Monitoring System Design and Realization for Unmanned Mobile Robot Based on Web

Yuchao Wang, Tianlong Huang, Guang Zou and Huixuan Fu

1 Introduction

At present, unmanned mobile robots are widely used in industry, agriculture, medicine, construction, military and other fields. It used to replace human accomplish some dangerous or difficult task. The research and development, manufacture and application of robots are the important symbols to measure a country's scientific and technological innovation and high-end manufacturing level [1, 2]. But the users and enterprises do not have the ability to handle fault of the robot. There is also a lack of effective methods for early warning and intelligent fault diagnosis. Therefore, it put forward the requirements for the after-sales service of robot manufacturers. ABB is a well-known industrial robotics company in foreign countries. ABB has developed a "remote service" platform [3]. In 2013, Shenyang SIASUN robot cooperation with the Dalian University of Technology developed a remote monitoring and diagnosis service platform. SIASUN robot remote monitoring service platform is limited for the type of robot, versatility should be improved. There are more universities and research institutions to start research on the remote monitoring system based on application requirements and achieved some results. In this paper, the unmanned mobile robot remote monitoring system based on Web [4]. Using 4G DTU to realize data transmission, with the advantages of fast speed and large amount of data transmission. The Web server based on JavaEE can satisfy the principle of open and close, good scalability and high network security.

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2 System Design

The monitoring system for unmanned mobile robot based on Web is composed of three parts which are data acquisition and controller, data monitoring center and client. As shown in Fig. 1. The ARM11S3C6410 main controller obtains real-time running data of unmanned mobile robot through the gyroscope, accelerometer, tachometer module, GPS and other sensors (The number of unmanned mobile robot, time, roll angle, pitch angle, yaw angle, latitude and longitude, the speed of the four wheels). The Data Monitoring Center consists of two parts, database servers and application servers. The database server receives real-time data uploaded by the main controller through 4G DTU (Data Transfer unit). The database server writes the data to MySQL database. The application server connect to the database and published on the Web for the client to view. The client accesses the application server remotely through the Web browser. The application server accomplish the functions of real-time data monitoring, historical data query, upload and remote control. The system is relatively independent of each part, with low coupling, good scalability, operability and practicality [5].

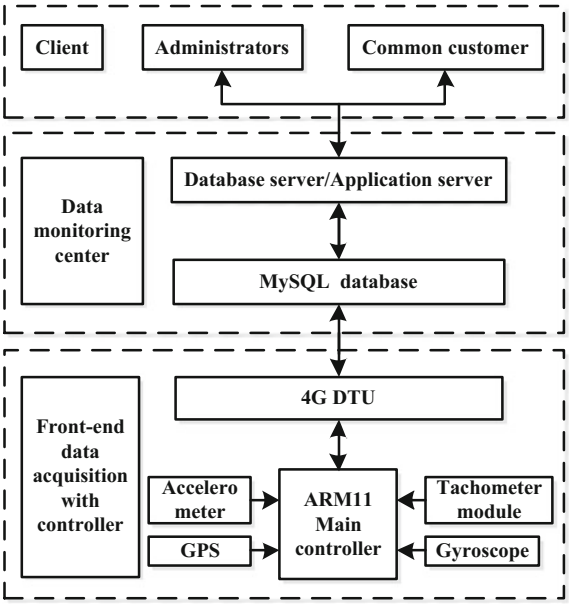

Fig. 1 Structure diagram of system

3 System Realization

3.1 Front-End Data Acquisition with Controller

The main controller of the system is the OK6410 development board made by Flying Ling embedded company. The S3C6410 processor is a 16/32-bit RSIC ARM111176JZF-S kernel with low-cost and low-power, which is launched by Samsung. The performance of this processor is the frequency of 533 MHz/667 MHz, 128M bytes of MobileDDR memory, 1G bytes of NAND Flash (MLC). S3C6410 has an excellent external memory interface which can meet the needs of broadband communications services [6].

Using 4G DTU named USR-G780 developed by People Network company as the wireless communication. This module supports 4G high-speed access for China Mobile, China Unicom and China Telecom, while supporting 3G and 2G access for China Mobile and China Unicom. It has three mode of operations which are transparent transmission, HTTPD and FTP, and supports TCP/UDP/NDS/HTTP/FTP network communication protocols. It also supports the maximum 4 TCP and 4-channel socket connections, each one supports 10 KB serial port data caching, though connection exceptions the optional cache data is not lost. It has three user configuration ways which are serial at commands, network at commands and SMS at directives. It supports two simple pass through methods which are TCP client and UDP client.

The main controller collects data through three line TTL level serial port by gyroscope, accelerometer, GPS and tachometer module. It connects the 4G wireless communication module through the RS-232 serial port. It controls the 4G wireless communication module to access Internet. The 4G wireless communication module and main controller realize two-way transparent transmission of network data through RS-232 serial port [7].

3.2 Data Monitoring Center

The structure design of data monitoring center is to separate the database server and application server. This design is conducive to the security of the data, also facilitates the upgrading and maintenance of the application server. Using Java programming language for the development of data monitoring center. Using relational database MySQL to store data and Tomcat as a Web server. The combination of this three makes up a good foundation for system development.

The database server stores the data to the database table in real-time. The application server reads the data from the database tables as Webs for Web remote clients to view and use. There are four data tables in the database which are userdata, monitordata, controldata and logdata [8].

The application server of data monitoring center to provides data access service to remote clients. Figure 2 is the structure diagram of the application server.

The B/S (Browser/Server) mode is the architecture of the application server. The remote client accesses the application server through the browser. The client sends the request and the business logic processing is done on the application server. The permissions of common customer are monitoring real-time data and querying historical data. The administrator could download the historical data file and select the export format for txt, Excel and CSV. Also it can send control commands to operate the unmanned mobile robot and get the positioning information of unmanned mobile robot in real time.

4 Design and Realization of Web Application

The design and realization of Web application is a concrete manifestation of the function of monitoring system for unmanned mobile robot. It is the basic requirement of this paper to build a system with good practicability, safe, reliable and highly scalable.

Using SSH (Struts + Spring + Hibernate) framework to achieve the application of the system. The MVC design pattern of Struts2 realizes the separation of model layer, view layer and control layer. The Spring container and control inversion solve the dependencies between components, modules and hierarchies in the system. Hibernate technology implements a lightweight package for JDBC access to the database. Therefore, use three advanced framework technologies of struts, spring and hibernate. Making the system has a good scalability and maintainability.

This system utilizes the most popular web development technology (HTML, CSS, jQuery, Ajax). Realizing the functions of system login, monitoring, data querying and exporting, remote control and so on. The system of the interface is simple, the function is reasonable and the user experience is good.

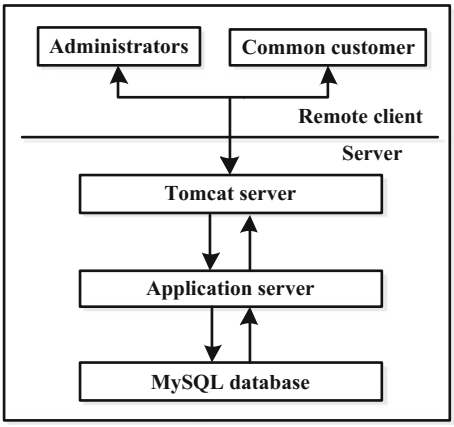

Fig. 2 Structure diagram of the application server

4.1 System Login

The system users are divided into common customer and administrators. The permissions of common customer are real-time monitoring and historical data viewing. The privileges of the administrator are real-time monitoring, historical data querying with exporting and remote control.

4.2 Real-Time Monitoring

The real-time monitoring interface is shown in Fig. 3. The running data of the unmanned mobile robot are arranged in reverse order by time. The latest data is shown at the top. The display page refreshes once per second, and the client sends access request to the server every second to ensure that the latest data is available in real time.

At the top right of the Real-time monitoring page, click the button of the velocity curve. Shows the real-time velocity curve of the four motors, as shown in Fig. 4. The real-time curves adopts the Highcharts graph library which are written in JavaScript. It is easy to analyze the change trend of motor velocity in the form of graphics.

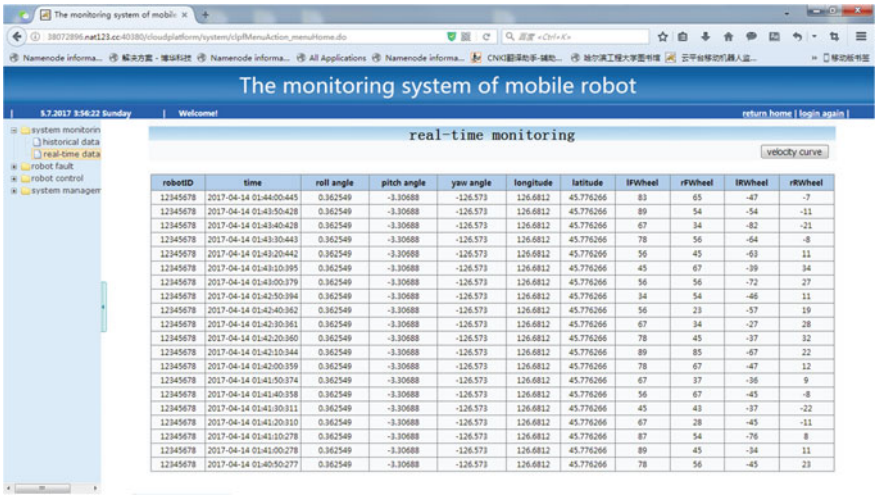

Fig. 3 Real-time monitoring

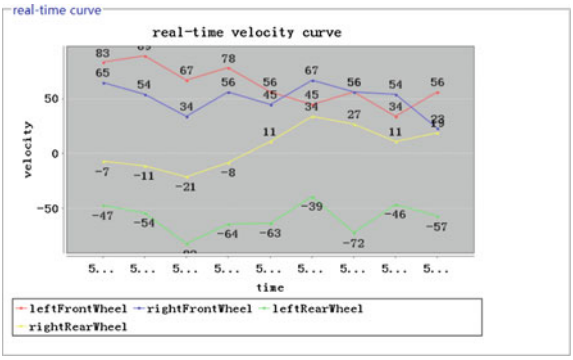

Fig. 4 Real-time velocity curve

4.3 Historical Data

There are three features in the historical data page, which are historical data display, query and output. Select the unmanned mobile robot number, time interval and data type. The system will display the real-time running data of unmanned mobile robot through a graph, shown in Fig. 5.

4.4 Remote Control

The remote control is one of the core function for unmanned mobile robot. In this paper, the unmanned mobile robot application is to complete the airport runway

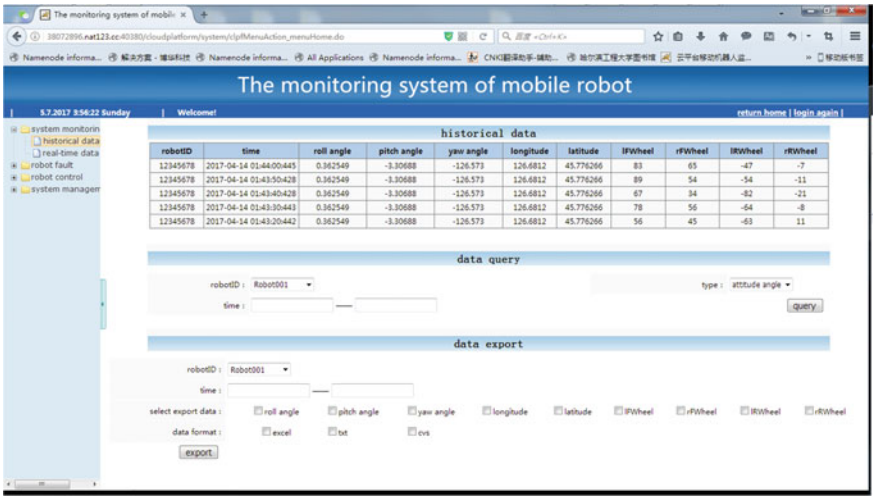

Fig. 5 Historical data interface

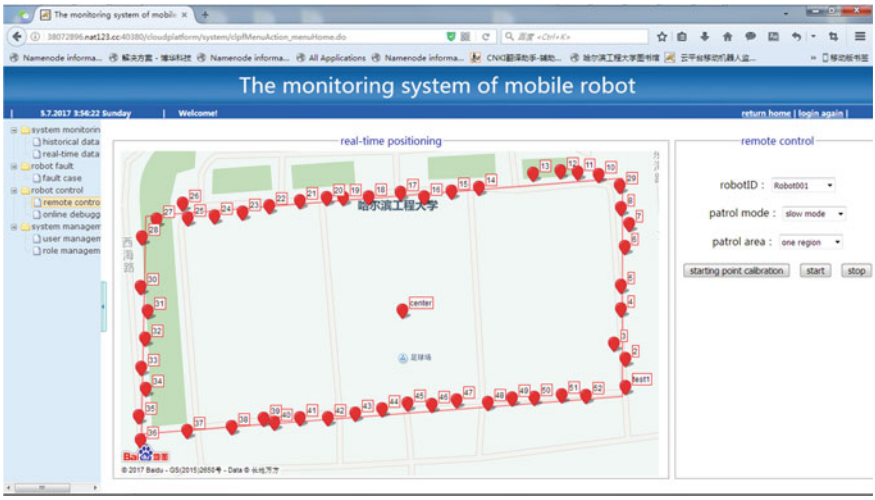

Fig. 6 Remote control interface

cracks and foreign substance detection. The implementation of the function is fixed-point movement and automatic cruise. The remote control interface of the unmanned mobile robot as shown in Fig. 6.

In this paper, on the left side of the remote control page is the location information of unmanned mobile robot. Obtaining real-time latitude and longitude of unmanned mobile robot by using GPS modules. Development based on Baidu Map to realize the real-time positioning of unmanned mobile robots. On the right side of the page is the setting of the automatic cruise parameters for the unmanned mobile robot. Set up the mode and cruise area of the unmanned mobile robot cruise to realize automatic inspection of the designated area of the runway. The remote client can monitor the running state of the unmanned mobile robot and view the position information in real time. In the event of failure, the field engineers conduct artificial intervention.

5 Conclusions

This paper describes a monitoring system for unmanned mobile robot based on Web, and provides the design and implementation of the system.

(1) In this paper, combine with the application and the needs of remote monitoring for unmanned mobile robot. Designed and realization the remote monitoring system for unmanned mobile robot based on the framework of internet. The monitoring system for unmanned mobile robot is composed of three parts that are front-end data acquisition with controller, data monitoring center and client.

This design effectively reduces the coupling between the parts to improve the scalability and maintainability of the system.

(2) The front-end data acquisition with controller collect information of the unmanned mobile robot. Including the number of unmanned mobile robot, data time, longitude, latitude, attitude angle and the velocity for four motor. Using 4G DTU as data transmission module to meet the basic requirements of real-time and security for data transmission.

(3) According to the requirement, the application server of the data monitoring center designed many kinds of functions, such as system login, real-time monitoring, historical data and remote control. To achieve the monitoring of the unmanned mobile robot anytime and anywhere, as well as the full utilization of historical data. Realizing real-time positioning of unmanned mobile robot based on the development of Baidu API. Setting the inspection parameters online to meet the basic requirements of remote control for unmanned mobile robot.

Through operation and testing, the system is stable, the function is set reasonable, the data transmission is reliable and the response of the application server is quickly. This system could meet the basic needs of remote monitoring for unmanned mobile robot, so that engineers could control and interfere with the unmanned mobile robot anytime and anywhere.

In addition, the security of the remote control system needs to be improved. High-definition video camera installed on the unmanned mobile robot. It is more intuitive to monitor the unmanned mobile robot through real-time images. To ensure that the unmanned mobile robot complete the runway crack and foreign substance detection.

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