Design of Intelligent Security Early warning system for unguarded railway crossing in mining area

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Abstract. There are many railway crossings in the mine, but there are not enough people to keep every crossing manned. For the traditional unguarded railway crossing, we set up a warning sign at a certain distance from the crossing to remind pedestrians and drivers. For some crossings with poor vision, both pedestrians and locomotive drivers at the crossings can't make timely and accurate judgment on the surrounding real-time road conditions, which is easy to cause safety accidents. In order to solve this technical problem and demand, an intelligent security and early warning robot with image recognition module and intelligent control board was developed by combining advanced theories and technologies such as Internet +, image recognition, beidou+ GPS dual-mode positioning, wind and solar complementary power generation and multi-sensor fusion. The system can improve the intelligent level of the unguarded crossing in the mining area, realize the unmanned or less unmanned crossing work, and ensure the safety of railway transportation in the coal mine.

1. Introduction

Railway is the main way of long-distance transport of coal resources, and the railway coal transport volume in China has been more than 60% of the total coal transport. In railway transportation, the crossing is the weak link of safety production and the high-risk area of railway transportation. The safety of the crossing directly threatens the life and property safety of the passing people, especially the unguarded crossing [1-3].

Traditional unguarded railway crossings have serious safety problems, most unattended crossings install warning signs to remind pedestrians to pay attention to locomotives, while a few unattended crossings install warning systems to remind pedestrians of locomotives approaching, this kind of warning system mainly uses the primary signal detection radar to realize the locomotive approaching warning [4-5]. The radar signal processing mechanism is relatively simple, but it is prone to misjudgment when there are obstacles in the monitoring range. There is no communication between the crossing warning system and the locomotive driver.

In this paper, the intelligent security early warning system can reliably be unmanned gate crossing the security early warning work [6-7]. Data collection and video monitoring remote transmission technology are used to upload the working status and data of the crossing security warning robot to the monitoring platform in real time, you will view the status data of the crossing security warning robot in real time on the monitoring platform, at the same time, the crossing security warning robot itself can store the crossing video images [8-10].
2. Introduction to intelligent security early warning system

The intelligent security warning system is mainly composed of three parts: the crossing system, the locomotive on-board system and the monitoring platform. The overall structure of the system is shown in Figure 1.

Crossing system, namely crossing intelligent security warning robot is the core of the entire security warning system. The robot can realize video image acquisition and identification, video image long-distance transmission and self-condition monitoring.
3. Working principle of the early warning system
The crossing intelligent security warning robot is always in working state, and the working state and sensor data of the robot are uploaded to the server of the monitoring center in real time through the 4G module. During the normal running of the locomotive equipped with the on-board host computer, the intelligent display terminal in the locomotive cab will display the video images of multiple on-board cameras in nine separate screens. When the locomotive approached the crossing where the intelligent security warning robot was installed, the vehicle-mounted wireless bridge will connect with the wireless bridge of the intelligent security early-warning robot at the crossing, the video image of the crossing is transmitted to the intelligent display terminal in the locomotive cab. The camera of the crossing intelligent security warning robot will analyze and process the road conditions on both sides of the road. When it recognizes that there are vehicles, pedestrians, cattle and sheep on both sides of the crossing, The robot control motherboard uploads the alarm information to the platform through 4G module. At the same time, it issues instructions to the robot internal communication control board and powers on the sound and light alarm module to remind pedestrians at the crossing to pay attention to the locomotive approaching the crossing. The intelligent display terminal in the locomotive cab will display the crossing video screen in two screens to remind the locomotive driver to pay attention to the road conditions. When the locomotive leaves the crossing, the intelligent display terminal of the locomotive cab will return to the normal nine-split screen display state. The flow chart is shown in Figure 2.

4. Design of Crossing system
The crossing system is composed of intelligent camera, host, wind-solar-complementary power generation system, multi-channel sensor acquisition, battery management system and wireless base station.

4.1. Smart camera
Crossing security warning system adopts intelligent cameras to identify motor vehicles, pedestrians and animals at the crossing. The video images can be transmitted to the locomotive approaching the crossing through the wireless bridge. Compared with the identification methods using radar and other methods, the real-time video images can provide more intuitive visual assistance to the locomotive driver.

The intelligent camera adopts AI algorithm. After training a large number of real scene samples, the real-time video images are used for intelligent analysis of the environment on both sides of the crossing. In the machine vision image, the image model is established through the object feature algorithm, and
the object is automatically recognized. When the pedestrian or motor vehicle is detected, the intelligent camera will control the 4G module of the main board to send alarm information to the platform. The camera can eliminate the false alarm caused by wind and grass movement, rain and snow weather, light and shadow changes, etc.

4.2. Wind-solar complementary power generation system
The intelligent security warning robot is installed at the unguarded crossing in the mining area, most of the unguarded crossings in the mining area are distributed in relatively sparsely populated areas, and it is difficult and uneconomic to set up lines from the power distribution network. It is easy to be affected by the external power distribution network, and the reliable operation of the equipment cannot be guaranteed. Therefore, according to the actual situation of the site, the wind and solar complementary power generation can reliable power supply for the intelligent security and early warning robot at the crossing.

The system realizes the overall control of the system through the wind-solar complementary controller. Under normal working conditions, wind power generation and photovoltaic power generation supply power to the battery and DC load through the controller. The sensor monitors the state of the battery at all times. When the battery power is about to reach the saturation state, the controller realizes the non-electrode unloading through PWM mode, so as to ensure the best battery charging characteristics, make full use of the electric energy, and ensure the service life of the battery.

4.3. Multiple sensors
The working environment of the crossing intelligent security and early warning robot is relatively bad, the equipment may be damaged due to man-made vandalism or environmental problems, If the equipment does not have a perfect self-protection function, there is a high probability that further damage will cause the equipment to stop, leaving great safety risks for safe driving at the crossing. Therefore, the technology of multi-channel sensor fusion is used to realize the function of self-preserving condition monitoring of the robot.

The multi-channel sensor is connected to the communication control board. The multi-channel sensor mainly includes smoke sensor, temperature sensor, humidity sensor, door status sensor, infrared human sensor, and battery sensor. The door status sensor is used to monitor whether the robot cabinet and battery cabinet are opened maliciously. Temperature sensor monitoring robot and the temperature of the battery box internal environment, within and around smoke sensor used to monitor the robot the existence of fire smoke, the battery sensor can be real-time monitoring of the battery status information, including the battery voltage, current, resistance, temperature, so as to realize the status monitoring and early warning.

4.4. Wireless bridge
The video image of the crossing needs to be transmitted to the approaching locomotive. This paper adopts Doublecom DB6000AVL, which works in the 5.8G license-free frequency band and adopts TDMA (Time Division multiple Access) communication protocol. Different from CSMA/CA protocol, TDMA protocol effectively improves the high-to-multi-point concurrent bandwidth and reduces the delay. The communication distance between the bridge and the bridge is up to 1500 meters, and the roaming switching function is supported, which can automatically realize the fast roaming switching among multiple base stations, meeting the needs of the actual scenario.

4.5. Robot control board
The communication control board is connected to the robot control board through the 485 serial port to read the status data of the sensor. The 4G module built in the robot control motherboard uploads the sensor status data to the server. When the alarm condition is reached, the server sends the instruction to the robot control motherboard through the 4G module, and the sound and light alarm module connected with the communication control board sends the alarm information. The intelligent camera at the
crossing is connected to the robot control motherboard through an RJ45 interface to transmit video images. The wireless bridge is connected to the robot control board through an RJ45 interface to transmit the video images of the crossing to the locomotive that is about to pass the crossing.

5. Conclusion
Aiming at the safety problems of unguarded crossing in mining area during railway transportation, this paper designs an intelligent security early warning system for unguarded crossing in mining area based on data acquisition and video monitoring remote transmission technology. Through on-site installation and test, the system can timely and accurately feedback the video images of road conditions at the crossing to the locomotive drivers who are about to pass the crossing, and make judgments and alarms according to different scenarios. The application of the system in this paper can realize early warning for the sudden road condition of the crossing, and relatively reduce the occurrence of traffic accidents. The application of the security early warning system of unguarded crossing can reduce the number of guarded crossings, and can realize high quality early warning of railway crossings, and save manpower and material resources.

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