle would do so as a result of a carefully planned risk assessment

strategy. The Decision-making process is based on probabilities. The result of each action performed by the vehicle will have a probability associated and based on the value of that probability, subsequent decisions are made. At the same time, each action has significance as well as a cost factor that is associated with it.

Actions are taken only when the cost-benefit exerts a certain value based on a formula where you multiply the significance factor with the probability.

By comparison, human ethics are individual whereas self-driving vehicles ethics could be by manipulating by the engineers working on programming the vehicle.

As such, the significance factor could be manipulated based on whether the vehicle drives in a poor or rich neighborhood, or by assigning different values whether the obstacle is a bicycle or a person.

That's because compensation amounts paid are substantially higher in wealthy neighborhoods, therefore the vehicle could and might change its behavior based on its location. Thus, it might be plausible that vehicle I would consider different significance levels when faced with hitting a child from a wealthy neighborhood compared to a child from a poor one.

Another variable in autonomous cars is the possibility of injuring the passengers it is carrying. It is possible that the passengers will assume the risks associated with an autonomous vehicle (Karnouskos, 2020).

The biggest challenge for autonomous vehicles is the fast ethical decision making, sometimes with incomplete data, in a situation that is not familiar and was not accounted for nor hardcoded by the programmers (Goodall, 2016).

As stated before, autonomous cars are to be implemented in the near future, making them part of transportation infrastructure. They'll have to make instant calls regarding the various ranges of split-second events.

As of now, ethical decision making is still in the early stage of pioneering, further experience and development will clarify some of these dilemmas.

IV. Data protection - autonome car background

By definition autonomous vehicles are systems that can collect data from the environment and make decisions based on that input without human interaction (Karnouskos, 2021). In regards to automated systems, autonomous systems can take action even if information and data are not 100% accurate. Using autonomous systems is directly subjected to some security issues, and is closely tied to data confidentiality. This is also

accentuated by the different data protection policies that exist worldwide, (Ex: Data Protection Act, GDPR, etc.), or by the fact that some countries don't have a set of policies in place regarding data protection.

At the time of this paper, on the market, there are several companies that make an effort to innovate by improving or even developing new autonomous systems. This includes Tesla Inc (Minchin, 2021), General Motors Co (2018), Alphabet Inc and Aurora Innovation Inc (Aurora Innovation, 2022) and others.

From past experience in regards to negligence with handling data:

- Tesla forgot to delete from Autopilot and Infotainment's hardware, previous client's personal information

- In 2018, over 5 million users were exposed during a security breach in Google+ API, personal data being exposed.

- According to Andy Greenberg, a senior writer at WIRED, published an article stating that millions of cars manufactured by General Motors were affected by the security breach (Greenberg, 2015).

We can conclude that there is a real possibility that this sort of security breach regarding confidentiality might happen in the future.

Data protection - ethics applied to autonomous car ecosystem

Security and privacy have in common the concepts of appropriate use and protection of information (Acquisti, 2006). Security is regularly seen as flexibility from perception, impedances or superfluous open consideration. It is frequently seen as a portion of security and is the reason for giving secrecy and when conceivable namelessness. Security on some occasions may be considered a violation of privacy. With regards to the autonomous vehicles more secure systems are needed, systems that are less prone to failure and human errors by means of exhaustive testing over a longer period of time and simulations as realistic as possible, but also with the additional experts from various domains such as justice, ethics, and even psychology (Fink et al., 2017).

Personal information creates a digital footprint of every individual, which makes it identifiable therefore every person should have full control over his personal data. Any use of the digital footprint of an individual without his preceding agreement in violation of his individual rights to privacy and property.

Autonomous vehicles collect and process huge amounts of data some of which is personal. This can be defined as big data (Diebold, 2012).

Due to the storage methods and the large volume of data, improper use of data such as accidental deletion, voluntary deletion, corruption and

disclosure to third parties not specified in the personal data processing policies or are not indicated for disclosure may occur (such as conflicts of interest). Therefore, storage type, data schema, data migration, costs, user types and security, may influence the appearance of ethical issues.

Extracting and analyzing saved data from an autonomous vehicle ecosystem, creates an opportunity to profile a consumer and predict their behavior (Herschel, 2017). These methods are already used to explore and to generate new customers and also to keep existing customers.

In regards to previously stated, a question arises regarding the purpose of collecting use and dissemination data processed by autonomous vehicles, that means that corrective legislation is needed to regulate, correct and ensure the protection of actors involved.

Some limiting factors that hinder the development of legislation to ensure a minimum standard in data protection:

- the sovereignty of existing legislation
- rapid development of systems that cannot be tested on a large scale
- Poor understanding of the system's complexity

When we talk about the widespread adoption of autonomous vehicles, within the European Union it is necessary that these systems comply with the laws that are already in place. Although EU data protection also applies to automated transport, no specific measures have been taken to ensure cyber security and to protect vehicles against cyber-attacks. Free will, freedom of speech and human dignity are some of the rules that autonomous vehicles must follow. The EU is currently developing guidelines and laws regarding artificial intelligence, but it may be necessary to include specific standards regarding autonomous vehicles.

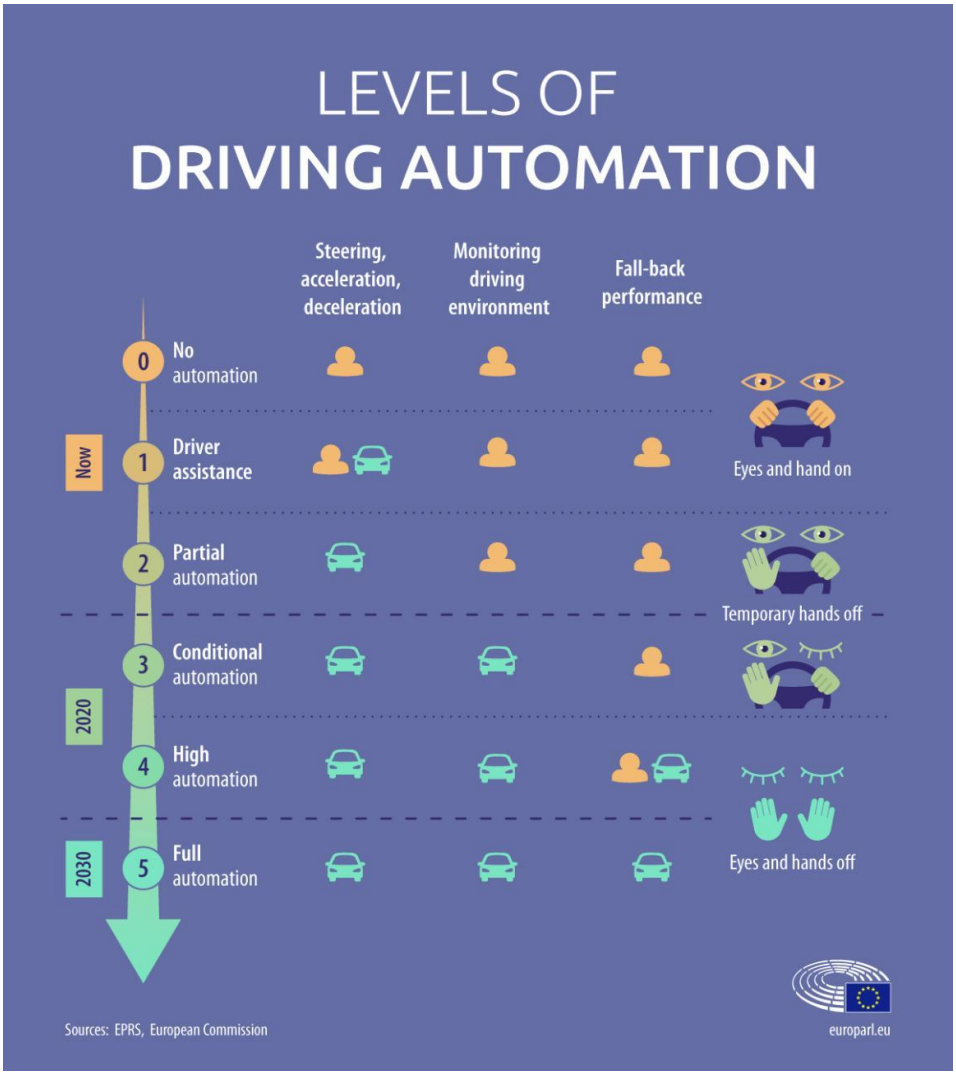


Figure 1: Automated levels of Automated Vehicles in Europe

Source: European Parliament (2017)

Driving assistance vehicles (automation levels 1 and 2) are already on the European market. Self-driving cars (Levels 3 and 4) are currently being tested and are expected to hit the market between 2020 and 2030, while fully self-driving cars (Level 5) are expected to arrive after 2030.

The European Union will have to regulate cyber security and personal data protection according to its regulation, in regard to

autonomous vehicles, especially General Data Protection Regulation no. 679 of April 27, 2016 (European Parliament & European Council, 2016). *"Existing legislation already imposes requirements regarding the security of stand-alone or automated systems, so that they become sufficiently secure communication-wise, with other entities, and integrity, confidentiality and availability of information are not compromised"* (Andraško et al., 2021).

Some advice that can be the basis of good practice in the future:

- each and everyone should understand the concepts of cybersecurity and be responsible, above all to protect ourselves
- in order to avoid cyber-attacks based on human errors, knowledge of cyber security will have to be taught in schools, the policy of promoting this motto implicitly, will have to be at the macro level
- the operating practices of autonomous vehicles must be mastered and respected
- Other systems that use collected from autonomous vehicles can evolve with the sole purpose to generate profits. Limiting the volume of data that is being transmitted and anonymizing it could prove to be one way to limit the phenomena of unauthorized use of personal data.
- information and consent must be tools that guide any process involving personal data
- The AI must be designed such that it can read and process that information and debrief the user but also be self-aware of data protection
- Car manufacturers on the other hand should be required to be authorized and to comply to some sort of periodic audits regarding data privacy
- user-centric rather than vendor-focused education will set the stage for the development of a security-oriented system

V. Conclusions

Although autonomous vehicles are in their early stages there is a big effort made towards evolving this technology. In comparison with other means of transportation autonomous vehicles are behind due to the complexity of factors like the environment, traffic, pedestrians whereas airborne vehicles, watercraft and rail vehicles either have a set bath that doesn't intersect with the environment as much or have another dimension to work with being 2D space or 3D space. Furthermore, even with airplanes and watercraft that are currently fully autonomous technology-wise, there is still a person maneuvering them. This is because of the high stakes associated with autonomous vehicles on one hand and partially that there is

no definite procedure that must be followed. Autonomous vehicles excluding 4-wheel vehicles are used in open spaces for the most part.

Autonomous vehicles development will always be closely tied to personal data protection. The development of dynamic legislation and the creation of sound principles of education will succeed in integrating this field into society. Data protection policies and principles will be developed further in conjunction with the development of autonomous vehicles technologies and legal matters are addressed with relevant laws and regulations.

Autonomous cars create an unprecedented change comparable to that of Stephenson's steam locomotive. Like anything that's innovative, this revolution will change the way we look at logistical, legal and moral issues. A month of Sundays will pass until the domain is stabilized and regulated. The first step will be for people to accept the change.

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