Design and Application of Operation and Maintenance Information System Based on Hydropower Station Production Data Platform

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Abstract: With the progress of society, people's lives have gradually become more and more shadowy by electric power equipment, which has greatly improved people's living standards. Unlike mature automation systems such as monitoring, protection and dispatching, online monitoring system is an automation system in the development stage. In addition to each automation system realizing its own function according to its function design, a large amount of collected data has not been fully applied. Through the application program deployed on the interface server, the real-time data of computer monitoring, water regulation automation system, dam online monitoring, unit status online monitoring, relay protection online monitoring and other systems are connected to the PI database server for storage. The monitoring computer and the data management computer are physically interconnected through Ethernet, and the data management computer can obtain all information that the monitoring computer can obtain through OPC point-to-point communication. It ensures the safe and stable operation of the real-time information platform and provides guarantee for the safe production of the power plant.

1. Introduction

With the continuous development of equipment condition monitoring technology, there are more and more on-line monitoring systems for hydropower stations, involving vibration, air gap, local discharge, chromatography and other specialties, covering units, electricity, dams, water regime and so on. Big data has become a new natural resource, which requires people to apply it more reasonably, efficiently and fully so as to bring greater benefits and values to human life and work [1]. China is rich in water resources, and it is the most economical to build hydropower stations to generate electricity. As a green energy source for power generation, hydropower has made great contributions to reducing environmental pollution and energy crisis [2]. However, the low efficiency of hydropower resources development in China has seriously hindered the development of hydropower resources. This is because hydropower station automation technology has become a routine technology in developed countries, and most of some small and medium-sized power stations operate unattended. Technical data such as drawings, technical specifications, installation process, equipment operation data, test data and the like of hydropower station equipment are integrated into a database, unified management is carried out on a computer network, rapid data resource sharing is realized, and a real-time information system can be used as a bridge between a management system and a production system, and the value of the real-time information system is being increasingly improved along with continuous enrichment of applications.

2. Requirement Analysis of Hydropower Station Operation and Maintenance Information System

2.1 Functional Requirement Analysis of Operation and Maintenance Information System

The functional requirements of the operation and maintenance information system are mainly aimed at the users. In this study, one-to-one interviews are conducted with the operation and maintenance workers of a hydropower station. The hydropower station production data platform shall ensure that the platform data is unique, accurate, real-time and comprehensive, and ensure the

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data quality [3]; In the design process, effective technological breakthroughs must be sought to solve various unfavorable factors affecting the establishment of the platform system. It is also unrealistic to require users to fully describe their requirements before programming. It is also unrealistic to require developers to fully understand the data and related contents through several investigations, and to develop programs to meet users' requirements. After receiving the information, the data processing and display system can display it to the user in the form of sound, image and so on to achieve the monitoring purpose [4]. Through various possible ways to fully describe the existing system's business processes and data to be processed, and analyze the logical rationality of these processes and data structures, finally give the logical scheme of the new system. Realize digitalization of management information, networking of communication platforms, standardization of information integration, integration of operation and management, interaction of business applications, intellectualization of decision support, and realization of management objectives such as safe, reliable and economical production and operation of small hydropower stations.

2.2 Business Requirements and Processes of Operation and Maintenance Information System

The production data platform of hydropower station does not directly collect information from equipment, but builds a data platform across multiple safety zones on top of the whole plant automation system. In the operation and maintenance system, frontline operation and maintenance workers can use the system to carry out operation and maintenance work on site. Relevant resources can be obtained through inquiry as operation guidance, and experts in the field can also be connected for precise guidance. When the data output service interface is exactly the same, the application module can run on both platforms [5]. Including the technical engineers in the field operation and maintenance of the power plant and the engineers in the design and technological transformation department, responsible for the modification, update and maintenance of the technical data of the power plant equipment.

Domain experts classify their own operation and maintenance work experience and audited workers' proposals according to file types, make them into fixed patterns of graphic audio-visual resources, publish them to the system, and store them in the resource pool. The business flow chart of domain expert resource production is shown in Figure 1.

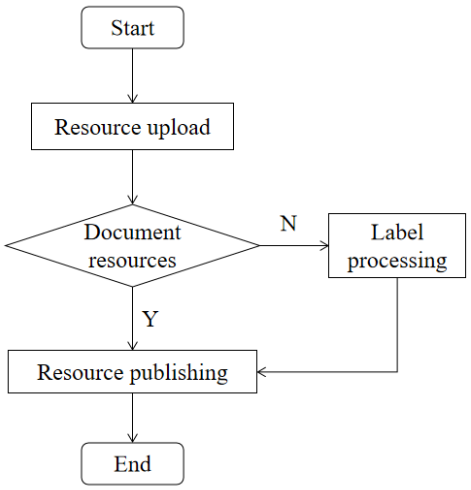

Fig.1 The Domain Expert Resources Make the Business Flow Chart

Maintenance personnel can manage, maintain and develop the system through the man-machine interface. This also includes the management model in the new system, that is, the management model and processing methods adopted in the specific management business. Cached data are arranged according to the order of receipt. After the data is written into the data buffer, the system calls the data writing subsystem to read the data through callback. The system organically integrates real-time production data, management data and external related data to form a comprehensive information platform with integrated management and control and hierarchical structure.

2.3 Requirements for Safety Production Management Functions

The hydropower station operation and maintenance information system is an exchange platform designed for members of the hydropower station operation and maintenance project team. According to the functional requirements, the data of the system requiring employee information and learning resources are obtained [6]. The production data platform of hydropower station must adopt reasonable network architecture and real-time communication mode to obtain comprehensive and real-time data of hydropower station. Generally refers to the real-time data provided by various types of data acquisition equipment and communication devices, generally taking time as a sequence and data labels as unique identifiers; After the completion of the whole debugging work with the original software part, finally check whether the function of the whole system can meet the required requirements. The quality of equipment maintenance is an important basis for ensuring safe power generation. Training hydropower station personnel and familiarizing them with the overhaul process and overhaul flow are helpful to improve the reliability of equipment, reduce the operation overhaul cost and shorten the overhaul time. According to the functional requirements and information requirements of the new system, the hardware structure and software structure of the system are designed [7]. In order to meet the production management needs of different hydropower stations, the randomness of usage modes and the diversification of requirements, the business process is designed to allow authorized users to customize their work. The data transmission adopts a data transmission mechanism of “change transmission” to effectively filter data that does not change or does not change much.

3. System Architecture Design

3.1 Data Security

The operation and maintenance information system is an information system that borrows the idea of cloud services. Its main targets are frontline operation and maintenance workers and domain experts. Since the historical data in the historical database are acquired and processed, there are errors or erroneous data caused by unstable instruments. Therefore, bad data should be eliminated during storage and screening. In order to be able to access these different types of data, the platform needs to have an extensible data conversion module, which can ensure the operation efficiency and carry out large-scale integrated deployment. It can communicate through various networks and has various control functions such as process control, sequence control, transmission control, etc. and advanced input and output technologies. Ensure the procedures are standardized and minimize human factors. Users in the process will judge, operate and record according to their own responsibilities and authorities. Then developers and users evaluate the model together, and give priority to users to put forward improvement suggestions on the deficiencies of the model. According to the evaluation results, the developers modified the model. This is repeated until the user is completely satisfied.

3.2 Interface Design Requirements

Unit condition monitoring data is the key data for analyzing unit performance, including effective value, average value, peak-to-peak value, etc. The peak-to-peak value of unit oscillation reflects the magnitude of unit oscillation amplitude. The interface design shall meet the requirements of correctness, integrity and real-time access data, as well as the stability of the interface and the convenience of maintenance. Modular design, each front-end module can be connected to a certain type of data source; Modules are independent and unrelated, which can ensure parallel operation between reading tasks.

PLC control program is mainly divided into two parts: data acquisition and unit operation control [8]. First of all, the input module at the bottom layer collects relevant digital data and transmits it to the acquisition program module, through which relevant operations are carried out on the data. The specific data collection flow chart is as follows: The specific data collection flow chart is as follows Figure 2:

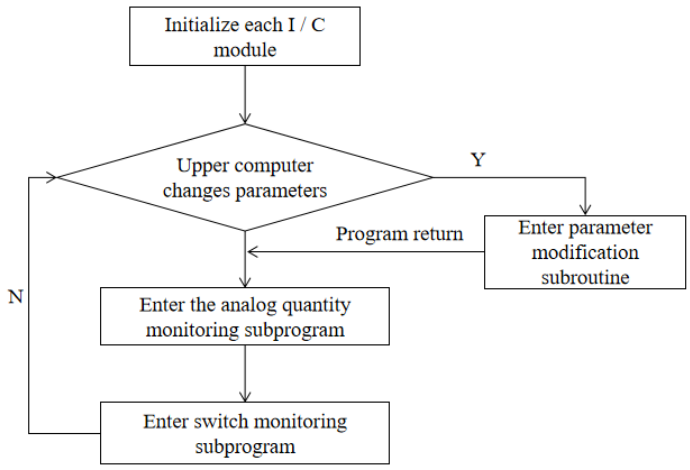

Fig.2 Plc Data Acquisition Flow Chart

Through the interface with the computer monitoring system, the data in the monitoring system database are filtered and processed and stored in the central database. In this process, users often criticize and criticize the system prototype to put forward improvement suggestions, which is much easier than describing their own ideas in an empty way. Through the system to develop training applications, prepare training programs, implement personnel training, according to the job requirements of different employees, regular or irregular training assessment. This not only ensures the safe and reliable circulation of various data streams between networks, but also improves the unity and flexibility of control, and greatly simplifies the network structure of the whole system.

3.3 System Architecture

The system is designed according to hierarchical logic architecture. The advantage of this design lies in the separation and decoupling of logic functions with different granularity. Logically, the system architecture is generally divided into four layers: database layer, business logic layer, service layer and user layer. The PI data server of the power plant adopts a cluster mode, the database system and data are stored in a disk array, and the data adopts a unified access mode. For example, there is no comparability between the vibration amplitude measured under design conditions and the vibration amplitude measured under vortex belt conditions. By directly reading the database table; Off-line data is identified and read from the production system by means of off-line document identification and entry, which requires interaction with the production system. After fully considering the user's needs and characteristics, the operability of the system is strengthened. At the same time, the detailed performance, such as changes in equipment parts and changes in operation situation, are carefully considered. When the user program executes, the relevant data of these input states can be obtained from these data memories, because the state of external input signals may change during program execution. Give full play to the role of computer monitoring system and water regime monitoring and reporting system to provide accurate and timely decision support for middle and upper level leaders [9]. Internet technology, network technology, data management and application technology are adopted to meet the system function design and provide valuable application functions.

4. Implementation of Hydropower Station Operation and Maintenance Information System

After the data processing introduced in this paper, the data of the hydropower station production data platform are all reliable, and there are no glitches and abnormal jump problems. System users can access the system using desktop computers or mobile terminals. In order to reduce the storage pressure of the upper computer of the computer monitoring system and provide convenience for data analysis, a background data server should be installed and data analysis and processing software should be developed. When the trigger condition specified by the trigger occurs, the set

trigger will be activated immediately to execute the action specified by the trigger. These are all important references for future system maintenance, upgrade or expansion. It can be said that document management is a very important part of the management information system construction process. Desktop and mobile terminal devices are used as ports for system data input, and system data processing and storage are all placed on cloud service platform. Through SOA technology, various business data query methods are combined to provide scalable enterprise business bus services.

The application center should be equipped with some basic application modules so that some basic data display, analysis and alarm functions can be performed when the data platform is established. The scalability of hydropower station technical data management system is mainly reflected in business scalability, performance scalability and technical scalability. Responsible for sending the task set to the server and waiting for receiving the processed result sent by the server, and displaying it to the user or making further processing in the corresponding form. The system management functions mainly include department management, post management, personnel management, authority setting, log management and other functions, including organization management, system setting management and user management. Whether the PI database is running or not depends on the activation of the main services of the PI Server and the operation of the PI Server process. The front page of the system is an information display interface, and the technologies used are mainly front-end technology and back-end technology to call database data. At present, people have gradually realized that the document management of the system is of great significance and has begun to be reflected in the actual management information system project management.

5. Conclusion

The equipment operation and maintenance of hydropower stations is one of the important factors to ensure the efficient operation of hydropower stations. Only by ensuring the efficient operation of hydropower stations can energy be brought to the masses of people and the smooth progress of China's construction. According to the current situation of hydropower station equipment technical data management, this paper studies the system architecture of the technical data management system by analyzing the requirements of the technical data management system, and gives the structure model of the system. The basic mode of hydropower station operation and maintenance system is constructed. According to the demand analysis and referring to the hierarchical logic structure of the system, the main structure of the system is constructed, and subsystems and functional modules are divided. With the arrival of the era of big data, it can be predicted that data mining and equipment status analysis based on hydropower station production data platform will become a major trend of hydropower station technology development in the future for a long time.

Acknowledgment

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