Design of Forest Security Defense System Based on Beidou-Positioning

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Abstract. Aiming at the problems that, it is difficult for the administrator to obtain various state information in the forest in real time, and it is impossible to make real-time and accurate judgments on the behaviors that endanger the forest and formulate effective countermeasures, a forest security guard service system based on Beidou positioning is designed. The system adopts STM32F103C8T6 as the main control chip to control different types of sensors such as flame sensor, temperature sensor, humidity sensor, sound sensor and so on, the information of temperature, humidity, illumination, fire situation, animal type, personnel alarm around the nodes in the forest environment associated with the location information of the Beidou module is transmitted to the server through the GPRS network in real-time, then the server broadcasts the normal information and the alarm information to the administrator through the control panel and the mobile client. The system adopts solar energy and can monitor the forest environment information automatically, which can greatly reduce the workload of the employees, low the costs of the network's layout and monitoring, and provide the researchers with massive and reliable research data. It has a wide range of application in the forest management, agricultural monitoring, environmental monitoring and other fields.

Keywords: Beidou positioning, GPRS Network, Server, Big Data.

1. Introduction

Since the emergence of forests on earth, forest fires have occurred from time to time. More than 200,000 forest fires occur on average every year in the world, and the burned forest area accounts for more than one thousandth of the total forest area of the world[1]. According to the National Forest Fire Report issued by the Ministry of Natural Resources in 2016, compared with 2015, the number of forest fires in China was totally 2034 and increased by 30.72% , including one major fire , which decreased by 83.33% in 2016. The total area of the fire site in 2016 was 18161 hectares, of which the affected forest area was 6224 hectares. China's Fire Outlay of 2016 was 120.1739 million yuan, an increase of 1.5071 million yuan over 2015[2]. In the forest, people who go on outings are missing and in distress. The information of these people is often not delivered in time, thus delaying rescue time and increasing labor costs[3-4].

The investigation on the situation of forest fires in recent years shows that the number of forest fire cases is decreasing and the losses caused by forest fires are increasing. In [5] the forest fire prevention
strategy in autumn is mainly discussed, but the introduction of complex terrain forest area is less. A Geographic Information System (GIS) forest fire prevention is introduced in [6], which analyzes the forest geographic information of various provinces and cities, and discusses different prevention plans. In [7] the Web Geographic Information System (WebGIS) is taken as the research focus, and various types of databases of WebGIS forest fire prevention system are designed, which publish forestry geographic information spatial data on the Web through Internet/Intranet, and provide users with geographic information browsing, editing, and space, providing support for forest fire prevention. The greenhouse gas is analyzed by remote sensing technology in [8]. Based on remote sensing data, the spatial and temporal analysis function of online polygon region is realized by Arc GIS the grid map data generated by preprocessing. A UAV application system in the field of security is designed in [9]. Airborne cameras need to keep shooting patrol areas. However, UAV patrol also has drawbacks, on one hand, the existing UAV patrol equipment is expensive; on the other hand, UAS patrol requires professional online surveillance, it's even less effective when it comes to heavy fog, it is also difficult to find out that there is no obvious abnormal situation for small fire and other targets.

In order to solve the problems that forest fire can not be predicted and controlled in time, and people in distress can not get rescue in time, it is urgent to establish a set of informative, digital and intelligent forest safety management service platform. This paper develops a set of forest security real-time monitoring and management system based on Beidou navigation technology, using intelligent sensing technology to detect the change of forest environment, and transmitting the change information of forest environment to the monitor in real time through Wireless Sensor Networks (WSNs). The main functions of the system are as follows:

1) Through temperature and humidity sensors, it monitors the environmental conditions throughout the forest in real time, predicts the high-risk areas of fire, and takes effective preventive measures. When a fire occurs, the flame sensor displays the location information of the fire at the same time as the alarm, uses the wireless network to track the spread trend of the fire in real time, and transmits the monitoring data to the monitoring center to provide reliable real-time data for fire rescue;

2) Through sound sensors, nearby gunfire can be identified and audio signals are transmitted to the monitoring center in real time to assist forest conservationists in enforcing the law, which on one hand eliminates forest hunting, and on the other hand, through the sound information from different animals provided by sound sensors, we can calculate the species and distribution of animals in this forest;

3) It can monitor various parameters of forest ecological environment, such as quarterly average light distribution, annual rainfall distribution and so on, which can provide the first-hand reliable information for forest maintenance and research;

4) It also has the forest distress function, if someone gets lost in the forest or encounters danger, he can use the system distress function and send the distress information to the monitoring center.

2. Design of the Hardware System
STM32F103C8T6 is used as the main control chip to control different types of sensors, such as flame sensor, temperature sensor, humidity sensor and sound sensor, the sensor information around the nodes in the forest environment is connected with the position information of Beidou module in real time. On one hand, the main control board communicates with all kinds of sensors through RS485 bus protocol to obtain sensor data and state, on the other hand, it communicates with Beidou positioning module through the serial port to obtain the position information. The sensor data and position information are integrated by the main control board at last, and the data is uploaded to the server through the SIM8000C data communication module. The server carries out data analysis, prediction, alarm, display processing, and broadcasts the information to the administrator through the control panel, mobile phone client and so on. The system consists of three parts:

(1) Information gathering nodes for replaceable sensors. A node can obtain the sensor data and its current position information, and transmit the relevant information to the server in real time through the GPRS network. You can also accept instructions from the server to perform operations such as turning on the alarm sound and turning on the lighting.
(2) Server and database systems. The server is mainly used to receive and persist the geographic information and sensor information uploaded by the node in real time. It analyzes the data in real time according to the set rules engine, and sends the alarm information to the terminal.

(3) Client (Data Analysis and Detection Console). Client is the main interactive interface, receiving the alarm information, analyzing results and data of the server, and uploading the setting rules, etc. The multi-sensor field nodes and their interconnected systems are shown in Fig.1.

3. Design of the Software Systems
A μC/OS-III real-time control system is used in the Single Chip Microcomputer (SCM). Once the SCM starts up, the system will start three tasks which are network callback task, system monitor task and sensor scanning task. The network callback task is responsible for receiving server instructions to control the sensor upload rate, the system monitor task detects power status and key status of the system, and the sensor scanning task gets the sensor’s value and uploads it to the server. The flow chart of the system is shown in Fig.2.
The sensors are mainly responsible for receiving and processing the request of the main control board. The main control unit is in standby or low power operation when it is not requested to save electricity. The server needs to run the three tasks at the same time. Task one is to identify the identity of the sensor, receive and store the uploaded sensor data; Task two is an intelligent monitoring engine, which analyzes the uploaded data through big data and artificial intelligence real-time, finds abnormal data and alarm information according to the rules in time; Task three is a WEB service, which sends client programs, receives and processes the client initiated requests and other work.

4. Design of the system interface
Login interface is mainly responsible for authentication user identity, password retrieval and other works. The simple interface brings refreshing feeling to the administrator. After logging into the system, there is a default home page, where the map will display the current location and number of online sensors, the information such as alarm information, nodes status and so on is displayed in the right side of the system, and click on the map bubble you can view the details of the sensors.

Fig. 2 Flowchart of the system
The data monitoring pages show upload status and predict risks in real-time, such as data exceeding half of the normal value (this value is analyzed by the smart engine), which changes the predicted state to a "risky" state and tops it. The data can also be screened and qualified according to conditions such as time and sensor type. The data monitoring interface as Fig.3.

You can select the type of sensor data to be retrieved according to the sensor data group, and then select the same type of data. The data of any sensor or sensor groups can be fetched from the get data interface, which is a SQL database file and needs to be opened with a SQL database software. The data retrieval interface can select any sensor or sensor group data to retrieve, as shown in Fig.4.
In the statistical analysis interface you can view the statistics and analysis information of the data, which is displayed in the form of chart, effectively reducing the burden of manual calculation and statistics. At the same time, the sensors are ranked according to the abnormal rate of data, so the administrators can understand which sensors need to be maintained in time. Fig. 4 is a workspace for analysis and statistics of a specific data, helping administrators to analyze the situation accurately.

The system setting interface can complete the setting of database, account number, node, etc., the content of which is mainly the database account and password that the system depends on, the switch of the rule engine, the account number of the administrator and so on.

5. Conclusion
The forest security defense system designed is solar powered, the data is unified processed through wireless data transmission, and the sensor nodes can possess their own location information, it is very convenient for the administrators for there is no longer cumbersome settings, only need a simple and practical server rules engine, the administrators can focus on their research and work, greatly reducing the workload and cost of the traditional monitoring network layout. The data can be displayed on a large screen in a graphical form, which reduces the workload of the data analysis. The innovations of the system are: (1) solar powered, which can lower the price and protect the environment; (2) has the function of alarm and monitor; (3) based on the Beidou navigation and has the function of distress; (4) effectively protects the forest; (5) combines the location and data to change the situation of previous wiring difficulties and real-time records.

ACKNOWLEDGMENTS
This work was financially supported by the National Natural Science Foundation of China (No. 61571188), the Construct Program of the Key Discipline in Hunan Province, China, the Aid program for Science and Technology Innovative Research Team in Higher Educational Institute of Hunan Province, the Research Foundation of Education Bureau of Hunan Province, China, Grant NO.18B458 and 19C0968, and University Student Innovation and Entrepreneurship Funding Project of Hunan-Province.

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