Explore the Application Status of Automatic Driving and Legal Gaps

Runze Wang[a]
The Business, Computer Science and Applied Technologies Division,
De Anza College 21250 Stevens Creek Blvd, Cupertino, CA 95014, U.S.A.
Wangrunze2.fhda.edu

Keywords: Automatic Driving, Law, Current Situation.

Abstract: With the development of AI, autonomous driving technology is becoming more and more mature. This article will explore the advantages and challenges of autonomous driving and explore the differences between autonomous driving and traditional driving. This article concludes that most traffic accidents are caused by subjective factors of the driver, such as drinking and lack of concentration. Autonomous driving can undoubtedly reduce the incidence of cases where these subjective factors lead to traffic accidents. However, although there have been many studies on the safety of autonomous driving, the discussion on ethical issues and legal responsibilities is still insufficient. In most of the cases of traffic accidents related to autonomous driving in China, most of them still cause controversy, and there are still many gaps in the formulation of legal provisions on autonomous driving. In summary, the significance of this article is to summarize the advantages and challenges of autonomous driving and combine the data of WHO to emphasize that the current legal provisions related to autonomous driving are still imperfect, to promote further research and improvement in this field.

1 INTRODUCTION

At present, the global road safety situation remains grim. According to the World Health Organization (WHO, 2023), about 1.19 million people are killed and another 20 to 50 million are injured in traffic accidents each year, with children and young people aged 5 to 29 accounting for a significant proportion. Human factors such as speeding, fatigue driving, drunk driving, and distracted driving are still the main causes of traffic accidents. With the advancement of artificial intelligence and machine learning technologies, autonomous driving has gradually become an important development direction in the global transportation field. Autonomous driving technology is highly anticipated, and many people believe that it can reduce human driving errors, improve driving efficiency, and ultimately reduce traffic accident rates. Therefore, the development of autonomous driving technology is very important (Xu, 2019).

As the global smart car industry is developing rapidly, advances in computing technology and communication mechanisms have significantly promoted the development of autonomous driving technology. Autonomous vehicles rely on perception results based on multiple sensors to make automatic decisions and control vehicle operations. The key to the success of these systems is the ability to make reliable decisions in real time (Liu et al., 2021).

However, some scholars have pointed out that the current autonomous driving technology in terms of high-precision maps still faces seven major challenges, including map models, high-precision positioning, three-dimensional reconstruction, fusion updates, data security, rapid review, and standard laws and regulations (Yang et al., 2023) .To overcome these challenges, the newly developed Transformer has achieved remarkable results in the field of natural language processing due to its powerful remote modeling and parallel computing capabilities. When extended to the multimodal trajectory prediction task of autonomous driving, it also shows excellent

[a] https://orcid.org/0009-0006-3924-3589

Wang, R.
Explore the Application Status of Automatic Driving and Legal Gaps.
DOI: 10.5220/0013681500004670

In *Proceedings of the 2nd International Conference on Data Science and Engineering (ICDSE 2025)*, pages 230-234
ISBN: 978-989-758-765-8

performance and effectively copes with related challenges. In addition, the application of the Transformer model in the multimodal trajectory prediction task shows stronger generalization ability and interpretability, which makes it have broad application prospects in this field (Huang et al., 2023).

The purpose of this paper is to explore the impact of autonomous driving technology on road safety and analyze its potential in reducing traffic accidents as well as the current challenges. The paper first introduces how autonomous driving technology can reduce accident rates through intelligent decision-making and environmental perception, and analyzes key factors that affect driving safety, such as speed, distraction, and environmental conditions. Then, the article discusses the legal gaps facing autonomous driving, including the division of responsibilities and regulatory adaptability. Finally, the future research directions of autonomous driving are summarized, focusing on how to optimize the legal framework and human-machine collaboration to further improve road safety.

2 SAFETY ANALYSIS OF AUTONOMOUS DRIVING

Autonomous driving technology has significant advantages in improving road safety. According to statistics from the World Health Organization (WHO, 2023), about 1.19 million people die in road traffic accidents each year. In addition, about 20 million to 50 million people suffer traffic accident-related injuries, a considerable number of whom are children and young people aged 5-29. Speeding and traffic violations are the main causes of road traffic deaths, and autonomous driving systems can effectively improve the overall safety level by accurately controlling vehicle speed and reducing human errors.

The occurrence of traffic accidents is affected by a variety of risk factors, among which speeding is closely related to the probability and severity of collisions. For example, for every 1% increase in vehicle speed, the risk of fatal collisions increases by 4% and the risk of serious collisions increases by 3% (WHO, 2023). In addition, the increase in vehicle speed directly affects the risk of pedestrian mortality. Studies have shown that for every 10 km/h increase in speed, the risk of pedestrian death increases significantly. For example, when the speed increases from 50 km/h to 65 km/h, the risk of pedestrian death increases by 4.5 times. At the same time, not wearing a seat belt will also increase the risk of death for occupants in the car. At a speed of 65 km/h, the risk of death for occupants in the car increases by 85%.

The application of autonomous driving helps reduce traffic accidents. Its main features include intelligent speed control, predictive driving, and reducing driver fatigue.

The autonomous driving system can adjust the speed according to the real-time road environment to avoid speeding; it predicts dangerous situations through historical data and real-time perception capabilities to avoid potential risks on time. In addition, autonomous driving reduces dependence on manual driving, thereby reducing accidents caused by fatigue, driving, or distraction.

In addition to driving behavior, other factors also have an important impact on road safety. For example, alcohol and psychoactive substances can reduce the driver's judgment and reaction speed, greatly increasing the risk of fatal traffic accidents. WHO (2023) pointed out that even if the blood alcohol concentration (BAC) is low (such as 0.02 g/dl), the risk of traffic accidents is still significantly increased. When the BAC exceeds 0.04 g/dl, the risk of accidents increases further. In addition, drivers who take psychoactive drugs are five times more likely to have an accident than those who do not take drugs (WHO, 2023).

The use of safety equipment also affects road safety. Correctly wearing seat belts can reduce the risk of death for passengers by 50% and the risk of death for children by 71% (WHO, 2023). In addition, the use of helmets has a significant impact on the survival rate of motorcycle accidents, reducing the risk of death for passengers by 63% and the risk of brain damage by 74%.

Distracted driving has become a major traffic safety issue in the modern driving environment, such as using mobile phones and in-car entertainment systems. Studies have shown that the likelihood of a collision while driving with a mobile phone is about four times that of normal driving (WHO, 2023). Although autonomous driving can reduce the impact of human distraction, the human-machine interface still needs to be improved to prevent drivers from over-relying on the autonomous driving system and causing distraction.

The current road traffic safety issues are mainly affected by multiple subjective factors of drivers, including speeding, driver fatigue, distracted driving, the influence of alcohol and psychoactive substances, and insufficient use of safety equipment, etc. These factors significantly increase the probability of traffic accidents and threaten road safety.

In this context, autonomous driving technology can be seen as a key means to improve road safety. Through intelligent speed control, predictive driving, and effective intervention in driver fatigue and distraction, autonomous driving systems can effectively reduce human errors and reduce traffic accident rates. In addition, advances in technologies such as V2X (Vehicle-to-Everything) communication, AI decision-making algorithms, and real-time environmental perception enable autonomous driving systems to more accurately judge road conditions and optimize driving strategies, thereby further improving driving safety.

Therefore, with the continuous development and optimization of autonomous driving technology, its role in improving road safety will become more and more significant.

3 CASES AND LEGAL GAPS RELATED TO AUTONOMOUS DRIVING

3.1 Advantages and limitations of autonomous driving technology

Although autonomous driving technology has shown great advantages in reducing human driving errors and optimizing driving safety with its precise environmental perception and AI decision-making capabilities, it still cannot prevent traffic accidents. Especially in extreme weather (such as fog and heavy rain) or in cases of system perception errors (such as insufficient prediction of pedestrian behavior), the autonomous driving system may not be able to make the best response, thereby increasing the risk of accidents.

Therefore, when discussing the legal liability of autonomous driving, it is necessary to clarify the division of responsibilities when an accident occurs and the criteria for its determination. At present, the legal framework for the determination of autonomous driving responsibilities in various countries is still being improved, and one of the key discussion points is the definition of the concept of "driver".

3.2 Definition of legal liability

When an autonomous driving traffic accident occurs, it is particularly important to clarify the concept of "driver". Autonomous driving technology is usually divided into six levels according to its autonomous control capabilities, from L0 (fully manual driving) to L5 (fully autonomous driving). Each level represents the degree of dependence of the vehicle on human drivers during driving. L0-level vehicles need to be driven entirely by humans, while L5-level vehicles can be driven completely autonomously in any situation without human intervention.

At present, L4 and L5 autonomous driving technologies are under intense discussion and controversy. The main feature of these two levels is that the vehicle can make driving decisions autonomously under specific environments and conditions, while the intervention of human drivers is limited. Due to the continuous development of technology, the laws and regulations of various countries have not yet fully adapted to this change, which has led to large differences in the determination of legal liability. Different countries have significantly different regulations on the identity of "driver", which directly affects the attribution of liability after an accident.

For example, in China and the European Union, the law requires that drivers still bear certain legal responsibilities in autonomous driving at levels L3 and above. This means that even in highly automated situations, drivers are still responsible for the operation of the vehicle and must be able to take over control at any time. This regulation reflects the emphasis on the ability of human drivers to intervene in emergencies to ensure safety.

In contrast, the National Highway Traffic Safety Administration (NHTSA) made a different judgment in 2022, believing that L4 and L5 autonomous driving systems themselves can be regarded as "drivers". This change in position means that as technology advances, autonomous driving systems will gain greater independence and responsibility in law. This not only changes the understanding of the legal liability of autonomous vehicles, but may also affect future legislation and policy-making processes.

In general, how to clarify and define the concept of "driver" in different levels of autonomous driving is not only a challenge that the legal community needs to face, but also an important issue that countries must solve in the process of promoting the development of autonomous driving technology. Solving this problem will play a key role in the popularization and application of autonomous driving technology, and it can also provide protection for future traffic safety.

3.3 The challenge of the social public opinion and the legal framework

In contrast to research based on existing laws, Jamy Li and colleagues at Stanford University surveyed

120 adult US citizens through two online experiments about their views on the legal liability of self-driving cars in traffic accidents. The results show that in the same accident scenario, the public views self-driving cars as less at fault than human drivers, and is more likely to believe that legal responsibility should be borne by automakers and governments, because self-driving cars themselves are not seen as independent moral agents. In addition, the study also found that the public generally believes that ethicists and automobile manufacturers should be responsible for developing ethical and legal norms for autonomous vehicles (Li et al., 2016). In line with this study, the fatal Uber self-driving vehicle accident in 2018 also exposed the current deficiencies in the identification of legal liability.

On March 18, 2018, an Uber self-driving test vehicle in Arizona, the United States, hit a pedestrian, Elaine Herzberg, who was crossing the road during a road test, killing her on the spot. This accident became the world's first case of a self-driving car causing death and quickly triggered widespread discussion on the legal liability of self-driving cars.

Alexander Hevelke believes that autonomous driving is different from traditional driving. When an accident occurs, if the driver cannot take over the car quickly, then the driver has no obligation to bear responsibility (Hevelke et al., 2015). However, this article only analyzes traffic accidents caused by autonomous driving at a moral level and has no legal basis. Siming Zhai's article also uses experimental tests to show that when an autonomous driving accident occurs, the driver often has no way to take over the car in time to avoid the accident. Siming Zhai also believes that the driver often faces great social pressure after an accident, so the user may not be responsible (Zhai et al., 2024).

At present, the legal status of autonomous vehicles is not clear, and there are certain obstacles in the application of traditional tort liability rules, which greatly restricts the development of the entire industry. In order to conform to the inherent law of the development of rights, autonomous vehicles should be endowed with independent legal personality, and the corresponding tort liability rules should be formulated according to the purpose of their use (Zhang, J., & Xiao, G., (2019)).

Nick Belay studied the different roles and division of responsibilities of manufacturers, individuals, insurance companies and legislatures in terms of legal liability in autonomous vehicle accidents. He pointed out that before driverless cars are officially put on the market, the legal system must clearly define the boundaries between "control rights" and "driving rights".

This process requires the revision of relevant legal provisions in the Criminal Law, the Road Traffic Safety Law, the Insurance Law, etc., to clarify the responsibilities of all parties and provide legal guarantees for the legal operation of self-driving cars on the road. On this basis, he further proposed that the future legal framework should take the protection of the rights and interests of car owners and passengers in the vehicle as the core, ensuring that the clarity of the law does not become an obstacle to the promotion of self-driving technology (Belay et al., 2015).

4 CONCLUSION

This paper looks forward to the future development direction of autonomous driving technology and puts forward suggestions for further research. Future research can focus on how to optimize human-machine interaction to improve the safety of autonomous driving, how to improve the legal system to adapt to the development of autonomous driving technology, and how to improve the decision-making ability of autonomous driving systems through smart infrastructure and V2X technology. Existing research shows that autonomous driving has great potential in reducing accident rates, but there is still a need to improve human-machine collaboration and emergency response capabilities.

This article believes that autonomous driving will effectively reduce the incidence of traffic accidents in the future, but it still faces many challenges such as imperfect laws and imperfect high-precision map technology. After overcoming these challenges, autonomous driving will usher in a new era. Future research should focus on the mixed environment of autonomous driving and traditional driving and explore how to optimize traffic management and laws and regulations related to autonomous driving to further improve road safety.

REFERENCES

Belay, N., 2015. Robot Ethics and Self-Driving Cars: How Ethical Determinations in Software Will Require a New Legal Framework. The Journal of the Legal Profession, 40(1), 119-155.

Hevelke, A., & Nida-Rümelin, J., 2015. Responsibility for Crashes of Autonomous Vehicles: an Ethical Analysis. Science and Engineering Ethics, 21(3), 619–630.

Huang, J., Tian, Y., Dai, X., et al., 2023. Research progress and prospect of multi-modal trajectory prediction method for automatic driving based on deep learning. Journal of Intelligent Science and Technology, 5(2), 180-199.

Li, J., Zhao, X., Cho, M. J., Ju, W., & Malle, B. F., 2016. From Trolley to Autonomous Vehicle: Perceptions of Responsibility and Moral Norms in Traffic Accidents with Self-Driving Cars. SAE Technical Paper 2016-01-0164. doi: 10.4271/2016-01-0164.

Liu, L. et al., 2021. Computing Systems for Autonomous Driving: State of the Art and Challenges. IEEE Internet of Things Journal, 8(8), 6469-6486, 15 April. doi: 10.1109/JIOT.2020.3043716.

WHO, 2023. Road Traffic Injuries. [Online] Available at: https://www.who.int/zh/news-room/fact-sheets/detail/road-traffic-injuries.

Xu, Z., Zhang, Y., Wang, Y., Song, R., Wang, R., & Zhao, X., 2019. Discussion on the development status and existing problems of China's autonomous vehicle industry. Automotive Practical Technology, 1, 13-21.

Yang, M., Jiang, K., Wen, T., Chen, H., Huang, J., Zhang, H., & Yang, D., 2023. Status and challenges of multi-source update technology for high-precision map for autonomous driving. China Journal of Highway and Transportation, 36(5), 244-259.

Zhai, S., Wang, L., & Liu, P., 2024. Engineering, 33(2), 121-132.

Zhang, J., & Xiao, G., 2019. Research on tort liability of autonomous vehicles. Journal of Shanghai University (Social Sciences Edition), 36(1), 16.