10.70711/frim.v2i7.5029

Application of UAV System in Highway Communication Engineering Technology

Ning Xiang

Xihua University, Chengdu, Sichuan 610039

Abstract: In order to improve the technical level of highway communication engineering, this paper discusses the specific application of daily road condition monitoring, traffic control, emergency response and supplement and expansion of communication network from the perspective of the application of UAV system. This paper analyzes the advantages of UAV system applications, including high efficiency, economy, flexibility and safety, and points out the challenges in technology, management and laws and regulations. In response to these challenges, strategies, such as technological innovation, management optimization and regulation improvement, are proposed, aiming to promote the safe, efficient and compliance application of UAV systems in highway communication engineering and promote the development of intelligent transportation.

Keywords: UAV system; Highway; Communication engineering technology

Introduction

With the rapid development of science and technology, uav technology has expanded from the military field to the civil field, showing great potential in the highway communication engineering. As an important national infrastructure, the efficiency of the communication engineering system of the highway is directly related to the traffic safety and operation efficiency. This research focuses on the application of uav system in highway communication engineering technology, and discusses its innovative solutions, aiming to improve the level of expressway management and promote the construction of intelligent transportation. The research results of this paper are expected to provide a valuable reference for traffic management departments, communications engineers and technicians, and related policy makers.

1. Advantages of UAV system application in highway communication engineering

The application of uav system in highway communication engineering shows many advantages and significantly improves the overall efficiency of communication engineering. The efficiency is reflected in the rapid deployment and strong mobility, which can complete a large range of communication facilities inspection and data collection in a short time, which greatly shortens the time required by traditional manual operation. In terms of economy, the UAV system reduces the input of human resources, reduces the risk of aerial work and related insurance costs, and its equipment has a high return on investment, which can achieve significant cost savings for long-term use. The safety advantage is particularly prominent. The UAV system reduces the direct exposure of staff in dangerous environments, such as high-altitude work or accident site investigation. At the same time, through real-time monitoring and rapid response, the safety level of the overall operation of the expressway is improved. The comprehensive play of these advantages of uav system not only improves the work efficiency and quality of expressway communication engineering, but also provides strong technical support for the development of intelligent transportation, and promotes the development of expressway management to a more intelligent and refined direction[1].

2. Challenges for UAV system applications

Although the UAV system shows significant advantages in highway communication engineering, its wide application still faces many challenges. From the technical point of view, improving the endurance ability of the UAV, enhancing its anti-electromagnetic interference ability and realizing the all-weather operation ability are urgent problems. The challenges at the management level are mainly reflected in the complexity of airspace management and the guarantee of data security. How to ensure the integrity and confidentiality of communication data while ensuring flight safety has become a key issue. In terms of laws and regulations, the application of UAV involves sensitive issues such as privacy protection and responsibility definition, and the existing legal framework has not been fully adapted to the rapid development of UAV technology. These challenges not only reflect the limitations of UAV technology itself, but also highlight its complex interaction with multiple dimensions of society, management and law during practical application. Addressing these challenges requires collaborative advances of tech-

nological innovation, management optimization and regulatory refinement to ensure safe, efficient and compliant applications of UAV systems in highway communications engineering.

3. Application of UAV system in highway communication engineering

3.1 Daily road condition monitoring

In the modern highway management system, the UAV system has brought about the revolutionary changes to the daily road condition monitoring. By being equipped with high-resolution camera equipment, the UAV can collect road condition information in real time and provide all-round and multi-angle road condition data. This aerial view not only expands the scope of monitoring, but also quickly identifies problems such as traffic congestion and road damage. The application of high-definition image transmission technology ensures that the collected video and image data can be transmitted to the control center in real time and clearly, providing a timely and accurate basis for traffic management decisions. In particular, the introduction of automatic cruise mode greatly improves the efficiency of monitoring. By preset flight path and monitoring point, the UAV can autonomously complete the cruise tasks according to the established procedures, reducing the intervention of human operation, and ensuring the continuity and comprehensiveness of monitoring. This intelligent monitoring method not only improves the efficiency of road condition information collection, but also can continue to work in bad weather or night conditions, filling the blind spot of the traditional fixed camera monitoring system. The application of uav system in daily road condition monitoring provides strong technical support for the safe operation and intelligent management of expressways, and promotes the development of traffic monitoring to a more refined and intelligent direction.

3.2 Traffic control

The application of UAV system in the field of highway traffic control marks that traffic management has entered a new intelligent era. In terms of accident site tracking, the UAV, with its flexible mobility and broad vision, can quickly reach the accident site and transmit the situation back to the scene in real time, providing first-hand video information for the traffic management department. This will not only help to quickly assess the scope of the impact of accidents, but also provide accurate guidance for accident handling and traffic diversion. In terms of illegal behavior monitoring, the advantages of drones are more obvious. Through high-altitude patrols, the drone can cover a wider range of road sections and effectively detect and record traffic violations such as speeding and illegal lane changes. The introduction of remote warning and command function has further enhanced the flexibility of traffic control. Drones can provide real-time voice warnings and guidance to drivers in specific areas through a mounted speaker system, especially in emergencies or severe weather conditions. Through the uav system, the traffic management department can realize the dynamic and all-round control of the expressway, effectively improve the efficiency and accuracy of the traffic control, and provide strong technical support for ensuring the safety and smooth flow of the expressway.

3.3 Emergency response

In the field of highway emergency response, the introduction of uav system has significantly improved the disposal efficiency and safety. Rapid field investigation is the primary application of UAV system in emergency response. In case of a traffic accident or natural disaster, the drone can arrive at the scene in the shortest time. Through high-definition cameras and thermal imaging equipment, it can fully grasp the scene information, including casualties, the degree of vehicle damage and the risk of the surrounding environment. These real-time data provide an important basis for the emergency command center to develop scientific and effective rescue strategies. In the delivery of emergency supplies, drones show unique advantages. For areas where traffic disruption or complex terrain is difficult to reach by ground rescue vehicles, drones can quickly and accurately deliver urgently needed light supplies such as medical supplies, food or communication equipment to designated locations to provide timely assistance to trapped people. In terms of rescue command assistance, the UAV system establishes an efficient information channel between the field rescue personnel and the remote command center through real-time video transmission and communication relay functions. This not only helps the command center to fully control the rescue progress, but also provides real-time guidance for rescue workers, optimize rescue routes and methods, and maximize rescue efficiency. The application of uav system in emergency response has greatly enhanced the emergency response capacity of expressways, and provided strong support for reducing accident losses and ensuring the safety of personnel[2].

3.4 Supplement and expansion of the communication network

UAV system plays an increasingly important role in supplementing and expanding highway communication network, effectively solving the limitations of traditional fixed communication infrastructure. As a temporary communication relay station, the UAV can be deployed to a designated location in a short period of time to quickly establish a communication link. This function is particularly critical in the cases of damaged fixed communication facilities or insufficient signal coverage, which can quickly restore or enhance the communication capacity and ensure the continuous operation of the highway management system. Especially during emergencies or large events, UAV relay stations

can flexibly adjust position and height, optimize signal coverage, and meet temporarily increased communication requirements. In terms of network coverage blind area filling, the uav system shows unique advantages. For areas with complex terrain and difficult to cover by fixed base stations, the UAV can be used as a mobile base station to provide stable communication services. This not only improves the communication quality of the whole expressway, but also provides a reliable data transmission channel for the monitoring and management of remote sections. By carrying different types of communication devices, drones can support a variety of communication protocols and realize various forms of information transmission, such as voice, data and video.

4. Conclusion

To sum up, the application of the uav system in the highway communication engineering technology has shown significant advantages, which has brought about revolutionary changes to the traditional communication engineering. From daily monitoring to emergency response, from traffic control to network expansion, the uav system is comprehensively improving the management efficiency and safety level of expressways. Despite the technological, management and regulatory challenges, the UAV system will certainly play a more important role in the future intelligent transportation system through continuous innovation and optimization. Future research should focus on exploring the deep integration of uav, artificial intelligence, 5G network and other emerging technologies, so as to promote the development of highway communication engineering to a more intelligent, safer and more efficient direction.

References

[1] Li Lei. Application of UAV system in highway communication engineering technology [J]. Equipment management and maintenance, 2022 (6): 107-108.

[2] Liu Zhe, Li Ou. Application of UAV system in highway communication engineering technology [J]. Computer Campus, 2020 (11): 3272-3273.

[3] Wu Zhongqing. Reverse analysis of communication protocol for small UAV system [D]. Xidian University, 2018.