

Autonomous Vehicles Difficulties and Challenges

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Abstract

With new technologies arriving almost every day in our current life and providing assist and support on all aspects, autonomous vehicles has been obviously a major part in this era and thousands of resources are being spent into developing this technology. However, difficulties and challenges that must be addressed strictly to ensure continuous success and development of this important technology.

Chapter 1

1.1 Introduction

In a world where travelling has become an essential act of almost every human being in this planet, people are lately preferring using airplanes and trains in favor of using cars with statistics showing clear decline in numbers of car sales growth and cars license obtained all over the world [1]. AV technologies can play an important part in changing these numbers if it can challenge and successfully addresses those challenges and difficulties.

1.2 Background

In 1920, NavLab of Carnegie Mellon University was the first to develop AV technologies [2]. And a century later development and researches are still continuing to be addressed due to the huge demand of such important technology, and the more invention and development are obtained, the more challenges and obstacles arisen which has to be handled carefully and effectively.

1.3 Problem Statement

In light of the recent AV growth and the high demand all over the world from people who simply want to switch into AV or to high-end military systems which are acknowledging the abilities delivered by this technology [3]. However, with various researches conducted to address the difficulties and challenges that is facing the AV technology from safety and regulation to communications and liabilities, these articles and researches still remain to be inefficient and clearly not covering wide ranges of aspects required. With the current incomplete researches and statistical data, a world with largely distributed AV will take much longer time and efforts.

1.4 Research Objective

- To propose designing a world-wide data center that conduct and contain all required statistical and data that can be highly beneficial in the current AV development.
- To provide clear data and insights of the AV difficulties and challenges to encourage effective collaboration from all over the world researchers and manufacturers which can lead to considerable jump into an era of AV technologies dominance.

1.5 Research Scope

This research will emphasize less on the AV technology itself but more on the difficulties and challenges that comes with the AV technology, all present researches have already made a great contribution in AV technology. However, the need for more of these researches will continue to grow as the AV technology gets widely used. Aspects from safety and end-user experience, Hybrid relevance, environment and low carbon costs, and hardware and precautions effective decision-making are insufficiently discussed and reviewed in the present researches on AV technology.

Chapter 2

2.1 Literature Review

2.1.1 Autonomous vehicles: challenges, opportunities, and future implications for transportation policies

This article explores the Autonomous vehicles (AV) Technologies in general, and the challenges, opportunities, and future implications in particular. The article presents how AV technologies can decrease the transportation cost and increase accessibility to low-income households and persons with mobility issue. The cost decrease can get as low as 2000\$ and up to 4000\$ when crash costs are counted. The articles acknowledge the gap in communication over cars infrastructure and routing behaviour and the obvious fact of how AV is still in infancy stage with a path full of problems and several challenges, although the biggest challenge remains to be the perception of the environment. Using the Braess example, centrally dispatching, a fleet of vehicles (the AVs in this case) following the system-optimal pattern can indeed improve overall traffic flow. In theory, the improvements may be as high as 2.15 times, which is astonishing. This article provides a methodological framework to concurrently model AVs navigation as a SO traffic pattern with UE traffic patterns of conventional vehicles (non-AVs). Numerical applications using methods such as Variational Inequality, Complementarity, or fixed point are worthy of far more investigation. At the same time, providing an agent-based micro-simulation formulation for the integration of AVs and non-AVs following the SO and UE principles should be the subject of further studies. Such agent-based modelling can then be utilized in real-time traffic management.

2.1.2 Current challenges in autonomous driving

The paper investigates the different level of driving automatization and its effects on the environment and safety with insights of how important are the regulations and moral aspects of these technologies that are taking quantum steps into the future, minimizing driver's role in driving their vehicle to being excluded. The article presents difficulties such as faster decisions making, driving habits that can reduce environment pollution, and the gap between current regulation and the self-driving technology. The articles expect significant number of autonomous vehicles (AV) by 2030 without an idea of how they'll handle unexpected and extreme occasions, for which development are divided between solely relying on sensors and improvement on infrastructure to help decision making. The article highlights the importance of mechatronic in AV indispensable and integral it is to the AV industry. The article stresses on the reasonable expectation of AV surpassing current vehicle.

2.1.3 The autonomous car—a blessing or a curse for the future of low carbon mobility? An exploration of likely vs. desirable outcome

In light of the autonomous vehicles (AV) phenomenon that started to take place in Europe and all over the world, the article addresses the large focus by researchers and development on the ‘autonomous’ rather than the ‘car’ element. Not neglecting the opportunities and improve mobility system there are high risks of high cost and high carbon emissions as well. By the use of elements such as Low Carbon Mobility (LCM), this article aims to find the gap between the desirable and the likely outcome in developing AV and how it would be possible to reduce it. The article emphasizes on the how AV can be a blessing by taking into account the social change and global empirical evidence with forecasts in technology development of AV. The article provides a comprehensive view of the importance of taking in consideration low carbon mobility when with overwhelming excitement in the development of AV.

2.1.4 Autonomous cars: Recent developments, challenges, and possible solutions

With the current development pushing of internal combustion engines cars, the article stresses that AV are still taking a very slow steps into the bigger picture, with all of the large amount of resources spent in the very beneficial AV development, the technology is still in gathering space. While the future of the technology is very ambitious, difficulties in technical, non-technical and legal challenges must be overcome to achieve the astonishing future. The article acknowledges the fact that with all the phenomenal progress already been made in AV development, it is still not possible to definite a year in which AV will be fully available to public.

2.1.5 Exploration of issues, challenges and latest developments in autonomous cars

The article at first emphasizes on the major latest growth in autonomous (AV industry following the development in computing, communicating and other technologies, which made many cars manufacturer spend huge resources in developing AV to prepare for the near future. However, challenges from security and privacy to consumer satisfaction and real-time implementation are hindering element to achieve this goal. This article provides comprehensive overview of the latest developments in AV and addresses the challenges to the progress of AV implementation. This article highlights the researches needed to be focused on such as computer vision using deep learning, decision-making using machine learning, navigation, planning, control, perception, blockchain technology, cloud

infrastructure integration, A number of real-life tests that have been conducted. Furthermore, the article discussed essential technologies in AV such as AI decision-making-based path planning, layered architectures, cyber threat protection mechanism, and the use of blockchain for transaction. The article concludes that many areas and aspect are yet to be researched in AV to obtain the needs of the current AV era.

2.1.6 Autonomous Car: Current Issues, Challenges and Solution: A Review

The article starts with highlighting the fact that from 1920 until the present day, autonomous vehicles (AV) has been proven to be in high demand in all areas especially in military-based technology offering advantages that were realized through researches and development in AV. This paper presents review on challenges such as human behaviour and liabilities, in which companies like Google and Mazda were able to provide successful solutions in some areas. The article outlined that until such challenges are solved fully AV will not see the light of day, but with current development discussed they have a predictable future. Academic researches on the potential effects of AV discussed thoroughly in this article which proved lower costs compared to the alternative automobile, with keeping in mind the challenges that must be overcome beforehand. The article highlighted and examined historical challenges and compared it to existing achievements with an insight to the future prediction on AV technologies.

2.1.7 Autonomous vehicles: theoretical and practical challenges

The expectation of the AV technology revolution remains to be highly anticipated especially in terms of challenges such as accidents and congestions. But with the obstacles and difficulties grows it will take time for AV manufacturers to launch driverless cars in the foreseeable future. Researchers have made significant progress in addressing these challenges, but very essential aspects such as detection of obstacles variance and cooperatively behaviour of the vehicles aren't efficiently addressed yet. This article provide insights on the findings reached and propose a frame work that can help addressing in the future studies.

2.1.8 A Review on Autonomous Vehicles: Progress, Methods and Challenges

The article emphasizes on the obvious popularity lately on AV technology, but it stresses on the difficulty of designing accurate position technologies to achieve safe and reliable intelligent AV. The article is clearly optimistic on the AV full distribution by carmakers in the near future especially that AVs with Level 3 automation are in fact ready for formally commercialization.

2.1.9 A Survey of Autonomous Vehicles: Enabling Communication Technologies and Challenges

The incline in car accident cases lately is hardly neglectable, in UK more than 25k deaths related to cars accident have been recorded in 2019. The article investigates into how AV technology are crucially important to reduce these cases through the development of hight tech sensors and well-established communication system. Studying through various communications options for AV, the study highlighted that the use of technologies such as 5G are the most favourable for AV communication for its long area of support and hight tech qualities.

2.1.10 Safety challenges for autonomous vehicles in the absence of connectivity

AV technology major distribution are highly anticipated for their promising effortless driving experience. However, safety aspect remains the most important anticipated factors, with 94% reduction rate in crashes caused by human error as claimed by the AV manufacturers, the communication between AV that currently available is not effective enough which can be fatal in crashes now and in the future if not implemented effectively. The articles investigate on the importance of communication in AV technology and how strongly it can increase the safety in driving experience.

2.2 Articles Table

Article Title	Authors	Publication Year	Limitation
Autonomous vehicles: challenges, opportunities, and future implications for transportation policies	SA Bagloee, M Tavana, M Asadi, and T Oliver	2016	More statistical data required to support the article argument.
A Survey of Autonomous Vehicles: Enabling Communication Technologies and Challenges	M. Nadeem Ahangar, Qasim Z. Ahmed, Fahd A. Khan, Maryam Hafeez	2021	Additional communication options could have been covered, with focus on the safety aspect of these options.
A Review on Autonomous Vehicles: Progress, Methods and Challenges	Darsh Parekh, Nishi Poddar, Aakash Rajpurkar, Manisha Chahal, Neeraj Kumar, Gyanendra Prasad Joshi, and Woong Cho	2022	The article has an overestimated optimism on the AV distribution without providing enough data to support that.
Current challenges in autonomous driving	I Barabás, A Todoruț, N Cordoș, and A Molea	2017	The article doesn't include Hybrid AV. And there is exaggerated criticize on the regulation challenges, with less focus on the AV industries themselves.
Safety challenges for autonomous vehicles in the absence of connectivity	Akhil Shetty, Mengqiao Yu, Alex Kurzhanskiy, Offer Grembek, Hamidreza Tavafoghi, and Pravin Varaiya.	2021	The article underrate the other various causes of cars crashes that has to be properly addressed in AV technology.
The autonomous car—a blessing or a curse for the future of low carbon mobility? An exploration of likely vs. desirable outcome	Nikolas Thomopoulos ¹ , and Moshe Givoni	2015	The article should've explained the cost related in low carbon mobility, and how to overcome that
Autonomous cars: Recent developments, challenges, and possible solutions	Sehajbir Singh, and Baljit Singh Saini	2021	The article is showing significant underestimation of the current development of AV.
Autonomous vehicles: theoretical and practical challenges	Margarita Martínez-Díaz, Francesc Soriguera	2018	The article lacks an effective scope and focuses on various topics and aspects instead.
Autonomous Car: Current Issues, Challenges and Solution: A Review	RGS Deemantha, and B Hettige	2023	Not enough data and evidence discussed to support the article review.

Chapter 3

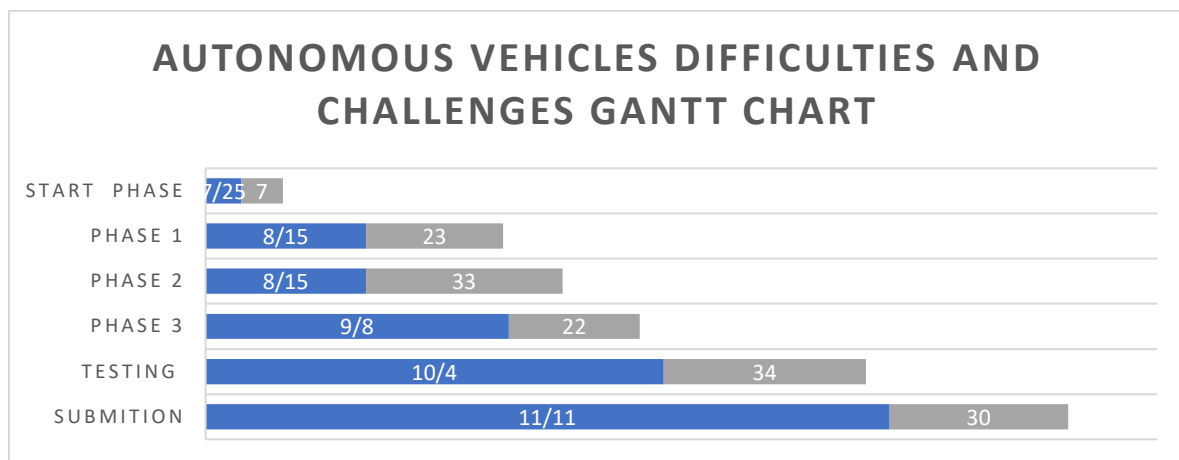
3.1 Research Methodology

Throughout this research it has been clearly shown the importance of collaboration between AV technology manufacturers all around the world to share all statistics and insights and latest development between all parties involved. Designing a well-established data centre well have a very big impact on the future of this technology to prevent or at the very least lower potential problems and improve the AV technology collectively. This data centre will have the responsibility to keep providing data and statistics of the current and the upcoming difficulties and challenges, with also providing solutions that can overcome such issues.

3.2 Expected Outcome

The study aims to provide AV manufacturer easy access to all required data to improve AV development, which will ensure that the AV technologies can thrive and majorly distributed throughout the world. Having such technology will definitely impact the daily life of every car driver in terms of safety first as AV technology will heavily lower car accidents caused by human error, and it will provide an amazing effortless driving experience.

3.3 Gantt Chart



References

- [1] Goodwin P, van Dender K (2013) BPeak Car[^]—themes and issues. *Transp Rev* 33(3):243–254
- [2] Kanade T, Thorpe C, Whittaker W. Autonomous land vehicle project at cmu. In: *Proceedings of the 1986 ACM Fourteenth Annual Conference on Computer Science, CSC '86*, (New York, NY, USA), pp. 71–80, ACM, 1986.
- [3] RGS Deemantha, B Hettige (2023) Autonomous Car: Current Issues, Challenges and Solution: A Review