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Application of Internet of Things Technology on Predictive Maintenance System of Coal Equipment

Li Dong*, Ren Mingyue, Meng Guoying

School of Mechanical Electronic & Information Engineering, China University of Mining & Technology (Beijing), Beijing 100083, China

Abstract

As production safety in coal mines attract more and more attention, coal mine informatization has great developed. At present, however, there are still some problems. The Internet of things technology provides a new train of thought for the development of coal informatization. The mine safety monitoring and maintenance of equipment system is taken as an example in this paper, and we establish predictive maintenance system which is based on Internet of things technology to change the existing coal mine equipment maintenance mode. And it guarantees the safe and efficient operation for mining equipment.

1. Introduction

The strategic concept of the "new silk road economic belt" and "the 21st century maritime silk road", which is hereinafter referred to as "The Belt and Road Initiative", was put forward respectively by Chinese President Xi jinping in 2013. And it has aroused strong repercussions at home and abroad. "The Belt and Road Initiative" strategy is a new strategy mode when the Chinese economy enters a new phase of opening-up, and it is an important pathway to solve the equipment structural overcapacity of manufacturing industry in our country [1]. "The Belt and Road Initiative" strategy is the important measure of the equipment manufacturing industry in China to find a way out. As taking the use of the advantage of our production capacity and the relevant national development requirements close docking, a batch of production capacity can be taken out through exporting products. In the future, railways, highways, aviation, ports and other infrastructure construction will become the new breakthrough point for economic

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* Corresponding author. Tel.: 15652294753;
  E-mail address: tbp130402013@student.cumtb.edu.cn

development. Infra-structure construction and equipment manufacturing will also drive the iron and steel, non-ferrous, building materials and other energy-intensive products demand in the future, then pull the demand for coal, and alleviate the pressure of the domestic coal excess capacity [2].

With the continuous development of coal industry, the coal production safety has always been a key problem. In recent years, China's coal mine production safety situation improved year by year. The accident, death toll, one million tons mortality rates have fallen sharply, but there are still a certain gap compared with other main coal-producing countries in the world. Coal mining process are commonly affected by gas, coal dust, roof, water, fire and other hazards. In addition, low degree of informationization is the main factor to restrict coal production safety. At present coal mine informatization mainly exist the following problems: unbalanced development as a whole; Lack of reasonable development plan; Lack of necessary information and it is hard to realize the communication and data sharing; Innovation ability is insufficient, Big data and cloud intelligence is ignored; These problems directly restricts the development of the whole coal mine informatization.

2. Internet of Things

The concept of Internet of things was originally derived from the network of radio frequency identification (RFID) system by the automatic identification center which was established in Massachusetts institute of technology (MIT) in 1999. In this system, all the items can be connected to the Internet by radio frequency identification information such as sensing devices. And it is to realize intelligent identification and management. Its main function include:

- Information acquisition
- Information transmission
- Information processing
- Information apply-effect

In 2005, the ITU identified the "Internet of things" concept formally at the world summit on information society (WSIS) in Tunisia. And then the ITU Internet reports 2005 - the Internet of things which is released at this summit introduced the characteristics of the Internet of things, related technology, challenges and future market opportunities. In the report ITU pointed out that we are standing on the edge of a new era of communication. The target of information and communications technology (ICT) has been developed from satisfy the communication between people, to realize the connection between the people and things, things and objects. The ubiquitous Internet communication era is coming. The Internet of things make us in a world of information and communication technology. The connection of at any time, any place, to anyone, has been extended to connect any this, and that's Internet of things. The connection can be described in Fig1:
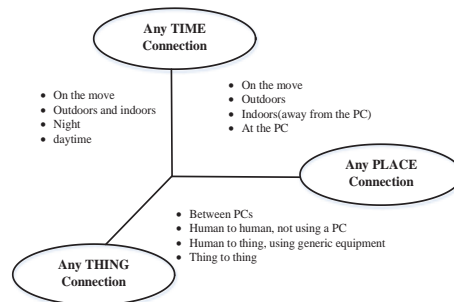

Fig. 1. The connection dimension of Internet of things.

Sensor network and detection technology is the premise and foundation of Internet technology, Internet of things perceive the whole world through all kinds of sensors and wireless sensor network. Sensor is the "sense organ" of the material world. It can sense the thermal, mechanical, optical, electrical, acoustic and displacement signals, and provide the most original information for the network system of processing, transmission, analysis and feedback. With the continuous development of science and technology, the traditional sensor is gradually realize the

miniaturization, intelligent, informatization and networking, and it is experiencing a development process from dumb sensor to smart sensor and embedded Web sensor [3].

The normal operation of large equipment (such as ventilator) is the foundation of the coal mine production. Coal mine Internet of things system needs to monitor all key main equipment production to establish archives for equipment repair and maintenance. The equipment in coal mine enterprises mostly used under harsh conditions, in addition, the main mechanical and electrical equipment's internal structure are complex, malfunction cannot be avoided after long time continuous operation. At present most of the coal mine enterprises adopt prevention of maintenance method to mine mechanical and electrical equipment management. But this way of maintenance is not targeted and it is easy to omit problems to cause potential safety hazard. Therefore it is of great significance to establish a set of mining equipment state monitoring and predictive maintenance system based on the technology of Internet of things to protect equipment's safe and efficient operation.

3. Predictive Maintenance System Design of Coal Equipment

System is mainly composed of equipment state monitoring station, coal mine monitoring center, re-mote predictive maintenance system. The system composition is as shown in Fig2 [4]. Monitoring station communicate with mine monitoring center by using wireless network and it doesn't need the mine network bandwidth. Mine monitoring center collect parameters information from the equipment monitoring sub-station, and connect to the remote predictive maintenance center through the wireless network or cable. Remote predictive maintenance center obtain the monitoring data by communicating with mine monitoring terminal, and the analysis results were sent to the database; Experts and technicians give evaluation and maintenance proposal through the obtained parameter values, and transmit them to the monitoring terminal in the form of statements through the network. Various related leaders or technical staff, as well as remote office staff, can log on to remote monitoring predictive maintenance center through the network, and check all equipment's current situation, historical record of the fault and maintenance record through the account and password.
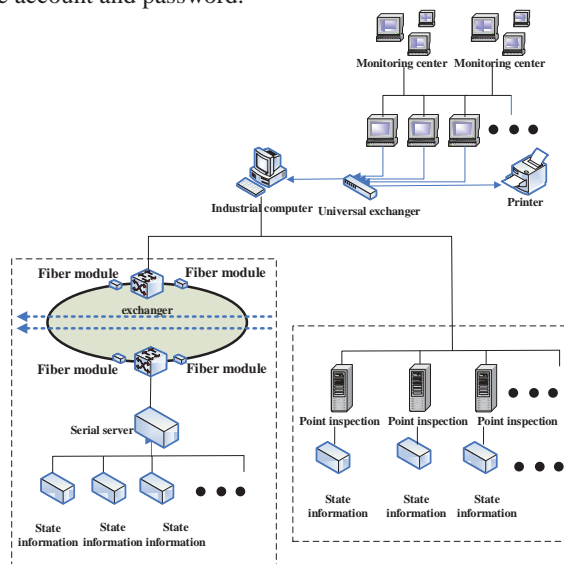

Fig. 2. System composition.

This research take the mine ventilator equipment condition monitoring system as an example. The sensors are distributed on the equipment, and the monitoring system is consist of data acquisition, data processing terminal, and wireless network transmission system [5]. The monitoring system is shown in Fig3.
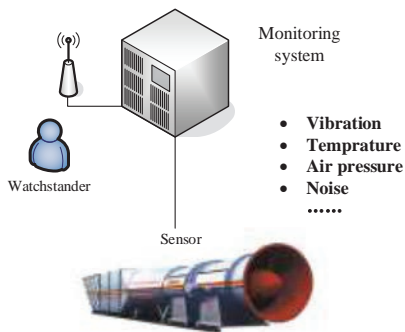
Fig. 3. Monitoring system.

Mine monitoring station is responsible for the acquisition of equipment operation parameters, and the parameter through the bureau, mine network transmission to mine monitoring terminal; Monitoring terminal is located in the coal mine dispatching center, where can display the real-time equipment operating condition, and the parameter will be transmitted to the remote health diagnosis center. Before that, we must set up wireless data transmission line. Mine monitoring terminal computers connect by the Internet access way. Terminal device also can connect the wireless access through the module equipped with [6]. The network structure is shown in Fig4:
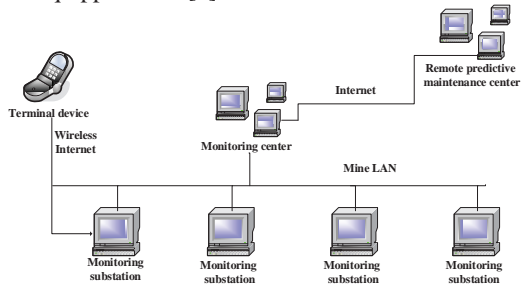

Fig. 4. Network structure.

Portable monitoring terminal can be a smart phone or a tablet and it is to realize the mobile office. The user can view all the equipment's operation status anytime and anywhere by the terminal device [7]. The function of monitoring terminal can be shown in Fig5:
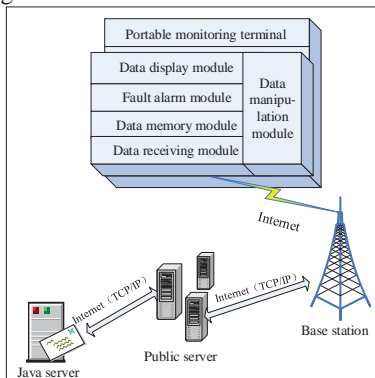

Fig. 5. Function of portable monitoring terminal.

4. Conclusion

Coal is still the main energy in our country. The stable and efficient operation of the mining equipment is the key to the safety of coal production. The coal equipment cannot avoid a series of problems due to the site conditions and continuously run for a long time. Traditional maintenance mode is difficult to find the failure accurately and timely in the early days. In recent years, the rapid development of Internet technology provides mining equipment maintenance mode for a new train of thought. To establish a set of mine equipment state monitoring and predictive maintenance system based on Internet of things technology can identify the fault and forecast the potential threat accurately, and it is of great significance for the safe and efficient operation of the coal equipment.

Acknowledgements

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