

Construction of Legal System for Autonomous Vehicles*

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Abstract—The self-driving car is a major revolution in the field of human transportation in the 21st century. With its large-scale commercial use, it will greatly liberate the human brain and limbs. However, there are also some problems in the development process of self-driving cars, and the relevant laws and regulations are urgently needed. Based on the current practice in China, through comparative analysis of the legislative policies of self-driving cars in major foreign countries, we explore and propose legal systems for self-driving cars in China.

Keywords: *self-driving car, public safety, road test, legal system*

I. INTRODUCTION

Thanks to the great progress made by artificial intelligence technology in recent decades, through practical combination with related application scenarios, artificial intelligence technology has been widely used in many subject areas. Self-driving cars are a typical application of artificial intelligence in the automotive field. Through the use of artificial intelligence technology for autonomous learning and training of massive amounts of data, cars have a considerable level of intelligence in environmental perception, planning decisions, and vehicle control, achieving highly autonomous operations that are independent of human operations. Therefore, people define self-driving cars as machines that can drive themselves without human input or supervision. Self-driving cars are one of the most anticipated technological developments of our time, and they are more exciting than any other transportation technology of the past half century. In today's society, cars have firmly integrated into our urban culture, bringing new societies, including the joys of commuting, family life, community, leisure and sports. Cars have reshaped our subjective consciousness, the daily habits we live in and the evolution of our city. In short, cars are a way of life, not just a transportation system.

II. REGULATORY VALUE OF SELF-DRIVING CARS

A. Based on public safety needs

One of the essential characteristics of autonomous vehicles is their "autonomy", that is, the autonomy of driving and the autonomy of route selection. This is also the main sign that distinguishes them from traditional cars. The core link of autonomous driving for autonomous operation lies in the planning and decision-making part, that is, the fusion of multiple algorithms to obtain the optimal decision model. Considering that this algorithmic decision model is highly dependent on real-time perceptual positioning, data information collection, autonomous learning capabilities, and the network environment, if there is a deviation in any of the above links, it is likely to cause security risks. For example, during the operation process, how to ensure that the decision-making and judgment of autonomous vehicles conform to human ethics? Another example is how to ensure that the user data recorded during driving cannot be obtained and used illegally? Another example is the car in the semi-autonomous driving stage, how to solve the problem of "car-to-car switching" in emergency situations? All these have brought many challenges to the security and order of human society. Therefore, the development and testing of self-driving cars is always centered on the "safe" core through legal regulations, which is an important guarantee to eliminate safety risks to the maximum extent and maintain public safety.

B. Guiding the development of the autonomous vehicle industry

Driven by autonomous driving technology, the future automotive industry will form an industrial structure with multi-industrial integration and the participation of multiple types of subjects with autonomous driving cars as the hub. [1] The development of this new type of industry needs to be supported by matching system specifications. Mismatched laws and regulations will not only lead to unnecessary increases in corporate costs, but also restrict the healthy development of the industry. At present, China's existing policies and legislation clearly cannot meet the needs of the development of autonomous vehicles. The lag of rules has led to vicious competition between R&D enterprise, market failures, information imbalances, and product risks in the

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field of autonomous vehicles. At the same time, for the critical period of road tests currently underway, a unified and convenient road test specification is of great significance to ensure that R&D companies can successfully conduct road test tests of autonomous vehicles, improve work efficiency, and reduce research and development costs. Autonomous vehicles are highly intelligent, informational, and networked. At the national level, the management and regulation of autonomous vehicle R&D, road tests, and subsequent operations through legislation are important guarantees for the healthy and orderly development of the autonomous vehicle industry.

C. Connecting with China's current legal system

Due to the change in the role of people on vehicles caused by autonomous vehicles, the current laws and regulations have many inapplicability in the face of the development of autonomous vehicles. For example, how the Road Traffic Management Law regulates the driving regulations required by drivers to interface with users of autonomous vehicles; How to determine the annual inspection and compulsory scrap standards for self-driving cars; how to divide responsibilities for self-driving cars after a traffic accident; how to adjust self-driving cars for crimes such as dangerous driving crimes and traffic accidents offences under the current criminal law. In the face of these conflicts and contradictions with China's current laws and regulations, it is urgent to adopt a system-specific self-driving car law to explain and clarify relevant legal issues so as to effectively connect with China's current legal system.

III. COMPARISON OF FOREIGN LEGISLATION AND POLICIES FOR SELF-DRIVING CARS

A. U.S. legislation and policy on self-driving cars

The United States has given great support to autonomous vehicles in legislation. Overall, the United States is a global leader in the field of autonomous vehicle legislation. At the federal level, the Federal Autonomous Vehicle Policy was first issued by the Ministry of Transport in September 2016 to provide policy guarantees for autonomous vehicles and make important preparations for legislation. Then, on September 7, 2017, the U.S. House of Representatives unanimously passed the "Autonomous Driving Act", which will uniformly regulate road testing and deployment of autonomous vehicles at the federal level. The bill consists of 13 sections and establishes a basic framework for supervision from aspects such as the management of autonomous vehicles, safety standards and assessments, cyber security plans, exemptions, and privacy protection. On October 4, 2018, the U.S. Department of Transportation released the latest version of the guiding culture "Preparing for the Future of Transportation: Automated Vehicles 3.0", which called for all autonomous driving R&D groups to voluntarily adopt standardized development behaviors, and emphasized again Priority of federal law over state law. At the state level, Nevada is the first state in the United States to accept self-driving cars. As early as 2011, the state passed

laws allowing self-driving cars to go on the road, and began accepting applications from various R&D companies for road testing. Since then, more than 20 states, including Florida, California, Colorado, Pennsylvania, Arkansas, Georgia, and Washington, DC have successively promulgated road test regulations for autonomous vehicles. The remaining states are basically at the legislative research or review stage.

B. European legislation and policy on self-driving cars

As early as January 2015, the UK Department of Transport promulgated "The Pathway to Driverless Cars: A detailed review of regulations for automated vehicle technologies", and began to allow self-driving cars to be officially tested on the road. Later in July, the "Development Road for Unmanned Vehicles: A Guide to Road Testing" was issued, which focused on testing vehicle and driver issues. It is worth noting that the UK's legislation on autonomous vehicle insurance systems is at the forefront of the world. On July 19, 2018, the "Automated and Electric Vehicles Act" passed specifically stipulated the insurance system of autonomous vehicles, including the inclusion of drivers in the insurance coverage, the advance payment mechanism, and the liability relief system in special circumstances. The German Senate passed a bill for self-driving cars in May 2017, allowing self-driving cars to be tested on the road, and has established many access regulations for this purpose. And in May 2018, the world's first ethical standard for autonomous driving technology was formulated. The code takes the safety of the system as the basis for its existence and stipulates that when a vehicle is in emergency avoidance, human life must always take precedence over property or animals. In addition, it is also explicitly required that a driving data recording device similar to an aircraft "black box" will be installed in the vehicle in order to divide the ownership of responsibilities. The French government considers testing self-driving cars a public safety measure. France announced the roadmap for the development of autonomous vehicles in February 2014, and in August 2016, officially allowed foreign autonomous vehicle R&D manufacturers to test and verify on their own roads. The French government also plans to deploy highly automated vehicles on the roads by 2022. However, France has not issued special policies and documents on the road test process of autonomous vehicles, and still adopts a one-to-one approval mechanism.

C. Japanese legislation on self-driving cars

In May 2016, the Japan Police Agency issued the "Guidelines for Road Testing of Autonomous Vehicles", which imposes strict requirements on the safety technologies of test institutions, drivers, and test vehicles. In June 2017, the Japan Police Agency issued the "Remote Autonomous Driving System Road Test Permit Processing Benchmark", which allows cars to perform unmanned road tests on specific public road sections. In September 2018, the Ministry of Land, Infrastructure, Transport and Tourism promulgated the "Technical Guidelines for the Safety of Autonomous Vehicles", which established a series of safety

standards for autonomous vehicles, and made specific requirements for the human-machine interaction mechanism of autonomous driving systems. At the end of December 2018, the National Police of Japan announced a revised draft of the Road Traffic Law that would allow L3 autonomous vehicles to drive on public roads, and plans to implement the bill in the first half of 2020. The amendments to the Road Transport Vehicles Act passed in March 2019 impose requirements on automatic driving devices, inspection and repair of vehicles, and regulatory equipment, and allow drivers to operate smartphones while driving L3 vehicles. It can be said that Japan is a world leader in autonomous vehicle legislation worldwide.

D. Enlightenment to China's legislation

There has been fierce international competition in the field of self-driving cars. It should be noted that all major developed countries in the world have given high attention and legislative support to autonomous vehicles. Its rich experience in legislative practice is worth learning. First, Unbundling the development of autonomous vehicle technology is the primary goal of legislation. Autonomous vehicles are in a critical period of transition from research and development to testing. If too high administrative costs and legal responsibilities are given to R&D manufacturers in the legislative regulations, it is likely to hinder technological progress, resulting in the lagging development of the country's self-driving car industry. Formulating reasonable road test specifications and clarifying the legal responsibilities of enterprises can promote the healthy development of the industry. Second, balance the relationship between central legislation and local legislation. China's regional development varies greatly, leaving room for local legislation is a necessary condition for absorbing and absorbing local needs. But if local legislation is too fragmented and differentiated, it will hinder cross-regional exchanges and collaboration of industries. Just as self-driving cars will eventually achieve unlimited roads across the country. Therefore, how to fully mobilize the enthusiasm of local legislation under the premise of both central and local regulatory needs has become a legislative must face the problem. Third, The necessity of advanced legislation, research and unified supervision with safety as the core.[2] In the field of self-driving cars, due to the rapid development and continuous breakthrough of autonomous driving technology, if legislation is still used to summarize practices, then in the context of fierce international competition, it is impossible to effectively guarantee that China's self-driving car industry actively seizes the world market. Therefore, the legislative research should be carried out simultaneously with the development of the industry, and it must be forward-looking.

IV. THE LEGAL CONSTRUCTION OF SELF-DRIVING CARS IN CHINA

A. Construction of a standard system for autonomous vehicles with "safety" as its core

First, develop ethical standards for autonomous driving technology. Generally speaking, the current driving is made by the driver to make decisions. In the future, the car will make decisions by itself, which involves algorithmic calculations. For example, when an automobile needs to avoid danger in an emergency, is it a priority to protect human life or property safety? For another example, when a traffic accident suddenly occurs, one's life and health rights must be harmed. Is the party with a larger number of people than the party with fewer people, or a woman than a man, or a baby over an adult? When self-driving cars need to make decisions in the above situations, this actually involves ethical issues. If self-driving cars are not designed with ethical and moral weights in mind when designing algorithms, then such products must not be accepted and accepted by society. Therefore, we need to formulate relevant ethical standards as a prerequisite for market access.

Second, formulate technical standards for autonomous vehicle cybersecurity. At present, various countries and regions mainly focus on the technical standards and road test procedures of autonomous vehicles, and they lack sufficient attention to network security issues. In fact, since the realization of autonomous driving technology relies heavily on information networks for information perception and decision-making control, network security issues become critical. Once the network loopholes of self-driving cars are exploited by hackers, it is likely to change the vehicle's perception and computing system, or even remotely control and hijack the vehicle, thereby endangering public safety and order. In addition, if the driving data and information collected by the vehicle during the operation of the self-driving car are leaked and improperly used, the user's privacy right is violated. To solve this problem, cyber security should be used as the market entry threshold for autonomous vehicles. If there are major loopholes in the level of cybersecurity of autonomous vehicles and they do not meet the technical standards regarding cybersecurity, they will not be eligible for market access. At the same time, a complete network security verification procedure and follow-up supervision measures should be established to ensure the effective implementation of this security standard.

B. Improving the road test and supervision system for autonomous vehicles

Self-driving cars must pass road tests to obtain the massive amounts of data that are critical to their development. Only by passing the road test can we fully prove our safety and stability to be approved for mass production. Therefore, it is imperative to establish a scientific and reasonable road test system. At present, the country and many places in China have issued normative documents for road tests of autonomous vehicles, which stipulate the qualifications, conditions, processes and

requirements for road tests of autonomous vehicles. However, some problems have also been exposed in the actual application process, which need to be modified and improved.

First, strengthen the central government's overall planning of road testing in various places. Autonomous driving technology, as a hot spot in a new round of international technological competition, represents the interests of the country. The positive significance of the current road test management regulations in different places should be acknowledged, but in view of the current large differences in local road test management specifications, it has affected testing companies to carry out cross-region road tests. Therefore, in terms of legislation, the central government should take the overall situation into account, centrally regulate the core issues in autonomous vehicle road tests and rules with universal applicability, take the lead in establishing a linkage platform for autonomous road tests between provinces and cities, and gradually realize cross-regional Test site interoperability, test records, and mutual recognition of permits. In addition, in view of the current status of jurisdiction of the Ministry of Industry and Information Technology, the Ministry of Communications, and the Ministry of Public Security, a unified and authoritative competent authority should be established at the national level to facilitate the docking of local working groups with the central government and avoid the phenomenon of multiple management and fragmentation management.

Second, establish a hierarchical management system. At this stage, self-driving cars are technically immature, with many unknown risks, and have not reached the full level of autonomous driving. Therefore, the current domestic road test regulations have strict restrictions on the road test section, time, and driver's duty of care. In the future, as autonomous driving technology becomes more and more mature, it is an inevitable trend to operate independently on all roads and without roads. In fact, some countries and regions have already broken the test restrictions in some aspects. For example, Japan allowed test drivers of L3 vehicles to be absent from the driving seat in 2017. In terms of domestic road test management specifications, based on the demonstration and classification of autonomous driving technology, we should explore the establishment of restrictive regulations to phase out road testing, and gradually realize the unlimited driving of all-weather and all-road sections of autonomous vehicles to promote Autonomous driving test works smoothly.

Finally, divide the responsibility of the accident. In the road test phase, due to the immature and unproven nature of autonomous driving technology, the risk of traffic accidents at this stage is high. In essence, the introduction of autonomous driving technology has not completely changed the traditional motor vehicle accident liability system. [3] For traffic accidents caused by the lack of software and hardware of self-driving cars, manufacturers should bear product liability for their self-driving cars. However, at the practical level, it is difficult for the victim to prove the defects and

causality of the highly technical self-driving cars. Therefore, it needs to be corrected through legislation. Specifically, on the one hand, it is mandatory to install a recorder similar to a "black box" on self-driving cars to clarify the specific cause of the accident, thereby reducing the burden of proof of the victim. On the other hand, liability insurance can be created specifically for manufacturers. Manufacturers are forced to purchase this insurance service for their self-driving cars. For a traffic accident caused by a defect in its own product, the insurance company will first compensate it, and the shortfall will be recovered from the manufacturer.

C. Exploring market access and management mechanisms for autonomous vehicles

At present, various countries mainly carry out relevant legislative regulations around road testing of autonomous vehicles, and there is less research on subsequent commercial access. However, after all, self-driving cars will be put on the market. The large-scale commercialization of self-driving cars will inevitably pose challenges to many current regulations, including the Road Traffic Safety Law. Therefore, we should plan ahead and explore the legislative issues after the marketization of autonomous vehicles.

First, formulate market access rules. For large-scale commercial use of self-driving cars, they must be licensed by the administrative authority before they can gain market access. However, as there is currently no technical standard system for self-driving cars, it is difficult for existing access permit management methods to cover self-driving cars. Therefore, the establishment of a set of market access mechanisms suitable for it is of great significance for the smooth entry of autonomous vehicles into the market in the future. Specifically, based on public safety considerations, static technical standards and specifications can be formulated based on the technical characteristics of autonomous vehicles. For self-driving cars that meet the standards, field tests and verifications are conducted to ensure that the self-driving cars applying for the market have sufficient safety and stability.

Second, restructure the driving license system. The current driving license system is based on the characteristics of traditional cars. Drivers of motor vehicles are required to pass a driving test, and they must meet the age and health conditions. However, the current driver's license system not only restricts the rights of some disabled people, but also is not conducive to the use and popularization of driverless cars.[4] In fact, due to the high degree of automation of vehicles, the cooperation of artificial intelligence systems can operate safely without human intervention,[5] and the requirements for users are relatively relaxed. Therefore, relevant laws and regulations related to the driver's license system should be adjusted in due course, relax restrictions on the use of autonomous vehicles, and focus on the technical safety standards of the vehicles themselves.

Third, improve the rules for handling illegal. For self-driving cars, because their actual driving is controlled by their own artificial intelligence system, and the original

driving license system cannot be applied to autonomous vehicles. Therefore, a new punishment mechanism should be established. Specifically, for traffic violations caused by self-driving car technical defects, manufacturers can be punished with warnings, fines, suspension of production, or even suspension of licenses according to the violations, and require them to find and repair the corresponding Failures can be put back into use after being verified by relevant agencies. For illegal behaviors caused by improper operation of users, those with lighter circumstances may be educated and fined; if the circumstances are serious, they may be prohibited from using autonomous vehicles within a certain period of time.

V. CONCLUSION

Self-driving cars are different from traditional cars, and the biggest feature is that they give considerable artificial intelligence to driving. With the help of global positioning system and information network technology, information exchange and feedback between the car and the surrounding environment, users and remote data clouds are realized. Autonomous driving is a collection of Internet of Things, software development, artificial intelligence and innovation. As a major revolution in the field of human road traffic, the high level of safety and convenience it brings will greatly liberate people's limbs and brains, and affect the transformation of social operating modes. With the increasing maturity of autonomous driving technology, in the future stage of autonomous vehicle road testing and formal commercial use, the current road testing system will be improved by constructing a safety-focused autonomous vehicle technology standard system, and exploring and constructing The market access mechanism of self-driving cars and the supervision system after admission are of great significance for maintaining public order, ensuring the healthy and orderly development of the self-driving car industry, and achieving effective connection with China's current legal system.

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