Research and Design of Data Acquisition and Monitoring System for Intelligent Production Line of Prefabricated Building Components

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Abstract. In order to solve the intelligent production and management level of assembly parts and components production line, a data acquisition and monitoring system scheme is designed to collect key parameters in the product production process, such as vibration strength (amplitude) information, concrete weight information, temperature information, humidity information, energy and other data. The scheme can realize the functions of on-site data display and processing, dynamic monitoring of equipment status and so on.

1. Introduction
Prefabricated building is a kind of building construction method, which divides the whole building into parts, standardizes and automates in the factory, produces on the assembly line, and then assembles on the construction site. The production line adopts modern industrial practice, and the working mold is the key problems including production process data and quality related data basically are recorded manually circulated to realize the mass production of residential prefabricated components.

At present, there is no production monitoring and production management system in the production workshop. The key problems include production process data and quality related data basically recorded manually, which is not timely, accurate and incomplete. For orders, the delivery date cannot be accurately estimated. The management is unable to timely and accurately grasp the production situation, analyze and master the production line capacity, and effectively control the product quality.

With the gradual improvement of the automation and intelligence level of China's manufacturing enterprises, modern industrial production is gradually entering the era of automatic control. Data, as the basis of the manufacturing process, is very important to collect and monitor all kinds of data information generated in real time in the manufacturing site [1-2].

In view of this, the scheme of data acquisition and monitoring system for intelligent production line of prefabricated building parts (PC) is studied and designed, which can realize the following functions. One is to collect the equipment data of the production line. The second is the display and processing of field data. The third is to dynamically monitor the equipment status of the production line. Fourth, the information system is used to manage the storage and access of data. Fifth, it is the interface requirements for data interaction between PC production line system and MES system after realizing information management.

2. Key supporting technologies of the system
The intelligent factory monitoring system for prefabricated building components uses a variety of modern advanced technologies such as information technology, automation technology, Internet
technology, cloud computing technology and big data mining technology. It uses data acquisition, equipment monitoring, data transmission, equipment and other means to network all parts of the automatic production line of prefabricated components. It can collect the data generated in production in real time, fully master the manufacturing process data. It can analyze, predict and solve the abnormal conditions that occur or may occur in the production process. Meanwhile, it can realize the fine, information and intelligent management of remote control, and achieve a high degree of automation in the component production process.

2.1 Configuration software platform technology
SCADA (supervisory control and data acquisition) configuration software can realize data acquisition function and monitoring control. A software development environment usually used in the monitoring layer of automatic control system. Through the flexible use of configuration mode, the monitoring function of industrial automatic control can be realized. And the construction efficiency of the system is very high. It is a universal and hierarchical software tool. From the application level, configuration software is widely used, including manufacturing, construction and other fields. The functions provided include real-time database, real-time control, networking, communication, opening of data interface and support of I/O (input and output) equipment. The monitoring includes monitoring and control. With the help of computer signal transmission and reception, it can complete the monitoring, control and related management functions of automatic equipment or process.

2.2 Real time database technology
The main data in the industrial real-time database is the process data from various production equipment. These data are time series data. The database composed of such time series data is usually called time series database in academia. Different from the traditional relational database, time series database needs to deal with the data flow composed of thousands of variables and variable data with time stamp. Each data stream is identified and indexed by variable ID and timestamp, while variable data is usually not indexed.

3. Functional requirements analysis of PC production line
At present, the process flow of the physical production line mainly includes formwork cleaning, formwork erection, reinforcement placement, concrete pouring and other processes. The specific process is shown in Figure 1.

![Figure 1. process flow diagram of PC production line](image_url)

The system equipment of the production line can only be controlled manually through the station, and the real-time condition monitoring of the equipment in the whole process of the production line cannot be carried out. In order to realize intelligent production, combined with the key parameters of the production line, this paper mainly collects and monitors the mold position information, vibration strength (amplitude) information, concrete weight information, temperature information, humidity information, energy data, maintenance time, traveling speed of the distributor, storage and logistics information of parts and components of the production line.
4. Functional requirements analysis of PC intelligent production line
The upper computer communicates with Siemens S7-200 PLC through industrial Ethernet to collect station operation status, fault, operation data, etc. It can display the status and fault data in real time, analyze the collected data and generate reports. At the same time, it can collect vibration strength (amplitude) information, temperature information, humidity information and energy data, build an automatic production line monitoring system, and integrate it with MES system to realize the remote control of intelligent equipment [3-4].

4.1 Data acquisition function
The information and data to be collected include operation status, fault, operation data, etc. The operation status includes the line body and station operation status (line stop, operation, call, alarm), etc. The operation data includes vibration strength (amplitude) information, temperature information, humidity information, energy data, etc.

4.2 Data storage function
The data collected from PLC shall be fully recorded, backed up and solidified to ensure data traceability and verification; The data in the database shall be stored in the appropriate data format, and the text format shall not be used to store the mismatched data such as numbers, floating point numbers and binary. The data storage format shall be properly designed according to the actual needs of the data, so as to facilitate the report summary and data analysis in the future.

The data record in the database shall have a complete data header to facilitate the rapid query, sorting, verification and complex data processing of the data. The data header of the database record shall at least include: data record serial number, data record writing date and time, and data record receiving date and time.

4.3 Data communication function
It needs to build industrial Ethernet, and the field control layer and monitoring management layer, which form a unified information platform through industrial Ethernet networking.

5. Intelligent production line scheme design
The main contents are shown in Figure 2 [5-7].

5.1 Build industrial Ethernet
The industrial computer and IOT gateway equipment are connected through Ethernet and Modbus/485 network. The IOT gateway equipment realizes 485/Modbus to Ethernet and is responsible for message forwarding.

The industrial Internet of things network adopts industrial Ethernet to realize the communication
among equipment layer, control layer and management layer. According to the process environment, the combination of wired LAN and wireless LAN is adopted to form the basic industrial network. Industrial Ethernet is a fully open and digital network. According to the network protocol, the equipment of different manufacturers can easily realize interconnection. For RS-232/485/422 serial port equipment, it is necessary to configure serial port server. So that the serial port equipment can also have networking function, realize two-way data transmission between RS-232/485/422 serial port and TCP/IP network interface, and realize automatic acquisition of vibration strength (amplitude) information, temperature information, humidity information and energy source data.

5.2 Data acquisition
The industrial computer communicates with the PLC through TCP IPv4 and Internet of things gateway. Using S7 communication protocol, the industrial computer sends a message to the Internet of things gateway, which forwards the message to the PLC through TCP IPv4 connection, and forwards the PLC response message to the server through TCP IPv6 connection.

After the second handshake between the server and PLC is successful, it can send read or write messages to interact with PLC. The server will collect the operation status, fault, production data and other information of the line body and station. The server can be integrated with MES system to realize remote control of intelligent equipment. The workflow is shown in Figure 3.

![Figure3. work flow chart](image)

The vibration strength (amplitude) information, temperature information, humidity information and energy data are converted into Ethernet protocol through the Internet of things gateway, connected to the industrial switch and uploaded to the industrial control computer to realize data storage and display.

5.3 Analysis report
It can make statistics on the collected production data and fault information, generate reports, and support export.

5.4 Remote monitoring platform
It can build a remote monitoring platform for the intelligent production line of prefabricated building parts, realize data storage and visualization, and integrate with MES system to realize the remote control of intelligent equipment of automatic production line.
6. Conclusion

Based on the analysis of the process and key technologies of the production line of fabricated building parts, this paper puts forward a scheme of on-line data acquisition technology and monitoring system for the intelligent production line. The implementation of this scheme can realize the acquisition of key parameters, such as vibration strength (amplitude) information, temperature information, humidity information, energy and so on, and realize the display and processing of field data and dynamic monitoring of equipment status. Thus, it can improve the intelligent production level and management level of PC production line.

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