Design and Implementation of Intelligent Monitoring Terminal System For Construction Machinery

Wenfang Zhang, Qingchun Hu
Hunan City University, Yiyang, 413000, China

Abstract: In this paper, the key technologies and design contents of vehicle monitoring system which is taken in construction machinery remote monitoring as the research subject have been studied. Related to the integrated design of vehicle monitoring system. By using the data collection, local video monitoring and wireless network transmission to achieve an efficient and intelligent construction machinery Equipment Internet of Things monitoring terminal, Through the terminal can effectively improve the construction machinery and equipment job scheduling efficiency, to achieve the remote real-time monitoring equipment.

Keywords: Construction machinery; Remote monitoring platform; Vehicle monitoring system

1. Introduction

As an important part of the equipment manufacturing industry, the construction machinery industry is one of the key areas for national development, and plays a vital role in national economic contribution, industrial strategic planning, related industry influence and industrialization level. As the control core of construction machinery, the monitoring system occupies an extremely important position in various complicated construction machinery, and is also the technical core of various engineering machinery and equipment, and has a very huge market. The remote monitoring system can realize the intelligent, automatic and networked construction machinery, and is an important part of the informationization of the construction machinery industry.

2. Research Background

Remote monitoring is a technology that uses a computer as the core to monitor and control remote device status through an Internet network system. The remote monitoring system of engineering machinery is a kind of remote monitoring technology applied in the field of engineering machinery. It mainly uses computer technology, satellite positioning technology, wireless communication technology and network technology to remotely monitor the running status, geographical location and work progress of construction machinery.

3. Key Core Technology of Vehicle Monitoring System

The remote monitoring system of construction machinery mainly consists of three parts: vehicle monitoring system, wireless communication platform and remote monitoring center. Among them, the vehicle system is the core part of the whole monitoring system, responsible for collecting working condition data and geographical location information of the construction machinery; the wireless communication platform is responsible for the network transmission between the vehicle system and the remote monitoring center, which is the link between the two data interaction; The remote monitoring center analyzes and processes the received data to realize real-time monitoring and remote control of the construction machinery.

The key core technologies of the vehicle monitoring system mainly include three parts: remote data acquisition technology, image compression coding technology and wireless network transmission technology.

3.1. Data acquisition technology

Data acquisition is to convert the analog signal output by the sensor into a microcontroller, and the identifiable digital signal is processed according to different needs to obtain the target information. For example, image acquisition, the function of the image acquisition unit is to visually monitor the working condition of the construction machinery. If a certain failure of the construction machinery can be solved locally, the fault image can be sent to the remote data monitoring center through the transmission module. Provide a physical basis for troubleshooting. The method of data acquisition by the microprocessor is different depending on the type of target signal.

3.2. Image compression coding

Image coding is the process of converting a video format file into another video format file by standard compression techniques. Since the image data itself has a strong correlation and the information redundancy is very high, as long as the redundant information in the data is removed, the original image data can be greatly reduced, thereby achieving the purpose of video compression.

3.3. Wireless network transmission

Remote monitoring systems typically implement data transmission over the air. The wireless network transmission function is mainly to realize data communication between the vehicle terminal and the remote monitoring center. At present, wireless networking communication methods mainly include wireless local area networks, satellite communication systems, microwaves, and mobile communication networks. Among them, the mobile communication network has the advantages of convenience, flexibility, moderate cost and long transmission distance, and has become the preferred method.

4. System Design and Implementation

The remote monitoring system of construction machinery mainly consists of three parts: vehicle terminal, wireless communication network and remote monitoring center, as shown in Figure 1. The vehicle terminal is responsible for collecting the working parameters of the engineering machinery and transmitting it to the remote monitoring center through the wireless network carrier; the monitoring center analyzes and displays the received data, and the user can use the monitoring software to observe the working state of the engineering machinery in real time.

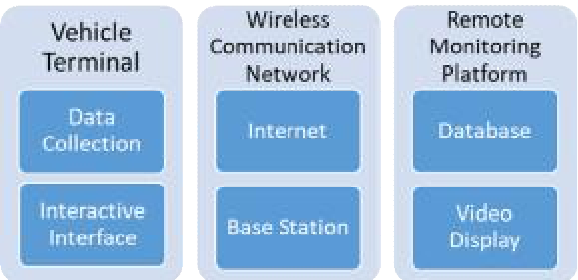

Figure 1. Remote monitoring system structure

4.1. Design

The whole system includes two parts: hardware system and software system. as shown in Figure 2.The hardware system includes four core modules: central processing subsystem, human-computer interaction subsystem, data storage subsystem and communication interaction subsystem. The software system includes Ubuntu and user interaction subsystem. Event tracking processing subsystem and communication interaction subsystem.

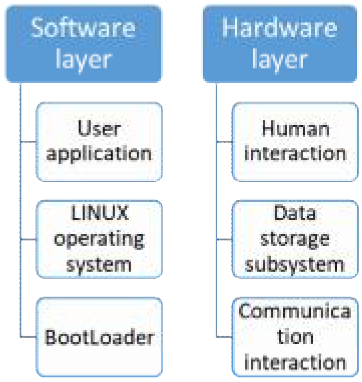

Figure 2. Vehicle system architecture diagram

4.1.1. Human-computer interaction subsystem

The subsystem is mainly composed of a 7.0-inch LCD module Smart3231170 module, which is a 720p industrial-grade intelligent display screen. It communicates with the CPU based on SPI and UART. It has built-in UI display processing interface, without using the central processing unit. The system performs graphical display calculations, has very low performance requirements for the central processing unit, and supports audio output interfaces, thereby extending audio output interaction.

4.1.2. Data storage subsystem

The system builds a storage subsystem based on DDR2 and SSD. The DDR2 chip uses SDIN4C2-4G-H. The industrial-grade memory chip provides memory support for the system. The SSD uses the ELSKY SSD 8G storage SSD module. A separate module and independent power supply design on the hardware.

4.1.3. Communication interaction subsystem

The subsystem mainly provides communication interaction support for the system, including the can module and the UART module. The UART uses the RS232 module and the Can uses the 485 can bus module. The subsystem is mainly based on the Linux system driver, which implements the CAN bus driver and the uart two driver modules, and builds a data-driven mapping based on the event tracking processing subsystem on the two driver modules, which can quickly turn the engineering machinery and equipment. The data in the data is mapped to the event tracking processing subsystem on the upper layer of the system through a configuration file for real-time event processing.

The implementation of the onboard system function requires the creation of two threads, a data collection thread and a data transmission thread. The data collection thread processes the data, extracts it, parses it, etc., and sends it to the sending thread for real-time transmission. In order to achieve communication between two threads, a shared buffer needs to be opened in the memory, consisting of 8 buffer segments. At the same time, each buffer segment is combined into a ring buffer, which can make the buffer reuse. This is a relationship between "producer and consumer". The data collection thread writes data to the buffer to the consumer. The data sending thread reads the information in the buffer, then sends and empties it, belonging to the producer. However, the speed of the two threads reading and writing buffers is different. If the thread is written too fast, it will overwrite the unread data in the buffer; instead, the sending thread will read the duplicate data. Therefore, it is necessary to use semaphores to synchronize the read and write threads.

4.2. Vehicle system structure design

The vehicle system adopts a modular approach to the overall structural design and can be divided into the following modules:
Controller: Embedded system computing and control core.
Data collection module: including camera interface, device interface and unit interface, respectively responsible for collecting video images, working condition data and geographical location information.
LCD liquid crystal display module: Real-time display of captured video image data for local video surveillance.
4G module: Responsible for establishing communication connection with remote monitoring center to realize data transmission.
RTC module: Provides real-time clock information for the system.
Power Management Module: Includes main power circuit, backup battery charging circuit and hardware reset circuit to provide stable and reliable power for the system.
Program debugging module: including serial communication interface and Ethernet interface.

Figure 3. Surveillance camera

4.3. Experimental result

The engineering software of the construction machinery monitoring system is designed to realize data collection, local video monitoring and wireless network transmission. Among them, the data collection task process is mainly to complete video image acquisition and data acquisition; the local video monitoring task process is responsible for the application design of the human-computer interaction interface video display; as shown in Figure3. the wireless network transmission task is responsible for implementing network dial-up access, video compression coding and wireless data. Transfer application design.
The vehicle monitoring system uses the CMOS camera to follow the software architecture process to achieve video data collection. Here, one of the video sources is selected for the collection function test, the width of the image is set to 1024P and the height is 768P, and the progressive scan mode is used to continuously collect 10 frames of data and output to the file in the YUV format. The monitoring display effect is shown in Figure 4.

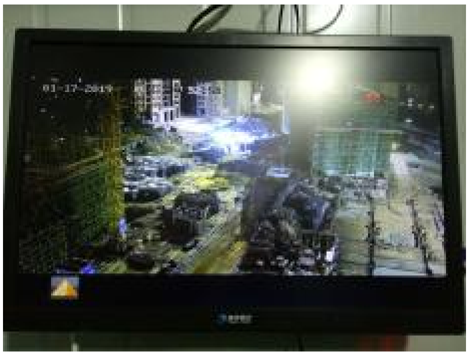

Figure 4. Monitoring effect chart

5. Conclusion

This paper studies and analyzes the existing engineering machinery intelligent monitoring technology. Based on the existing embedded platform core module, the hardware and software of the system are designed in detail, and an in-vehicle terminal integrating remote and local video monitoring functions is designed. The device, through the intelligent terminal system of engineering machinery equipment constructed in this paper, can greatly simplify the development of future engineering machinery equipment, and solve the shortcomings of the existing monitoring system in data collection type and wireless network transmission.

6. Acknowledgment

The work is supported by the general scientific research of Education Bureau of Hunan Province, China (No.15C0252).

References

[1] Zhu Kun. Analysis on the development trend of China's construction machinery. Ability and Wisdom. 2012,17:70.

[2] Wu Wei Guo. Research on remote monitoring system for construction machinery. Construction Machinery and Equipment. 2007(5).

[3] Pan Jun Wei. Research of Remote Monitoring Vehicle Device for Construction Machinery based on Embedded Linux System. Zhejiang University. 2011.

[4] Li Yu He. Design of a Remote Monitoring System for Construction Machinery. Construction Machinery and Equipment. 2007(4).

[5] Long Tan. Research on excavator remote monitoring onboard system and its key technologies based on embedded system. Zhejiang University. 2011.

[6] Li Z. Development Countermeasure and Suggestion on Agricultural Machinery Internet of Things in Beijing. Agricultural Engineering. 2013, 52-58.

[7] Shi Yong. Research and Implementation of Remote Upgrade Security Mechanism for Vehicle Terminal System. Hebei University of Science & Technology. 2016.

[8] Li Bochen. Embedded system reliability design. Beijing, Publishing House of Electronics Industry. 2006.

[9] WEI Jing cheng, CHEN Xiu-sheng. IoT-based design for construction machinery monitoring systems. Chinese Journal of Construction Machinery. 2014, 12(04).

[10] Zhang R, Hao F, Sun X. The Design of Agricultural Machinery Service Management System Based on Internet of Things. Procedia Computer Science. 2017, 107, 53-57.