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Review and Analysis of Autonomous Vehicles - Current State and Challenges

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ABSTRACT

Vehicles that can function independently of human control are known as autonomous vehicles. They detect their surroundings, make judgments, and steer clear of danger using a network of sensors and cameras fed data by complex computer algorithms. The findings of this study summarise the present status of autonomous car technology and its ramifications on society. The paper begins by discussing the different types of autonomous vehicles and the sensors and technologies used to enable their operation. It then examines the challenges that must be overcome to achieve widespread adoption of autonomous vehicles, including safety, regulation, and public acceptance. Finally, the paper also explores the potential benefits of autonomous vehicles, such as improved transportation efficiency, reduced traffic congestion, and improved accessibility for people with disabilities.

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Introduction

Autonomous vehicles, also known as self-driving cars, have been a topic of research and development for several decades. These vehicles can be used for various purposes, such as transportation, delivery, and mining. Some examples of autonomous vehicles include self-driving cars, drones, and robots. They are still under development and testing but are expected to be widely used. Autonomous vehicles could revolutionize transportation, delivery, and other tasks. However, before autonomous vehicles become mainstream, several issues must be resolved. This study examines autonomous vehicle technology, its potential effects on society, and the obstacles to widespread adoption.

Background

Pendleton and coworkers (2017) claim that the idea of automating vehicles dates back to 1918. General Motors made the original idea in 1939 [1]. The technical developments that led to modern AVs started with the invention of cruise control in 1948 [2]. Since their inception, AVs have benefited from the steady march of technological progress over the last seven decades. Advanced information technology businesses, like Google, began developing autonomous cars in 2009 and unveiled them in 2010 [3]. Vehicle manufacturers have been heavily engaged in R&D efforts to further the evolution of AV. Volvo plans to release its first AV to the market in 2021, while competitors such as BMW, Audi, Nissan, and Mercedes-Benz are trying to do so by 2020 [4]. Many things, including laws and regulations, will need to change drastically to achieve these specific car industry objectives.

Review of the Literature

According to a study conducted by growing populations increase the need for transportation, creating difficulties with congestion, pollution, and accidents that affect mobility, particularly in densely populated areas [5-6]. Governments must carefully organize transportation systems to tackle traffic flow and mobility issues [7]. also forecasted the future automation of both private and public transportation [5-6]. City infrastructure will be substantially impacted by automation, necessitating a fundamental overhaul [8]. As the shift from manual to autonomous driving continues, there is more interaction between AVs and infrastructure.

Mobility is one of the significant challenges of modern society that is discussed worldwide, according to [9]. As a result, AVs are anticipated to play a significant role in the new transportation system, making them the most well-liked study issue in recent history and a topic of interest for projects involving automotive research and development. AVs will impact society, the transportation network, and urban mobility [10]. Several issues need to be worked out before AVs can be widely used, such as the impact of autonomous driving on mobility patterns, human-machine interaction, and safety [11]. Deployment of AVs will change the makeup of cities in ways whose effects on people's lives are unclear at this time [12].

concluded that AVs could improve mobility for older people and those with special needs, minimize resource consumption, decrease parking needs, and negatively impact the environment [13]. However, another objective of AVs is safety, and concerns about privacy infringement and safety issues still need to be resolved. For instance, considering AVs entail individuals delegating jobs and making decisions to computers, it is unknown what disruptions they may bring about in society.

Types of Autonomous Vehicles

Authorities from Europe, America, and Australia developed the Society of Automotive Engineers (SAE) International Standard in 2017 as a standard vocabulary for describing AV capabilities.

The following are the six levels that the SAE has identified.

i. No Robotic Processes Allowed (Level 0) The vehicle's speed, direction, braking, and throttle completely control the driver.
ii. Automation tailored to individual tasks (Level 1) Features such as electronic stability control, and precharged brakes are automated.
iii. Some robotics assistance (Level 2) Human drivers are still responsible for maintaining awareness of their surroundings and responding appropriately, but the technology helps with steering and speed control.
iv. We still have partial autonomy in our vehicles (Level 3). In some situations, the driver may trust the car to monitor the road and traffic ahead for any changes that might need them to retake control.
v. Highly Automated (Level 4): This is like Level 3, but there is no need for a person to take control of the vehicle while it is in automated mode.
vi. Fully automated driving system (Level 5) An advanced system allows the car to keep an eye on the road and handle everything from steering to braking on its own, without human intervention.

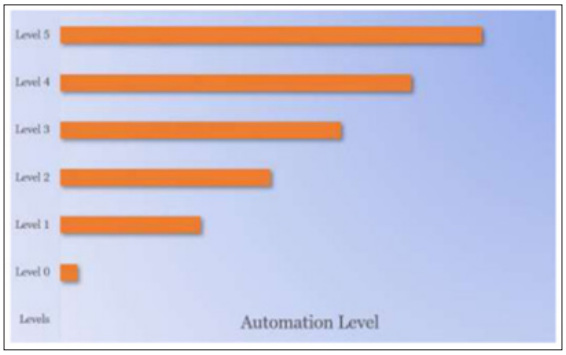

Figure 1: Graphical Representation of Autonomous Vehicles (Adapted from Singh & Saini, (2020))

Comparison

Table 1: Comparison of Literature Review

Related Works	Topic	Key Contribution	Limitations
[14]	Autonomous vehicles: scientometric and bibliometric review	This study uses keyword analysis to investigate AVs' development, traits, and trends, each distinguished by burst strength. Using the CreateSpace program, we can determine 96 broad areas.	WoS not be identified as a place to look for information. In addition, the keyword search may include terms specific to certain automobiles.
[15]	A Survey of Autonomous Driving: Common Practices and Emerging Technologies	This research uses tools and datasets for autonomous driving to compare themes, including relevant object and image detection applications, system design, and societal effects.	The algorithms under review lacked precision and efficacy. Therefore, collaboration among academic institutions is necessary to advance new technologies.
[16]	Autonomous Cars: Study, Outcome, Problems, & Coming Problems	The applications and design difficulties are divided into sections in this research, including cost, software complexity, creation of digital maps, simulation, and validations.	Only the social or non-technical aspects of autonomous driving are examined in this research.

Challenges in the Widespread Adoption of Autonomous Vehicles

Autonomous cars will disrupt everyday life and society, but numerous challenges must be solved before being extensively deployed [17].

i. Cyberattacks might be possible against autonomous vehicles. To ensure data protection, reliable security procedures that cover several automakers and cloud-based communication systems are required [18]. If the security issue is not resolved immediately, it might prevent the widespread use of driverless vehicles. The current regulations governing data use and legal problems are insufficient, raising data ownership and privacy challenges [19].
ii. Giving a machine complete control causes people to hesitate. Therefore, determining a smooth transition from "automatic" to "full" driving is difficult. The difficulty that, when overcome, will permit the progressive acceptance of technology in automobiles that will ultimately become autonomous is the creation of a collection of new help systems and a framework that determines the control delegation level under different circumstances.
iii. New rules and regulations must be formed or updated before autonomous cars may be used on public roads. There have been self-driving vehicle experiments on public roads recently, but no legislation has been introduced to regulate the technology.
iv. Technological progress: The objective is to enhance autonomous vehicle technology to adjust to circumstances [20]. Autonomous vehicles rely on hardware like cameras and sensors to navigate. Still, they may run into the same problems that human drivers experience on the road (such as dense fog, heavy rain, or snowfall).

Sensors and Technologies

Autonomous vehicles rely on a complex array of sensors and technologies to enable their operation. Cameras are a crucial kind of sensor for autonomous cars. Cameras record the scene, and computer vision algorithms evaluate the data to find and label things like other cars, pedestrians, and traffic signals. Lidar is a kind of sensor that plays a significant role in autonomous vehicles. Light Detection and Ranging (Lidar) is a technique that employs lasers to produce a three-dimensional map of an area by

determining how far away particular objects are from one another. Lidar is particularly useful for detecting objects at a distance and in challenging lighting conditions, such as dark or fog.

Global Positioning System (GPS) is an essential technology in autonomous vehicles. GPS provides the vehicle's location, speed, and heading, which the vehicle's navigation system uses to plan its path. In addition, Ultrasonic sensors are another essential technology used in autonomous cars. These sensors detect and measure distance with sound waves [21]. They help detect nearby curbs, parked cars, and pedestrians. Finally, inertial Measurement Unit (IMU) sensors measure vehicle orientation, angular velocity, and linear acceleration. It tracks and balances the vehicle in real-time.

Conclusion

Despite significant technological advances from autonomous vehicle manufacturers, it will be quite some time before these vehicles are widely accessible to the public. It may be too early to provide a firm-year estimate. Some estimates put 2035 as the possible cutoff year for fully autonomous vehicles. We need to be prepared to make use of this new technology. It is also essential to find solutions to the problems we identified above to advance the technology without hiccups. This article should serve as a valuable primer for anyone interested in autonomous car technology [22-25].

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