Research on Safety Evaluation and Early Warning Decision System of Hydropower Equipment based on Big Data Technology of Electric Power

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Abstract: With the advent of the information age and the rapid development of big data technology, it is an important means to monitor the status of hydropower equipment based on the power big data technology and realize the equipment safety evaluation and early warning decision-making to ensure the safe operation of hydropower facilities. This paper first introduces the technology based on big data of electric power, then discusses the theory of safety evaluation and early warning decision system of hydropower equipment based on big data, and finally gives the construction scheme of state safety evaluation monitoring and fault early warning system of hydropower equipment.

1. Introduction

With the continuous development of smart grid technology and Internet technology, China's hydropower grid is rapidly evolving into a system that gathers multi-dimensional massive heterogeneous data and multi type huge and complex computing. On the other hand, with the deepening of intelligence and complexity of hydropower equipment, the composition of big data of hydropower equipment state is more and more complex. At present, the latest equipment condition online monitoring and fault early warning system can realize the intelligent management of equipment condition, give full play to the professional efficiency of equipment managers, and change the fault post-processing to early prevention. So as to greatly improve the operation safety level and efficiency of equipment, reduce unplanned downtime and accidents caused by equipment reasons, reduce equipment operation and maintenance costs, and create more benefits for hydropower enterprises. Therefore, it is a new trend of the development of hydropower equipment in the power industry to study the state safety evaluation and early warning decision-making system of hydropower equipment based on big data to improve the power supply safety and reliability of hydropower equipment, which also has important practical significance.

2. Technical Analysis Based on Big Data

2.1 The process of big data mining

The purpose of mining the safety evaluation and early warning decision system of hydropower equipment based on big data is to mine the operation rules and patterns of hydropower equipment, establish the health state model of equipment, and judge the operation state of equipment based on this to carry out early warning of faults. The data mining process is divided into three processes: data preparation, data mining and the interpretation and evaluation of the results. Among them, data preparation is the most complicated in the mining process, as shown in Figure 1 below.

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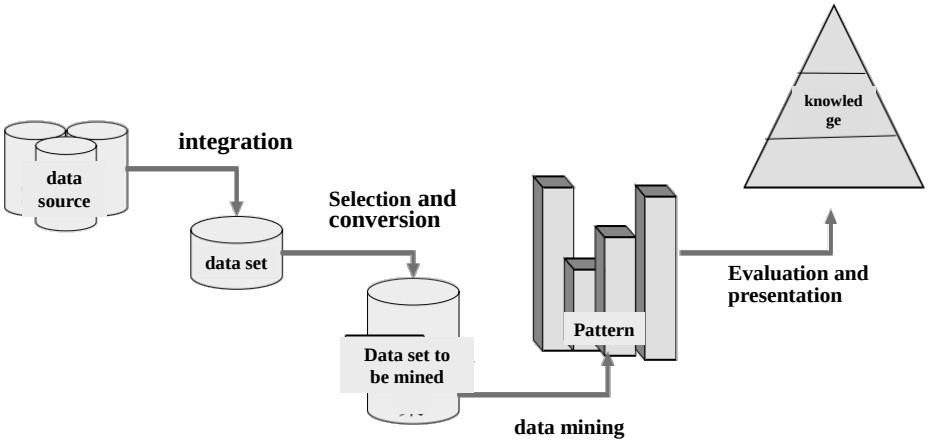

Figure1. The preparation process in data mining

2.1 Common methods of data mining

There are many methods for data mining, including regression analysis, neural network, association rules, clustering, classification and web data mining, as shown in Figure 2 below.

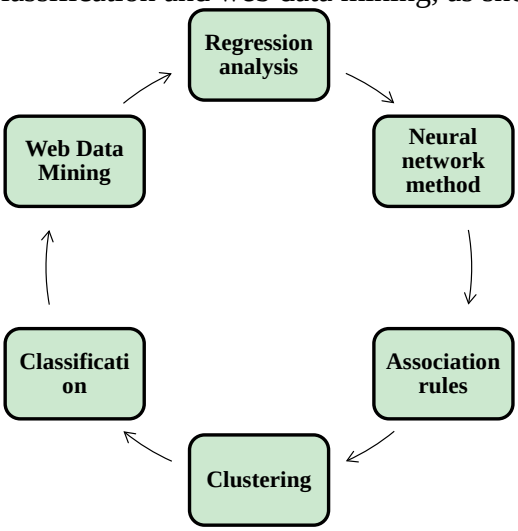

Figure2. The methods for data mining

3. Safety Evaluation and Early Warning Decision System Theory of Hydropower Equipment based on Big Data

3.1 Calculation of operation mode

Power data are mostly time series data. Based on big data analysis technology, hydropower equipment safety evaluation and early warning technology, its core is to use big data technology to mine out the operation law of hydropower equipment, realize the monitoring of operation state, understand the operation law of equipment, and study its law. Clustering method is used to classify many data based on the differences between the data. Clustering method has high flexibility and can effectively explore the potential relationship between data. The function data clustering analysis method is applied to the field of hydropower equipment safety evaluation and early-warning decision-making. With the help of clustering results, the status monitoring of hydropower equipment can effectively reduce the risk of equipment operation.

3.1 Clustering method of functional data based on basis function expansion

In order to reduce the time and complexity of the calculation process, the distance between the expansion coefficient vectors of the basis function is used to replace the distance between the original functions to transform the problem. The clustering problem of functional data is transformed into the clustering analysis of basis function expansion coefficient vector in low dimensional space, which makes the problem simpler. In order to solve the problem of time series data clustering, first of all, it is very flexible to select the base function, and use different functions to expand the data according to the actual situation; second, the clustering method based on Euclidean distance is the limited means of time series data clustering analysis.

4. Construction of State Safety Assessment Monitoring and Fault Early Warning System for Hydropower Equipment

4.1 System structure design and composition

The online safety assessment monitoring and fault early warning system of hydropower equipment is based on the standard TCP / IP network environment through two architectures of B / s and C / s. The collected data breaks through the limitation of the closed system, as shown in Figure 3 below.

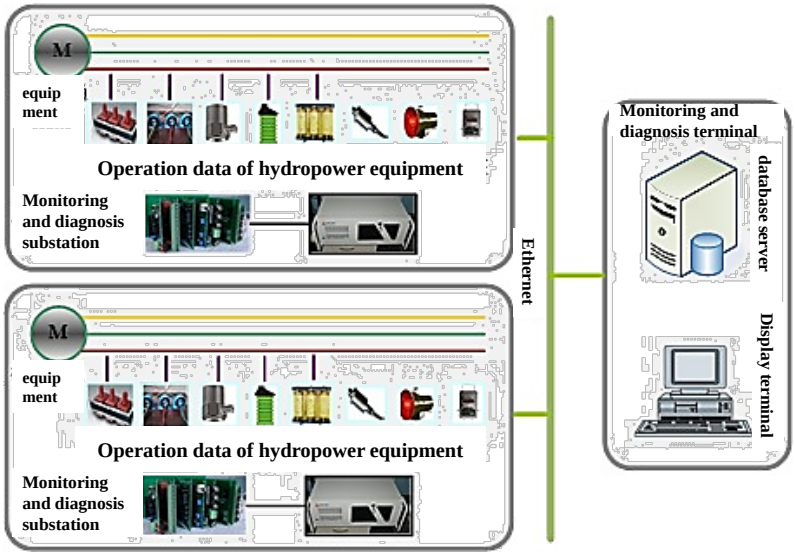

Figure3. Online safety assessment monitoring and fault early warning system structure

The system can automatically collect the real-time / historical database system from the operation of hydropower equipment or any data source supporting the OPC data communication standard, without the need for additional field detection equipment. Therefore, the system has less investment and convenient operation. For the data source of the proprietary system in the operation of hydropower equipment, the equipment condition online monitoring and fault early warning system can also support the development of the corresponding data communication interface in the way of API.

4.2 Dynamic model building of equipment operation

The dynamic model of hydropower equipment safety assessment monitoring and fault early warning system is based on the historical data of equipment operation, and the historical data should be the collection of normal state in the process of equipment operation to ensure the simultaneity of

each variable in the sampling value. The generation of dynamic model is to select the state value which can best represent the characteristics of the operation process of hydropower equipment from the set of normal operation state of equipment, and build the model of normal operation state of equipment based on the state value. In addition, the internal state values of the hydropower equipment model are compared, and the internal space of the dynamic model of the hydropower equipment is divided by setting related reference points. The dynamic model of hydropower equipment operation is constructed by calculating boundary points and internal reference points of correlation similarity.

4.3 Safety operation evaluation and fault early warning of hydropower equipment

After establishing the dynamic model of online safety monitoring and fault early warning system for hydropower equipment, the operation status of hydropower equipment is predicted based on correlation similarity. According to the real-time data of the hydropower equipment received by the system, the gap between the current state of the equipment and the model state is judged, and the similarity of the equipment state is determined to generate the prediction of the operation state. By shielding the interference signal, the accuracy of state safety assessment and prediction of hydropower equipment is improved. Through the application of dynamic model, the difference between the real-time predicted value and the real-time value of hydropower equipment can realize the early warning of fault and the location of fault point, so as to timely warn the potential abnormal state and greatly improve the sensitivity of early warning.

5. Conclusions

In this paper, a state safety assessment and early warning system of hydropower equipment based on big data technology is designed, which can create a dynamic real-time operation model for the equipment and system on the site of hydropower operation in real time and accurately, and realize the safety assessment and management of the performance of hydropower equipment. Through the use of the system's safety evaluation and early warning decision-making function, it can effectively reduce the unplanned downtime of hydropower equipment, reduce the maintenance and operation costs of hydropower equipment, and provide effective support for the operation and maintenance technical services of hydropower equipment.

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