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A Review of Research on UAV Remote Sensing Technology

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Abstract

In this paper, UAV remote sensing technology is a new spatial information acquisition technology that integrates UAV flight platform, high-sensitivity remote sensing sensors, high-precision navigation control system and intelligent data processing technology. With the core advantages of low-cost deployment, high maneuverability response, and centimeter-level high-resolution imaging, it effectively breaks through the dual limitations of traditional satellite remote sensing in terms of temporal resolution (easily obscured by clouds, long revisit period) and manned aviation remote sensing in terms of operating cost (high equipment maintenance and personnel support costs) and space flexibility (many restrictions on low-altitude flight). Whether it is the rapid capture of disaster images in emergency response, the accurate monitoring of crop growth in the agricultural field, the tracking of pollution sources in ecological environmental protection, and the collection of refined terrain data in urban planning, this technology can obtain dynamic spatial information of the target area in real time with an efficient and flexible operation mode, providing timely and accurate data support for decision-making in various industries, and has become an indispensable key component of the modern spatial information collection system.

Keywords

UAV Platform; Remote Sensing Sensor; Data Support; Sensing Technology.

1. Introduction

With the development of space information technology in the direction of high precision, real-time and low cost, traditional remote sensing methods have gradually revealed their limitations: satellites can remotely sense the orbital period and the influence of clouds, making it difficult to achieve high-frequency and high-resolution regional monitoring; Manned aerial remote sensing is inflexible in small-scale fine observation and complex terrain operations due to high operating costs and severe take-off and landing conditions. In this context, UAV remote sensing technology can flexibly carry a variety of sensors such as multispectral and thermal infrared to quickly obtain refined spatial information in the target area, effectively make up for the shortcomings of traditional remote sensing, and become a key technical link connecting macro satellite remote sensing and ground observation. The research purpose of UAV remote sensing technology is to break through the bottlenecks of traditional remote sensing in terms of spatiotemporal resolution, operation cost, and scene adaptability, and to overcome core technical problems such as rapid image splicing, high-precision positioning, and intelligent interpretation of ground objects by optimizing the performance of UAV platforms and the integration and adaptation of multiple types of sensors, and to build an efficient, accurate and low-cost spatial information acquisition and processing system. The ultimate goal is to promote the in-depth application of this technology in agriculture, surveying and mapping, ecology, emergency response and other fields, realize the full chain of technology empowerment from data acquisition to information extraction to decision support, and provide more efficient and refined technical support and solutions for industry information management, resource and

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environmental monitoring and emergency response. The research significance of UAV remote sensing technology lies in its breakthrough and empowerment from three dimensions: at the technical level, it promotes the innovation of remote sensing observation systems, fills the technical gap between macro satellite remote sensing and micro ground observation, and promotes the integration and innovation of multidisciplinary technologies such as aerospace, sensors, and artificial intelligence; At the industry level, it provides low-cost, high-precision and time-sensitive solutions for agriculture, surveying and mapping, ecology, emergency response and other fields, which greatly improves the efficiency of industry information monitoring and management, such as accurate identification of crop diseases and pests and rapid modeling of disaster sites. At the social level, its application in public affairs such as resource survey, environmental protection, and emergency rescue can provide timely and reliable data support for scientific decision-making, which has important practical value for ensuring food security, improving disaster response capabilities, promoting the construction of ecological civilization, and helping the sustainable development of social economy.

2. UAV Platform

2.1. UAV Equipment Management List Management

The platform manages UAVs in a unified manner, records basic information such as model and load, and tracks their status and ownership. These data are shared with the comprehensive command and dispatch module, and the commander selects the appropriate UAV according to the task; Status information is synchronized to the shelter management module for easy maintenance and charging. Condition monitoring: Collect UAV flight data and video in real time to provide decision-making basis for command and dispatch, and help it flexibly adjust tasks. The data is also used by the flight record management module to record details, and the equipment management module uses it to predict faults and arrange maintenance.

2.2. Comprehensive Command and Dispatch Online Equipment

Intuitively present the real-time position, trajectory, parameters and video of the UAV. Relying on equipment management, condition monitoring, and flight recording module data, combined with AI intelligent analysis results, tasks and routes are scientifically planned. If the AI finds an abnormality, the commander can quickly dispatch the drone accordingly. Remote lever control: Convenient route planning, route information sharing to the flight record management module to record preset routes, and flight trajectory feedback to the online equipment module. At the same time, it collaborates with AI intelligent analysis to avoid no-fly zones and other issues in advance.

2.3. Flight Record Management Flight Record

Detailed recording of each element of the flight mission. The equipment management module evaluates equipment loss and formulates maintenance plans accordingly; the command and dispatch module refers to the historical record optimization strategy; Data also helps AI to intelligently analyze and optimize algorithms [1].

At present, the application of UAV in overhead transmission line inspection has been widely used, and the continuous development of UAV relay technology has brought new methodologies to the power line patrol communication problem in remote mountainous areas. Ref proposed a tethered relay UAV power inspection system, which was verified on a 500 kV mountain transmission line with a total length of 70 km and passed through 43 towers distributed between 400 m and 1 500 m above sea level [2]. Ref. uses a static deployment method in which the tethered UAV for relay is hovered at an altitude of 3 000 m, while Ref. proposes a dynamic relay patrol operation scheme for UAV to solve the problem of limited UAV power patrol distance [3]. Through the research of spatial diversity reception, efficient error correction coding and other technologies, the best deployment position of the relay UAV is determined: in the area with large terrain fluctuations, the relay UAV and the patrol UAV should be kept at a distance of 5~10 km, and the distance between the relay UAV and the patrol UAV in the gentle terrain area can be appropriately extended, but the maximum distance should be within 20 km. This method can effectively improve the communication distance of power inspection drones in remote areas, and has certain reference value for realizing over-the-horizon UAV inspection data transmission. In addition, UAV relay technology has had a number of application cases in the power industry, such as State Grid Fujian Information and Communication Company, State Grid Gansu Gong4 China Test Division, Guangdong Power Grid Company, etc., which have applied UAV relay technology to assist in completing multiple distribution network inspections and emergency maintenance work, effectively increasing operational efficiency, but the above applications only consider the requirements of signal coverage and do not involve the optimal allocation of resources [4,5]. As constraints, the general method of designing the optimal relay deployment based on actual scenarios will be an important research direction in the future [6].

3. Remote Sensing Sensor

3.1. Remote Sensing Sensor Platform

Remote sensing sensors are the eyes of the remote sensing platform and one of the basic equipment for the promotion and application of UAV remote sensing. Since the 80s of the 20th century, with the rapid development of computer technology and communication technology and the continuous emergence of various digital, lightweight, small and high detection accuracy new sensors. Sensors have developed from the early film camera to the digitalization of large area array, and the digital aerial survey camera manufactured in China has more than 80 million pixels, which can shoot high-precision aerial films in color, infrared and full color at the same time. The Chinese Academy of Surveying and Mapping uses a number of Hasselblad cameras to combine photography, and uses the software developed to splice and splice, effectively improving the efficiency of remote sensing flight and aerial photography. The 22 million pixel professional camera launched by the German company Rollei is equipped with a camera gimbal that automatically maintains level and corrects rotation, and the corresponding mapping software has been developed. In addition, small high-precision sensors such as laser 3D scanners and infrared scanners also provide room for the application of UAV remote sensing. In 2004, Wang Binyong et al. designed and completed a small multispectral imager based on the multi-faceted array CCD sensor imaging method suitable for the unmanned aerial vehicle SE-1 (Ocean Exploration 1), which has built-in photography control software, which has the functions of flight control system communication, obtaining flight parameters, calculating appropriate exposure time, correcting exposure time, and storing data in real time. Jia Jianjun et al. designed a practical UAV large-area array CCD camera remote sensing system by using the method of system integration to view the characteristics of UAV remote sensing payload, and carried out a flight test on the Y-12 unmanned remote sensing aircraft to obtain images that met the requirements. 2·2 Development of flight attitude control technology The quality of UAV flight attitude control is directly related to the effect of remote sensing images. To complete the task of autonomous flight remote sensing aerial photography, the control system needs to have good control characteristics for both the inner loop (attitude loop) and the outer loop (horizontal position and altitude loop). From the beginning of the birth of UAVs to the present, the flight attitude control technology has gone through the nonlinear dynamic control stage, the adaptive thrust reversal control stage, and the neural network intelligent control stage[7].

3.2. UAV Remote Sensing

UAV remote sensing monitoring system is an organic combination of UAV platform and remote sensing data collection and processing equipment, which is equipped with an autopilot and flight control system, with GNSS navigation function, which can automatically record geographical location and monitor UAV flight attitude. The system uses unmanned aerial vehicles as the basic flight platform and is equipped with high-resolution remote sensing imaging equipment to obtain low-altitude high-resolution image data, providing a basis for generating orthophoto images and three-dimensional structural models. The traditional monitoring system is relatively easy to deploy routes and fly, but it requires a lot of manpower, material resources and time to measure a large number of image control points in the future, and the use of UAV remote sensing monitoring system can save manpower, material resources and shorten the time cycle. On the basis of multiple tests and explorations, the UAV monitoring system uses the KC2800 UAV of Wuhan Smart Bird UAV Co., Ltd., equipped with Nikon D800 camera and the AG200 receiver of Wuhan Interspace to form a GNSS aerial photography processing platform. Based on the advantages of superior unmanned platform and algorithm processing, it is equipped with a high-definition digital camera to collect images, and the image results can meet the requirements of large-scale mapping. In addition, the UAV remote sensing monitoring system has carried out practical application and production in major national projects and in the construction of small towns and new rural areas, surveying and mapping in difficult areas, land and resources monitoring, etc., and has obtained more accurate monitoring image data and obtained good economic and social benefits [8]. Research UAV remote sensing technology, collect information through UAV remote sensors, combined with data processing and analysis, to achieve accurate monitoring of land disturbance, soil erosion and the effectiveness of soil and water conservation measures [9].

4. Summary and Discussion

UAV remote sensing technology has formed a complete technical chain of "platform-payload-data processing-industry application", and has made significant breakthroughs in platform lightweight and long endurance, load multispectral/hyperspectral integration, and intelligent data interpretation. Current research still faces three key challenges: first, flight stability and data reliability in complex environments (such as strong electromagnetic interference and bad weather) need to be improved; second, the rapid processing and real-time interpretation efficiency of massive multi-source remote sensing data is limited by the algorithm computing power and model generalization ability; Third, there is a problem of "insufficient technical adaptability" in industry applications, and general technical solutions are difficult to meet the in-depth needs of specialized scenarios such as high-precision surveying and mapping, trace pollutant monitoring, etc. Future research should focus on multidisciplinary integration, on the one hand, promote the deep integration of UAV platforms and new sensors (such as lidar and hyperspectral imagers), on the other hand, strengthen the combination of AI large models and remote sensing interpretation, overcome the bottleneck of real-time data processing, and develop customized technical solutions for specific industry needs, and finally realize the leapfrog development of UAV remote sensing technology from "usable" to "easy to use and easy to use".

Refrences

[1] Zhang J. (2025) AI Vision Algorithm and Private Cloud Empowering Police UAV Platform Construction. Fujian Computer, 41(06):64-69.

[2] Deng, C., Wang, S.W., Huang, Z. (2014) Unmanned aerialvehicles for power line inspection: a cooperative way inplatforms and communications. J Commun, 9(9):687-692.

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[3] Ding, J., Fu, H., Tang, J. (2016) Design of power inspection data transmission scheme based on UAV relay. Journal of Air Force Early Warning College, 30(6): 426-430.

[4] Song, X., Qiang, W. (2023) State Grid Gansu Electric Power Develops UAV Equipped with Miniaturized 5G Relay Base Station. http://www.chinapower.com.cn/dlxxh/wurenji/2023-12-14/228365.html.

[5] Kong, D., Zheng, Z., Yang, X. (2023) Guangdong Power Grid Company Uses Relay UAV for the First Time to Carry Out Distribution Network Intelligent Inspection. https://www. chinapower. org.cn/detail/403181.html.

[6] He, C., Wang, F., Zhu, L. (2025) Research progress on power line patrol related technologies based on UAV platform. China Testing, 51(03):1-15.

[7] Jin, W., Ge, H., Du, H. (2009) Overview of the development and application of UAV remote sensing. Remote Sensing Information, (01):88-92.

[8] Zhang, X., Wei, G., Ge, C. (2025) Surveying, Mapping and Spatial Geographic Information, 48(09): 111-113, 118.

[9] Liu Y. (2025) Application of UAV remote sensing technology in soil and water conservation work. Value Engineering, 44(29):166-168.