A Design Based on Internet of Things for Safety Monitoring System in High-speed Railway Maintenance

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Abstract. Safety monitoring system for high-speed railway maintenance based on Internet of Things aims to ensure the supervision of the status of operation gates and the safety of the lines after operation is completed, thus ensuring the safe driving of high-speed railway. Combined with the characteristics and demands of high-speed railway maintenance Operation safety assurance, the paper studies and determines the monitoring contents, overall framework and system functions of safety monitoring system for high-speed railway maintenance based on internet of things.

Introduction

With the rapid development of China's high-speed railway, a number of high-speed passenger dedicated lines have been put into operation. It demands higher requirements for the safety of high-speed railway operation which the train running speed has reached more than 300km/h. The management of high-speed railway skylight line protection facilities safety operation gate is the key to ensure that maintenance personnel do their job according to the maintenance plan, regulate maintenance operations, avoid maintenance personnel operating at will, improve high-speed railway safety, increase Skylight utilization efficiency, ensure the quality of maintenance [1,2]. At present, there are some problems in the maintenance window of high-speed railway in China, such as the standard of operation gate management is not uniform, the management equipment is backward, and so on. To a certain extent, it affects various types of comprehensive maintenance work [3]. Therefore, carrying out a comprehensive and systematic research and putting forward a suitable scheme for high-speed railway safety monitoring system is an important part of China's high-speed railway construction. The Internet of Things (IOT) technology can save the cost of wiring, network layout and easy to expand, the RFID wireless transmission technology, which can provide a reliable guarantee for the safe and stable transmission of monitoring data [4]. In this paper, a complete set of high-speed railway maintenance operation safety monitoring system is designed based on IOT-related technologies. It can monitor operation gates, maintenance workers, tools and related materials in and out of the high-speed railway operation gate. The system turns the related work from manual control into automatic control, reduces the work strength of the maintenance workers, reduces the risk of left material or staff caused by human negligence, and realizes the unified information management of the operation gates, maintenance workers, tools and related equipment.

Safety Monitoring System for High-speed Railway Maintenance

The system should be designed concise and practical, which is in line with the management demand of the safety of the high speed railway maintenance operation. The safety monitoring system of high-speed railway maintenance operation is designed according to the requirements of high-speed railway maintenance operation process, such as construction plan, maintenance plan, emergency repair arrangement, etc. The safety monitoring system of the high-speed railway maintenance operation will login, inquire and logout the maintenance workers, tools and related materials in and out of the high-speed railway operation gate. The system turns the related work from manual control into automatic control, reduces the work strength of the maintenance workers, reduces the risk of left material or staff caused by human negligence, and realizes the unified information management of the operation gates, maintenance workers, tools and related equipment.
The system should be designed to meet the realistic demand of the high-speed railway maintenance work, with powerful function but convenient operation. Safety monitoring system for high-speed railway maintenance manages maintenance workers, tools and related materials by “individual accounts, information sharing”.

The Structure and Function Design of Safety Monitoring System for High-Speed Railway Maintenance Based on Internet of Things

Structure Design
Safety monitoring system for high-speed railway maintenance based on internet of things consists of recording system of operation gate, e-tags, portable handheld terminals, management terminal software and data servers. The logical relationship is shown in Figure 1.

![Diagram of Safety Monitoring System](image)

Figure 1. The Structure of Safety Monitoring System for High-speed Railway Maintenance Based on Internet of Things.

Safety monitoring system for high-speed railway maintenance based on internet of things consists of recording system of operation gate, e-tags, portable handheld terminals, management terminal software and data servers. Its system layout is shown in Figure 2.

Working Principles
Recording system of operation gate is mainly used for alarm and record. It will trigger alarm when maintenance worker get into operation gate in the non-operation time. When the maintenance workers and material are still not getting out of the protection fence at the end of the operation time, the system will also trigger the alarm. The system is equipped with a solar battery and it can supply power by itself; The e-tags are used for identification of personnel and material tools; The portable handheld terminal completes personnel, material tool records and abandoned objects alarms, and completes the collection of key data, such as in-out stock record list, location of upper and lower roads, and record of patrol information. The information and data collected by portable handheld terminal and recording system of operation gate will be transmitted to ground data server. After processing, analysis and statistics, those data will be used for providing query and alarm services through the Internet or railway office network, so as to realize the management of field operations personnel, material tools, equipment facilities.
Figure 2. The system layout of Safety monitoring system for high-speed railway maintenance based on internet of things.

**Functional Design**

Because of the safety monitoring of railway traffic operation, it is expected to monitor the station’s traffic control, the operation of the field service and the operation of the station throat area by 24 hours a day. Therefore, monitoring points should be set up in the traffic control room (signal building), field operation point and throat area. The following main functions should be able to be achieved, as shown in Figure 3.

Figure 3. The Function Diagram of Safety monitoring system for high-speed railway maintenance based on internet of things.

**Identity Registration**

Paste an electronic label for every personnel, equipment and materials entering the high-speed railway operation gate, register each of them and then uploaded the registration information through the
wireless network. Personnel can register with a worn-on e-Tag wristband or badge. The quantity of small pieces of materials (such as screws, split pin, etc.) should be counted, packed into boxes, and sealed with electronic tags. The amount of Write-Off material after each opening should be equal to the amount of waste recycled. The large tools and material can paste the e-Tag directly on its surface.

**Identity Write-Off**

When the maintenance work is finished, personnel should read the e-Tag with the portable handheld terminal, or automatically scanned by the operation gate. Each time a piece is read, the client and the portable handheld terminal will automatically display the write-off time. When the maintenance workers and material are still not get out of the protection fence after the operation time ends, the system will automatically trigger the alarm and display alarm information on the corresponding item.

**Reminder function**

Through the client maintenance operation time settings, one hour before the end of operation time, the portable handheld terminal will voice prompt user to check the tools, and pop up the prompt box, at the same time, the client will also display the prompt. Using GPS function, the portable handheld terminal will voice prompt user to check the tools when they pass the operation gate, and pop up the prompt box. After the personnel and materials are automatically written down by the operation gate or after manual written down on the portable handheld terminal, the client and the portable handheld terminal will prompt the evacuation results of the character material. The client and the portable handheld terminal will generate an alarm at the end of the working hours when there still are personnel, materials and tools in the protect fence.

**Inspection statistics**

After the client finishes reading the e-Tag of the inspector by using the portable handheld terminal or the recording system of operation gate, the information table of inspection is automatically established, including inspection time, inspection location, equipment name and patrol personnel name. Each time a piece of equipment is checked, the e-Tag of the equipment is read by a portable handheld terminal. The information is automatically recorded and uploaded to the client.

**Summary**

In this paper, a safety monitoring system for high-speed railway maintenance based on internet of things is designed. In view of the problems existing in the safety management of the high speed railway maintenance operation, according to the technical features of the internet of things, based on the theory of system engineering, the structure model of safety monitoring system for high speed railway maintenance operation is set up. Based on this model, this paper designs the safety monitoring system of high-speed railway maintenance operation and explains its working principle taking advantages of the related technologies of IOT.

**References**


