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The Impact of Artificial Intelligence on Product Development in the Autonomous Driving Cars Industry

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Abstract

With the continuous development of modern technology, autonomous driving technology is becoming more and more mature, and people's demand for autonomous driving is increasing. At the same time, artificial intelligence technology has also made certain progress. Artificial intelligence can help further develop autonomous driving technology to meet people's expectations. This report explores the impact of artificial intelligence technology on autonomous driving technology to gain a deeper understanding of these two technologies and promote the development of autonomous driving technology. Autonomous driving technology can bring a lot of convenience to people's lives, but at the same time, there are also many risks. Therefore, we need to approach this technology rigorously to minimize the occurrence of accidents. Artificial intelligence technology can bring help and support to autonomous driving technology in many aspects to achieve our goals. Autonomous driving technology can meet the driving needs of many people. For example, autonomous driving cars can help some disabled people who want to drive on their own, as well as those who want to save energy but don't want to drive on their own. Artificial intelligence technology can help autonomous driving technology achieve more functions, and the development of autonomous driving technology can meet the needs of the times and promote social development, bringing a lot of convenience to people's lives.

Keywords

artificial intelligence, autonomous driving, vehicles

1. Introduction

In the digital age, the automotive industry is undergoing profound changes and transformations, with autonomous driving being a crucial aspect and artificial intelligence becoming a key driving force. Modern vehicle design is becoming increasingly complex, and consumers' demands for safety, comfort, and intelligent functions are growing, as well as the need for more efficient manufacturing processes, all of which are driving the widespread application of artificial intelligence in the automotive industry. AI has not only fundamentally transformed the traditional automotive manufacturing industry, but also redefined the concept of driving, creating new possibilities for future development. This study investigated the automatic driving technology

related to artificial intelligence, the benefits of artificial intelligence technology to automatic driving technology, and people's attitudes towards autonomous cars [1].

2. Industrial Background

Grey combined the results of various research reports, and claims that by 2030, the market value of autonomous vehicle will reach 87 billion dollars [2]. According to it, by 2030, there will be no use of level 4 and 5 vehicles. 92% of the market share will be for level 2 cars, with the remaining portion for level 3 cars. It further emphasizes the research findings from Allied Market Research, which suggest that the relevant market may grow from $54.23 billion in 2019 to $556.67 billion in 2026 at a compound annual growth rate of 39.47%. It also predicts that Europe's compound annual growth rate will reach its highest point between 2019 and 2026, at 42.6%. By 2035, 25% of total car sales will be autonomous vehicles, with partial autonomous driving accounting for 15% and fully autonomous driving accounting for 10%, compared to 12.4% in 2025. At present, the utilization rate of autonomous vehicle is not very high [2].

Most industry experts believe that the main market for autonomous vehicle will be in North America. In addition, the research shows that the market leader of autonomous vehicle will be the United States. However, McCarthy analyzed the research and indicated that there are other countries that want to develop and deploy autonomous vehicle more than the United States [2]. The Netherlands has the highest level of readiness for autonomous driving. A survey ranked relevant aspects of each country based on 26 different variables, which are divided into four types: policy and regulation, technology and innovation, infrastructure, and consumer acceptance. The Netherlands ranks first in the rating based on advanced infrastructure, strong government support, and a strong passion for electric vehicles. Singapore ranked second among them after it revised its Road Traffic Law to allow autonomous vehicle to conduct relevant tests on its streets. The United States ranks high in this ranking due to its large number of testing programs and having the most companies developing autonomous driving technology. It has great advantages in technology and innovation, but it does not have advantages in infrastructure improvement and consumers' adoption of autonomous vehicle [2].

3. Research Objective

This paper discusses the influence of artificial intelligence on autonomous vehicle by analyzing the technology closely related to autonomous vehicle, discusses the relationship between the two, and promotes the further maturity of autonomous vehicle related technology.

At the same time, it discusses people's attitude towards autonomous vehicle and the shortcomings of current autonomous vehicle technology, so that autonomous vehicle can better meet people's requirements.

4. Theoretical Background – AI in Autonomous Driving

4.1 Artificial Intelligence Technology

Professor McCarthy, the father of artificial intelligence, created the concept of artificial intelligence at the first academic conference at Dartmouth University in 1956 and defined it as "the science and engineering of manufacturing intelligent machines, especially intelligent computer programs" [3]. Artificial intelligence is a method that enables computers or software to think in a way that is close to the level of human thinking, originating from science such as mathematics, statistics, and biology, as well as algorithms and models. Russell & Norvig pointed out that artificial intelligence can be defined by eight definitions, which can be divided into four categories: human thinking and rational thinking related to thinking and reasoning, and human behavior and rational behavior related to behavior [3]. As various goals and methods are used to define artificial intelligence, these studies are effective as AI can obtain a working definition through the final research objective, as it can emphasize the "big picture" of intelligent systems [3].

4.2 Autonomous Driving Technology

The basic principle of autonomous vehicle is a passenger car that can drive itself without human manipulation. Autonomous vehicle is also known as driverless vehicle, next-generation vehicle or automated

guided vehicle. The automation system implemented in them can effectively reduce fuel consumption by reducing road congestion, thereby reducing exhaust emissions to protect environmental sustainability. It can also provide more convenience for the elderly and the disabled, and minimize accidents to prevent serious accidents, thereby helping to change and optimize the transportation system. According to the SAEJ3016 standard defined by the American Society of Automotive Engineers (SAE International), six levels of autonomous vehicle is being defined, of which Level 0 has not achieved automation at all, and human drivers do all kinds of work on their own driving. The main reason for the design of autonomous vehicle is to help people achieve functions that cannot be achieved by their own driving, such as improving the driving ability of drivers when they are tired, and the ability to accurately plan travel related plans [3].

4.3 AI Defines Automotive Theory

The content of AI defined automotive theory includes proposing a new vehicle classification: AIDV. It refers to AI autonomous reasoning as a structural component of vehicles, enabling them to independently mediate interactions with other entities and extend the vehicle's operating surface to other road users through continuous information exchange.

4.4 Interaction Driven Multi-agent Emergence Theory

AIDV is a system where behavior originates from a continuous learning process and dynamic interaction with external participants. This theory suggests that driving and collaborative strategies emerge as a result of continuous interaction between multiple AI agents, rather than being determined by fixed programs.

5. Literature Review

5.1 The Benefits Brought by Artificial Intelligence to the Autonomous Driving Industry

The rule-based control method faces fundamental limitations in autonomous driving: the rule system requires engineers to exhaustively search for all possible driving scenarios in advance, but the real road environment has infinite diversity, and no rule library can fully cover it, resulting in the system directly failing without defined rules. The perception scheme based on physical models is extremely sensitive to sensor accuracy and atmospheric conditions. When the camera encounters strong backlighting or rainy weather, the signal-to-noise ratio in the physical imaging model drops sharply, leading to feature extraction failure; Lidar generates a large amount of noise and echo attenuation in the physical wave propagation model in rain, snow, sand and dust, resulting in severe degradation of point cloud data quality. The electromagnetic wave reflection characteristics of millimeter wave radar on stationary metal objects cause a sharp decrease in its Doppler effect, resulting in missed detection of stationary targets. The planning method based on high-precision maps and predefined trajectories, once encountering temporary road changes, construction diversion, or environmental changes after map collection, conflicts between pre-stored information and the actual environment, the system cannot operate safely due to the lack of online adaptive capabilities. The error propagation theory in modular architecture states that the perception, prediction, decision-making, and control modules are sequentially connected in series, and the small errors in the previous stage will be amplified step by step in the subsequent modules, ultimately causing the control instructions to deviate from the ideal value by more than an order of magnitude. Finally, when the physical response delay (brake build-up time, upper limit of steering angular velocity) in vehicle dynamics and control delay theory is combined with a fixed parameter PID controller, it cannot maintain stability at different vehicle speeds and road adhesion coefficients, and is prone to overshoot or oscillation.

Autonomous vehicle is affected by artificial intelligence technology from the initial coding stage to the post implementation maintenance stage. The benefit is that artificial intelligence can significantly reduce the occurrence of traffic accidents by reducing errors caused by human operation, thereby making road traffic and driving safer. Platooning and planned more efficient driving routes can reduce congestion and improve traffic and transportation efficiency. People with physical disabilities or abilities, such as the elderly, can gain stronger mobility and approach the level of normal driving. Optimizing driving can reduce fuel consumption and exhaust emissions, thereby promoting sustainable environmental development. Passengers can enjoy their travel time more effectively and improve service efficiency and delivery levels [4]. With the full auto drive

system/auto drive system, autonomous vehicle can respond to the internal and external conditions managed by human drivers in a safe and regulated manner. SAE International and other industry experts have released a new visual chart for their J3016TM "Driving Automation Level" standard, which defines six levels of automotive driving automation from not achieving automation to fully achieving automation [5].

Artificial intelligence is the backbone of modern autonomous driving technology, with various technologies such as machine learning, deep learning, and computer vision enabling vehicles to perceive and interact with their environment. The main function of ML algorithm is to train a pattern that can recognize and analyze large amounts of data through autonomous systems, enabling it to make real-time strategies based on the collected data. Deep learning is a subset of machine learning that plays a crucial role in promoting environmental object detection and classification, enhancing its ability to recognize pedestrians, vehicles, and road signs in the environment. The visual data obtained from the camera will be analyzed and processed by computer vision algorithms, and the captured images will be converted into information that can be used for relevant operations, enabling vehicles to safely drive in complex environments. These artificial intelligence technologies work together to enable autonomous vehicle to learn, adapt to the environment and respond dynamically to traffic conditions, road conditions and unpredictable events.

Light detection and distance measurement (LiDAR) technology can generate more detailed 3D maps, enabling autonomous vehicle to accurately detect and avoid obstacles. The radar improves the ability of the vehicle to cope with severe weather conditions, such as fog and rainstorm, while the response effect of the laser radar may be poor. Cameras can capture high-resolution visual data, which is crucial for identifying and analyzing road signs, lane markings, and other important visual cues. With the joint action of these sensors, autonomous systems can operate more reliably in various situations, enabling them to integrate the advantages of each technology and compensate for the limitations of each technology itself [6]. The logic of traditional multi-sensor fusion is simple superposition-concatenating data from LiDAR (AT1440, ETX, etc.), camera (STURDeCAM88_CUOAGX, 70mai 4K T800, etc.), and millimeter wave radar (8T8R 4D millimeter wave radar, Tianqiong Insight Radar, etc.) after time alignment. However, as the complexity of AI systems increases, a fundamental problem arises: the system can make the right decision, but cannot explain why it made that decision. Explainable artificial intelligence can change this aspect. The latest research systematically reviews the intersection of multi-sensor fusion and XAI, pointing out that existing fusion technologies have made significant progress in enhancing AV perception, but the main challenges remain the lack of transparency and interpretability. The study emphasizes the need to seek a balance between performance and interpretability, especially in high-risk applications where real-time interpretability must be provided to stakeholders without sacrificing security or accuracy.

Deep learning theory enables models to automatically extract hierarchical features from massive driving data, even in the case of sensor degradation (such as dirty or low light camera lenses), while maintaining perceptual robustness with redundant features, traditional physical models will directly fail under this condition. The generalization theory of neural networks shows that well trained deep networks can make reasonable inferences in out of distribution scenarios, solving the inherent problem of traditional rule systems being unable to cope with rare scenarios without defined rules. The end-to-end learning framework reduces the loss of information transmission and human rule design errors between perception, decision-making, and control modules, while in traditional modular architectures, errors at each level accumulate and amplify layer by layer. Reinforcement learning theory enables the auto drive system to learn the optimal strategy independently in the interaction with the environment, without the need to manually write control rules explicitly for each situation, especially for continuous decision-making problems such as lane keeping and adaptive cruise. The data closed-loop and continuous learning mechanism enables the auto drive system to continuously mine difficult cases and edge scenes from actual operating data, and achieve self-iterative optimization through active learning and model fine-tuning. This ability is not available in traditional control methods that rely on static rules and predefined parameters. Finally, the combination of deep reinforcement learning and adaptive control theory allows the controller parameters to be dynamically adjusted based on contextual information such as vehicle speed, road conditions, and adhesion coefficient, thereby maintaining stability under different operating conditions and overcoming the overshoot and oscillation problems of fixed parameter PID controllers facing nonlinear dynamic systems.

5.2 People's Attitudes Towards Autonomous Driving Technology

The negative asymmetric effect in the trust dynamic model shows that a serious accident or obvious mis-operation (such as sudden braking of shadows) can cause a sharp decline in user trust, and the difficulty of recovery is much greater than that of initial establishment. The theory of mental models and interpretability states that a system that does not provide any explanation for lane changes or deceleration can prevent users from establishing a correct mental model, leading to feelings of uncontrollability and anxiety. The theory of psychological resistance suggests that in high-risk scenarios such as ice, snow, or mountain roads, users experience a sense of control deprivation due to the inability to directly control the vehicle, significantly reducing their willingness to use it. The theory of situational awareness and takeover time budgeting reveals that when a system issues a takeover request during a sudden danger, users are unable to restore situational awareness within seconds due to prolonged passive monitoring, which can easily lead to takeover failure and loss of confidence. The social amplification effect and risk perception theory indicate that repeated media coverage of accidents can form a social consensus that "autonomous driving is unsafe" and suppress individual acceptance. The learning curve and initial adaptive barriers mean that users need to spend a high learning cost to grasp the boundaries of trust and takeover. Once the initial use is frustrated, they may give up continuing to use.

Buchholz put forward a survey result on Statista about consumers' trust and safety in autonomous vehicle in six countries. Generally speaking, despite the slow growth rate, people's trust in the safety of autonomous vehicle has improved in the first three years. The continuous development and progress of related technologies have increased the level of trust in this technology among people in South Korea and Japan. However, accidents of autonomous vehicle, such as Tesla, have caused people to question the safety of this technology. This concept is demonstrated in changes in acceptance. The Chinese people have been constantly accepting the technology of autonomous vehicle, so the proportion of suspicion has declined to a certain extent in the first three years. However, in 2020, technical issues reappeared in the country, and India was no exception. According to the level of technology related to autonomous vehicles in markets around the world, people's interest in this technology varies. Consumers in China and India seem to be most interested in the technology of autonomous vehicle and related concepts, but German consumers seem to be suspicious of the technology of driverless cars. Although China and the United States have increased their interest in fully autonomous vehicle technology since 2014, the situation in other countries in the global market is not the same. The interest in these markets is either stable or declining. In terms of intergenerational interest, Y/Z generation consumers are more interested in the technology of fully autonomous vehicle. At present, the safety of autonomous vehicles has always been a concern for consumers. If the reliable record of safe driving of autonomous vehicle on the road is found, or the technology is proposed by an enterprise trusted by the public, these will enhance consumers' support and trust in this technology [2]. Software holds a significant position in this industry. Although not all software used in the automotive industry is safety critical, the code used to implement functional operations must be safe and reliable. The quality of software should be carefully checked, and relevant regulations on software security should be followed [7]. Only in this way can we increase public trust in this technology.

6. Discussion-Limitation of AD

Through this research, it can be concluded that artificial intelligence technology can bring many benefits to the development of autonomous vehicle. But at the same time, autonomous vehicle still faces many challenges to be solved. Autonomous vehicle tries to reduce errors caused by human driving by using electronic control units, route planning, global positioning system, 3D maps, light detection and distance measurement and other technologies, so as to make driving safer and optimize traffic flow. Safety and security are challenging tasks in the audio-visual field that require continuous research to solve.

The safety problems in the safety system of autonomous vehicle include the safety of electrical and electronic related systems and the safety of mechanical systems. Network and physical security systems are security issues in the security system of autonomous vehicle. The safety of autonomous vehicle includes protecting the vehicle from attack and preventing the vehicle from collapsing accidentally due to accidents. The multi-sensor autonomous vehicle can sense the attack in advance and deal with the corresponding situation. Autonomous vehicle can avoid attacks and accidents by changing the direction of the vehicle. In the safety

system of autonomous vehicle, how to apply deep learning technology is a problem that needs to be considered. We are working hard to make the security of our features more closely aligned with the computing intelligence community. For example, the correlation analysis and calculation of autonomous vehicle and their moving travel time series need to be conducted through in-depth learning, so that the feasibility of their operation can be reasonably and accurately predicted. The future development trend of autonomous driving as a highly efficient closed system can be predicted through deep learning.

Deep learning is a very important technology, which plays an important role in the realization of autonomous vehicle. For example, it can answer physics questions and recognize and analyze photos in Google lenses. It can also predict the relevant behavior of vehicle driving and accurately identify objects on the road around the vehicle. It has strong adaptability and can be used almost unrestricted in any situation. Accurately locating the position of objects in the external environment and detecting and classifying them is difficult, which can reduce perceptual errors. An arduous task in the safety of autonomous vehicle is to solve the problem of perception errors. A precise, stable, and effective decision-making system can quickly and comprehensively make decisions based on the surrounding environment. Strict and thorough software and hardware testing should be conducted to reduce decision-making errors. Observe the system's response in different environments and situations to avoid failure. The most concerned problem of relevant staff is the network security of autonomous vehicle, and how to conduct wireless communication safely. Safety and security are important issues, and the quality of these situations can greatly affect the public's perception and attitude towards new audiovisual technologies. The accuracy of the data obtained by sensors as input signals affects the performance of artificial intelligence technology. The input obtained by artificial intelligence technology is influenced by sensors. V2X technology can connect vehicles with devices and other objects on the road. Protecting privacy and maintaining secure communication are important concerns for relevant parties. The continuous increase in code lines has prolonged the software update time, requiring the use of specific mechanisms to address this issue [8].

7. Conclusion

This study illustrates the impact of AI technology on autonomous driving cars, the public's attitude towards autonomous vehicle and the challenges faced by autonomous vehicle in their development. With the increase of the number of cars, the traffic flow and exhaust emissions continue to increase, resulting in great problems. Autonomous vehicle can effectively optimize the traffic flow and reduce exhaust emissions, protect the sustainable development of the environment, and also help the disabled or people who want to make full use of driving time to obtain a better driving experience. Artificial intelligence technology is a very important part in the design of autonomous vehicle. The use of artificial intelligence technology can help autonomous vehicle save more programs. Artificial intelligence related technologies can help autonomous vehicle achieve more functions and improve existing functions, such as improving the perception and decision-making ability of autonomous vehicle and improving the safety of autonomous vehicle. Only by constantly improving the functions of autonomous vehicle and improving their stability can we improve the public's attitude towards autonomous vehicle. At present, autonomous vehicle still face many challenges, such as perception error, decision-making error, insufficient security privacy and other issues. Solving these challenges can help autonomous vehicle reach a higher level. Therefore, we should correctly use artificial intelligence technology to constantly improve the relevant functions, including perception of autonomous vehicle, perception of autonomous vehicle, safety and user privacy protection. Such improvement could increase public trust, support and expectation.

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