Research on the course, form and strategy of autonomous driving competition

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Abstract. Autonomous driving is the future development trend, which will greatly change the way human beings appear and the form of entertainment. Based on the background of the rapid development of autonomous driving technology, this article summarizes the development status of autonomous driving competitions at home and abroad, analyzes the integration of the motorsport industry and the autonomous driving industry, and proposes strategies to promote autonomous driving racing events.

1. Introduction
Autonomous driving vehicle (AV) refers to a car that can realize autonomous environment perception, decision-making driving planning, and control of vehicle functions in a highly intelligent manner[1]. With the rapid development of theories and technologies in the field of intelligent transportation, Internet of Vehicles, and artificial intelligence, autonomous vehicles can not only provide a more convenient and safer way of travel than traditional manual-driving cars, but also alleviate traffic congestion, reduce traffic accidents, and reduce energy consumption. Road safety testing is a prerequisite for the wide application of autonomous vehicles, and it is also a necessary way to improve the stability and reliability of autonomous driving systems. A large number of professional closed and open racing tracks at home and abroad can be used as an effective means for scene-based testing of autonomous vehicles, alleviating the pressure of insufficient test venues and test demonstration areas. At the same time, the mature vehicle competition system of motorsports can also enrich the needs of autonomous vehicles to test scenarios under specific conditions, provide diversified data, improve autonomous driving technology, and promote the sustainable development of motorsports.

2. The development status of autonomous vehicles
The Society of Automotive Engineers (SAE) divides autonomous vehicles into 6 levels from L0 to L5 according to the degree of automation. Levels 0-2 are mainly intelligent auxiliary systems, where people control the vehicle, and level 3-4 is when the automatic system starts to take over driving. Operation, and the fifth level realizes completely unmanned driving. Autonomous driving technology is still in the early stages of development. As far as the degree of automation is concerned, it is in the advanced stage of research and development from semi-autonomous vehicles to fully autonomous vehicles. The highest level of mass production release on the market is L3, that is, conditional autonomous driving; As far as the testing process is concerned, most of the test models are currently being tested, and the main purpose of the test is to accumulate data and improve the product. The United States is in a leading position in intelligent driving decision-making and control technology and networking. Standards, new technology research and development, key chips, product development, and communication applications have
basically formed a relatively mature system. The downstream has mature supplies and products, and has strong international competitiveness.

China started research on self-driving cars in the 1980s. In 1980, three universities including Harbin Institute of Technology participated in the national “remote-driving anti-nuclear reconnaissance vehicle” project. In 1992, five universities including the National University of Defense Technology and Tsinghua University jointly developed China's first unmanned vehicle ATB-1, which means that China's autonomous driving technology research and development has officially started. The latter ATB-2 and ATB-3 have been introduced one after another, and the driving speed and cognitive functions of unmanned vehicles have been enhanced. Since 2001, the National University of Defense Technology has cooperated with FAW to develop self-driving cars. The Hongqi CA7460, which was successfully developed in 2003, can automatically change lanes according to the situation of obstacles in front of the highway on normal traffic conditions, and its maximum travel speed can reach 47 meters per second. Later, the National Defense Science and Technology University developed the second-generation self-driving vehicle Hongqi HQ3 in 2006. On July 14, 2011, the Hongqi HQ3, jointly developed by the National Defense Science and Technology University and FAW, completed the 286-kilometer high-speed unmanned journey from Changsha to Wuhan for the first time. The driving test indicates that my country's unmanned vehicles have achieved new technological breakthroughs in complex environment recognition, intelligent behavior decision-making and control. In August 2015, the country's first driverless passenger car completed an autonomous driving test in a completely open road environment and drove a total of 32.6 kilometers. In December of the same year, Baidu's self-driving car completed the automatic driving test on Beijing's open highway, and the maximum speed during the test reached 100 km/h, which means that a technology has been implemented from scientific research to product. In April 2016, Changan Automobile, in cooperation with Huawei and Tsinghua University, successfully completed the 2000 km super unmanned driving test project, and plans to achieve mass production in 2025. In June 2016, the first national pilot demonstration zone for intelligent connected vehicles was established in Shanghai. The construction of the test and demonstration site for the National Intelligent Networked Vehicles has entered a large-scale stage, with various construction subjects and demonstration types. According to the statistics of Yiou Automobile, in 2019, the number of domestic intelligent networked demonstration areas increased by 146% from the previous month. Among them, the number of prefecture-level demonstration areas increased by nearly three times, from 14 to 41, and the number of highway demonstration areas also increased rapidly. With the increase, the number of various test sites is close to 30, and the test environment is abundant. The governments of Changsha, Guangzhou and other places have established joint ventures with technology companies such as Baidu and Wenyuan Zhixing, which are deeply bound and become a new milestone in the development of China's autonomous driving. Baidu Group's accumulated test mileage of L4 autonomous driving has exceeded 10 million kilometers. Models built with L4 autonomous driving technology have been launched in Beijing, Shanghai, and Guangzhou, starting the journey of mass-produced autonomous driving to truly experience the "city as you go" journey. In 2021, Baidu's Apollo smart driving area will cover urban roads and highways in 20 cities, and 100 cities will be covered by 2023. In recent years, companies in the Chinese automobile industry chain have actively explored and advanced in the field of autonomous driving, and have achieved breakthroughs in a number of key technologies such as autonomous driving perception, automatic car following, and automatic parking. [2]

3. The status quo of foreign autonomous driving competitions

The development of unmanned vehicles has led to the formation of unmanned driving competitions. The earliest competition was DARPA's "Unmanned Vehicle Challenge" in 2004. The main purpose was to provide innovative solutions for the U.S. Army's unmanned ground combat vehicles, which later evolved into a competition to fund intelligent robots. The Autonomous Vehicle Grand Prix organized by the Advanced Research Projects Agency of the U.S. Department of Defense has stimulated the enthusiasm of automakers and new technology companies to develop autonomous driving. It is only at this time that autonomous driving technology has received a lot of attention. At the same time, the DARPA Challenge
has initiated important development activities in many fields and spawned new industries. Many of the newer commercial entities in this field, such as Waymo and Uber, have established direct connections with the DARPA Challenge. There are now more than 20 commercial companies around the world, including traditional automakers, who are developing self-driving cars. New technology providers have also emerged, which is a direct result of the pursuit of self-driving car competitions [3]. In November 2015, Formula E launched the "Robocar" unmanned electric vehicle global competition series. This competition will provide a competitive platform for autonomous driving solutions, which are now used by many large industrial vehicles and technology companies as well as top technical universities. Development. The “Robocar” plan is to become part of the support package of the FIA Formula One Championship. The goal is to set up ten teams with two driverless cars in each of the main city circuits of the FE Class. Hours of competition. All teams will have the same "Robocar" car, which can use real-time computing algorithms and AI technology to compete. In the future, all vehicles in the world will be assisted by AI and driven by electricity to improve the environment and road safety. It is powered by Nvidia's Drive PX2 brain, which can perform up to 24 trillion AI operations per second. Roborace has introduced unmanned electric technology to the Formula E circuit, and has taken another big step in advancing unmanned electric technology [4]. The Indianapolis Motor Speedway (IMS) announced in 2019 that the world’s first face-to-face high-speed driverless racing competition will take place on the 2.5-mile oval track of the world’s racing capital for 20 laps, 11 of the four continents. More than 500 people from two countries participated, and the championship prize was up to one million US dollars. In October 2021, 30 teams will use the Dallara IL-15 independently developed by IMS for a formal competition. The final decision on the championship depends on the complex software system designed by each team. Each Dallara IL-15 race car is equipped with lidar and optical cameras, as well as other advanced technologies, worth up to $1 million. The competition in the IMS professional racing environment is not only an extension of the absolute limit of autonomous vehicles, but also a breakthrough in the use and trust of unmanned driving technology [5].

4. The status quo of China's autonomous driving competition

| Event | Time | organizer | project setting |
|-------|------|-----------|----------------|
| China Smart Car Future Challenge | 2009 | National Natural Science Foundation of China | Set up two major events, a real comprehensive road environment competition and an offline test competition. |
| China Smart Car Competition | 2016 | China Automotive Technology Research Center | Remote call, start task, 8-touen driving, pedestrian avoidance, straight-line acceleration and deceleration, overtaking and changing lanes, etc. 11 items |
| World Intelligent Driving Challenge | 2017 | National Development and Reform Commission, Ministry of Science and Technology | Including autonomous driving challenge, information security challenge and virtual scene challenge |
| e-VISTA Self-Driving Car Challenge | 2018 | Organizing Committee of China International Intelligent Industry Expo | Level 5 Autonomous Driving Challenge, ADAS Driver Assistance System Challenge (AEB/APS), Autonomous Driving Commercialization Process Challenge, Virtual Simulation Challenge |
| Chinese University Student Driverless Formula Car Competition | 2019 | Chinese Society of Automotive Engineering | Straight line acceleration, high-speed tracking, high-speed obstacle avoidance, eight-character winding pile |
| Self-driving car ice and snow challenge | 2021 | Changchun Municipal People's Government, China Automobile Industry Association | Urban Ice and Snow Challenge, Minibus Ring Lake Exhibition, Cross Country Ice and Snow Rally |
| China Driverless Racing Grand Prix | In preparation | China Automobile and Motorcycle Sports Federation | There are three types of skills races, challenge races and competitive races for production cars and non-production cars |

In order to promote the exchange and development of autonomous driving technology, a competition for autonomous vehicles in China has begun to rise. Since 2009, the National Natural Science Foundation of China has organized the "China Smart Car Future Challenge", which has attracted the participation of multiple universities and research institutions. Since then, the China Smart Car
Competition, the World Smart Driving Challenge, and the i-VISTA Autonomous Driving Car Challenge have also been held one after another. In 2017, the 2nd China Smart Car Competition attracted 12 teams from scientific research institutions and enterprises to participate. This is the first time that a domestic driverless race will use the highest-level race track (Shanghai F1 International Circuit), Which can meet a variety of test conditions for unmanned vehicles [6]. In 2018, the 2nd World Intelligent Driving Challenge started in Tianjin. The total number of teams registered for this challenge reached 91, including 9 teams from abroad. It was also the first autonomous driving competition to be carried out on a highway. In August 2018, the first i-VISTA self-driving car challenge was launched in Chongqing. More than 30 teams participated in 5 projects in more than 30 scenes of real car competitions, and there were more than 200 industry leaders and more than 100 well-known media. Come to the arena. (See Table 1) There are three main forms of domestic self-driving vehicle competition: the first type is a competition on the unmanned driving technology innovation project conference, and the second type is a test competition of unmanned driving technology, which is mainly for the perception of different scenarios. Level, decision level and control level test competition, the third type is based on the intelligent control system of the same automatic racing platform racing competition.

5. Stages of development of autonomous driving racing events

5.1. Initial stage: Provide test scenario services

The extensive development of unmanned vehicles has led to the formation of unmanned driving competitions. The high-speed and fierce racing competition on the professional track provides a test platform for accelerating the development of technology. The professional track competition has become an effective supplement to the testing of autonomous vehicles. Road testing is a key link in the development and application of autonomous driving technology, including virtual testing, closed park testing, designated road testing, and public road testing. Motorsports has always been closely related to the automobile industry in the development process. Motorsports is actually the best way for cars to strengthen road experiments. With the development of autonomous vehicles, there is a huge demand for testing. Carrying out high-intensity unmanned vehicle "actual" testing on specific tracks can save a lot of time, manpower, and material resources in just a few days and hours of competition. It is necessary to withstand the test results equivalent to the number of months or even years of vehicle driving on the road. Many problems that are not easy to find under routine tests will be exposed during the car race, which provides an excellent experimental environment for engineers. Motorsports includes a closed circuit and open circuit competition, and has been built into a large-scale high-standard racing track in various parts of the country, which can effectively alleviate the contradiction of insufficient test roads. At the same time, according to the test requirements, a variety of traffic application scenarios can be set on different tracks, and a comprehensive test of the functions and performance of the unmanned vehicle can be realized through professional test equipment and quantitative evaluation, so as to improve the overall performance and limit level of the autonomous vehicle. In the different stages of L0-L5 of automatic driving, setting the corresponding competition goals can meet the requirements of different degrees of automatic driving technology on the overall performance of the vehicle.

5.2. Cooperation stage: provide professional racing services

With the strengthening of cooperation between motorsports and autonomous driving technologies, the level of autonomous driving competitions will be improved through professional car racing standards, and the industrialization and commercialization of unmanned driving will be accelerated. By aligning with the standards of international professional car races, the automated driving vehicle race introduces the operation mode of international professional races, which improves the antagonism of the race and can better display the latest achievements and the highest technological level of each participating team in terms of autonomous driving. Unmanned driving competitions on professional tracks greatly test the comprehensive capabilities of autonomous vehicles in perception, decision-making, and execution, and can meet the comprehensive testing requirements of autonomous vehicles, which is conducive to
promoting healthy competition among participating teams and actively responding the national strategy of artificial intelligence. By promoting driverless racing events, Chinese motorsport institutions and enterprises can better serve the related industries of automobile intelligent network connection, improve their own industry product layout, and play a leading role in the world. By creating a national-level driverless racing event, strengthening the cooperation between the racing industry and the artificial intelligence industry, closely communicating with car manufacturers, parts manufacturers and Internet technology companies, lowering the industry threshold, and building a driverless racing platform. Driverless racing events play a positive role in promoting the industrialization and commercialization of driverless driving, and solving the problems of laws and regulations, ethics, and infrastructure. Through commercial operation, increase media promotion, set up full live broadcast and professional commentary, improve the viewing and fun of autonomous driving competitions, increase the acceptance of driverless cars in the market, increase the penetration rate of intelligent driving functions of passenger cars, and accelerate the pace of commercialization.

5.3. Integration stage: Promote technological innovation and application

Motorsports is a representative of technological innovation. From the perspective of the development history of motorsports, the common technologies in the automotive industry are actually directly derived from technological innovations in motorsports. Racing technological innovations are emerging in endlessly and are constantly being converted to civilian use, such as ground effect, flywheel system, rear diffuser, active suspension, ventilated disc brakes, ESP body stability system and other technologies. In the field of motorsports, the promotion of autonomous driving and other intelligent networked car competitions can not only improve the level of research and development and application of autonomous driving technology, but also promote the technological innovation of motorsports and consolidate its leading role as an accelerator of technological innovation. The telemetry technology, carbon fiber technology, and data analysis technology of existing motorsports can all be integrated and applied in unmanned vehicles. For example, the racing car is equipped with a large number of telemetry sensors, forming a fast race system of collection, analysis and decision-making. In F1, McLaren engineers have developed an artificial intelligence system that can be used in conjunction with a customized electrical control unit (ECU) to analyze the race and predict the most effective strategy. This artificial intelligence system incorporates almost all variables that affect the racing performance, and intelligently analyzes all real-time data obtained through a self-adapting algorithm developed for the competition strategy. These technologies will provide greater support for autonomous vehicles.

Although most of the research and development of self-driving cars are focused on handling routine driving situations, to truly realize the safety of self-driving cars, it is also necessary to focus on driving within the limits of vehicle control. For example, the overtaking and lane-changing project set up based on the professional track, the ability test of the unmanned millimeter wave radar speed measurement, image pattern recognition, multi-sensor information fusion, lane line recognition and blind zone warning, etc., has greatly improved the difficulty and achieved efficiency overall enhancement. The self-driving racing car (such as Roborace) developed based on the technological advantages of motor sports is itself a representative of technological innovation. The research and development and competition of self-driving racing cars will bring greater challenges to the design algorithms and hardware of self-driving racing cars, achieving technological breakthroughs in head-to-head multi-agent racing, AI-enabled racing solutions, sensor fusion, overtaking and other aspects.

6. Promoting strategies for autonomous driving competitions

- Introduce relevant policy support to promote the deep integration of the motorsport industry and the driverless industry.
- Deeply integrate the resources of the motorsport industry and the unmanned driving industry, jointly promote the research and development of autonomous driving racing cars, and promote autonomous driving racing events.
• Make full use of the existing professional track, actively serve the development requirements of the autonomous vehicle industry, improve and tap track service functions, and create better benefits.
• Improve the driverless racing competition system, give full play to the experience of holding professional competitions, set up the competition items scientifically, improve the competition evaluation system, and raise the level of competition. Equations.
• Create an unmanned race brand, enhance the influence of races, strengthen commercial operations, expand publicity and interaction, and accelerate the pace of commercialization.

7. Conclusion
With the rapid development of theories and technologies in the fields of intelligent transportation, Internet of Vehicles, and artificial intelligence, autonomous driving technology is advancing to the research and development stage of fully autonomous driving. In order to promote the improvement and development of autonomous driving technology, the race for autonomous vehicles in China has begun to rise. There are three main types of competitions: technological innovation project competition, test challenge and unmanned racing competition. The motorsport industry has a long experience in holding professional events and strong support for the innovation of racing engineering technology, and has unique advantages in unmanned driving competitions. Motorsports institutions continue to improve the product layout of the industry, deepen integration, and achieve sustainable development by providing test scene services, increasing cooperation in professional racing events, and building an automatic racing platform. Faced with the upsurge in the research and development of unmanned driving technology, motorsport institutions should seize the opportunity, integrate innovation, promote the research and development of autonomous driving racing cars and the operation of competitions, and achieve common development.

Acknowledgments
This work was funded by the Wuhan Association for Science and Technology's 2019 Science and Technology Innovation Think Tank Construction Project "Research on the Development Path of Wuhan Automobile Industry Transformation and Upgrading" (Project No. WHKX201917).

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