

Exploration of Fault Diagnosis Technology for Air Compressor Based on Internet of Things

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Abstract With the development of network and communication technology, this article puts forward to new methods and ideas on the fault diagnosis technology of air compressor based on Internet of Things, ensure the safe, stable, and reliable running of air compressors, and carry out some beneficial exploration for remote diagnosis technology of mechanical equipment.

Keywords Internet of Things · Air compressor · Fault diagnosis technology · Remote monitoring

1 Introduction

Compressed air is the second largest power after the electric power energy, air compressor (hereinafter referred to as the compressor) is the main part of manufacturing the compressed air, and it is the original motivation (typically a motor) that convert the mechanical energy into a air pressure energy. Air compressors are widely used in industrial production, and most of the work environments are harsh [1]. When a machine fails, it cannot be diagnosed and be treated immediately, this must cause the increase of the loss. So the establishment of remote intelligent control for monitoring the response of the system has become a pressing problem of air compressor technology for the early prediction of failure.

In this paper, the use of Internet of Things technology carries out a useful exploration of the air compressor fault diagnosis technology.

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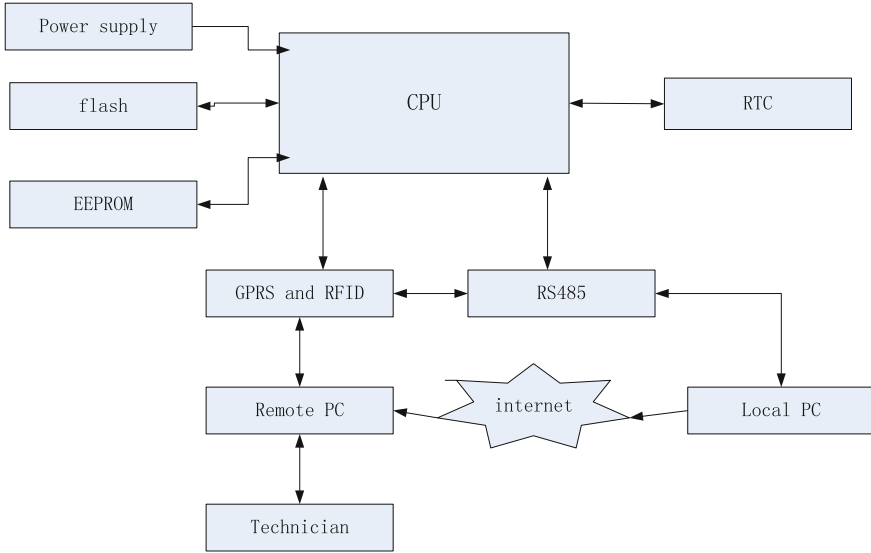


Fig. 1 Basic structural diagram of the system

2 The Remote Diagnosis System Designment of the Air Compressor Using Internet of Things

With the attention of the state to the Internet of Things technology, the Internet of Things technology has been more widely used in China. The application of the Internet of Things technology in air compressor for remote monitoring and diagnosis function conforms to the needs of society, and it will show considerable application prospects for the future development.

Basic structural diagram of the system, see Fig. 1

This system includes CPU with external GPRS system, flash memory, RS485 communication port; by the RS485 port, the real-time state of the compressor is transferred to a host computer and realizes the remote communication of the screw air compressor. The operator can start and stop the screw air compressor through the computer. The GPRS module and radio frequency identification (RFID) of the screw air compressor control system can fix the position of the air compressor, get to know where the parameters come, and ensure to control the machine correctly. The flash memory is used to store the historical running state, and when a mistake happens, the parameters can be drawn to help diagnose the problem and solve it. In addition, the acquisition of parameters can be transferred to the server through the Internet, there are many data from the working compressor in the server, and there is an expert diagnostic system according to the experience, the server can deal with collected data and make the plan of the equipment maintenance [2].

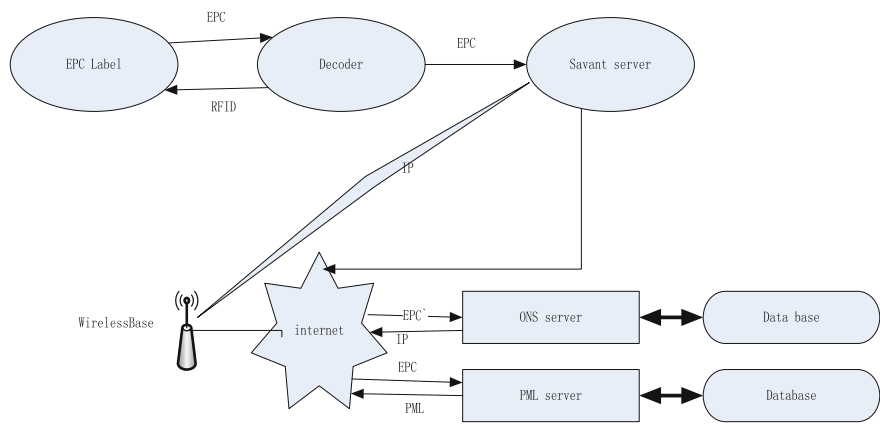


Fig. 2 Technical principle logic diagram

3 Field Information Collection with the Internet of Things Technology

In this paper, the technology of the Internet of Things is mainly used to locate the compressor, as well as its relevant technical indicators, operation parameters, etc.

Internet of Things is a kind of network that according to the agreed protocol, through the RFID, infrared sensors, global positioning system, laser scanners, and other information sensing devices, connects any objects with the Internet, and exchanges information and communication, and realizes the object’s intelligent identification, location, tracking and monitoring and management. With the Use of the Internet of Things technology, people can implement intelligent and accurate regulation and operation of the devices in the network [3].

Internet of Things’ key technology includes five segments: electronic product code (EPC), the information identification system (ID system), the EPC middle-ware (implementation information filtering and sampling), discovery service (information discovery service), the EPC information service (EPCIS). Its technical principle logic diagram is shown in Fig. 2:

There is a quite good coverage of wireless communication network in China, and it is a good infrastructure of the Internet of Things. The M2M business support platform launched by China mobile can provide the M2M business users of the data acquisition, transmission, processing, and business management, and other functions.

4 To Realize Remote Monitoring Using Communication Technology

This article adopts the type of site monitoring and remote monitoring, and through the GPRS network or the Internet, information is transmitted to the specified server, carries on the analysis processing, and achieves remote monitoring of equipment through the communication interface link.

Remote monitoring refers to the use of a computer to monitor and control of the remote industrial production process control system via a wired or wireless network system. A remote monitoring system is a computer hardware and software system that can achieve remote monitoring.

There are two types of remote monitoring system, one is no on-site monitoring system, but collects the data directly to a remote computer for processing, this remote monitoring has no difference with the general site monitoring except there is a long distance to transmit; the other is site monitoring and remote monitoring coexist. Generally, the remote monitoring adopts fieldbus technology connecting distributed sensors of monitoring equipment and develops the discrete cell to integrate unit, and at last, Intranet is built.

Remote monitoring function to achieve

1. Acquisition and process function: detect sample and pretreat all kinds of analog or digital signals, and output them in a certain form, such as printing form, display, or database server to help technician to analysis and know the situation of the compressor.
2. Supervision function: analyze, summarize, finish, and compute the detected real-time data, inputted parameters by the operators and so on, store them for the real-time data and historical data.
3. Management function: with the help of the existent valid data, images and reports related with the working condition, analysis, fault diagnosis, risk predict the working state, alarm with noise, light and electrical form.
4. Control function: Based on the detected processing information and pre-determined control strategy, control output is formed and works on the compressor directly.

Because the remote monitoring system can realize real-time data collection of the site operation data and rapid concentration, the base for remote fault diagnosis technology is formed. The remote monitoring system connects with the enterprise Intranet; this makes it possible for manager to grasp the working states, and it works with the management strategy system, a much more advanced applying system will be built. It provides the possibilities of no-one on-duty at the site and achieves more profit ultimately.

5 To Build Fault Model

Due to the mechatronics degree is low and lack of the original fault data gathered, it will take a long time to accumulate the practice experiment and much fund to build the fault model, and it may be difficult to achieve in practice. In order to build up the fault document quickly, the most economic way is to combine experimental and computer simulation, namely to establish mathematical model of the compressor and verify the correctness of the model through the experiment, if there are some difference, change some parameters in the model to simulate the machine fault. With the deeply study of the compressor working process, mathematical model research can be achieved and working more accurately and credible. The specific steps are as follows: (1) establish a mathematical model of the compressor; (2) establish valve cavity fluctuating pressure calculation model; (3) through the “pressure arouse,” combined the cylinder pressure with the body cavity of fluctuating pressure calculation; (4) verify the correctness of the mathematical model and calculating program; (5) change the related parameters, simulate the fault state, and set up a corresponding fault document.

To establish a standard machine fault-state model, you should take full account of their volatility. This is because, the first, the boundaries of the machine fault status and fault conditions are not clear, and no fault condition contains a certain state change; the second, with kinds of fault's severity difference, its characteristic parameters necessarily change; the third, parameter measurement on the control deviation, the changes of environmental conditions, etc., will make the characteristic parameter fluctuate. In order to improve the accuracy of fault diagnosis, the characteristic parameters (parameter fluctuation range) of the fluctuating nature is considered to construct standard mode.

6 To Establish Fault Diagnosis Expert System

The content of this paper is to build expert database in accordance with the public theoretical knowledge and long-term day-to-day empirical data, store them into SQL SERVER database, with a certain algorithm analysis, compare analysis result with knowledge database, plan the equipment's maintenance and repair, and the results are displayed in Web way, if possible, give some advice to improve the equipment designment [4].

The expert system consists of the knowledge base, database, data interface, and reasoning machine.

1. Knowledge base

Knowledge base is the core of the diagnosis expert system, its main function is to store and manage the knowledge of expert system. There are two main types of knowledge in the knowledge base, the first is the related theory in the field; the second is gained practical day-to-day maintenance data by the experts.

2. Database

Database is a data storage area that stores the real-time state in the expert system and the intermediate results that from the reasoning process of the device, and these values are changing in the running system.

3. Data interface

The data interface is responsible for transferring data in real-time database into the reasoning machine, and at the same time, the information inputted by the user converts the normalized expression within the system, output fault-type and disposal programs.

4. Reasoning machine

Reasoning machine is a group of program that compare the data from real-time database and single analysis system with the framework of the knowledge according some rules, and finally, fault conditions are obtained.

7 Summary

Remote monitoring and fault diagnosis system of air compressor based on Internet of Things and the mobile business of things adopts the advanced data communications, database and Web technologies; its application in high-voltage inverter air compressor products can achieve, transmit, process, and manage the run-time data, dynamic location information and user information collection of the air compressor, help to complete the fault diagnosis quickly, realize the product's maintenance services online, and quickly response after-sales. It makes it possible plan the overhaul and real-time development and help technicians exclude faults or hidden faults timely, improve efficiency, and reduce operating costs. It is a great significant thing for the long-term development for the air power industry, and it is a useful exploration of remote fault diagnosis in mechanical equipment.

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