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# Research and Design of Industrial Equipment Maintenance Management System Based on the Internet of Things

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***Abstract:*** With the continuous increase of industrial production scale, traditional industrial equipment management methods are no longer applicable to current industrial production. In this context, the application of industrial equipment management systems is in line with the current development trend of the industry. This article starts from the perspective of system design and implementation, and designs an industrial equipment maintenance and management system from the aspects of system architecture, system functional modules, etc. for practical application needs. By combining IoT technology with industrial equipment, real-time monitoring, intelligent diagnosis, predictive maintenance, and remote control functions are achieved, thereby achieving equipment health management.

***Keywords:*** Internet of Things; Industrial equipment maintenance management system; Health management

## Introduction

In recent years, with the continuous development and application of Internet of Things technology, new ideas and methods have been provided for the health management of industrial equipment. By real-time monitoring, data collection, and intelligent analysis of equipment, remote monitoring and predictive maintenance of equipment operation status can be achieved. This not only compensates for the errors and omissions of traditional management methods, but also improves equipment operation efficiency.

## 1. Advantages of the Internet of Things in Industrial Equipment Maintenance

The Internet of Things technology can collect real-time data on the operating status of industrial equipment through various sensors installed, and analyze this data in real time. It can timely detect abnormal situations during equipment operation and provide early warnings. At the same time, using AI algorithms such as expert systems, machine learning, deep learning, etc., to predict equipment failures greatly reduces the time and cost of equipment maintenance, in order to achieve the goal of predictive maintenance. In addition, IoT technology can also achieve remote maintenance functions. No matter where the devices are located, they can be operated remotely through network devices, solving the problem of time-consuming and labor-intensive manual inspections, thereby improving the core competitiveness of enterprises.

## 2. Design and implementation of an industrial equipment maintenance and management system based on the Internet of Things

The industrial equipment maintenance and management system designed in this article adopts a hierarchical system architecture, which is divided into four levels: equipment layer, transport layer, platform layer, and application layer.

### 2.1 Equipment layer

The device layer is the perception layer of the system, mainly responsible for the collection, processing, and transmission of sensor data. When designing, modularity, reliability, and scalability should be considered. In system design, the device layer can be divided into data acquisition module, data processing module, communication module, and device control module, with each module performing its own duties. The data acquisition module collects sensor data, and then the data processing module filters and samples the collected data. The communication module is responsible for transmitting the processed data to the transmission layer. Finally, the device control module is responsible for receiving control instructions from the platform layer and executing corresponding operations. The data exchange between the device layer and the platform layer adopts standardized communication protocols, such as MQTT, CoAP, etc. The device layer packages the collected data and sends it to the platform layer. After receiving the data, the platform layer unpacks, analyzes, and stores it; The platform layer can also send control instructions to the device layer, and the device layer executes corresponding operations after receiving the instructions.

## 2.2 Transport layer

In the system, the transport layer is responsible for transmitting and routing data between devices and servers. Usually, TCP/IP protocol stack is used to ensure reliable data transmission, real-time performance, and security. Among them, the transport layer mainly includes TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). TCP protocol is a connection oriented and reliable transport layer protocol. It establishes a connection through three handshakes to ensure the reliability of data transmission. The TCP protocol is suitable for scenarios that require high data reliability, such as device status monitoring, fault diagnosis, etc; The UDP protocol is a connectionless and unreliable transport layer protocol. It is mainly used in scenarios with high real-time requirements, such as voice and video transmission [3]. Therefore, it is necessary to flexibly choose TCP or UDP protocols according to actual needs to achieve efficient data transmission. At the same time, for scenarios where a large number of devices are connected, the transport layer should achieve load balancing to improve system performance and stability. The characteristics of both are shown in Table 1.

**Table 1 Characteristics of TCP and UDP protocols**

| protocol | characteristic |
|---|---|
| TCP | (1) Connection oriented: Establish connections before transmission to ensure orderly transmission and reliability;<br>(2) Flow control: Adopting a sliding window mechanism to control the sending speed of the sender;<br>(3) Congestion mechanism: Avoiding network congestion through mechanisms such as slow start and fast retransmission. |
| UDP | (1) No connection: Directly send data packets to reduce latency;<br>(2) Unreliability: Data loss, duplication, and other issues may occur during transmission;<br>(3) Real time performance: suitable for scenarios with high real-time requirements;<br>(4) Data packet size limit: suitable for scenarios with small amounts of data. |

## 2.3 Platform layer

The platform layer is the core of the system, including modules such as data collection and transmission, processing and storage, mining and analysis. It is responsible for integrating various device data, providing functions such as data processing, analysis, display, and control.

Firstly, the platform layer needs to have integration functionality. The data collected by sensors, PLCs, robots, and other devices will be transmitted in real-time to the platform through wired or wireless means. At the same time, in order to ensure the stability and security of data transmission, encryption technology and data technology should be used according to actual needs to improve the reliability of data transmission.

Secondly, the platform layer needs to have strong data processing capabilities. The data processing module preprocesses the collected data and stores it in the data center. Meanwhile, big data processing technologies such as Hadoop and Spark can be used to achieve distributed storage and processing of data. Generally speaking, using database technologies such as SQL and NoSQL to store and manage data can ensure data security and stability.

Thirdly, the platform layer should have data analysis and mining capabilities. In this process, it can be combined with AI algorithms to achieve a "1+1>2" effect. Through expert systems, it is possible to conduct in-depth analysis of the historical data of equipment, in order to discover the operational patterns and potential hazards of the equipment. At the same time, in order to ensure that data analysis and mining functions play their due role, machine learning algorithms can be used to gradually replace manual operations, which can largely avoid many unnecessary problems.

Fourthly, the platform layer needs to provide device control and optimization functions. In the platform layer, integration with third-party systems can be achieved through API interfaces. Integrate the enterprise's ERP system, equipment manufacturer's system, etc. with system software, and based on the analysis results, remotely control equipment, adjust equipment parameters, optimize equipment operation status, thereby achieving full lifecycle management of equipment.

Fifthly, a user-friendly interface can achieve twice the result with half the effort for operation and maintenance personnel. When designing, the user interface should be designed based on the principles of friendliness and simplicity. In practical applications, a user-friendly interface and simple usage process can enable operation and maintenance personnel to conveniently view device operation status, analyze reports, and perform device control. At the same time, to ensure system security and stability, security measures such as identity verification and permission control should be taken to ensure the safe operation of the system. In addition, it is necessary to regularly maintain and upgrade the system to adapt to constantly changing business needs.

## 2.4 Application layer

The application layer collects data during device operation (temperature, voltage, vibration, etc.) and analyzes and predicts the collected data in real time, thereby achieving real-time monitoring of device operation status. And through AI algorithms such as machine learning and expert systems, intelligent diagnosis of equipment faults is achieved by establishing training models and analyzing historical data. When a device malfunctions, the system can quickly locate and identify the fault, analyze the cause of the malfunction. At the same time, when the equipment operates abnormally, the system should be able to issue timely warnings to avoid large-scale production accidents caused by equipment failures. In addition, the application layer should support remote monitoring and maintenance functions. Enable operation and maintenance personnel to remotely connect devices through Windows, Android, and IOS systems, and implement real-time monitoring and control. When equipment malfunctions, maintenance personnel can promptly detect and take corresponding measures to control the scope of the fault and avoid significant losses caused by the malfunction. At the application layer, the system should provide tracking and management information for equipment maintenance to ensure effective execution of equipment maintenance work. At the same time, the system can also track and manage the maintenance status of equipment, provide online customer service functions, provide technical support and consulting services for maintenance personnel and users, and ensure the effective execution of equipment maintenance work.

## 3. Epilogue

By combining IoT technology with industrial equipment management, the problems in traditional equipment maintenance and management can be effectively solved. It can monitor the real-time operation status of equipment, predict and diagnose faults, and then automatically generate maintenance plans by the application layer, providing technical support for operation and maintenance personnel to achieve optimized resource allocation. However, in practical applications, the system still faces some challenges, such as excessive data volume, high computational time and hardware configuration requirements, resulting in high deployment costs and a lack of generalization. Future research can further optimize system performance, improve data processing speed and accuracy, expand system applicability, and meet the needs of different industrial scenarios. At the same time, the deep integration of AI, big data and other technologies with IoT technology can achieve high-level development of system intelligence, automation, and digitization, providing strong technical support for the development of China's industry.

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