Design and analysis of DNC production data acquisition and monitoring system

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Abstract. The DNC production data acquisition system is designed based on TCP/IP protocol, which is responsible for monitoring the data of the single state of machine tool production and collecting production and processing information. In this paper, we analyze the design of a DNC production data collection and monitoring system. The first step is to design the framework of the entire system, then propose an implementation method to exchange client and server data and combine it with a network connection, and design a data request program for server and client. Optimized server-side data collection patterns were upgraded to ensure that clients could parse log information more efficiently.

1. Introduction
In recent years, China has widely promoted the DNC production data acquisition system, so that the level of industrial production automation continues to improve. The level of enterprise information technology has been continuously improved, and DNC technology has been further developed. In the early days, DNC technology was used mainly to deal with communication problems, allowing two-way transmission of parameters such as computer and machine program, centralized calendar program, and continuous improvement of production and processing efficiency. Modern industrial production companies are using network DNCs extensively in order to focus on solving communication transmission problems, and in this case higher requirements are proposed to meet the needs of industrial information production management. The processing site guarantees the efficiency of data collection for statistical analysis. Through the design of the overall software system architecture, server side, database side and client side, the design and implementation of the entire DNC production data acquisition system is completed.

2. Design of the overall framework of the system
Networked DNC production data collection and monitoring systems use sockets to set up client-server systems, and the server side is set up on the machine side to monitor machine status [1]. The server is able to accept client requests and send relevant data. Finally, the main function of the client to send relevant alarm information is, on the one hand, to reflect machine status information and to receive alarm information. Those responsible are to be notified promptly. Receives and records information about production and can transfer machine log files.

In general, the PC as a client mainly implements the three main functions of communication and data logging and monitoring, while the communication part is mainly responsible for receiving and
monitoring alarm signals and processing data and log data. The back-office data logging department mainly records relevant information, and the monitoring function must visually display the machine's machining status [2]. The intermediate connection section can provide basic network support, establish a local area network at the processing site, use TCP/IP protocol to transfer data, set up the network port for advanced machine tools directly, use the custom asynchronous serial server, can be based on the TCP/IP protocol network communication to achieve traditional equipment networking. Its overall system architecture design is shown in Figure 1.

![Design of the overall project structure summary diagram.](image)

**Figure 1.** Design of the overall project structure summary diagram.

### 3. Server-side design

During the service of the device MMC, the data of the terminal is monitored using the server side, connected to the PC via socket communication, the data between the MMC and the device PLC controller is passed using the Windows standard data exchange protocol, and the device status data is collected using DDE.

In order to transfer data more efficiently, it is possible to classify data according to its status, and different data types are linked in different ways. For tool adjustment and alarm information can be classified as dynamic high frequency data, the DDE client server can establish dynamic links to update data information in a timely manner and improve the real-time performance of data transmission. CNC system information is static information, and it is necessary to establish cold links to achieve a single output of information [3].

Implement socket communication, using proactive notification and request acceptance methods to establish shared data areas and provide optimized services. The monitoring PC client can send a request for static information data about the device, and the MMC server can send public data to the client when it receives the request. If the static information for that area or device status data changes, the DDE server can actively track the new data and send a notification to the DDE client. In contrast to the DDE client, dynamic data can be stored in public data, and the socket part can make use of this data.

In the socket communication part of the design process, automatically created thread patterns can be established by socket requests on the PC side. In addition, through the multi-point monitoring PC side of the monitoring device can effectively obtain the status data of the public data area, reduce the service burden on the device side of the service, improve the network communication transmission efficiency, realize the data acquisition, exchange and monitoring management efficiency optimization improvement. The DDE client forms communication with DDE-SERVER and collects the communication session data. The data is then stored in the data structure of the shared data area to initialize the DDE, and then a dynamic link is established through the second line to get the static data, and the first line is used to send the static data into the shared data structure [4]. Then use the second line, using the DDE callback function to handle the dynamic link part. Its server-side internal communication schematic is shown in Figure 2.
In the figure, the socket part is responsible for transmitting network data, listening to the PC socket command signal, during the device alarm, the socket part can send an alarm signal to the PC side, after obtaining the data of the shared data area, and send the data. The DDE client part and the socket part are formed together to improve the device side services, so as to complete the server side design work.

4. Database form design
Based on the company’s existing database and the utility of choosing a Microsoft SQL Server database, the premise of building a database form is to give properties and meaning to the fields, and the form has only a unique primary key identification to associate other forms containing its primary key data, the database form and the form connection is achieved through the primary key. According to the database form design specification, we created a database form to store data collected from CNC machines.

4.1. Machine status table design
First, the database stores a large amount of collected equipment data information, which contains data such as shop machine ID, name, machine status, program name, equipment yield, equipment current status start time, machining feed value, spindle speed, alarm information, etc. These data are stored in different tables, all of which are associated with the machine ID as the primary key, and the start time and status information of the machine can be extracted for statistical information about the machine operating status and operating parameters. The keywords in the machine parameter data table MA_STATUS are shown in Table 1 below.

| field name     | Description          | Field type  | primary key |
|----------------|----------------------|-------------|-------------|
| MAC_NBR        | Machine ID           | varchar     | Y           |
| STATUS_ID      | Machine Status ID    | int         | N           |
| StatusStartTime| Status start time    | datetime    | N           |
| FEEDSPEED      | feed value           | double      | N           |
| SPINDLESPEED   | Spindle speed        | double      | N           |
| PROGRAM        | program name         | String      | N           |
4.2. Machine yield information table design

CNC machine tool production table MAC_YIELD primary key field for the device ID, mainly statistics of the machine tool equipment production count and other information for statistics, as well as the current state start time, current state program name, production count description and other information. The table also uses the machine ID as the primary key to identify a fault alarm machine, and some of the fields in the table are shown in Table 2.

| field name          | Description     | Field type | primary key |
|---------------------|-----------------|------------|-------------|
| ID                  | Machine number  | varchar    | Y           |
| StatusStartTime     | Status start time | datetime  | Y           |
| PROGRAM_NAME        | program name    | String     | N           |
| PROGRAM_COUNTER     | yield           | varchar    | N           |

4.3. Machine tool alarm information table design

MA_ALARM table is mainly to summarize the alarm information of the machine tool, such as the current alarm information, alarm time, etc. MA_ALARM table also uses the ID of the machine tool as the primary key to identify a fault alarm machine, because the CNC machine itself comes with a lot of alarm content and will store these data database, some fields of the table is shown in Table 3 below.

| field name          | Description     | Field type | primary key |
|---------------------|-----------------|------------|-------------|
| WARNING_CODE        | Alarm number    | varchar    | Y           |
| StatusStartime      | Alarm start time | datetime  | N           |
| StatusEndTime       | End time of alarm | datetime | N           |
| ALARMNUMS           | Number of alarms | int       | N           |
| ALARM TATU          | Alarm Description | varchar | N           |

5. Design of the client

When the client is set up to monitor the application system on the PC side, and then connected through the socket communication on the device side, it can cope with network transmission problems and achieve log storage of data and log files. The monitoring unit reflects the production status of the machine through an intuitive interface. During data processing, data log files need to be written to the data server, which can be utilized by the statistical analysis distribution. Data acquisition is very important, first of all to set the parameters of the equipment, the equipment can generate log information, such as the time and alarm time of operations such as machine tools and machining, etc [5]. Which are of high value in the statistical analysis department. Based on the user's needs, personalized configuration information logging types, based on the final improvement of the program, set up equipment to absorb relevant parameters, use the network to extract log information at regular intervals, and then the subsequent processing of the information obtained, good marking.

Data parsing is implemented primarily to separate log information into data segments that can be stored in a server database and used in statistical analysis departments [6]. Provide different algorithm schemes in combination with user requirements, take out the information of the txt text file item by item, transform different data types, transform time strings. In the end, the data is stored in a database, and the system of production data collection and monitoring system in the network DNC can provide an interface, which can be written to the data during the system integration, and the data can be used in the statistical analysis system query process. Network DNC in production data acquisition and monitoring system can process and operate a variety of state information, realize multi-point monitoring scraping, improve the fluency of the data transmission process, enhance the real-time and stability of enterprise debugging.
6. Conclusion

In the production data collection and monitoring system of network DNC, the monitoring management and data collection work is very important, so that the company's information technology level can be further improved. By using standard data exchange protocols to monitor the status of production equipment, it is possible to collect information and data about the production process and rely on these accurate and reliable data for statistical analysis to achieve "transparency" of the production process.

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