Research on the detection of high-speed current transformer core corrosion based on LabVIEW

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Abstract: Aiming at the corrosion degree of current transformer cores in high-speed EMUs, a corrosion detection system of current transformer cores in high-speed EMUs is developed by using LabView as a development tool and combining with wireless transmission technology based on TCP/IP remote communication. The system includes two subsystems: vehicle unit and vehicle unit. It realizes signal acquisition, data processing, parameter display of rust determination, real-time wireless transmission of data, parameter preservation and alarm prompt. It also realizes portable and portable data acquisition requirements combined with relevant hardware equipment. The test results show that the system can meet the requirement of iron core corrosion detection of current transformer in high-speed EMU, and the hardware equipment adopted make the system more convenient to use and meet the practical application requirements. It has a certain reference value for the construction of automatic fault detection system for high-speed EMU.

1. Introduction
Traction transformer is the main equipment of the locomotive group, and its operation quality is directly related to the safe and smooth railway transportation. The correct transfer of the current transformer of the moving group is the key to the safe and normal operation of the moving group, the current after the transfer must meet certain error requirements, so in the uncertain situation, we must study the transfer of the current transformer of the moving group, we must analyze and determine the current and voltage waveforms after the transfer, and calculate and analyze the error[1,2].

In recent years, in the course of the operation of the moving group, there have been many differential current failures, the reason is that the original edge input and output of the traction transformer of the moving group are equipped with current transformers, the moving car in the detection of the current difference between the two transformers to produce errors, trigger differential current protection, causing differential current fault[3]. In sharp contrast to the important role of the traction transformer of the locomotive group, the research of the current transformer at both ends of the traction transformer of the moving group and the related detection technology are obviously inadequate[4,5]. Therefore, on the basis of the preliminary research, it is necessary to study the effect stoush of current detection error and develop a set of high-precision system detection device, and at the same time optimize the strong quantitative design of its detection device, so as to achieve easy operation, easy to carry, high detection accuracy. It is of great significance to detect the potential
failure of the current transformer at an early stage and to enhance the safety and reliability of the operation of the moving group.

2. Detection system software workflow

The workflow of the iron-heart rust detection system is shown in Figures 1 and 2. The main function of the system is to detect the rust of the iron heart of the 10-T105, 10-T104, 10-T103 three-way current transformer on the train set. The system will divide the detection software into two parts of the vehicle unit and the undercar unit for the acquisition and transmission of signals. Among them, the vehicle unit is mainly on the train group to test the three-way current transformer signal acquisition, the collected voltage signal through the NI-USB6211 acquisition card transmission to the upper unit system, in the form of the amplitude-time sine wave display. At the same time, the undercarriage unit collects three new sets of current transformer voltage value signals and a standard set of current sensor voltage value signals in real time via NI-USB6211 acquisition card, and displays the sine waves of horizontal coordinates by two sets of amplitude-time. When the system is running, the vehicle unit is connected to the undercar unit by specifying the IP port, and the acquired signal is transmitted to the undercarriage unit in real time by the vehicle unit, thus comparing it with the standard signal collected by the new current transformer and current sensor, and the current transformer is calculated by the background to find the current transformer to be measured. Ratio and phase errors of the new current transformer, then, by means of threshold comparison[6-8], the rust degree of the iron core of the current transformer is determined. Communication module workflow is shown in Figures 3.

![Diagram](image_url)

Figure 1 On-board unit system workflow
3. Detection system software workflow

The main function of the iron rust detection system is to detect the iron rust condition of the current transformer installed on the train set, which avoids the long workflow and the disadvantage of the large detection error[7]. The main functions of this system include the real-time acquisition function of the new current transformer and the new current transformer and current sensor, the wireless transmission function of real-time signal data from the vehicle unit to the undercar unit, the function of alarm information display and the function of data saving and recall. The system function structure is shown in Figure 4.
4. System-specific implementation

4.1. Implementation of the main interface of the system System

Before the system can collect all the signals and follow-up work, it is necessary to call the specific current transformer detector VI through the main interface in the under-truck unit software. After
clicking on any numbered button, the lower unit of the car pops up the new current transformer detector subroutine corresponding to the number, while the vehicle unit automatically ejects the corresponding number of the current transformer detector subroutine by wireless transmission of the signal. Main interface of the system is shown in Figure 5.

![Figure 5 Main interface of the system](image)

4.2. Implementation of single-way detection software for under-vehicle units

The software for the detection unit under the car includes three sets of sine wave waveform display controls, which respectively show the voltage signal waveform acquired by the new current transformer, the voltage signal waveform acquired by the standard current sensor, and the voltage signal of the current transformer detected by the unit on the vehicle. Waveform under the car. Through background data processing, the brand new current transformer ratio error and phase error, the measured current transformer ratio error and phase error are displayed on the right side of the interface, and the rust situation is detected in real time through the alarm display lamp on the upper right. In addition, the subsystem can also display the communication between the on-vehicle unit and the under-vehicle unit by means of indicator lights, and can display the current amplitude under the current working state through the collection of feedback current values. A data storage control lever is added above to store the detection history data in the specified EXCEL file in real time, and the average value of the ratio error and phase error of the current transformer to be measured can be calculated by calling. The data collection of the various signals is shown in the following figure 7 to figure 10:
Figure 7 10-t05 voltage signal waveform collected by new current transformer

Figure 8 10-t04 collection voltage signal waveform of new current transformer

Figure 9 10-t03 voltage signal waveform collected by new current transformer
Figure 10 Voltage signal waveform collected by standard current sensor

The specific algorithm for the background of rust detection is described below (take 10-T05 as an example):

The current transformer core is damaged and the transmission error is caused. Transmission error is mainly manifested in two aspects: ratio error and phase error. Among them, the ratio error is caused by the difference between the actual current ratio and the rated current ratio, and it is the error generated when measuring the magnitude of the current. The phase error is the difference between the phases of the primary current and the secondary current vector. The formula of the current transformer ratio error is:

\[ \varepsilon = \frac{K_n I_s - I_p}{I_p} \]  

Where: \( K_n \) is the rated current ratio; \( I_p \) is the actual one-time current; \( I_s \) is the actual secondary current that \( I_p \) flows under the measured conditions.

The phase error calculation formula is:

\[ \Delta = \alpha_s - \alpha_p \]  

Where: \( \alpha_s \) is the phase of the primary current; \( \alpha_p \) is the phase of the secondary current;

According to the 0.5-level current transformer ratio error and phase error limit table, 10-T05 was found to have a ratio error limit of 0.5% and a phase error limit of 30'.

4.3. Realization of single-way detection software for vehicle units

Figure 11 Interface of detection subsystem of on-board unit 10-t05

The on-board unit detection subsystem is mainly used to collect and transmit the voltage signal waveform of the current transformer by configuring the specified acquisition device name and the
specified acquisition port name. The collected waveform signal peak mean and phase mean are displayed in real time. Interface of detection subsystem of on-board unit 10-t05 is shown in figure 11.

5. Conclusion

In this paper, the software program of the train group current transformer rust detection system is programmed by the LabView8.6 programming tool. Overcoming the current train group maintenance process, the current transformer rust detection under the manual operation of the detection period is long, the detection process is cumbersome and the test results error is large. The system includes the functions of data acquisition of current transformer voltage signal, real-time transmission of data between vehicle and under-car units, detection and detection alarm display, collection data and storage and calling of processing data. And combined with the domestic mature error calculation method to ensure the accuracy of the results, for China's train maintenance intelligent and information-based development and construction provides a certain reference value.

References

[1] BAI huan, MENG Jianjun, WANG Anming, YANG Xing, DUAN Han. Design and Application of Core Quality Detection System for Open-ended Current Transformer [J]. Measurement and Control Technology, 2018, 37(04): 78-81+87. (in Chinese)

[2] CAO Yongzhi, WANG Yang, GENG Min, LI Haiyou, HAN Shun. CRH_3 EMU traction transformer differential protection causes analysis and preventive measures [J]. Railway locomotives and motor vehicles, 2014 (09): 34-37+6. (in Chinese)

[3] LIANG Shibin, WANG Jianxin. Excitation characteristic test of current transformer and its new method [J]. Relay, 2007 (S1): 398-402. (in Chinese)

[4] Principle and Classification of Current Transformers [J]. Volkswagen Electricity, 2019, 34 (03): 27. (in Chinese)

[5] JIANG Peng, LI Yuanzong, LONG Xingqiang, ZHANG Jianjian. Analysis of factors affecting errors of current transformers and their application [J]. Standardization and measurement of instruments and instruments, 2014 (01): 32-34. (in Chinese)

[6] LI Chunli. Vehicle monitoring system based on ArcGIS Engine [J]. Computer Engineering, 2006 (32): 257-259. (in Chinese)

[7] CAO Tuanjie, ZHANG Jian, YIN Xianggen, ZHANG Zhe. Error Analysis and Engineering Calculation of Current Transformer [J]. Electric Power Automation Equipment, 2007 (01): 53-56. (in Chinese)

[8] FENG Yuanyuan. Fault case analysis and preventive measures of current transformer [J]. Automation application, 2018 (11): 91-92. (in Chinese)