Ethical Challenges and Countermeasures of Autonomous Vehicles

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Abstract. Autonomous driving is one of the greatest new technologies in the 21st century, but to a certain extent, it has caused conflicts in bioethical standards and the ownership of accident responsibility. For the ethical dilemma of autonomous cars, every country currently does not have a perfect solution. First of all, this paper predicts the development of intelligent connected vehicles through the analysis of the domestic and foreign intelligent vehicle market. Then lists and analyzes the legal and countermeasures of ethical dilemmas in various countries. According to the knowledge of psychology and ethics, this paper puts forward a way to solve this problem which is more in line with the development of industry and ethics.

1 Page layout

The research and development and application of intelligent connected vehicles can promote the transformation and development of the automobile field, and promote the in-depth integration of the automobile field and information management technology. It has high application value and can promote electronic devices, communications, Internet technology, etc. The rapid development of the industrial layout has a positive impact on the infrastructure of the national industrial chain's intelligent system. The development of intelligent networked vehicles can ensure safety during driving, significantly reduce the traffic accident rate by 50%-80%, prevent road congestion, improve the efficiency of road counterparts by 10%-30%, and can also reduce fuel use, Reduce the harm to the ambient air, more in line with the information characteristics of the industrial production 4.0 era, and promote the country's sustainable development. According to the classification standards issued by the American Society of Automotive Engineers (SAE), intelligent connected vehicles are divided into driving assistance (L1), combined driving (L2), conditional autonomous driving (L3), highly automated driving (L4), and unmanned driving (L5) Five levels, unmanned driving is the ultimate goal of intelligent connected cars. Nowadays, intelligent networked vehicles are entering a period of steady growth globally. Mass production of L1-L2 driver assistance system software has been completed, and L3-L4 autonomous driving system software is in product development and small-scale trial production. [1]

Nowadays, self-driving cars are tested on the road in some cities in many countries. In the future, self-driving cars are expected to be a safer and more convenient means of transportation. But in fact, smart cars not only still have many key technical problems to be overcome,

but also some ethical problems to be solved. Since Uber self-driving cars caused traffic accidents, self-driving vehicles have had many traffic accidents around the world, but insurance, ethics, and traffic laws are still not sound, and the existing road traffic laws cannot adapt to the driving conditions of driverless cars. There are ambiguities in the identification of legal liability between people and vehicles. There is no national legislative basis for the identification of civil, criminal, insurance liability, and penalties for violations of regulations. There are also deficiencies in laws and regulations related to the production of driverless cars. At the same time, there are huge risks to the security of personal information and national data. Therefore, with the continuous popularization and application of autonomous driving technology, smart cars may cause large-scale accidents and ethical crises..

2 Prospect analysis of the intelligent vehicles industry

2.1. International Intelligent Vehicles Market Analysis

In recent years, the global autonomous driving technology has developed rapidly and the smart car production market has continued to grow. The developed countries in Europe and the United States are actively deploying the smart networked car industry, including Google, Apple, Mercedes-Benz, etc., are actively developing driverless cars. The revolution of intelligent networking in the automobile industry has become an undisputed general trend in the development of the global automobile industry.

According to the "IDC Global Intelligent Connected Vehicle Forecast Report" data, in 2019, the shipments of

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vehicles that can be connected to the three-party service platform and the global intelligent networked vehicles equipped with embedded mobile networks reached 51.1 million, an increase compared to 2018 45.4%, the annual compound growth rate of the future intelligent networked vehicle shipments is about 16.8%, the intelligent networked vehicle market will usher in rapid development. It is estimated that by 2025, the global shipment of intelligent networked vehicles will further increase to 93.23 million units. [2] According to the "2018-2023 China Driverless Car Industry Market Prospect Survey and Investment and Financing Strategy Research" report, by 2021, the global driverless car market is expected to reach 7.03 billion US dollars; by 2035, it is expected Global sales of driverless cars will reach 21 million. 12 million cars become fully driverless cars. [3] IEEE (Institute of Electrical and Electronics Engineers) predicts that by 2040, driverless cars will account for 75% of the total number of vehicles on the road, and smart cars may subvert the current mode of operation of the automobile transportation industry..

Figure 1. Global smart car shipments and forecasts ,2018-2025.

2.2. Analysis of Chinese intelligent vehicles market

2.2.1 Formatting author names and author affiliations

From 2016 to 2020, Chinese auto market has entered a period of stable development. In 2019, the domestic auto market demand was sluggish, with annual sales of 25.69 million vehicles, a decrease of 8.23% from 2018. Due to the impact of the new crown pneumonia epidemic in 2020, the national auto market continues to be sluggish. As of January-September 2020, China's auto sales reached 17.116 million, a year-on-year decrease of 6.9%. Although the downward pressure on China's auto industry is quite huge due to various factors such as the economy, in terms of overall volume, the scale of domestic auto sales is still relatively high. On the whole, the scale of Chinese civil vehicles is still showing a rapid growth trend, and the development prospects of Chinese auto market are huge.

The introduction of national policies is very beneficial to the development of driverless driving in China, and it also further promotes the follow-up of policies by local governments to support the development of local driverless companies. The rapid development of Chinese smart car industry has arrived. According to the "Automotive Industry Fission under AI Intelligence-A Report on the Convergence and

Development of Chinese Auto Companies and New Generation Information Technology" jointly issued by the Daily Economic News and the National Industrial Information Security Development Research Center (2019) ", it is estimated that by 2020, the penetration rate of new models of intelligent connected vehicles will reach 51.6%. It is speculated that China's smart car market will reach 13 million in 2020 and 17 million in 2025. By 2035, global driverless car sales are expected to reach 21 million. [4]Chinese smart car market has ushered in rapid development.China has become the most potential market for smart cars in the world, but it will inevitably bring a large number of traffic accidents and ethical crises caused by autonomous vehicles.

Figure 2. Market Size and Forecast of Intelligent Vehicle Industry in China, 2016-2025.

3 Ethical issues caused by autonomous driving and current countermeasures at home and abroad

3.1. Ethical risks brought by autonomous driving

Driverless cars need to be matched with relevant ethics and laws on the road. Overcoming multiple customs clearances in technology, ethics, laws, and management are important conditions for ensuring the safety of driverless cars. In the face of inevitable collisions, can the driverless system make the most correct judgment? Under the existing traffic management methods, autonomous driving will face many challenges, and because automobiles and traffic are closely related to life safety, the social problems and ethical contradictions will be more profound. I think it is mainly in the following two aspects:

(1) The choice when the unmanned driving system faces a moral dilemma.

Similar to the moral dilemma faced by human drivers, how to make decisions when automatic control software faces the "life and death" problem has become a widely debated issue in the field of intelligence. During the operation of driverless cars, it is extremely easy to face a large number of ethical dilemmas such as "simplified" tram and tunnel problems. These ethical dilemmas must be faced as soon as possible. When there is an accident on the road, the driverless car makes a judgment whether it should give priority to protecting the car owner, or sacrifice themselves and the car owner to protect the school bus full of children. Let the car choose to kill one

person or several people before the accident, who should the car crash into before the accident. And if this is the case, it will turn people into three or sixty-nine classes, and violate the principle of equality before life.

(2) The problem of division of responsibility for accidents in unmanned vehicles

The most prominent problem facing driverless cars is that the driverless car kills a person. Who is responsible? This issue is indeed very tangled. At present, self-driving cars are still under development, and relevant laws and regulations have not been perfected. What is the responsibility of the company? passenger? Or the driverless car itself? It is difficult to decide.

For example, on May 7, 2016, Joshua Brown, a former Navy SEAL in Canton, Ohio, drove a ModelS on a two-way highway near Williston, Florida, and The trailer collided and died unfortunately. This is the world's first fatal accident due to autonomous driving. In March 2018, an Uber self-driving car killed a 49-year-old woman who was crossing a road in Arizona, USA. The woman died of injuries after being taken to the hospital. This was the first case of a self-driving car. Death on public roads. [5] With the continuous popularization of autonomous driving, traffic accidents are increasing. When an unmanned car encounters an emergency on the road, what decision should be made and who should be responsible for the accident has become the ethics we should pay attention to. The problem, this also determines the future of smart cars.

3.2. The current situation of domestic and foreign solutions to ethical problems

As a strong country in the production of autonomous vehicles, Germany is at the forefront of the world. In May 2017, Germany amended the "Road Traffic Law" and became the world's first legal document regulating autonomous vehicles, allowing auto-driving systems to replace humans under certain conditions in the future drive. However, it is stipulated that autonomous vehicles need to install black box devices, and record vehicle operation to clarify the responsibility for traffic accidents. First, the legal responsibility is clarified. If an accident occurs under human driving, the driver shall bear the responsibility for the accident; if the artificial intelligence system causes the accident, it will be The car manufacturer assumes responsibility. [6] In June 2017, the German Ministry of Transport issued the "Automated and Connected Driving Report", which became the world's first self-driving car ethics principle, and proposed 20 ethical rules that self-driving cars need to comply with, including life first, manufacturers also need Responsibility, moral dilemma decision-making cannot be programmed in advance and other principles. [6] It can be said that Germany has made an attempt to provide a clear division based on civil accident liability, setting a model for all countries.

In September 2017, the U.S. Department of Transportation issued a self-driving car guide entitled "Autonomous Driving System 2.0: Safety Vision", allowing self-driving cars to be conditionally on the road,

and Congress promoted self-driving car legislation to create a self-driving car regulation Federal framework to accelerate the deployment and testing of autonomous driving technology.

In February 2017, the "Automotive Technology and Aviation Act" of the United Kingdom made it clear that victims of self-driving car accidents can receive compensation from insurance companies, with passengers as the priority. [6]

In February 2017, Singapore promulgated the "2017 Road Traffic Amendment Act", relying on management to reduce the risk of accidents. [6]

On October 14, 2017, the Ministry of Land, Infrastructure, Transport and Tourism of Japan first introduced safety standards for autonomous driving. It is stipulated that it must be equipped with a function that will issue a warning when the driver leaves the steering wheel when driving automatically on the road, or even switch to manual driving. [6]

4 New countermeasures to deal with the ethical crisis of unmanned driving

Technological development is a creative driving force. Technology is the forerunner. After that, human society needs to formulate corresponding rules to adapt to technological innovation. This was true of the power problem 100 years ago, and so was the automatic driving. Not only must a new traffic rule system be re-established, but also the ethical problems faced by smart cars must be resolved.

More than 100 years ago, electricity was just discovered not yet universal. However, many ethicists have pointed out that electricity cannot be popularized because people may be electrocuted in the process of using electricity, but electricity as a technology cannot bear the responsibility. In contrast, electricity has been used so widely, but humans have not encountered the so-called moral dilemma. How can the dilemma of electricity killing people be solved when inventors, power supply agencies, and electrical appliance manufacturers do not need to take responsibility?

We resolved it through a complete set of accountability mechanisms. This set of rules includes laws, technical regulations, education regulations, insurance clauses, etc. In addition, the government plays an important role in it. First, the government designed a set of education regulations. Whether through school education or community propaganda, the government tries to make everyone aware of the rules of electricity use. When a person knows the rules of electricity use but does not follow the rules, he or his guardian should Take certain responsibility; the inventor of the second electric power does not need to take responsibility. The theory proves that there are a large number of insulators. As long as the electric power is used in the correct way, the electric power is absolutely safe. Secondly, the power supply organization may be responsible. The government has formulated in advance a set of binding rules composed of laws and technical specifications. When the power supply organization complies with the

laws and technical specifications set by the government, it does not have to take responsibility, otherwise it should take responsibility; in addition, electrical design manufacturers also May need to be held accountable, similar to the responsibility mechanism of the power supply organization, so I won't repeat it here. Finally, through a series of insurance clauses, the government, related companies or individuals can hold the insurance company accountable after the disaster. Even so, a normal adult who is killed by electricity may still not be attributable to the above-mentioned responsible subjects. In this extreme case, the government will eventually cover the issue in the name of disaster relief. In other words, the government, as a responsible subject, bears the ultimate and unshirkable responsibility. At this point, mankind has finally solved the moral dilemma of killing people with electricity but no one is responsible.[7]

Therefore, for the ethical dilemmas faced by autonomous vehicles, such as the decision-making problem and the problem of accountability, we can learn from the power problem solution and the 20 ethical rules issued by Germany, and consider from the following aspects:

(1) Speed up the improvement of Chinese relevant laws and regulations on smart cars

China related standards for intelligent networked vehicles are not complete. The power to formulate standards is scattered in different departments such as automobiles, transportation, and communications. The existing standards are part of the group standard or industry standard, which is difficult to meet the needs of the rapid development of the intelligent networked vehicle industry. Therefore, China should continuously update its regulations in accordance with the current technological development, and promptly revise the relevant provisions in the "Road Traffic Safety Law" and its implementation regulations, highway law, highway safety protection regulations and implementation rules, and eliminate the need for intelligent networked vehicles to test and go on the road. Legal obstacles; in response to the mandatory requirements related to manual driving in laws and regulations such as the Standards and Regulations, the Certification and Accreditation Regulations, and the Regulations on Motor Vehicle Registration, the study explores appropriate exemptions for intelligent networked vehicles to effectively avoid large-scale revisions of existing At the same time as the standards, the intelligent networked car will be given a certain development space in time, and the indirect and invisible legal constraints are removed .

In terms of legislation, it is necessary to continuously formulate laws and regulations that match it according to the current technological level, and to fully consider the advantages of foreign precedents, solicit technical engineers, transportation experts, jurists, philosophers, and informatics researchers., As well as the representatives of the Consumer Protection Association and the business community to formulate comprehensive laws and regulations. It is necessary to insist that the protection of human life is above all legal considerations. It is strictly forbidden to use the attributes of the population (age, gender, number) as the criterion; In

extreme situations where one's life is harmed or even sacrificed to save other parties' choices, dilemma decision-making cannot be standardized and programmed.

(2) The issue of accountability can be considered from the following aspects:

According to the current level of intelligence, intelligent networked cars below the L3 level have auxiliary driving functions such as collision prevention, vehicle following, and automatic parking, and they are all human drivers. If the driver takes off his hands from the steering wheel when starting assisted driving, the vehicle will remind the driver to manually control the direction and should not rely entirely on the automatic driving system. Therefore, there is no difference between the method of determining the civil liability of motor vehicle traffic accidents and the existing management methods when driving with the more popular assisted driving.

When the future reaches the level of L5, unmanned driving, humans give way to the control of vehicles to machines, and it becomes unclear who is responsible for safe driving. How advanced the driverless technology is, and accidents are inevitable. When a vehicle faces an accident, how should the driverless system make decisions?

First of all, the new traffic laws should be strictly promoted. The government should ensure that everyone knows the traffic rules as much as possible. Traffic lights are set at every intersection to greatly reduce the risk of accidents caused by the masses not following the rules. If there are risks, they can be based on whether they obey the traffic rules, whether the community, the school, the guardian do their duty of publicity and supervision, whether there are problems with the traffic instructions. Thus can judge its responsibility belongs to oneself, guardian, traffic department and so on. Second, the government will formulate strict standards for the production of autonomous vehicles, and should learn from Germany, and each car should be equipped with a "black box" to record the operation process to help clarify responsibilities. If an enterprise follows the production standard, and the car breaks down and causes an accident due to the responsibility of a third party, the third party should bear the responsibility. If the product fails to be produced or has a small probability of unqualified products due to car hardware defects or program failures, the manufacturer or technology provider should be held accountable. For people sitting in artificially driven cars, they don't need to know the details of automatic driving technology, they don't need to understand the code algorithms of artificial intelligence, and they don't need to sign a so-called "ethical agreement" when buying an autonomous vehicle. At that time, they did not and did not need to make any choices, and therefore they did not need to bear any responsibility. Finally, through some insurance clauses, the government, related companies or individuals can hold the insurance company accountable after the disaster. Despite this, extreme situations may exist, but extreme situations are a small probability event that the government can handle in the name of disaster relief. In

this way, I believe that the occurrence of traffic accidents can be greatly controlled and the problem of accountability for accidents can be solved.

Take the "tram car dilemma" as an example. When the intelligent network technology develops to an advanced level, it can perceive the situation in advance to issue instructions. In addition, when the government, schools, guardians, etc. implement traffic laws, it can be greatly improved. Probability avoids the emergence of this ethical dilemma. Even when a driverless car is facing a difficult choice, whether the car meets the technical specifications, whether the people next to it have complied with the new traffic rules based on artificial intelligence, whether the community or school has fulfilled its publicity and supervision obligations, and even whether the government's laws and technical specifications themselves. There are loopholes, these are all factors that need to be considered. When these factors are all considered, if there is still no accountable person, the government should bear the ultimate responsibility, because the use of artificial intelligence with a certain degree of risk to drive cars is the common cause of all people. Choice, and this type of event will only be an example.

Secondly, starting from the design of the vehicle, driverless cars should consider a protective measure under extreme conditions to minimize risks. For example, through the application of controllable traffic environment, vehicle sensors, braking performance, signaling to the threatened person in dangerous situations, and prevention of danger through "smart" road infrastructure, so as to maximize road safety and avoid The dilemma occurs.

5 Conclusion

The above are some of my thoughts on solving ethical challenges. In any case, although autonomous vehicles are still facing many difficulties and problems in terms of technology, cost, laws and regulations, and the industrialization has also encountered bottlenecks, but driverless vehicles are important for transportation. The safety and traffic efficiency of the system are highly guaranteed, which represents the future development direction of intelligent driving.

The most important thing at present is not to give up development because of risks. Just as we look at the ethical dilemma of electricity now, in the future, will human beings sneer at the moral dilemma we currently envision for artificial intelligence? When autonomous driving can improve human well-being becomes a universal consensus of mankind, when relevant laws and technical regulations will advance with technology, the ethical problems of autonomous driving will be solved, and the country must formulate regulations and other traffic regulations that comply with current technological development as soon as possible. , And keep updating with technological development to eliminate concerns and ensure technological development to the greatest extent.

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