Discussion on Remote Monitoring and Fault Analysis Technology of Mechanical Manufacturing Equipment

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Abstract—Due to the interference of external factors, it is essential to adopt scientific and reasonable remote monitoring methods in mechanical manufacturing. Remote monitoring can ensure the efficiency of abnormal data acquisition, identify faults, improve equipment efficiency, save maintenance time, prolong service life, improve efficiency, and ensure the service life of machine production equipment. Therefore, it is necessary for the subordinate departments to effectively combine the actual situation and introduce some advanced technologies to effectively identify the remote controller and faults and ensure the regular and stable operation of the machine.

1. Introduction
As a significant development of the mechanical engineering industry, the remote control of mechanical engineering equipment shows apparent advantages in many fields, promoting managers to have a more convenient and efficient working style. Compared with traditional monitoring and management, the remote monitoring of mechanical manufacturing equipment breaks space limitations. Manufacturing equipment mainly includes procurement terminals and monitoring terminals [1][2]. Analyze the mechanical manufacturing equipment to obtain more detailed information about it, so it is necessary to ensure that the supervisor has a complete understanding of the mechanical equipment. Of course, the work of the terminal is not only about the manufacturing equipment but also about the changes in the surrounding environment of the mechanical manufacturing equipment, helping managers have a better control effect. The monitoring terminal mainly focuses on the specific work of managing and providing corresponding services [3]. Presenting all the data collected by the terminal in detail will also ensure that the management is finally effective through detailed analysis of the data. To maintain the stable operation of mechanical equipment, the relevant control work can also show substantial accuracy and applicability, and the procedure is more convenient and faster.

The development of mechanical equipment is usually large-scale, continuous and electromechanical integration, and the performance and complexity of its hardware system are also improving. Therefore, the fault problem of mechanical manufacturing equipment is becoming more and more prominent, and fault diagnosis technology has become more critical and complex. Although the standard diagnosis technology can meet the fault analysis and treatment, it can’t ensure the quality of equipment maintenance. Since the equipment is often in different positions, the problem of equipment maintenance becomes very urgent. Outdoor environment machinery is mainly the working environment of manufacturing equipment, which means that mechanical equipment is often affected by the external environment and weather factors in external processing and manufacturing. However, fault detection technology can’t realize resource sharing, so the necessary remote monitoring has become a meaningful way to improve the influence of mechanical manufacturing equipment. Remote monitoring of
mechanical manufacturing equipment can make the control of mechanical manufacturing equipment more convenient and efficient and reduce the working pressure of managers [4]. The use of fault diagnosis technology can improve error problems and reduce the formation of more severe faults.

2. Structure of remote monitoring and control system
Remote monitoring and control (M&C) systems are designed to control large or complex facilities such as factories, power plants, network operations centers, airports, and spacecraft, with some degree of automation. It receives data from sensors, telemetry streams, user inputs, and pre-programmed procedures. The software may send tele commands to actuators, computer systems, or other devices. M&C systems may perform closed-loop control [5][6]. The M&C system generally consists of an acquisition terminal, data transmission module, and monitoring & control terminal, as shown in Figure 1.

![Figure 1: The structure of the remote monitoring and control system](image)

2.1 Acquisition Terminal
The acquisition terminal is mainly responsible for collecting the machine manufacturing equipment from the field data and reporting the machine's operation status. The takeover model can be machined and manufactured on-site because the terminal will work the same environment as the machine manufacturing equipment. The acquisition terminal must perform two main tasks: one is to establish the connection between the company and machine manufacturing equipment, and the other is to establish the link between mechanical equipment and mechanical equipment control system. At the same time, there is an additional function related to the takeover terminal, which can realize mechanical fault analysis.

2.2 Data Transmission
Wireless transmission technology is composed of many sensor units with the characteristics of self-organization and multi-hop. As a neuron that humans perceive the real world, it can automatically sense, collect, process, analyze and transmit the state information of the sensed object. It will significantly enhance the communication and interaction capabilities between humans and the real world. With the scale, standardization, and low cost of digital circuits, wireless communications, and MEMS devices, wireless sensing technology will usher in a new round of leapfrog development in the field of intelligent monitoring, simplified, modular, adaptive, and highly integrated will be the main direction for the development of intelligent surveillance in the future.

2.3 Monitoring and Control Terminal
The monitoring terminal is divided into a remote monitoring terminal and a local monitoring terminal. The remote monitoring terminal is used to connect the monitoring equipment to the computer through
the Internet, while the local monitoring terminal is used to connect the monitoring equipment to the computer through the LAN and send it to workers or experts to solve the problem.

2.4 Diagnosis
When the mechanical equipment installed under the information acquisition equipment for fault acquisition, analysis, and transmission for some reason is detected to be unable to work normally, the information will be transmitted to the fault analysis system. After receiving the information, the fault analysis system will analyze and diagnose immediately, eliminate some causes, and obtain the specific causes of mechanical equipment faults. Remote diagnosis includes real-time diagnosis and email diagnosis. Due to these differences, the real-time diagnosis means that experts can discuss the diagnosis process through the network, draw broad diagnosis conclusions through real-time monitoring, and send the final results to the site through email. The data provided by email is transmitted back from the site by diagnostic experts. Based on their own experience, the accuracy of such results is relatively poor.

3. Remote Monitoring and Fault Identification Method
The running state monitoring and fault identification are two essential models of the M&C system. Figure 2 illustrates an M&C system of the machining tool. Generally, there are a series of technologies required to realize these two models. These technologies include database technology, transmission and compression technology, available diagnostic technology, virtual reality technology, artificial intelligence, and network technology [7].

![Figure 2: remote monitoring and control system of machine tool](image)

3.1 Database technology
Database technology stores the professional information and technology required for remote diagnosis on the website server to provide technical reference information for service personnel. When the mechanical manufacturing equipment is damaged, the maintenance personnel can detect the server keyword phenomenon and retrieve the data. The application methods are as follows. To meet the technical support of connecting DB Server, programmers need to place query scripts in HTML to query and obtain data. In addition, the server-side programming program can also ensure the connection between the database and it, such as PHP technology.
3.2 Transmission and compression technology
The remote tracking process and troubleshooting need a lot of data support. The data can be in the form of tables, text, images, video, and audio. Imagine that if there is no compression technology, too large files will affect the transmission rate, and the system's operation cost and energy consumption will be better. Therefore, data compression technology should ensure the authenticity and accuracy of data transmission, and the transmission technology is the basis to ensure effective data transmission. In practical work, we should ensure the efficiency and quality of network transmission and obtain the fault situation in time. Experience shows that the transmission effect is the best when the digital coding transmission rate is not less than 384kbs. Therefore, at this stage, an integrated digital network or particular railway network is usually used for transmission to ensure timely feedback in case of failure.

3.3 Open diagnostic technology
Traditional troubleshooting adopts an expert decision-making system with more vital reference sealing ability and is relatively conservative. The diagnosis system of the new era is transparent and can be remotely controlled and interacted with. The database covers a wide range of contents. Advanced technology and new technology are provided and maintained. In addition to professional programmers, industry experts, professionals and research experts are also involved. Comprehensive quality statements and successful experience make sure the fault diagnosis break through the space limit, realize the communication and interaction of all walks of life, and ensure that the diagnosis technology is open. The open diagnosis system is also interactive, from a kind of learning to two-way interaction, to improve the system's operation and ensure high quality and high efficiency.

3.4 Virtual Reality Technology
Virtual reality technology covers many fields such as Internet technology, multimedia technology, simulation technology, and sensor technology. It can solve practical problems by simulating the real world and having higher work efficiency when debugging and diagnosis. The main application methods of virtual reality technology are as follows. First, solid modeling. VR technology can conduct physical simulation and present the mechanical modeling of fixed equipment on the computer screen, convenient for detailed observation and in-depth research. The second is the equipment fault. The abnormal noise can be loaded into the online diagnosis system. The fault decision system can be made by analyzing the audio data to simulate at the end. Otherwise, the on-site disassembly is a waste of time.

3.5 Network technology
At present, the development of the market economy and science and technology will promote the development of large machinery manufacturing equipment. The structure and operation of the system will become more complex and diversified to ensure a more accurate fault diagnosis. Integrate network information technology into fault detection and strengthen resource allocation to develop a series of functions such as remote planning, control, and management. Use network technology to obtain necessary data and information in real-time to ensure a reasonable guarantee of equipment use. In addition, maintenance personnel should also develop advanced monitoring and diagnosis technology to pave the way for the progress of the production process. The network-based remote monitoring system has many functions, such as resource sharing, remote scheduling, expert diagnosis, dynamic expansion, etc. The equipment forms a central control platform, which can diagnose, monitor and adjust communication, data management and fault management. Therefore, the monitoring terminal must complete five functions, including mastering the operation mode of local equipment and storing historical information about the operation mode of local equipment. The equipment shall carry out fault diagnosis according to fault conditions and cooperate with specific personnel for fault diagnosis. To sum up, it can be said that if the equipment fails, the fallback channel will have problems. According to the instructions of the local server, if the error can’t be eliminated, it must be diagnosed in the error diagnosis center on the server-side. The error diagnosis center will determine the cause through the database and diagnostic analysis database and send the discrimination results to the problem-solving
3.6 Artificial intelligence technology

In the remote monitoring and troubleshooting of mechanical manufacturing equipment, intelligent technology has also become the critical content and the main direction of future research. Combined with artificial intelligence technology, remote monitoring and troubleshooting of machines used in specific applications can better understand management redundancy, directly complete some simple automation solutions and problem analysis, and put forward problem-solving strategies in time. The neural network is the most popular method in this field. The structure and work principle of it can be seen in Figure 3. Although the use of artificial intelligence technology has certain advantages, it is not perfect and needs further research.

![Figure 3: Structure (a) and work principle (b) of the neural network](image)

**4. Conclusion**

In a word, for the remote fault diagnosis of mechanical manufacturing equipment, an essential purpose of the popularization of computer technology is to ensure the safety of diagnosis information so that the diagnosis data is real, specific, and practical. Therefore, modern technology can break the limitations brought by traditional detection and diagnosis methods. It effectively reduces the scope of equipment faults and explores the causes of problems, monitors the equipment in real time, saves a lot of human resources, and provides fault information for employees in case of an abnormal condition. The machinery manufacturing industry should strengthen the modern investment in remote monitoring and diagnosis system and apply it scientifically to the work link to ensure the stability of production and operation. To better optimize the operation effect, we must be aware of the flexible application of appropriate technical means. Based on ensuring safety, with the help of virtual reality technology and artificial intelligence technology can better optimize the control activities of mechanical manufacturing equipment and transmit and use data information stably and safely.

**Reference**

[1] Wang Wei. Analysis on Remote Monitoring and Fault Diagnosis Technology of Mechanical Manufacturing Equipment [J]. Chemical Enterprise Management,2019(36):142-143.

[2] Wei Shanshan. Analysis of Remote Monitoring and Fault Diagnosis Technology of Mechanical Manufacturing Equipment [J].Scientific and Technological Innovation,2019(16):96-97.

[3] Ji Qiang. Analysis on Remote Monitoring and Fault Diagnosis Technology of Mechanical
[4] Meng Ke. Analysis of Remote Monitoring and Fault Diagnosis Technology of Mechanical Manufacturing Equipment [J]. Internal Combustion Engine and Parts, 2018(20):168-169.

[5] Zhu Rui, Ding Guobao, Yu Jie. Present Situation and Development of Mechanical Equipment Fault Diagnosis Technology [A]. Jilin Science and Technology Association. Give Play to the Supporting Role of Science and Technology and Further Promote Innovation and Development——Proceedings of The 8th Annual Conference of Science and Technology of Jilin Province [C]. Jilin Science and Technology Association: Academic Department of Jilin Science and Technology Association, 2014:3.

[6] Wang Binglin. Risk Assessment in Mechanical Manufacturing Process [A]. Tianjin Society of Electrical Engineering, Tianjin Electrotechnical Society. Proceedings of 2012 Academic Annual Meeting of Tianjin Society of Electrical Engineering [C]. Tianjin Society of Electrical Engineering, Tianjin Electrotechnical Society: China Electrotechnical Society, 2012:5.

[7] Zhou Xuan, Liang Liequan. Design and Implementation of Remote Monitoring and Fault Diagnosis System for Construction Machinery [A]. Technical Committee on Control Theory, Chinese Association of Automation. Proceedings of the 26th China Control Conference [C]. Technical Committee on Control Theory, Chinese Association of Automation, 2007:4.