A Brief Discussion on the Construction of Unmanned Logistics Transportation System on Highways

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Abstract. With the advancement of technology and the development of intelligence, unmanned logistics transportation systems on highways have gradually become an important research direction in the logistics industry. This article explores the construction of an unmanned logistics transportation system for highways based on current technological conditions, including a technical support system, a standard specification system, and an infrastructure construction system. By analyzing autonomous driving technology, Internet of Things technology, big data analysis and cloud computing, technical standards, safety standards, as well as infrastructure such as roads, communication, and range maintenance, specific paths and key elements for building an unmanned logistics transportation system on highways are proposed.

Keywords: Highway, unmanned logistics, transportation system

1 Introduction

The research on autonomous driving systems on highways is an important topic for current technological progress and intelligent development. The establishment and development of this system have sufficient technical conditions, including advanced autonomous driving technology, precise navigation and positioning system, reliable in vehicle communication technology, and efficient data processing and analysis capabilities. However, the core issue is to ensure the safe and stable operation of autonomous vehicles in various environments and conditions. This article aims to comprehensively explore the construction of unmanned logistics transportation system on highways, providing reference for its future development.

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2 Technical Support System

2.1 Autonomous Driving Technology

Autonomous driving technology is the core of the unmanned logistics transportation system on highways[1]. Currently, autonomous driving technology has the ability to operate stably on highways, but further improvements are needed to enhance its adaptability to complex environments and its ability to respond to unexpected situations. It is necessary to strengthen the research and development of autonomous driving technology to improve its safety and reliability.

2.2 Internet of Things Technology

The Internet of Things technology achieves real-time monitoring, intelligent scheduling, and optimized management of transportation processes through the collaborative work of the perception layer, network layer, and application layer[2]. The perception layer is responsible for collecting raw data of roads and vehicles, the network layer is responsible for data transmission and communication, and the application layer is responsible for data processing and analysis. The application of IoT technology can significantly improve transportation efficiency and safety.

2.3 Big data Analysis and Cloud Computing

Big data analysis and cloud computing systems play a crucial role in the unmanned logistics transportation system on highways. By collecting, analyzing, and processing transportation data, combined with the powerful computing capabilities of cloud computing, it is possible to optimize and dynamically adjust transportation routes, thereby improving transportation efficiency. Meanwhile, big data analysis can also provide decision support for management and optimize resource allocation[3].

3 Standard Specification System

3.1 Technical Standards

To ensure the efficient, safe, and reliable operation of unmanned logistics transportation systems, it is necessary to establish a comprehensive technical standard system. When selecting unmanned trucks, factors such as sensor performance, hardware configuration, and software systems need to be considered. At the same time, corresponding certification and testing institutions should be established to conduct strict testing and evaluation of unmanned vehicles and road infrastructure.

3.2 Safety Standards

Safety standards are an important component of the unmanned logistics transportation

system on highways. It is necessary to establish safety standards regarding vehicle performance, environmental adaptability, information exchange security, and human factors, and verify them through simulation testing, closed field testing, and public road testing. At the same time, software and hardware systems should be regularly updated and upgraded to address new security threats.

4 Infrastructure Construction System

4.1 Road Infrastructure

The signs and markings on highways are an important foundation for the operation of unmanned logistics vehicles. Advanced reflective materials and weather resistant coatings are required to ensure that the logo remains clear and visible under various harsh weather conditions. At the same time, an efficient and stable signal system should be established to achieve real-time communication and collaborative control with unmanned vehicles. The application of intelligent transportation management systems can improve road traffic efficiency, optimize traffic signal timing, and enhance transportation efficiency[4].

4.2 Communication Facilities

Communication facilities are an important component of the unmanned logistics transportation system on highways. A stable and reliable communication network needs to be established to ensure real-time information exchange between vehicles and road infrastructure, as well as between vehicles. 5G or future 6G technology can be used to achieve high-speed and low latency communication services. At the same time, it is necessary to optimize the communication network layout inside the tunnel to ensure stable signal transmission within the tunnel.

4.3 Range and Maintenance Facilities

The endurance and maintenance facility system is a key link in ensuring the stable and efficient operation of unmanned logistics vehicles. A charging and swapping station system needs to be built to meet the range requirements of unmanned logistics vehicles. At the same time, a comprehensive maintenance facility system should be established to regularly maintain and upkeep unmanned logistics vehicles, ensuring that they are in good condition.

5 Regulatory and Policy System

5.1 Legal Regulations

Establish a permit system for unmanned logistics transportation, strictly review the qualifications of enterprises and individuals, clarify the responsible parties and their

legal responsibilities, and ensure that the technical, equipment, and management capabilities meet the standards. Simultaneously formulate data protection and privacy security regulations to prevent data leakage and abuse. Within the regulatory framework, formulate laws and regulations to prohibit unfair competition and monopolistic behavior, establish market access mechanisms, and ensure orderly market competition. Strengthen industry supervision, increase law enforcement efforts against illegal activities, and maintain market fairness and order. To promote international cooperation and exchange, we should draw on advanced international experience and technical standards, and jointly promote the development of the global unmanned logistics transportation industry.

5.2 Policy Support

Establish special funds to support the research and development, application, and promotion of unmanned logistics technology, provide policy measures such as low interest loans, tax reductions, and value-added tax incentives, reduce enterprise financing costs, and encourage enterprises to increase research and development investment. Simplify the market access approval process, establish unified standards and regulations, and ensure fair competition in the market. Establish a sound regulatory mechanism, strengthen the supervision of enterprise operation safety, and safeguard public interests and social stability. A leading group for the development of unmanned logistics systems on highways has been established to be responsible for policy formulation, coordination, promotion, and supervision and evaluation. Strengthen policy promotion and enhance the understanding of unmanned logistics transportation among all sectors of society. Emphasize talent cultivation, encourage cooperation between universities, research institutions, and enterprises. Strengthen international exchanges and cooperation, introduce advanced foreign technology and management experience, and enhance the international competitiveness of unmanned logistics transportation in China.

6 Regulatory and Emergency Response System

Establish a comprehensive regulatory and emergency system, led by the transportation management department, in collaboration with government departments, industry associations, and research institutions, to form a multi-level regulatory network. Utilizing technologies such as the Internet of Things, big data, and artificial intelligence for real-time monitoring, combined with traditional regulatory methods, to ensure compliance in all aspects[5]. Improve the regulatory process of pre-examination of enterprise qualifications, in-process supervision of transportation processes and handling of violations, and conduct comprehensive risk assessments. Utilize technological means to monitor key parameters and abnormal situations in real time to ensure transportation safety. Establish a warning information release system to quickly convey warning information. Establish an emergency command center to coordinate the handling of emergencies, coordinate various forces and resources for rescue, carry out

evacuation, control, and cleaning work, and adopt professional technology and equipment for emergency repairs. After the accident handling, organize forces to carry out facility repair and system restoration, summarize lessons learned, evaluate the operation of the emergency system, and continuously improve and optimize. Establish a comprehensive emergency response system for unmanned logistics systems on highways through a closed-loop management process of prevention, warning, response, disposal, recovery, and evaluation. In the future, we will continue to enhance our emergency response and disposal capabilities to ensure the safety, stability, and efficiency of unmanned logistics transportation, providing a solid guarantee for the transformation, upgrading, and high-quality development of the logistics industry.

7 Establishment of High-Speed Unmanned Logistics Transportation System

7.1 Scene Setting

The Linhe to Baikele section from Bayannur City in western Inner Mongolia to Alxa League has been selected as a pilot project, with a total length of about 930 kilometers. The traffic flow on this section is relatively small, providing an ideal testing environment for autonomous driving. In terms of vehicle selection, we adopt SAIC Hongyan pure electric intelligent heavy-duty truck, equipped with 5G+L4 Honghu intelligent driving system, which integrates laser, vision and millimeter wave sensors to achieve 360 ° all-round perception and centimeter level high-precision positioning, meeting the perception and prediction needs in complex traffic scenes.

7.2 Technical Support

The Honghu Intelligent Driving System relies on various sensors (LiDAR, millimeter wave radar, high-definition cameras, ultrasonic sensors, IMU) and devices such as GPS and high-precision maps to achieve comprehensive perception and precise positioning of the surrounding environment. Vehicles use SLAM technology to construct real-time environmental maps and combine behavioral decision-making and motion control algorithms to achieve autonomous driving. The application of 5G and V2X technology has further enhanced the vehicle road coordination and information exchange capabilities, enhancing driving safety and efficiency.

7.3 Standard Specifications

To ensure the safe operation of unmanned trucks, a series of rigorous safety tests are required, including simulating automatic emergency braking, lane keeping assistance, adaptive cruise control and other functional tests under different driving scenarios, as well as system safety testing, durability testing, collision testing, and network safety testing. The vehicle must meet IOS 26262 ASIL level D or higher standards and verify its adaptability and safety through road testing.

7.4 Road Infrastructure Construction

To achieve unmanned logistics transportation, it is necessary to evaluate and renovate existing roads, add dedicated lanes for unmanned vehicles, optimize road signs and markings, and install intelligent traffic signal equipment and perception monitoring systems. At the same time, the service area needs to be equipped with intelligent charging stations, battery swapping stations, and maintenance service facilities, and toll stations should set up dedicated toll channels to achieve automated operation of unmanned vehicles.

7.5 Transportation Process

Before transportation, the vehicle conducts self-inspection and establishes real-time communication with the dispatch center to obtain the optimal driving path. During the driving process, the Honghu intelligent driving system perceives the surrounding environment in real time and works in coordination with surrounding vehicles and infrastructure through the 5G network. In the face of complex road conditions and emergencies, the system can quickly respond, such as slowing down and avoiding, finding the nearest service area for battery replacement[6]. The system will also dynamically adjust routes based on real-time data. After arriving at the destination, the vehicle completes the unloading of goods through the automatic loading and unloading system and automatically goes to the logistics park to load new goods and return.

7.6 Regulation and Emergency Response

The regulatory center remotely monitors unmanned vehicles through real-time collection of vehicle status and road condition information to ensure compliant driving. Once the accident monitoring system detects any abnormalities, it will immediately activate the emergency plan and dispatch emergency personnel to the scene for handling. The emergency management system schedules corresponding resources based on the type and severity of the accident, ensuring on-site safety and properly handling subsequent matters related to the accident.

8 Conclusion

The construction of unmanned logistics transportation system on highways is an important direction for the intelligent development of the logistics industry. Through the joint efforts of technical support system, standard specification system, infrastructure construction system, and emergency supervision system, the safe and stable operation of unmanned logistics vehicles on highways can be achieved, improving transportation efficiency and safety. In the future, it is necessary to continue to strengthen technology research and development and standard setting work, and promote the continuous improvement and development of unmanned logistics transportation systems on highways.

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