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Design of train traction brake monitoring system based on wireless transmission

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Abstract

With the rapid development of wireless communication and high-speed railway, wireless technology has been widely used in high-speed railway. The traditional wired train traction platform has some problems, such as large floor area, poor expansibility and difficult construction. Therefore, this paper designs the train traction brake monitoring system based on wireless transmission. The wireless transmission monitoring system includes four functional modules: user management module, equipment monitoring module, data transmission module and data storage module, which can realize real-time monitoring of train traction and brake status. Finally, a test platform is built in the laboratory to verify the effectiveness of the system designed in this paper.

Keywords

Wireless transmission, real-time, traction brake monitoring system , RTSP protocol.

1. Introduction

High speed railway provides a new type of transportation mode with large passenger volume, low energy consumption, safety and reliability, which has been favored by many countries. With the development of high-speed railway and wireless communication technology, wireless transmission has been widely used in railway system. The world radiocommunication Conference (wrc-19) in 2019 formed a resolution to form a global unification of the spectrum of train radio applications [1]. Under this background, this paper presents the design of train traction brake monitoring system based on wireless transmission [2-5]. Compared with the traditional wired train traction platform [6-8], the system in this paper has the advantages of small floor area, good expansibility, high debugging efficiency, convenience for later maintenance and function adjustment, etc. at the same time, in case of sudden driver accident, it can realize the remote brake controlling of the train and strengthen the safety guarantee of railway operation.

2. Hardware composition of the system

The train traction brake monitoring system consists of two parts: in vehicle wireless monitoring and vehicle ground wireless monitoring. The system hardware is mainly composed of traction brake monitoring control system, wireless camera, cab display, remote display, transmitting equipment and receiving equipment. The camera of wireless traction brake controlling and monitoring system in the train is located in the motor car at one or both ends of the train, and the remote display is located in the cab at the front of the train. The camera of vehicle ground wireless traction brake controlling and monitoring system is located in the cab, and the remote display is located in the dispatching center. The driver or the operator of the

remote dispatching center sends a command according to the demand, and the signal sends the command frame and data request frame to the traction brake controlling system according to a certain period through the transmitting equipment through the mobile communication base station. When the traction brake controlling system receives the command frame, perform corresponding operations according to the command frame; When the traction brake controlling system receives the data request frame, the traction brake controlling system sends real-time status information to the driver display screen and the remote dispatching center through the mobile communication base station, such as traction motor brake torque, traction motor traction torque, traction motor voltage, traction motor current and so on. Or when the traction brake controlling system fails, send fault information to the driver's display screen. After the driver's display screen receives the fault information, the operator will implement corresponding solutions according to the specific fault.

3. Software system design

The software of train traction brake monitoring system is developed by QT software. According to the different functions required by the software system, the overall architecture of the software is divided into four functional modules, namely user management module, data transmission module, video monitoring module and data storage module. The user management module provides users with two functions: user login and user registration. After the user logs in, the wireless transmission system of train traction brake platform can be operated. According to different operation permissions, users are divided into two permissions, ordinary users and administrators, to ensure the security of the system. The data transmission module adopts the socket communication of TCP / IP protocol to transmit data with the traction brake controlling system, improves the message filtering rules for setting the receiving port, receives and analyzes qualified data messages, and can construct and send control messages concurrently according to the needs of users. The video transmission module uses RTSP protocol to pull the monitoring video, and displays the monitoring video to the video monitoring page in real time through wireless communication. The data storage module stores the relevant information and operation permissions of the general users and administrators who are logged in, and stores the state data and fault information from the traction brake controlling system, so as to facilitate the subsequent call.

3.1. User management module design

Train traction and brake operation is very important for the reliability and safety of normal train operation. Therefore, in order to be responsible for the train and the personnel on the train, the system adopts the user login system, and sets different application permissions for the login operator. First, initialize the program. After that, the login page is displayed. New users need to register their account first, register on the user registration page, fill in the user account, password and other real name information, and compare the information with the information in the database. If there is no duplicate user name, the user registration is successful, and the program jumps to the login page. Newly registered users need to contact the administrator to increase their corresponding permissions. In order to ensure system security, if there is no administrator to increase their permissions, the user cannot complete any operations; If the user has an account, directly enter the user name and user password on the login page. The system compares the user account and user password entered by the user with the information in the database. If the user name and user password are entered incorrectly, an error prompt will be displayed, and the user name and user password need to be re entered; If the user name and password are correct, log in to the wireless transmission system of the train traction brake platform, display the main page of the system and complete the subsequent operation commands.

3.2. Design of equipment monitoring module

The system monitors the position of the traction brake equipment in the train in real time through the monitoring camera, so that the system operator can observe the operation status of the traction brake equipment in real time. When the equipment fails, it is convenient to deal with it in time, better communicate with the maintenance personnel through the monitoring screen, and ensure that there are no irrelevant personnel close to the traction brake equipment. The equipment monitoring module uses RTSP protocol to pull the real-time video stream and display it on the human-computer interaction page. The detailed process includes the following five steps:

(1) C--->S OPTIONS Request：The client sends the options request to the server to request the available methods.

S--->C OPTIONS Response：The server replies to the client, and the message contains the currently available methods.

(2) C--->S DESCRIBE Request：The client requests the media description file from the server. Generally, the request is initiated through the URL beginning with RTSP. The format is SDP.

S--->C DESCRIBE Response：The server replies to the client SDP file to inform the server of the audio and video streams, codec information, frame rate, etc.

(3) C--->S SETUP Request：The client sends a connection establishment request to the server, requests to establish a session connection, and is ready to receive audio and video data.

S--->C SETUP Response：The server determines the port to send control data according to the port number requested by the client to match the port of audio and video data.

(4) C--->S PLAY Request：The client requests the server to play the video.

S--->C PLAY Response：The server replies to the confirmation information and then starts sending data through the port specified in setup.

(5) C--->S TREADOWN Request：When the playback ends, the client sends an end request to the server.

S--->C TREADOWN Response：After receiving the request, the server sends a confirmation message to the client, and then disconnects.

3.3. Data transmission module design

The system sends command frame and data request frame to the train traction brake control ling system in the form of data frame according to a certain time period, and receives the status information returned from the traction brake controlling system. The data transmission module is particularly important for the system, which needs to take into account the reliability and real-time of data transmission [9,10]. This paper uses socket communication based on TCP / IP protocol to complete the design of data transmission module. In the process of communication, the server and the client need to create sockets respectively. The server binds the socket to the IP address and port number through the bind function, and uses the listen function to enter the port listening state to prepare to answer the connection request from the client socket. The server receives the connection request sent by the client, sends the accept function to the client, successfully establishes the connection, and realizes the data sending and receiving between the server and the client until one party disconnects and the socket communication process ends.

3.4. Data storage module design

In the process of data transmission, the system will receive a large number of operation parameters related to train traction brake equipment. It is necessary to generate data files through effective data storage method, so as to facilitate users to consult the status data of train

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traction brake equipment in the future. At the same time, user information, fault information and need centralized management.

4. System test

The system test needs to be configured with a driver display screen, a 5g module, a PC, a wireless camera, an Ethernet to can module and several sensors. The sensor needs to collect the motor speed, torque, current and other data, upload the collected data to the external network through 5g network, and the driver display screen can collect the motor status data and control the motor by accessing IP. The system test includes the collection and test of motor speed, torque, current and other status data Motor state control test and real-time monitoring video display test. In addition, the driver conole and motor are monitored in real time through the wireless camera, and 5g communication is provided to display the monitoring video on the human-computer interaction interface, see Figure 1.

Figure 1: Two or more references

According to the test results, the wireless transmission system of train traction brake platform can obtain the correct status data and monitoring video stream data, and can change the traction brake motion state of the motor according to the user's command. And pull the real-time video stream through RTSP to obtain the real-time monitoring video at the equipment. A user-friendly man-machine interface is designed to realize the sending of command data and the real-time display of status data and real-time monitoring video.

5. Conclusion

Combined with 5g wireless communication, this paper designs a wireless transmission system of train traction brake platform based on QT, realizes the modular design of software, and designs user login module, data transmission module, video monitoring module and data storage module in detail. While each module meets the corresponding functions, it improves the debugging efficiency and facilitates the later maintenance and function adjustment. Through 5g wireless data transmission, simplify train formation, simplify train wiring and improve train operation efficiency.

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References

[1] Y. Qiu: Railway vehicle ground wireless communication frequency is expected to achieve global unification, China Radio, Vol. 1 (2020), No. 1, p. 22-23.

[2] Z.W. Wang : Wireless transmission system and application of urban rail train operation data, railway vehicles, Vol. 58 (2020) No. 6, p. 19-22+5.

[3] D.X.Zhao,J.Che,Y.Guo, et al. Design of vehicle wireless transmission system based on PC104 architecture, industrial control computer, Vol. 27 (2014) No. 2, p. 29-30+33.

[4] L.L.Wang,S.G.Zhang,P.D. Ye: Development of EMU on-board wireless transmission module supporting 4G transmission and Beidou system, railway rolling stock, Vol. 40 (2020) No. 6, p. 24-27.

[5] G.L.Feng: Research on GSM-R network in railway wireless communication, Automation technology and application, Vol. 39 (2020) No. 2, p. 52-54.

[6] J.H.Feng,J.Wang,J.H. Li: Analysis and design of comprehensive simulation platform for traction transmission system of high-speed train, Journal of railways, Vol. 34 (2012) No. 2, p. 21-26.

[7] F.Zhang,S.Z. Si: Design of automatic train traction and emergency brake circuit, Electric locomotive and urban rail vehicle, Vol. 44 (2021) No. 3, p. 56-59.

[8] B.Z.Ma,C.X. Li: Research on train ETB control service based on Ethernet, Industrial control compute, Vol. 34 (2021) No. 5, p. 31-32.

[9] Z.W.Wang,Y.X. Yang: Wireless transmission system and application of urban rail train operation data, Railway vehicles, Vol. 58 (2020) No. 6, p. 19-22.

[10] N.Li,D.Zhao: Principle analysis and description of rail transit vehicle ground wireless transmission system, Industrial instrument and automation device, Vol. 40 (2019) No. 10, p. 202-204+208.