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Open Schools Journal for Open Science

Are autonomous vehicles the future of mobility?

G. Drakoulakou[1], P. Argyri[2]

[1]12th grade, Evangeliki Model High School of Smyrna, Athens, Greece.
[2]Mathematician, Evangeliki Model High School of Smyrna, Athens, Greece

Abstract

Autonomous vehicles, as well as many other technological inventions, are at the center of attention because of the rapid revolution in the use of new technologies. Autonomous vehicles have been an area of scientific study and research for a very long time. However, the era when driverless cars move in streets is yet to come. That creates the rational question: Are autonomous vehicles really the future of mobility or are they just another viral utopia that will not come true? Most people do not know what exactly that phenomenon is about, thus not understanding the boundaries and hardships of the adaption of such a venture. To figure out what stops driverless vehicles from becoming our reality, we need to examine factors such as what autonomy really is, in what level can and should we achieve autonomy and how will these vehicles exactly operate. That is why it is considered as important to analyze these issues in this paper, as well as the conclusions that emerge as a result of my participation in the European Student Science Parliament, as well as of discussions and interviews with my classmates. After analyzing all the positions, judgments and discussions, the most important problems regarding the adoption of this invention, along with proposing realistic and effective solutions for each of them, are recorded.

Keywords

Autonomous; vehicles; driverless; problems; solutions

Background information about autonomous vehicles [1]

An autonomous car is a vehicle that can recognize its surroundings via sensors and navigate itself, by responding to the environment. In order to drive safely a human driver or a self-driving vehicle must answer four questions: “Where am I?”, “What’s around me?”, “What will happen next?”, and “What should I do?”- And to make driving decisions based on that information. The function of autonomous vehicles is based on a system, much alike to the human neural system, which involves creating dynamic 3D maps, in order to create a route, pointing out the exact location of

the vehicle, using sensors (like cameras) to figure out possible obstacles, analysing the data, and, of course, an Artificial Intelligence (AI) system that will be able to receive the driver's decisions and to interact with traffic conditions. In order to more effectively examine the autonomous vehicles, the automobile industry has separated those cars into six levels, depending on their level of autonomy. The levels go as such:

- Level 0: No Automation (already deployed)
- Level 1: Hands on: Driver Assistance (already deployed)
- Level 2: Hands off: Partial Automation (already deployed)

(These first three levels of automated driving systems monitoring the driving environment whereas the second three involve the vehicle making decisions based on this monitoring)

- Level 3: Eyes off: Conditional Automation (already developed)
- Level 4: Mind off: High Automation (in development for public use)
- Level 5: Steering wheel optional: Full Automation (in development for public use)

Although driverless cars have not being released yet, other types of fully or semi- autonomous vehicles, such as trains, buses, metros, trucks, boats, and drones, are already being used.

The main problems of autonomous vehicles

1. The issue of liability for traffic accidents. Who is responsible for damages when an autonomous car is involved in an accident? Should the level of autonomy be considered? Autonomous car liability is a developing area of law and policy that will determine who is liable when an autonomous car causes damage. [2]

2. Should there be some limit on the personal data of the owner of the vehicle, like their route to work, the time they spend in their car, the places they visit often and their entertainment preferences, that can be selected and stored by manufacturers and sold to other corporations? Most automated vehicles have a built-in communication system that can communicate with the manufacturer’s servers and other vehicles. This communication is very important for safety. Passengers can also use entertainment and information networks during commuting. These co-exist with automotive control networks, which are administered by the vehicle producer. The connected car has the ability to generate, store and transmit users’ personal data. Hacking an autonomous vehicle’s control system could interfere with not only the privacy of passengers but also with people’s safety. Therefore, cyber security and data privacy of autonomous vehicles is crucial. [2]

3. The legislation should be updated in order to cover the issue of autonomous vehicles. The foundation of international road traffic regulations is the Vienna Convention of 1968 which established standard traffic rules among the contracting partners to increase road safety. These rules imply that every moving vehicle must have a driver and that every driver must at all times be able to control their vehicle. “Driver” means any person who drives a vehicle. Can a computer be a driver? Fully autonomous cars are not permitted to drive on public roads in any European country so far. It is even difficult for companies to test those cars, as they are only allowed on private test routes in Europe. The legislation was edited in 2014 by the amendment: “systems which influence the way vehicles are driven”.

4. We should ensure that available technology and knowledge is efficient to create effective and safe autonomous vehicles. Research capacity, the presence of relevant technology firms, patents and investment, and the presence of companies eager to integrate autonomous vehicles into their business model are all crucial for the development of driverless vehicles.

5. Current road infrastructure, including density of electric vehicle charging stations, quality of the communications network, and quality of roads, is definitely not ready for autonomous cars. How can infrastructure change, in order for driverless vehicles to function beneficially?

6. The lack of public acceptance. How can people become more positive about the idea of autonomous vehicles, in order to reach a point, when they are willing to send their own children to school using a driverless vehicle? Autonomous vehicles will probably soon knock on our doors, but public awareness and consumer acceptance will take far longer, perhaps decades. [2]

7. The issue of technological unemployment, as should we make use of autonomous vehicles, professional drivers will lose their jobs. There could be resistance from professional drivers and unions who are threatened by job losses. In addition, there could be job losses in public transit services, insurance agencies and crash repair shops.

8. The ethical issues linked to autonomous vehicles. When an accident is inevitable, what kind of harm should the vehicle choose to cause (e.g. A manned autonomous car will certainly hit some pedestrians, if it doesn’t change its direction immediately- but if it does it will certainly fall into a wall and injure or kill its own passengers). The ethics of autonomous vehicles is still in the process of being solved and could possibly lead to controversy [3]

9. The problem of “falling asleep”. When the driver’s intervention is needed, how can we be confident that the driver is awake, sober, and generally able to take control of the vehicle? As self-driving capabilities become commonplace, human drivers may become overly reliant on the autopilot technology and leave their safety in the hands of automation, even when they should act as backup drivers in case of software failures or mechanical issues.

Research framework

The above data recorded from the bibliographic research, as well as from the collection of opinions from the discussions at the European Student Scientific Council, were discussed in 2 sections (27 students each) of my school. With my classmates, who expressed their interest to participate and had a wide range of knowledge on the subject, we also discussed in person in the form of an interview. All conversations were recorded and then analyzed qualitatively for synergy and exporting solutions.

Discussion on research

All students agreed that autonomous vehicles are a matter of utmost interest and expressed a very positive attitude to participate in the discussion and to respond to key dilemmas. To the question of whether an automated vehicle encounters a pedestrian barrier and needs to change course, the answers are grouped into 3 categories: a) Automated engines respond more accurately to humans, b) Humans can make mistakes as a result of socio-economic factors , or there are drivers that do not drive cautiously, but the engine does not come under such restrictions c) We cannot express an opinion as nothing has been tested and officially evaluated. In the latter category there is the argument of lack of legislation, where there are commitments so that we can finally evaluate the results of the uses of automated vehicles.

A key question to be considered was the case of accidents involving self-propelled vehicles. Three basic parameters were considered: a) the construction of the automated vehicle b) the driver and c) the engine. In more detail, in the event of an accident the causes should be investigated. It may be possible to examine the black box that will map the whole course of the accident, and therefore to investigate whether it was a manufacturing mistake or the machine itself being inadequate to function properly. In the case of a non-automated vehicle, the driver holds full responsibility for any errors. So, the question remains unanswered: What will the motorists be responsible for in the event of an accident? Will these construction companies take responsibility?

Solutions

My classmates have recognized the importance of proposing solutions to these new technologies of technology. From the interviews and based on personal views on the topic, the suggestions made are the following

1. In the case of fully autonomous vehicles, manufacturers and software engineers should definitely be held responsible for potential accidents. This way, they will be motivated to conduct better research, invest more and construct even better vehicles, resulting in less malfunctions and defective products, thus even less accidents. In case of lower level autonomy vehicles, finding the cause of an accident is expected to be more complicated, but could be achieved with the use of a data recorder (similar to the black box used in planes). When the cause is found, the blame

will be put on, accordingly. In case of third-party unauthorized intervention, similar measures as if the vehicle has been stolen should be taken.

2. There must be a limit on the personal data that can be collected and stored by manufacturers. Also, this data shouldn't be sold to other corporations without the owner's consent. Furthermore, all data and information should be used ethically, only for providing better services. The connection between the manufacturer's central server and the in-vehicle system must be secure, to ensure that no third-party gains unauthorised access to the vehicle data.

3. Given that the 21st century is characterized by rapid development in science and technology, updates in legislation are of enormous importance, in order for science and society to keep functioning for the benefit of the public. Making amendments to primary legislation to ensure insurance products will be available for automated vehicles can be proven very beneficial. Furthermore, providing guidance for drivers about the safe and appropriate use of new technologies should bring in many positive effects. It is also needed to make some rules to manage public testing, in order to help testers to understand how to comply with the laws. It is clear that testers must obey all relevant road traffic laws, test vehicles must be roadworthy, a suitably trained driver or operator must be prepared, capable, and willing to take control if necessary, and appropriate insurance must be taken into consideration. Update of legislation has now become the point of reference for governments and regulators around the world. Last but not least, ensuring the enforcement of the above-mentioned laws is as crucial as making them.

4. Constant effort to overcome technical issues. Make the best of technological knowledge. It is important for young scientists and citizens to try to come up with fresh innovative ideas. It is crucial that we realise the benefits of driverless cars in order to invest time, money, and materials. There are tech-companies, as well as top-selling car brands in the US, often in collaboration with components providers, that have been working on this project for years and have also done some public testing. Why is public testing important? At a high level, our scientific, ethical, and epistemic situation with regards to driverless cars is very similar to our situation for novel drugs and other medical interventions. In both cases, we are dealing with a new technology that provides novel capabilities, but only as part of a complex, non-stationary environment, where we do not know exactly when or why technology works, or all of the environmental, user, or system factors that make a substantive causal difference. Of course, there are also differences between the situations, but these similarities suggest that the introduction of autonomous vehicles onto public roadways might be regulated in a manner analogous to the way that novel medical interventions are approved for, and introduced into, clinical practice. [4]

5. The state should be responsible for updating road infrastructure (traffic lights, charging points, parking space) in order for autonomous vehicles to be suitable. There is also the risk that traffic congestion might increase, rather than decrease. That is why appropriate public policies

and regulations, such as zoning, pricing, and urban design are required in order to avoid negative impacts. Starting with sharing lanes, and gradually dedicating more and more space to autonomous vehicles would be a good idea. As we consider decades-long transportation projects, it is important that stakeholders develop a point of view on what transportation will look like in several decades so that we can incorporate future developments into what we are planning today. As these technologies are introduced and their impact on modes of transportation grows, we need to maintain flexibility to make changes in our transportation plans.

6. Enormous importance of raising public awareness. Citizens should be informed sufficiently in order to realise the advantages and disadvantages of autonomous vehicles. That can be achieved using open data, as all people being able to seek out information openly. Moreover, a call for help to reach maximum levels of adequacy in this venture, would make people feel like a part of it, thus accepting it easier, not to mention that brainstorming is always a good way to find solutions to difficult problems. Same goes for asking them to fill in a questionnaire, where they will be asked to express their opinions about autonomous vehicles. Population living in test areas are the most important to include, because they will be the first to live with autonomous cars, even in some testing version. It is very positive that civil society technology acceptance has increased compared to the past. This juncture resembles to what has happened when automobiles replaced horses and the internet gained traction. In those cases, the technology changed the way people were leading their lives worked and got around. And the transformation occurred before the public or governments were ready to adapt the change. Being proactive about guiding this technological change is essential. Rather than waiting until it happens or leaving it for the last minute, now is the time for education, thoughtful discussion and planning.

7. Technological unemployment is an acceptable loss that is inevitable in order for technology and society to develop and take steps further. Job loss of professional drivers will be partly contradicted by the job creation effect. More specifically there will be more engineers, programmers and artificial intelligence experts needed, thus opening new job positions.

8. Human drivers are known to make biased ethical decisions when driving (often unconsciously, such as avoiding harm to themselves). In many cases, human thought and reaction time are too slow to detect an upcoming crash, think through the ethical implications of the available options, and take an action to apply an ethical choice. There are two main considerations that need to be addressed. First, what moral basis would be used by an autonomous vehicle to make decisions? Second, how could those be translated into software code? Researchers have suggested, in particular, two ethical theories to be applicable to the behavior of autonomous vehicles in cases of emergency: deontology and utilitarianism. The first theory suggests that an autonomous car needs to follow strict written-out rules that it needs to follow in any situation. Utilitarianism suggests the idea that any decision must be made based on the goal to maximize utility. This needs a definition of utility which could be maximizing the number of people surviving in a crash. Critics suggest that autonomous vehicles should adapt to

a mix of multiple theories to be able to respond morally right in the instance of a crash. The team of philosophers who develops algorithms has not given a statement about these issues, yet. They hope that they will not need to define the choice of the cars, rather they will create an environment where the owners themselves or the manufacturers will have to make final decisions in such cases. These worries are important, but they are often distractors to the greater benefits of autonomous vehicles and are impediments to their safe and secure introduction. A classic example is the trolley problem where a car must choose to either swerve and hit 2 people or continue ahead and hit 5 people. The broader benefit of a significant reduction in traffic accidents and fatalities from human error vastly outweighs these edge cases that often takes an oversize amount of attention and focus. There are plenty of reasons why we shouldn't focus that much on "trolley problems". First of all, no good solutions to these dilemmas exist or can exist. Humans are not able to make a 'right' choice when faced with such situations either. None of the alternatives one comes up with is 'ethically right'. If a human drivers are in the same situation, they will necessarily make a choice but any action they choose, is a bad action. How can we expect from a machine to make an ethical choice that no human is capable of making? Secondly, these dilemmas assume certainty and knowledge that does not exist in such situations. For these dilemmas to work, the harmful outcomes for all the actions must be known and specified. But in practice, nothing is certain. There is no certainty about the extent of damage for each of the actions. There is no certainty about the behaviour of the victims as the car approaches them. These cars cannot have exact information and understanding regarding the age, gender, health etc. of the persons in front of them, and cannot correctly predict the resulting harm. Also, these dilemmas are always incredibly contrived. The probability that a car faces such a situation is extremely low. Cases where drivers face such situations are extremely rare today and may be even less probable for self-driving cars. From a practical perspective, therefore, these dilemmas may be completely irrelevant. What we should focus on instead is that autonomous vehicles will reduce accidents to such an extent, that the possibilities for a driver to face such a situation are extremely low. [3]

9. Policy makers should create rules for low level autonomous vehicles to prevent such attitude. Driving with both hands on the wheel where possible should be obligatory. It will be significant to clarify this regulation by adding a statement that a driver meets this requirement even if they are not in the driving seat, as long as they have the ability to control the vehicle through a hand-held device. The use of a hand-held mobile communications device while driving should be prohibited. It is required that a TV/display screen is not visible to the driver unless it is showing information related to the driving task is needed. In due course, when vehicles achieve a high level of automation it may be possible to relax this regulation further. However, a relaxation would not currently be advisable.

Conclusion

All in all, it is more than verified that leaving everything up to market forces and consumer whims could possibly create more problems than autonomous vehicles would solve. The introduction of

autonomous vehicle technology is too important for public and private sector decision makers to make decisions in groups. This is a sector where technology, consumer demand, and corporate investments are moving too quickly for decisions to be made in isolation. Companies have already started working to bring this technology to market, but we also need public sector, academic, and non-profit groups to work together with one another and the private sector. Importantly we need channels and institutions to help bring both the public and private sectors together to plan the future of these technologies. The future of mobility consists of four trends: Autonomous vehicles, electric vehicles, shared vehicles and increasing urban density. All these trends should be positive. However, the interplay between these four trends could also lead to negative outcomes. Each of these four trends could independently yield many benefits. However, an examination of possible nightmare scenarios reveals that, without holistic planning and policy support for all four disruptions, negative consequences could follow. Planners and policymakers must consider how these disruptions will interact.

The effects of the uptake of autonomous vehicles are several and not all of them are already examined. It is like someone trying to predict the consequences and applications of the advent of electricity. Someone would simply claim it would just replace candles, but it proved to be much more than that. Back then, no one could predict how electricity would change people's lives. I believe that robotics and artificial intelligence fall into the same category.

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References

[1] Wissenschaft im Dialog. 2020. European Student Parliaments. [online] Available at: <https://www.wissenschaft-im-dialog.de/en/our-projects/european-student-parliaments> [Accessed 25 September 2019].

[3] Driving, A., Maurer, M., Gerdes, J., Lenz, B., Winner, H. and Heidelberg, S., 2020. *Autonomous Driving - Technical, Legal And Social Aspects | Markus Maurer | Springer*. [online] Springer.com. Available at: <https://www.springer.com/gp/book/9783662488454> [Accessed 15 September 2019].

[3] Martin, R., Kusev, I., Cooke, A., Baranova, V., Van Schaik, P. and Kusev, P., 2020. *Commentary: The Social Dilemma Of Autonomous Vehicles*.

[4] London, AJ., Danks, D., 2018. Regulating Autonomous Vehicles: A Policy Proposal. [online] Available at: <https://dlnext.acm.org/doi/abs/10.1145/3278721.3278763> [Accessed 25 September 2019]