Architecture Design of An Intelligent Monitoring System for Turbine Filtration Device

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Abstract. In order to improve the operation efficiency of the turbine and reduce the failure rate of the equipment, this paper takes the inlet filter device of the turbine as the research object, comprehensively utilizes computer technology, machine learning, computer network and other technologies, and proposes a remote monitoring system of the turbine filter device based on industrial Internet cloud service and C/S architecture. The industrial process monitoring system is designed according to the actual situation of the industrial process. By connecting the system to the industrial Internet cloud service, the remote monitoring of the on-site running state and operation data of the equipment is realized. On this basis, the artificial neural network is proposed to realize the timely diagnosis and treatment of faults, and the operation and maintenance suggestions are put forward to improve the stability of equipment operation, reduce the maintenance cost of equipment, so as to improve the economic benefits of system operation and maintenance.

1. Introduction

With the development of sensor technology, communication technology, data storage technology, Internet of Things, computer technology and other technologies in the production process of modern manufacturing industry, now it has been able to fully collect equipment information, environmental information, raw material information and other multi-dimensional data in the process of industrial production. At the same time, the industry has also entered the era of Internet big data [1]. As the product of the integration of a new generation of information technology and manufacturing industry [2], the industrial Internet cloud platform is an important part of the construction of new infrastructure. In addition, with the continuous deepening of artificial intelligence and industry integration applications, the new technology model that integrates industrial Internet cloud platform and artificial intelligence is providing important impetus for China’s new infrastructure construction. As a kind of high efficiency and low emission power machinery, turbine is widely accepted in Chinese market and plays an important role in the industrial field [3]. The turbine is characterized by compact structure and flexible operation, turbine output and efficiency are largely determined by the cleanliness of the air entering the turbine, in which the air intake system is equipped with a filter system to filter the air [4]. Connect the turbine filter system to the industrial Internet cloud platform and introducing artificial intelligence technology to conduct the thorough research to the turbine filtering system and intelligent upgrade, not only can improve the operation efficiency of turbine, can also strengthen the industrial enterprise intelligent level, improve the enterprise production efficiency, reduce equipment failure rate, to promote the efficiency of turbine work provide a reliable guarantee.
2. Working Principle of Turbine Filter System

In industrial production, the intake air filtration system of turbine adopts two ways: conventional three-stage filtration device and pulse air self-cleaning filter device [5]. This paper mainly studies the pulse air self-cleaning filter device. In the pulse air self-cleaning filter device, the air enters the intake system through the rain cover at the front of the air intake system, and the pulse back-blowing self-cleaning filter element is arranged at the back of the rain cover. The air is filtered and cleaned by these filters and then compressed into the compressor. The dust and other particles in the air are left on the filter. The pressure difference between the front and back of the filter increases as the particles on the filter core gather. When the pressure difference of the filter reaches a certain degree, the pulse back blowing system starts to work. The supersonic drainage equalization nozzle in the pulse reverse blowing system will spray the clean compressed air into the inner cylinder of the filter element periodically from the outlet of the clean air of the filter element at a certain pressure, and blow off the dust attached to the surface of the filter cylinder, so that the filter element can recover its filtration performance [6]. By the above process can be seen, the key data including: before and after the filter differential pressure value, high pressure difference alarm, system temperature, dust ion solubility, filtering level, supersonic flow balance the blow air flow data for the nozzle and the material fatigue strength data, real-time monitoring and reporting to FCS (fieldbus control system), to ensure the healthy operation of the system, as shown in Figure 1.

Due to the relatively complex working environment of turbine, temperature, humidity and air salinity have different influences on the operation of turbine filter device. At the same time, the automation and intelligence degree of turbine filter device at present are low, which is not conducive to equipment maintenance and operation. In addition, the existing filter system of turbine has some problems, such as less operation data collected by the system and blind area of key operation data monitoring. In addition, there are some problems in signal acquisition, such as lack of advanced architecture, single signal acquisition, lack of analysis of collected data, and lack of classification and application. As a result, the existing signal acquisition system is not enough to timely reflect the running health of the device, so that it is difficult to carry out efficient equipment operation and maintenance work. Therefore, it is necessary to design and develop a remote monitoring system of turbine filter device based on industrial Internet cloud service, which can not only carry out remote online fault diagnosis and fault troubleshooting for the equipment, but also avoid the huge loss caused to the production enterprises due to the long delay time when the equipment fails.
3. Intelligent Monitoring System of Turbine Filter Device

According to the process flow of turbine inlet system as shown in Figure 1, key parameters of turbine filter device system were selected, such as display of pulse cleaning program count, pressure difference, system temperature, dust ion solubility and other data, and real-time collection and display of key parameters were realized through PLC. At the same time, through the communication between the client and PLC, the opening and closing of the field dust removal fan, the start and stop of the pulse valve blowback work on the filter room, the opening and closing of the service compartment door, the opening and closing of the explosion release door and other control functions are realized. Then, the system database is compiled according to the operation characteristics of the equipment, and the local operation data of the turbine filter device is stored in the database in real time, so as to provide data judgment basis for the fault diagnosis, operation and maintenance of the turbine filter device and system early warning. On this basis, the development based on industrial Internet services in the cloud and C/S (server/client) model structures, equipment remote access system, the implementation of the local database cloud backup and remote terminal access to the data of field devices, remote data reading, analysis, so as to realize the remote data of operating equipment diagnosis and troubleshooting; The artificial neural network was designed and constructed. According to the operating characteristics of the system, the artificial neural network model was developed to realize intelligent fault diagnosis, as shown in Figure 2.

![Figure 1. Process flow chart of intake system](image)
The design steps of the whole system are as follows:

1. Collect the local data acquisition and write the upper computer software, realize the field data visualization and functional control. Combined with the actual working state of the turbine filter system, the key data are collected. NET Framework platform C# programming language is used...
to develop the upper computer. The upper computer uses Modbus protocol to communicate with PLC. The upper computer interface is designed according to the PID diagram of the actual operation of the turbine filter device, and the collected data is processed and displayed on the upper computer interface to realize the visualization of the operation data.

(2) According to the characteristics of the data, the database is created to achieve local and cloud data storage. According to the PID drawing of the equipment, MySQL database was used to build the database. The pulse cleaning program count, PDT002 differential pressure value, PDT002, 1500Pa high differential pressure alarm, PDT003 differential pressure value, PDT003, 2300Pa high differential pressure alarm, MT001, dew point temperature value and other data were stored in the database to provide data support for equipment operation diagnosis. Synchronize the database to the cloud based on cloud service to provide data support for remote terminal reading and analyzing field data, remote data diagnosis and troubleshooting, as shown in Figure 3.

(3) Build server program based on industrial Internet cloud service, and connect local on-site client. C/S mode is used to design the system. In view of the work flow of turbine intake system, Windows Server system is used as the server-side operating system, C# programming language is used as the server-side programming language, Socket and TCP protocol are used to realize the network communication between the Server and the client. The server side is designed to connect to the cloud database and respond to the data access request of the client side, so as to realize remote network access to the operation data of the local device and remote network access to the device, as shown in Figure 4.

(4) An equipment fault monitoring system based on neural network is developed. Neural network is built based on TensorFlow framework. The pressure difference PDT002 between the pressure measuring point A and the pressure measuring point B at the previous time, the working times of the pulse cleaning program, the dew point temperature value and the pressure difference PDT003 at the pressure measuring point C at the previous time were taken as the input of the neural network. The pressure difference value PDT002 between pressure measuring point A and pressure measuring point B measured at the current time is taken as the output. A data set containing 10000 sets of data was made, including 6000 sets of training data, 2000 sets of verification data and 2000 sets of test data. Comparing the pressure difference PDT002 between the pressure-measuring point A and pressure-measuring point B predicted by the neural network with the measured data of the sensor at the current time, the system is judged to be in normal operation. If the difference between the predicted value and the actual value exceeds the set threshold, the warning prompt will be transmitted to the local client and server to realize intelligent fault diagnosis.
4. Conclusions
When the monitoring system of turbine filter device is running, the data generated by the system is huge and the data type is complex. In the actual environment, there will be problems such as network instability and data transmission error. According to the data characteristics of the turbine filter device, this paper designs a highly reliable monitoring system based on the industrial Internet cloud service, which can better realize the data correction and discrimination in the case of unstable network transmission and data transmission error, and improve the stability of network transmission between the client and server. On this basis, the appropriate artificial neural network algorithm is used to achieve the purpose of intelligent fault diagnosis.

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