

The Research of Communication Technique between Host Computer and PLC in Automatic Assembly Equipment for Blood Taking Needle

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Abstract

In the automatic production equipment control system, the industrial configuration software is usually used to develop the host computer system; PLC is used as the lower level control equipment. However, with the rise of industrial Ethernet, compared to the configuration software, the advanced programming language is more suitable for the development of the host computer system, which has real-time response, rich functions, easy to expand, good flexibility and other technical requirements. The automatic blood taking needle production equipment will place 7 parts on the periphery can be fed separately, the 8 major processes to form the 8 modules. In order to achieve the same production efficiency, all the elements that affect the efficiency of the machine must be excluded to ensure the normal operation of the information interaction between the equipment. Therefore, it is necessary to find a way to make use of the advanced programming language to develop the host computer system, which can use industrial Ethernet to communicate with PLC. This project adopts industrial Ethernet technology, SIEMENS S7-300 PLC as the bottom control device. The method of Ethernet communication between two kinds of host computer is analyzed: One is by calling the PRODAVE software library to achieve data interaction; the other is to use the FB function block in PLC to realize the Ethernet open communication. Through the comparison and analysis of experimental data, using the PRODAVE software library method is suitable for the automatic control system of the design of this project, and Ethernet open communication method is more suitable for large multi-unit automation control system.

Keywords

Industrial Ethernet; PRODAVE; open communication; host computer; PLC.

1. Introduction

With the development of automation technology, it is possible to Large-Scale and mass production. In order to improve production efficiency and product quality, more and more manufacturers need to introduce automatic production equipment. In the automatic production equipment, the upper computer needs to carry on the real-time data acquisition and control to the bottom equipment. Because of the advantages of high transmission rate and strong compatibility, industrial Ethernet can ensure the fast and accurate data communication in the control system.

At present, in the automatic production equipment control system, we usually use the professional control configuration software to develop the host computer program, and the common configuration software is iFix, InTouch and WinCC, etc..Although the configuration software through continuous improvement has been compiled with the C language program block and call the VBS and VBA script functions, but the configuration software development environment is relatively closed, poor flexibility, communication speed is slow, and not like a high-level programming language that can flexibly and conveniently utilize all kinds of resources to write computer programs with a variety of functions. In order to overcome these defects, it is necessary to find a way to use the industrial Ethernet for data communication with PLC.

This project adopts industrial Ethernet technology, SIEMENS S7-300 PLC as the bottom control device. The method of Ethernet communication between two kinds of host computer is analyzed: One is by calling the PRODAVE software library to achieve data interaction; the other is to use the FB

function block in PLC to realize the Ethernet open communication. Based on the test results, PRODAVE is selected as the host computer communication method.

2. PRODAVE Software Function Library and Open Communication Method for Industrial Ethernet

PRODAVE software is developed by SIEMENS and is a direct tool for data communication between a host computer and S7-series PLC. It actually provides a dynamic link library DLL or LBI function to the Windows system, so it also supports VB.NET, C++, Python and other programming languages. The user simply calls the function in the dynamic link library, and then can achieve the upper computer and PLC data interaction. It is very convenient.

The principle of open communication is to call the existing FB program block in the PLC program, set up the relevant communication parameters. The communication adopts Self-defined-protocol to achieve the purpose of the upper computer controlling the lower computer. The called FB program block includes the building communication connection FB65 "TCON" module, the ending communication connection FB66 "TDISCON" module, the sending data FB63 "TSEND" module and the receiving data FB64 "TRCV" module. Compared to NetPro communication, the open communication provides a dynamic connection. PLC can increase or decrease the number of communication connections at any time without interrupting CPU operation that ensures the optimization of communication resources and system stability.

3. Experimental Comparison of Open Communication between PRODAVE Software Library and Industrial Ethernet

Their network traffic of the two communication methods are tested in the actual model. The data communication between the test system and the two S7-300 PLC is done by calling the PRODAVE software function library and the open communication mode of the industrial network. The test system sends a command to a PLC pro 10s, the length of the command is different from the method. The test time is 120s. In addition, when using the PRODAVE software function library method to test, the host computer program is added a 100ms timer for real-time scanning PLC to achieve data.

Figure 1 is the connection diagram of the experimental system; Figure 2 is the network data-flow comparison diagram by calling PRODAVE software function library method and the use of open communication method. The ordinate of the chart is the number of packets.

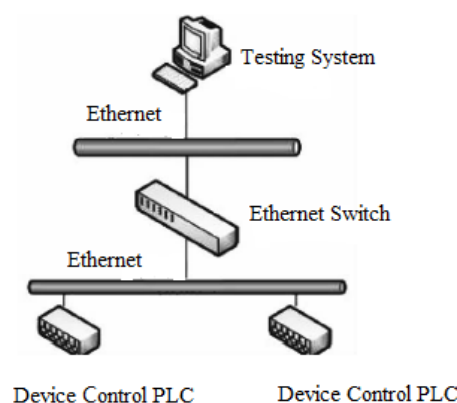


Figure 1 connection diagram of the experimental system

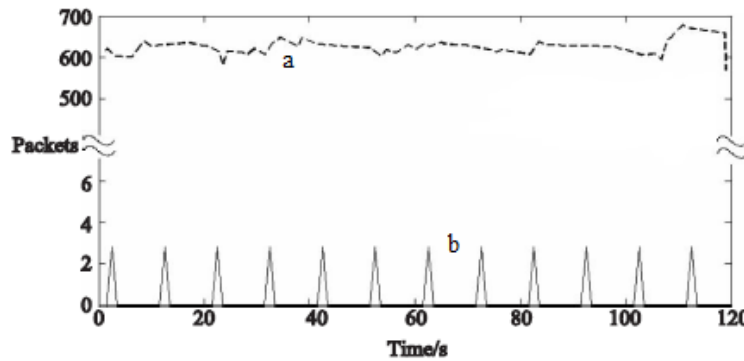


Figure 2 network data-flow comparison diagrams
 a. ---- PRODAVE software function library method
 b. ----- open communication method

As can be seen in Figure 2, it will be caused because of calling the PRODAVE software function library, that PLC abandons the function of active informing the host machine that data has changed, only passively accepts the reading and writing data. In order to ensure the reliability and real-time of the system, it is necessary to set a timer with a short period in the host computer program, which constantly scans and detects whether the data block has changed in PLC. Therefore, network data traffic always remains at about 650 packets/s, which cannot occur in such a large network traffic to send data to the PLC pro 10s. Open Ethernet communication method have data interaction between the host computer and the PLC only when needed, no longer like calling PRODAVE library software that frequently accesses to the PLC. Therefore, when the host sends data to the PLC, the network data traffic will appear a peak, and does not generate network traffic in the rest of the time. The open Ethernet communication method can effectively reduce the network load and optimize the running environment of the system.

The difference between the above two methods is showed in the table 1. Users do not need to consider the complex communication protocol between the host computer and the PLC communication, and the details in the use of PRODAVE software library method, only need to consider the upper function correct calling to realize data exchange and processing between PC and PLC. However, the method of calling PRODAVE software function library does not support multithread concurrent processing, and has a certain influence on the real-time data processing. Through the use of open communication method, the host computer needs not install additional software, and supports multiple concurrent processing of PLC data, higher real-time performance. However, the upper computer needs to establish the corresponding protocol with PLC, which increases the complexity of programming and increases the development cycle of the system.

Table 1. Comparison of calling PRODAVE software function library and open communication

Name	Network load	Multiple PLC connections	Real-time	Development speed	Method
calling PRODAVE software function library	big	one at a time	good	faster	simple
Ethernet open communication	small	concurrent processing	better	fast	complex

4. Establishing Communication by Calling the PRODAVE Software Library with PLC

The function of PRODAVE software can be divided into basic function, data processing function and telephone service function. When communication, the host computer mainly calls these basic functions, for example the LoadConnection_ex6, UnloadConnection_ex6, field_read, filed _ write

_ex6, mb_setbit_ex6, mb_bittest_ex6. LoadConnection_ex6 and UnloadConnection_ex6 functions are used to establish or disconnect the connection with the PLC. Field_read_ex6 and field_write_ex6 functions read and write bytes to the DB block in the PLC. Mb_setbit_ex6 and mb_bittest_ex6 functions make reading and writing operations on the bit memory in the PLC. By the following VB.NET programming language are shown the steps to achieve TCP/IP communication.

(1) In the host computer program, they must be first declared before calling the required above functions, such as:

Declare Function LoadConnection_ex6 Lib "Prodave6.dll" (ByVal ConNr As Short, ByVal AccessPoint As String, ByVal ConTableLen As Short, ByVal pConTable As CON_ TABLE _TYPE) As Integer

After calling the LoadConnection function to establish the connection with the PLC, man can read and write the data blocks to PLC by calling field_read_ex6, filed_write_ex6, mb_setbit_ex6, mb_bittest_ex6 and other functions.

(2) In the process of calling a function, you need to set the correct parameters, such as the function of reading bit memory:

mb_bittest_ex6(MBNo, BitNo, pReadBuffer)

The first parameter MBNo expresses the number of bits memory, the second parameter BitNo indicates the location of the bits memory, the third parameter pReadBuffer is the desired value from PLC after positioning according to the first and two parameters. Each function after calling has a return value to detect whether the function is normal. When the return value is 0, it indicates that the function is running normally. When the return value is a non 0 value, it indicates that the function is running at an error. The specific error information can view the err file under the root directory of PRODAVE software, or the error information is also displayed by calling the GetErrorMessage_ex6 function of PRODAVE software.

(3) Using mb_bittest_ex6 function can read the values of the PLC bits memory. The program segment is as follows.

Function ReadBitMemory_fromPLC(ByVal MBNo As Integer, ByVal BitNo As Integer) As Byte

Dim pReadBuffer As Byte

Dim ret As Integer

ret = mb_bittest_ex6(MBNo, BitNo, pReadBuffer)

If ret = 0 Then

Return pReadBuffer

Else

Msgbox("Error")

End If

End Function

(4) The program segment that handles the values obtained from the PLC bits memory in the host computer is as follows. The incoming parameter indicates that the first bit is took out from the bit memory 300.

If ReadBitMemory_fromLinePLC(300, 1) = 1 Then

Msgbox("The value you want is true. ")

ElseIf ReadBitMemory_fromLinePLC(300, 1) = 0 Then

Msgbox("The value you want is false. ")

End If

In figure 3 is shown the specific programming ideas of calling to the PRODAVE software function library, and the scheduling system has included the functions of PRODAVE. The scheduling system

is divided into two parts, the first part deals with the data communication from the database, other host computer programs, and the lower IPC; the second part is used to interact data with the lower PLC. Because the PLC cannot actively inform the host computer its own data changes, so only a timer is added to read the PLC data in the scheduling system. Whenever the timer triggers program, let it read the data of the lower PLC. This method is similar to the loop statement, by constantly scanning the data of the lower PLC to achieve the rapid response to the lower state and real-time control. When writing data to the PLC memory module, it is very probable that the data can not be written into the system for some reasons. In order to increase the robustness of the system, the detection mechanism and the multiple write function are added in the system.

It should be noted that, PRODAVE cannot be concurrent processing of multiple PLC data exchange. Therefore, in programming, we must assign a connection number to each PLC, and need to deal with switch problems between PLCs.

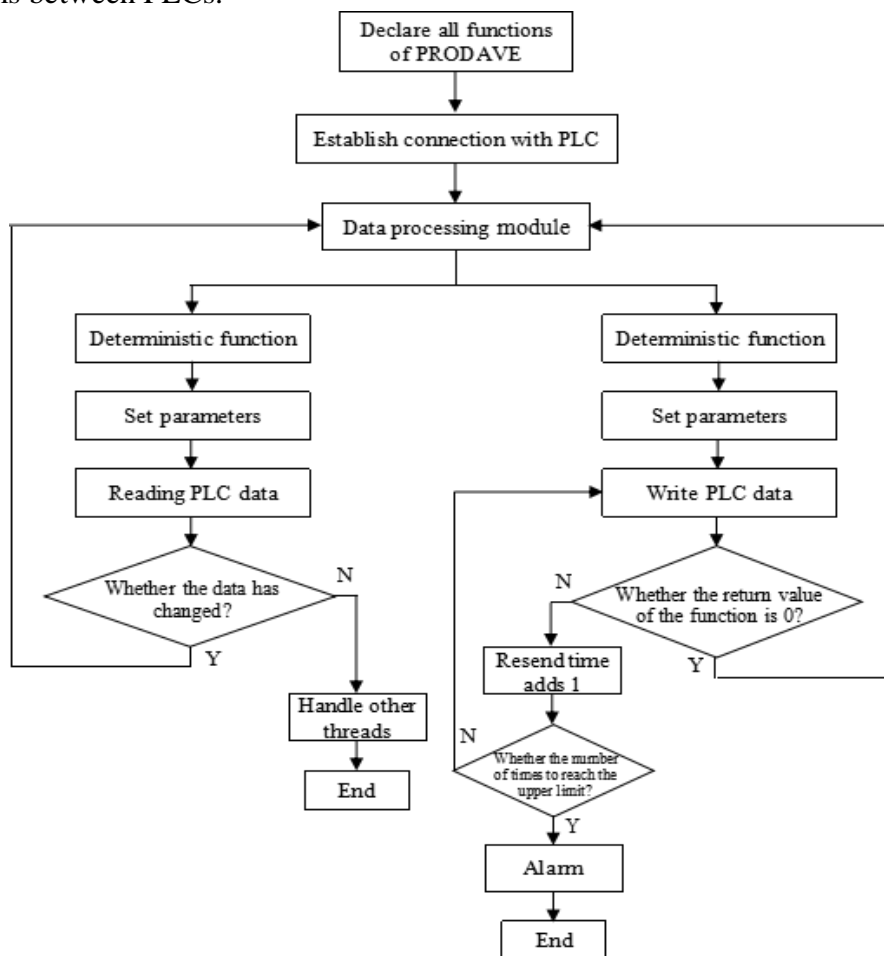


Figure 3. Flow chart of calling PRODAVE software library

5. Field Operation

Figure 4 is the overall architecture of the automatic assembly equipment control system that has been implemented in this project. Between the upper computer system and the lower computer system is adopted the communication mode of the industrial Ethernet, and the slave computer system realizes the control of the production line through the field control module.

The upper computer system is composed of upper management software, production scheduling control software and data storage software. The upper management software includes system-state monitoring module, historical-data query module and system-parameter setting module. The system-state monitoring module can monitor the states of the all production line, and real-time display the specific location of products in the production line, also understand the production status and the next step process through querying data storage system. The historical-data query module is used to query

and process the historical data of the product, and can generate the various visual charts of the historical data, and the required data can be exported into EXCEL files and printed. According to different production requirements, the system-parameter setting module can dynamically set the parameters of the production line, and can also shield some functional parts of the production line according to the field situation. The system-state monitoring module and the historical-data query module can be used by the field operator, and the system-parameter setting module can only be used by engineers with high level of authority.

The core of the whole control system is composed of data storage software and production scheduling control software. The data storage software stores the historical data of the product and the related production process steps; the production-scheduling control software controls the operation of the whole production line. The data-storage software and production scheduling control software have complex optimization algorithm and control mode. In the lower computer system, the function of product bar code and process binding module is writing the product number and production technology into the data storage system, to control and record the production data. No successful-entry products will be regarded as illegal products, and will be exited by the product-exit module, and prompted the reentry information. The finished-product sub-file module is responsible for the classification and sub file of the products after the completion of all the processing technology.

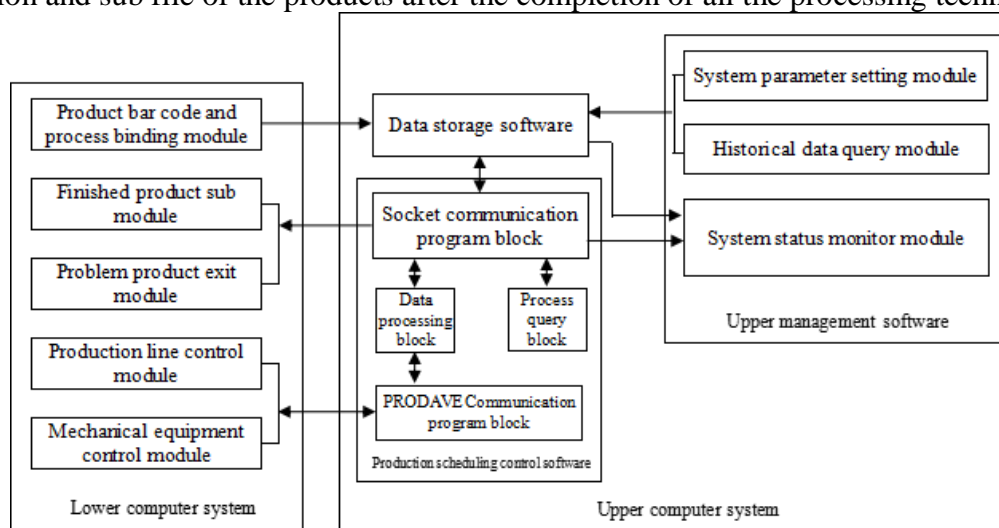


Figure 4. Design model of automatic production equipment control system

6. Conclusion

This paper discusses the communication method between two kinds of host computer system and lower PLC in the control system of automatic production equipment. Through the experiment and comparison, we can see that the two methods have their own characteristics and practical value. The method of calling PRODAVE software function library is easy to use, the development cycle is short, but the network load is large. Therefore, it is suitable for medium or small sized automatic control system. This project uses the communication method to achieve a very good practical purpose.

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