Research on Railway Intelligent Operation and Maintenance and its System Architecture

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Abstract—With the continuous development of railway informatization, railway operation and maintenance system also needs to be more intelligent. Starting from the basic concepts of operation and maintenance, intelligent operation and maintenance and railway intelligent operation and maintenance, according to the current operation and maintenance situation of some systems in the railway industry, this paper studies the overall architecture and workflow of the railway intelligent operation and maintenance system. Intelligent operation and maintenance technology can provide technical means for ensuring railway transportation safety, improving maintenance efficiency and reducing operation and maintenance cost. The implementation of railway intelligent operation and maintenance system will make railway operation and maintenance move forward from traditional decentralized mode to centralized and unified mode, so as to make railway operation and maintenance work more scientific and efficient and improve the overall operation and maintenance level of railway.

Keywords—Railway informatization, intelligent operation and maintenance, data analysis, fault diagnosis, intelligent decision-making

I. INTRODUCTION

With the development of China's railway informatization more and more mature, the number of rail transit lines is increasing, the speed of railway trains is increasing, the number of facilities and equipment is increasing, the maintenance and management of equipment is becoming more and more important. At present, the sub-professional railway operation and maintenance management system has formed a three-level information management system of "Railway Bureau Group Corporation-Station Section-work area", in addition to the joint maintenance of facilities and equipment by different disciplines under individual comprehensive plans, the current single professional self-operation and maintenance is still the main[1]. The traditional management mode has been very difficult to meet the requirements of high efficiency, standardization and refinement of operation and maintenance under the rapid development of high-speed railway in our country. Therefore, there is an urgent need for the operation and maintenance system to develop in the direction of high integration, intelligence and automation, so as to improve the information level of railway operation and maintenance, enhance the speed of operation and maintenance, and reduce the cost of operation and maintenance. So, the railway industry urgently needs intelligent operation and maintenance technology. With the development of big data and artificial intelligence technology, in relevant fields, experts and scholars have begun to study the railway intelligent operation and maintenance, the local locomotive[2], telecommunication and signal[3], EMU[4] and other departments have begun to implement the application of intelligent operation and maintenance system for practical management. However, at this stage, there is no unified and clear definition, architecture and process of railway intelligent operation and maintenance system, so this paper carries out relevant research and discussion.

II. RELATED CONCEPTS OF RAILWAY INTELLIGENT OPERATION AND MAINTENANCE

The traditional method of operation and maintenance is called "fireman". It depends on manual inspection and manual operation. And it is often only after the problem occurs that the operation and maintenance begins to check the fault, so that the operation and maintenance work is in a passive state, and the efficiency of operation and maintenance becomes very low[5].

Intelligent operation and maintenance refers to the improvement and upgrading of traditional operation and maintenance. Based on modern information technology, big data analysis, data fusion, machine learning, intelligent algorithm and other technologies, it can realize automatic fault detection of business system, automatically judge exceptions or warnings. The intelligent products of information technology are used to assist the operation and maintenance personnel to locate the fault quickly and effectively, and find the optimal operation and maintenance scheme, so as to improve the efficiency of operation and maintenance and reduce the cost of operation and maintenance[2].

The traditional railway operation and maintenance mode is manually processed by sending work orders according to the maintenance period, or after the monitoring object triggers the critical value, which has a long period. A lot of manpower and material resources may be wasted, at the same time may not be able to achieve good results. In addition, there are many departments involved in railway operation and maintenance work, including locomotive, track, telecommunication and signal and vehicles, etc., each department has various equipment and complex operation and maintenance information. Each system can only collect data or equipment status information through its own operation and maintenance mode.

Railway intelligent operation and maintenance is based on the data of railway telecommunication and signal, track, power supply, locomotives and other related disciplines, and integrates the data and information of decentralized operation and maintenance into an operation and maintenance center by combining intelligent means. Through the comprehensive collection of data, the comprehensive perception of equipment state, intelligent analysis and processing, the intelligent health state analysis, fault diagnosis and maintenance decision of equipment and key components are realized, and according to the results of state analysis and diagnosis, to achieve fault location, early warning, life prediction, etc., so as to reduce the investment of manpower and material resources, to achieve the cooperative work of personnel, equipment and environment. It has a more comprehensive perception, more extensive interconnection, more accurate early warning analysis, and more in-depth intelligent processing ability. It can build a safe, efficient, intelligent, green and environmental protection modern railway operation and maintenance system, realize the functions of centralized monitoring, dispatching and command of operation and maintenance, and improve the ability of daily operation and maintenance, rapid fault analysis and processing.

At present, some systems in the railway industry have begun to use intelligent operation and maintenance means. For example, the Shuohuang Railway locomotive intelligent operation and maintenance system[2], which comprehensively applies big data and intelligent means to provide a one-stop solution for local freight railway locomotive operation and maintenance. The system realizes data monitoring of daily operation and maintenance by building a big data platform for Shuohuang locomotive operation and maintenance, opening up information islands, and communicating with each other Through intelligent means such as data mining, sorting, fusion and analysis, the locomotive intelligent operation and maintenance application functions such as remote monitoring, fault diagnosis, emergency disposal, fault early warning, life prediction are realized. The Railway intelligent telecommunication and signal operation and maintenance[3] and the intelligent operation and maintenance system of EMU[4] use intelligent sensing network and sensors to collect the status and data of equipment and key components, combined with its operation status information, use intelligent algorithm to quickly and accurately locate the faults. It can realize the early detection and timely treatment of some key component faults.

III. OVERALL ARCHITECTURE OF RAILWAY INTELLIGENT OPERATION AND MAINTENANCE SYSTEM

Referring to the current application of intelligent operation and maintenance of some systems in the railway industry, this paper proposes the overall architecture of the railway intelligent operation and maintenance system. Its overall architecture can be defined as four layers: data acquisition layer, data processing layer, diagnosis and decision-making layer and user layer. The system collects data and uploads it to the data processing layer, extracts the relevant feature information through integration, mining, etc., conducts the fault diagnosis and early warning according to the extracted information, and carries on the life prediction, finally forms the maintenance plan and decision-making, and transmits it to the user layer for display and output. The overall architecture is shown in Figure 1.
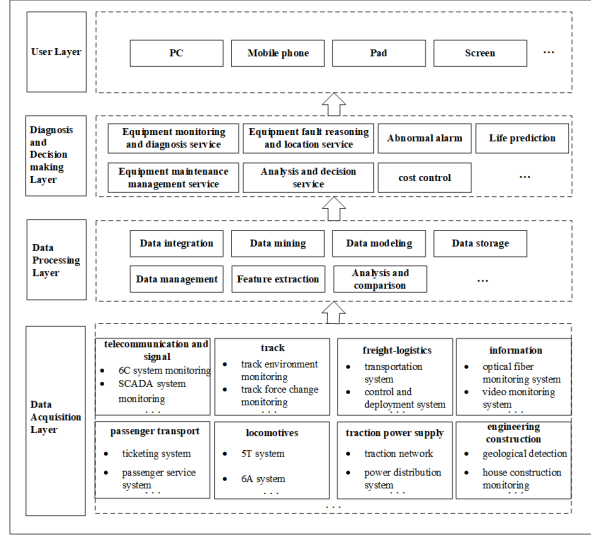

Fig. 1. Overall architecture of railway intelligent operation and maintenance system

IV. WORKFLOW OF RAILWAY INTELLIGENT OPERATION AND MAINTENANCE SYSTEM

First of all, the railway intelligent operation and maintenance system collects, integrates and analyzes the data of each system of the railway, and then intelligently diagnosis, forecasts and locates the faults of the equipment and key parts according to the information obtained from the analysis, finally forms the maintenance plan and decision-making. The specific workflow is shown in Figure 2.
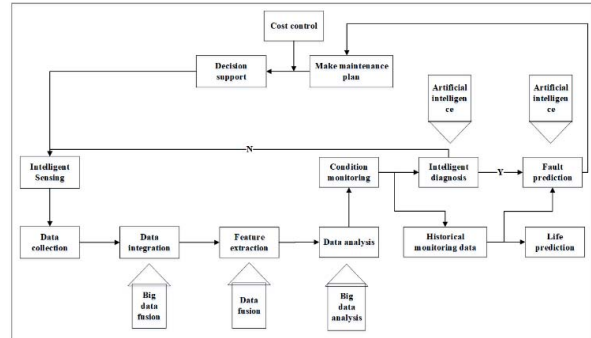

Fig. 2. Workflow of railway intelligent operation and maintenance system

V. CONCLUSION

The railway intelligent operation and maintenance system is an innovation of traditional operation and maintenance management mode. At present, the construction of the system is just in its infancy, but in the future, in this system, the intelligent perception will extend to a more full and detailed direction, through cross department data fusion, it will be able to carry out multi-dimensional and multi-level in-depth data mining, the technology of intelligent diagnosis analysis and decision-making will continue to develop and improve to achieve rapid fault location and strategy output. So gradually enhance the intelligence and information level of the railway operation and maintenance system, reduce cost, improve efficiency, and make the railway transportation system grow in a more safe and reliable direction.

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