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High-speed Train Axle Temperature Monitoring System Based on Switched Ethernet

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Abstract

China railway transportation is developing rapidly, the running speed of high-speed train is promoted. As the promoted speed, the running gear and gearbox of high-speed train produce more heat, causing hot axle easily. In view of the hot axle phenomenon of high-speed train during operating, in combination with the former failure condition of axle temperature monitoring system in terms of total composition, principle and failure condition during operating, analyzing the causes of system failure deeply, a new type of axle temperature monitoring system is designed. Through the test, it indicates that the system could monitor the axle temperature condition of high-speed operating train real-time and accurately, it plays an important role in ensuring the safe operation of high-speed train.

Keywords: High-speed train; running gear; monitoring system; axle temperature condition

1. Introduction

China's independent research and development in train technology known as Electric Multiple Units (EMU) is so well developed electrically powered train carriages can reach speeds of 250 km to 380 km per hour[1]. Safety of train operation is the crucial technical problem for the entire rail industry. Due to the ascension of speed, the increase of traction power, it leads to the increase of impact, dynamic effect, vibration between the EMU and the railway, meanwhile the increase of the EMU line part and gear box's heat. Axle bearing damage with possible catastrophic failures can cause severe disruptions or even dangerous derailments, potentially causing loss of human life and leading to significant costs for railway infrastructure managers and rolling stock operators[2]. Therefore, we put forward higher request to safe operation of the EMU. When abnormal warming, it shows the bearing conditions deteriorate, causes deformation of bearing parts, friction and wear intensifies. Furthermore, it causes the EMU axis accident. It would lead to serious traffic accident without handling in time. Therefore it is important to monitor the

axle temperature real-time. In this paper, a new kind of axle temperature monitoring system is used based on the NuMicro Nuc240. Compared with the traditional 8/16 bits MCU, 32-bit MCU based on Cortex-M0 architecture expends less power consumption and code space. In terms of monitoring data transmission, aiming at the problem that existing axle temperature of high-speed train monitoring system could not transfer the monitoring data to the cab and ground through reliable network, the design uses on-board Ethernet to realize the connection[3].

2. axle temperature monitoring system

2.1. System structure

All of high-speed train's vehicles should be equipped with axle temperature monitoring system. Temperature sensors are installed on the bogie of axle box at each shaft, connected with temperature monitoring device directly through the cable. Axle temperature monitoring device is installed in electrical enclosure of the train, responsible for condition diagnosis towards sensor, temperature acquisition, the analysis of temperature data, and transmitting the state sensor and temperature to network system for controlling real-time.

2.2. Temperature sensor configuration

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High-speed train consists of many carriages interlock, it could be divided into train unit and trailer unit according to the power. Assuming the number of high-speed train's monitored vehicles known as m , n point signals set in every vehicle, there are carriage subsystems in each measured vehicle, which control signal sampling, data analysis and the extraction of characteristic, and transmit characteristic parameters to train level management unit in the cab by using on-board ethernet bus. Model of the axle temperature monitoring system is shown in the Fig.1.

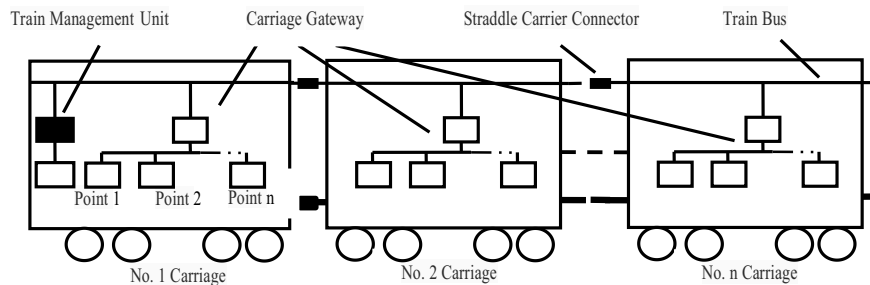


Fig.1 Model of the axle temperature monitoring system

Each EMU carriage contains two bogies, each bogie contains two axles, and each axle end has an axle box. In the process of monitoring node configuration, each axle box is installed a temperature sensor. DALLAS's contact digital temperature sensor DS18B20 is used, its main characteristics as follows: measurement results are transmitted in the way of 9–12 digital value, single bus interface.

2.3. Main principle of the system

The system consists of the monitoring control unit in each EMU carriage and the sensing unit installed in the bearing. The digital temperature sensor DS18B20 is used as the sensor unit, and monitoring and controlling unit is

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