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Research on Forest Environmental Data Monitoring Based on Unmanned Deployment

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Abstract

Forest is one of the important conditions for high output of agriculture and animal husbandry, but it is in the "marginal field" of emergency management and intelligent construction. With the development of China's economy and society, the urbanization process is advancing by leaps and bounds, the distance between public habitats and forests is shortened, and the threat of forest disasters will gradually become prominent. As a high incidence place of natural disasters and man-made disasters, the forest is effectively obtained by using unmanned deployment, and the forest is monitored in a comprehensive and real-time manner, so as to timely find diseases and pests, forest fires and other natural disasters, and then effectively organize rescue and reduce forest losses. At the same time, build an autonomous monitoring system of forest environmental data based on unmanned deployment, in order to significantly improve the ability to obtain real-time information of forest environment and accelerate the process of "intellectualization".

Keywords

UAV control; Data monitoring; Intelligent identification.

1. INTRODUCTION

Nowadays, with the rapid development of information technology, intelligence and unmanned aerial vehicle technology, the social demand for protecting the rights and interests of the country and people through the combination of intelligent systems and unmanned control technology is also increasing. As one of the important ecosystems of the earth, forests have also attracted more and more attention. With the rapid development of urbanization, the distance between public habitats and forests has been shortened, and the threat of forest disasters will gradually become prominent. Therefore, mastering accurate forest monitoring data is crucial to prevent natural disasters, reduce social losses and effectively protect the forest environment. The flexibility, safety and controllability of the UAV are used to survey the on-site environmental data under dangerous conditions and in a large range, so that the UAV can also capture stable and smooth on-site images in real time under all kinds of weather conditions and intense sports. At the same time, sensors are used to obtain dust (pm2.5/pm10\tsp), negative oxygen ions, noiseMeteorological elements (temperature, humidity, wind speed) and other information, and realize the transmission of images, sensor data and other information and intelligent data analysis results to the control center for real-time monitoring under a very short time delay. Figure 1 below shows the relevant data of forest coverage in some provinces in China in recent years. Among them, the annual logo is sgnyea, the area code is prvcd, the area name is prvnm, the forestry land area is frstua, the forest area is frsta, the plantation area plta, the forest coverage (%) is frstcv, the total volume of living trees is stpcm, and the forest volume is frstcm.

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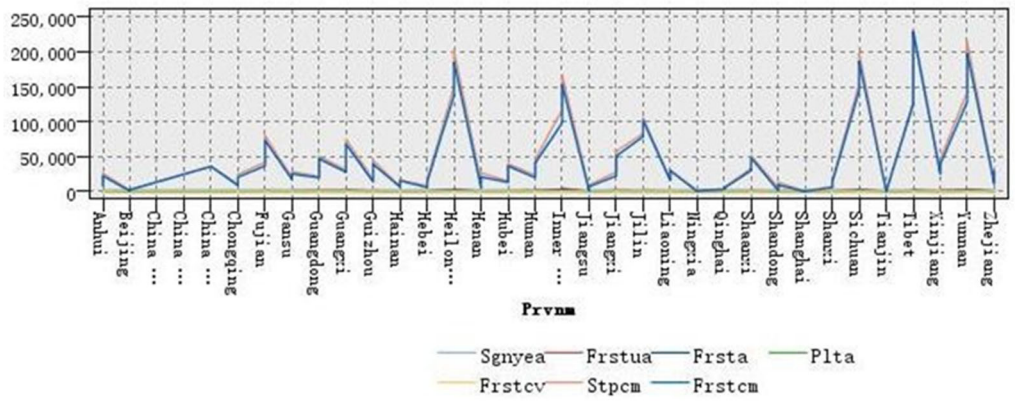

Figure 1. Visualization of forest area related data in some provinces of China

2. DESIGN OF FOREST ENVIRONMENTAL DATA MONITORING BASED ON UNMANNED DEPLOYMENT

2.1. System architecture

The four-wheel drive vehicle for forest environment monitoring is mainly composed of tm4c123g single chip microcomputer, central controller, attitude detection, gyroscope, power system, optical flow, ultrasonic and power module to ensure the stable flight of UAV. Mpu6050 and the main controller tm4c123g of the aircraft communicate with each other and transmit data through I2C protocol, and the noise signal is effectively removed through classical Butterworth filter. Using the UAV equipped with high-definition camera, visible light thermal imaging lens and a variety of data monitoring sensors to provide a global perspective, the airborne data is fed back to the background monitoring system, and then a series of intelligent data analysis and effective information extraction such as feature parameter statistics, detail matching and development trend prediction are carried out.

2.2. System Design

2.2.1Real time wireless transmission feedback

Based on the characteristics of wireless communication, such as not limited by geographical and other environmental factors, fast transmission time and accurate transmission content, low-power remote wireless transmission, high-capacity concurrent signal full probability detection and access technology and forest simulation data monitoring buoy node are used to realize the communication in the deployment environment of forest UAV, and after successfully obtaining the data, the data signal is sent to the satellite, The signal is transmitted to the ground receiving station by satellite. At the same time, in order to protect the accuracy and anti interception of the data, the signal encryption mechanism of multiple verification of the data ensures that the data cannot be tampered with by criminals.

2.2.2Environmental data collection

UAV load refers to the equipment required to implement various functions on UAV, such as signal transmitter, sensor, etc. Forest environmental data monitoring can obtain accurate data information by loading high-resolution visible light camera, meteorological temperature and humidity negative oxygen ion sensor, thermal imager, ultrasonic sensor, laser radar and other loads. Ultrasonic sensors and lidar can use strong penetration to accurately locate the height of aircraft, and can obtain large-area three-dimensional cloud data. They are applied in the fields of terrain change, biomass monitoring, forest vegetation information and so on. The high-resolution visible light camera and spectral imager can statistically analyze the vegetation species and distribution, the degree of forest damage and the trajectory of animal communities in the forest environment by capturing the video image information and the visible light band

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within the visible light band, and use the deep learning work technology to build various training sample data sets in the forest environment, so as to realize the automatic recognition function, Further effectively protect the forest ecosystem. The thermal imager can capture the electromagnetic radiation area belonging to the thermal infrared part, and convert the light radiation energy into electrical signals according to the difference of infrared reflection of different object surface temperatures. Through the temperature difference of each part of the object represented by different colors in the thermal infrared image, it can further judge the condition of the object to be tested. In the forest environment, pollutant monitoring, fire disaster monitoringIt is highly used in emergency rescue monitoring.

2.2.3Effective information extraction

The monitoring data of UAV deployment in forest area includes high-resolution visible light, high-definition video and images, hyperspectral, lidar, temperature and humidity and other data. It has the characteristics of massive data, rich information, complex structure and diverse types. For the high-altitude image transmitted by the UAV at the control point in real time, the outline of the environmental situation is distinguished and judged according to the color feature extraction, and the Fourier description method is used to describe the outline of the shape (its discrete Fourier transform expression is shown in Formula 1).On the shape boundary, different shape identification functions can be obtained by selecting different starting points, such as translating and rotating the image contour. After changing the starting point of the identification function, the Fourier transform an mathematical expression of the identification function is shown in Formula 2.so as to complete the feature extraction and matching of the image data. The system uses the one-dimensional data (such as temperature, humidity, negative oxygen ions, infrared intensity, etc.) transmitted by the control UAV and the deep learning technology to build a large number of training sets, and carries out a large number of verification and testing. It uses the forest control to complete the automatic collection and analysis of environmental data, and realizes the automatic monitoring and early warning function of the forest environment.

$$a_n = \frac{1}{N}\sum_{t=0}^{N-1} u(t)\exp\left(\frac{-i2\pi nt}{N}\right)(n = 0,1 \dots, N-1) \quad (1)$$

$$a_n = \exp(i\varphi)\cdot\exp(in\tau)\cdot s\cdot a_n^0(n \neq 0) \quad (2)$$

3. EXTRACTION AND APPLICATION OF UNMANNED FOREST ENVIRONMENTAL DATA

3.1. Ecological Environment Monitoring

The combination of temperature and humidity negative oxygen ion sensor, high-resolution visible light camera, infrared load, laser radar and other loads to obtain forest environment remote sensing data can match and fuse environmental data from different sources and characteristics in the same area in the forest environment, make up for the shortage of a single data source, and realize the spatial resolution, temporal resolution The advantages of spectral resolution complement each other, improve the reliability of information extraction, and present fine and accurate environmental data to relevant personnel, which facilitates the forest management of relevant departments and effectively promotes the rational utilization and sustainable development of forest resources.

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3.2. Biological Information Extraction

The way of UAV fixed-point control, track patrol and all-round coverage is adopted to collect accurate data in the forest area. Using the real-time image information transmitted by UAV, the biomass of the forest area can be accurately extracted and recognized, and the growth of vegetation can be observed in detail. It makes up for the shortcomings of the satellite monitoring system in terms of long monitoring cycle, low image resolution, slow signal transmission, vulnerability to clouds and high cost.

3.3. Natural Disaster Rescue

Natural disasters, such as forest fires and forest meteorological disasters, often have the characteristics of sudden and destructive. Using the characteristics of unmanned aerial vehicles that can fly at high altitude under adverse conditions, providing high-definition image data can further analyze the disaster situation, accurately determine the scope of forest disasters and carry out accurate rescue, including:

(1) Obtain the images taken by UAV, compare and analyze the original scene, judge the disaster situation, and monitor and evaluate the disaster situation;

(2) Use the transmission of real-time data to conduct high-altitude search and narrow the rescue scope for accurate rescue;

(3) Make disaster relief decisions and implementation measures quickly and accurately according to key environmental status information such as transmitted images and temperatures.

Forest fire is very destructive to the forest, and the UAV environmental monitoring system can be beneficial in the event of forest fire. Use all kinds of sensor equipment to quickly obtain the detailed information of the fire area for accurate fire suppression. After the disaster, we can also conduct a comprehensive index evaluation of the disaster site environment through the obtained data and establish a more complete disaster assessment system, so as to scientifically and effectively improve the early warning ability of forest fires and the emergency handling ability in case of disasters.

3.4. Plant Protection Activities

Forest diseases and insect pests seriously affect the species diversity and sustainable development of forest environment. Using the video and image data obtained by UAV monitoring, through the scientific analysis of the ground feedback center and the intelligent recognition and judgment model established through in-depth learning in the early stage, the unsupervised classification method is used to classify, compare and recognize the areas with similar pictures, analyze the possible pests and diseases in the current forest area, and accurately judge the health status of plants, It should be treated accurately to improve the economic and ecological benefits of the forest environment. At the same time, taking advantage of the characteristics that UAV can carry out low altitude flight operations, the UAV flight platform (fixed wing, helicopter, multi axis aircraft), navigation flight control and spraying mechanism are combined into one. Through system path planning, the functions of spraying chemicals and powders on forest vegetation can be realized.

4. ADVANTAGES AND LIMITATIONS

4.1. Advantages of Unmanned Aerial Vehicle Technology in The Application of Forest Environmental Monitoring

In terms of forest resources monitoring, UAV technology is significantly different from traditional monitoring methods. The forms of UAV monitoring and data collection are more

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diverse, and it can display data of multiple dimensions, such as video or pictures, so that the data can be presented more stereoscopically and intuitively. Using unmanned aerial vehicles to carry out fixed-point control and monitoring in the forest area can comprehensively monitor the forest area in real time, with a wide range of monitoring and more accurate monitoring data. Obtaining accurate data at the fastest speed effectively avoids the waste of human and material resources, and the obtained data information is richer and the work efficiency is higher. At the same time, in the face of forest disasters, UAV control can monitor and rescue high-altitude operations in real time under adverse environmental conditions, minimizing casualties in the rescue department when forest disasters occur. In daily monitoring, relevant technicians can adjust the flight altitude and route of UAV and carry out key monitoring on key areas according to the actual situation, so as to mine more biological information, which has a significant effect on preventing forest fires, forest pests and diseases, and monitoring biological species.

4.2. Limitations of Unmanned Aerial Vehicle Technology in The Application of Forest Environmental Monitoring

Although UAV technology has been widely used in forest area ecological environment monitoring, there are still some technical challenges. Compared with satellite monitoring, due to the low altitude flight characteristics of UAVs, the image data bandwidth obtained by UAV deployment monitoring is also lower than that of satellite remote sensing images, and the viewing angle range is also smaller than that of satellite monitoring. At present, this limitation can only be made up by the intensive deployment of a large number of UAVs in forest areas. Therefore, it is necessary to develop a higher resolution payload to enable the UAV to obtain wide-band and wide-range environmental monitoring data at a higher flight altitude. Due to the characteristics of large geographical range, many species and wide range to be monitored in the forest area, the UAV monitoring system needs to process a large amount of monitoring data, such as high-resolution visible light, high-definition video and images, lidar test distance and other data. It has the characteristics of massive data, rich information, complex structure and diverse types. How to transmit a large amount of data in the forest area in real time through the system Intelligent classification and effective recognition is a challenge at present.

5. CONCLUSION

To sum up, the forest environment monitoring system based on unmanned deployment built in this paper aims at the problem of timely, efficient and high-resolution marine real-time observation data acquisition during the construction of "smart forest", takes intelligence and unmanned as the main line, and integrates low-cost, high-resolution and lightweight loads with UAV flight control technology, Using the technical means of reasonable airdrop deployment, real-time signal transmission and image intelligent analysis of UAVs in the forest area, a forest environment monitoring system scheme based on unmanned deployment is preliminarily constructed, and the application scenarios of the system are analyzed in detail, in order to provide strong support for effectively developing and promoting the construction of "intelligent society" environmental protection capacity.

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