Design of Monitoring Control System Based on MODBUS for Transformer Measurement Equipment

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***Abstract*—To meet the demands of the transformer measurement equipment, it is necessary to need monitoring control system to control, display the characteristics of the testing transformer. The function of monitoring control system is to control the transformer measurement equipment which is mainly consisted of STM32F103RBT6(32-bit high-performance ARM core microcontroller), to test the characteristics of transformer , to save key data in data base and display them in form of picture .To realize this monitoring control system, the software VC6.0 and Microsoft Access are combined to program this system. By this system, tester can know about the characteristics of the testing transformer and judge whether it is qualified or not.**

Keywords-monitoring control; DLL;MODBUS; transformer

I. INTRODUCTION

The monitoring control system[1] is the host computer which is real-time monitoring of the parameters of the lower computer or slave computer. The purpose is for testers to make right judgments adjust to the specific situation. The design is including visual interface design, MODBUS[2-4] serial port communication, data sampling, database saving and picture drawing. It calls the serial communication DLL for the simplicity of the program. The slave computer(STM32F103RBT6)will transmit the data including the value of current and voltage to the monitoring control system, then the picture of characteristics of testing transformer is displayed and the data are saved in Access.

Transformer measurement equipment is used to test the characteristics of molded, frame and electrical transformer. In order to meet the requirements for visualization of testing transformer's characteristics, software VC6.0 is used to program. The protocol MODBUS is adopted to ensure the data form slave computer(STM32F103RBT6) transmit to the monitoring control system correctly and make the monitoring control system control sends commands to the slave computer(STM32F103RBT6) rightly.

II. TECHNICAL WORK PREPARATION

A. The serial communication DLL

The serial communication technology is usually used in engineering practice. Generally speaking, there are two methods to realize the serial communication by VC++. The first method is taking advantage of control MSComm, the merit is that the control MSComm is simple and convenient except flexible; The second method is using API function, the merit is that the API function is very flexible but programming is very sophisticated. The DLL technology and API function are combined to solve the above problem.

There are several key procedures to realize the programming of serial communication. First, the Function CreatFile is used to open a serial communication device and the appropriate configuration is made. Second, the Function WatchCommEvent is used to monitor the communication event. Third, the Function WaitForSingleObject is used to enter an alterable wait state. Forth, the Functions ReadFile and WriteFile are used to make out I/O operation. When the communication event is over, the Function CloseHandle is to used to close the serial port.

Concrete operations in software VC6 are following that: a project is built based on the extended dynamic link library in VC6.0. Then two classes are inserted which are including class CComControl and class SConfig. Class CComControl is to realize the operation about serial port. Class Sconfig is to realize the serial port configuration. AFX_EXT_CLASS must be added in class declaration header file. A Dialog is must be to built in class Sconfig for the Class ComControl to call it. The form of dialog is showed in the Figure 1.

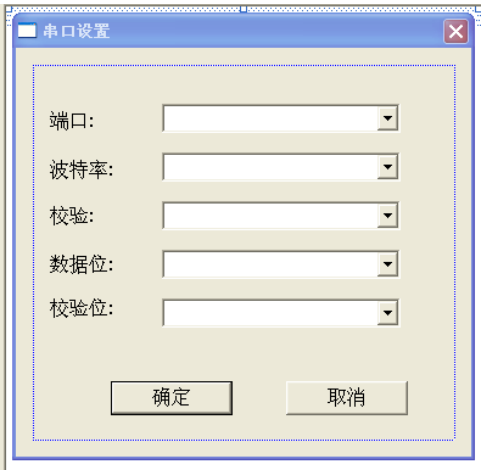

Figure 1.The form of dialog in Class Sconfig.

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After running the program, the comdll.dll and comdll.lib which can be transferred and used in the other engineering practice are generated in Debug file.

B. The application of serial communication DLL to the Monitoring control system for Transformer testing equipment

Transformer measurement equipment is used to test the characteristics of molded, frame and electrical transformer. The Monitoring control system not only control the slave computer but also save data ,display the curve and print it. The hardware connection between Monitoring control system and slave computer is shown as following Figure 2.

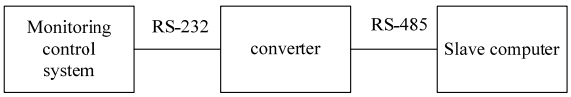

Figure 2. The hardware connection between Monitoring control system and slave computer.

This paper is showing the program which call the serial communication DLL which can make the program is seems succinct for that so long as the comdll.dll and comdll.lib are put in the main program project. “#pragma comment(lib,"comdll.lib")”must be put in the header file. The whole program flow charts is shown as following in Figure 3.

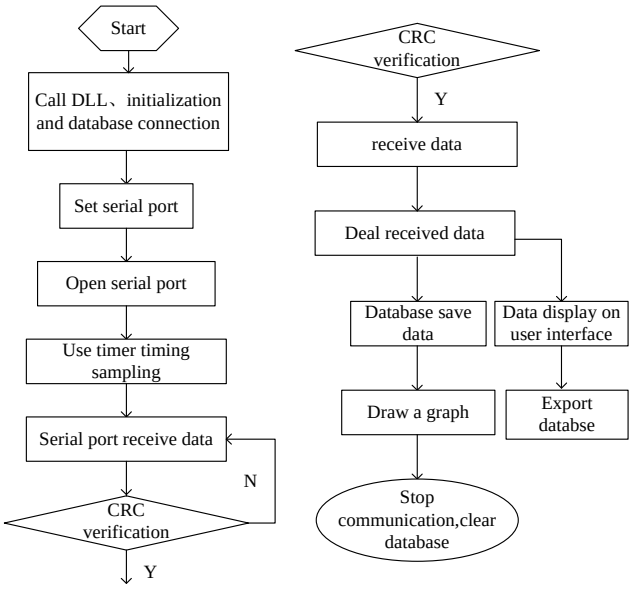

Figure 3.The main program flow charts of the Monitoring control system.

MODBUS communication protocol is used commonly in the industrial field. It is a message transfer protocol which is applied to layer 7 of the OSI model and it is used to provide the communication between the client and server. Function code 03,06 and 10 in MODBUS protocol are used in this monitoring system. There are two serial transmission modes in MODBUS protocol including ASCII and RTU. The RTU mode is selected in this program. General MODBUS frame [5] structure is shown as following Figure 4.MODBUS function codes are elements of MODBUS request/reply PDUs.

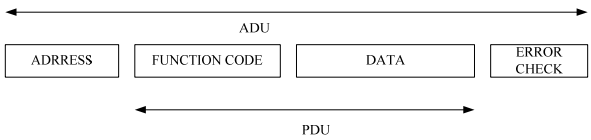

Figure 4.General MODBUS frame.

The program code of MODBUS frame is as following: the function code is 03.Then we can send the MODBUS frame to slave computer repeatedly by Timers in software VC6.0.

```
UpdateData();
ReadFrame[0] = 0X01;
ucharReadFrame = ReadFrame;
int ReadFrameNum = 0;
BYTE bytSlaveAddress=m_bytSlaveAddress;//0X01;
ReadFrame[ReadFrameNum++]
=bytSlaveAddress;//SlaveAddress
if(!m_nRead)bytComand = m_bytCommand;//0X02;
ReadFrame[ReadFrameNum++] = bytComand;//function
code
BYTE
bytHightStartAddress=HIBYTE(m_dwStartAddress);
BYTE
bytLowStartAddress=LOBYTE(m_dwStartAddress);
ReadFrame[ReadFrameNum++] =
bytHightStartAddress;//start address
ReadFrame[ReadFrameNum++] = bytLowStartAddress;
BYTE bytHightDataLenth=HIBYTE(m_dwDataLenth);
BYTE bytLowDataLenth=LOBYTE(m_dwDataLenth);
ReadFrame[ReadFrameNum++] = bytHightDataLenth;//
the length of data
ReadFrame[ReadFrameNum++] = bytLowDataLenth;
WORD CRC;
CRC=GetCrc(ReadFrame,ReadFrameNum);
BYTE bytLowCRC=LOBYTE(CRC);
BYTE bytHightCRC= HIBYTE(CRC);
ReadFrame[ReadFrameNum++] = bytLowCRC;//the
check code
ReadFrame[ReadFrameNum++] = bytHightCRC;
ucharReadFrame=&ReadFrame[0];
UpdateData(false);
return ReadFrameNum;
```

The error check of the MODBUS RTU mode is CRC 16. CRC(Cyclic-Redundancy-Check)[6] is using generator polynomial to encode. In the algorithm, firstly preset a 16-bit register of FFFF (all 1), and then the 2 Binary data (a byte) which is 8-bit XOR(Exclusive OR) with the low 8 bit of 16-bit CRC register, and the results returned to the CRC register at the same time register contents are shifted to the right, the most significant bit is Filled with 0, and to check

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right shifted out of the bit. If the shifted bit is 0, continue to shift the register contents to the right, or a CRC register XOR(Exclusive OR) with the polynomial. Repeat the above operation until the completion of an 8bit byte, and then continue to operate the next data for the same treatment until all the data is completed. At last, data in the CRC register is that the CRC code which is needed. The designed program interface shows in following Figure 5.The program adopt the Timer in VC6.0 to send the MODBUS orders repeatedly.

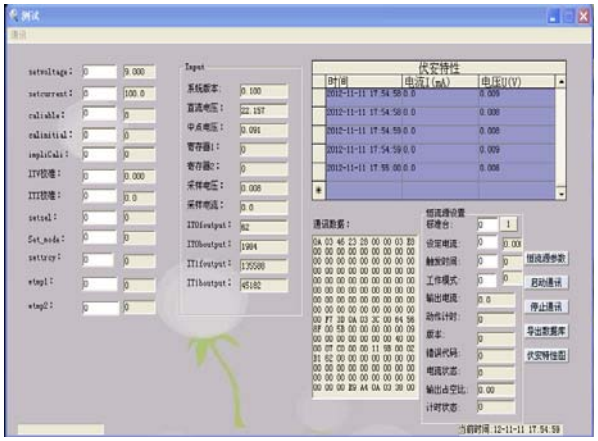

Figure 5. Program interface.

The way to save data in this program is ADO which is used to connect relational and non-relational database data. Microsoft Access is selected as the database[7]. The program code to connect the Microsoft Access is show as following:

```
try
 {
     CString strConnection;
     strConnection=
   "Provider=Microsoft.Jet.OLEDB.4.0;Data Source
     =computer.mdb";
     m_pConnection.CreateInstance(__uuidof(Connection));
     m_pConnection->CursorLocation = adUseClient;
     m_pRecordset.CreateInstance(__uuidof(Recordset));
     m_pConnection->Open((LPCTSTR)strConnection, "",
     "", adModeUnknown);
     m_pRecordset->Open(_variant_t("select * from
     TABLE2"),m_pConnection.GetInterfacePtr(),
     adOpenDynamic,adLockOptimistic,adCmdText);
 }
catch(_com_error e)
 {
    MessageBox(_T("连接数据库失败!"), "提示
    ",MB_ICONINFORMATION);
 }
```

The way to display the data which are saved in Microsoft Access is using the control DataGrid in VC6.0.Similarly,the picture control TeeChart5 in VC6.0 is used to display the picture of the characteristics of the testing transformer which the horizontal axis represent the current(mA) and the longitudinal axis represent the voltage(V).The form of picture is shown as following in Figure 6.When the mouse moves along the curve, the data can be shown in the EditBox lower right corner. Use Function GetExport( ).ShowExport( ) to save picture. The program code which is used to transmit the data in database to the controlTeeChart5 to draw the picture is as following.

```
if (m_chart.GetSeriesCount()<1)
 {
  m_chart.AddSeries(6);
 }
while (!m_pRecordset->GetadoEOF())
 {
   m_chart.Series(0).Add(m_pRecordset
   ->GetCollect("字段 1"),
   (_bstr_t)m_pRecordset->GetCollect("字段 2"),0);
    m_pRecordset->MoveNext();
 }
```

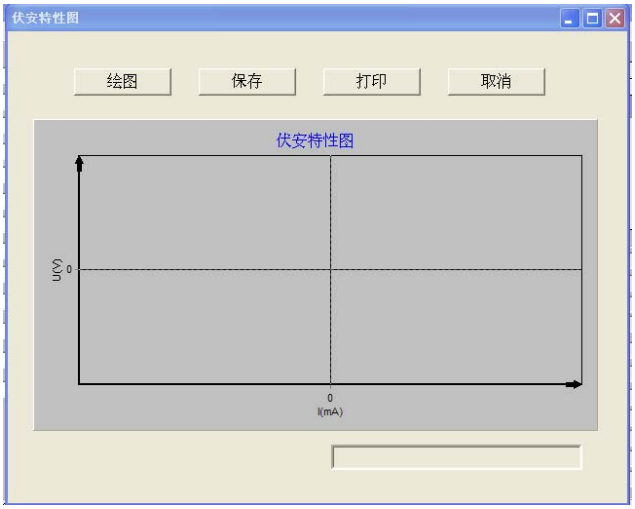

Figure 6.The form of picture.

III. TEST RESULT

In order to realize the purpose of testing the characteristics of transformer, monitoring control system is used in the experiment that hardware circuit is connected and the transformer to be tested. Figure 7 shows the schematic diagram of the experiment.

The monitoring control system can send orders to set the value of current. And Input voltage is 220V ± 15%,the transformer to be tested is LSZ12-12 current transformer which the current ratio is 2500A/5A.The condition of experiment is as following: operating temperature is 0-45° C; pressure is 86-106kPa;Relative Humidity is 40%-90%.The characteristics of the tested transformer is displayed in Figure 8.

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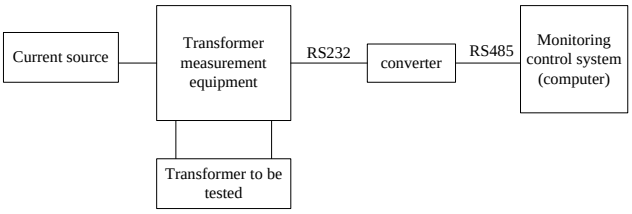

Figure 7.The schematic of the experiment.

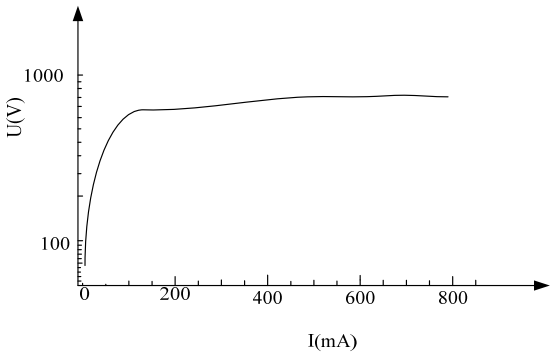

Figure 8.The characteristics of the tested transformer.

IV. CONCLUSION

After the experiment carried out in the part III, the monitoring control system can be used to control the transformer measurement equipment and save data in Microsoft Access from the equipment by MODBUS protocol. The characteristics of transformer which is to be tested is displayed in picture so the tester can judge the quality of the transformer in terms of it.

The experiment indicates the monitoring control system is carried out normally and can reflect the operation of the transformer measurement equipment.

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REFERENCES

[1] Prachi Rane, “Design of Modbus Controller Using VHDL for Remote Administrations of a Network of Devices,” 2010 3rd International Conference on Emerging Trends in Engineering and Technology (ICETET),Goa pp. 694-697, Nov. 2010.

[2] Tu Xuyue, “Design of Air Compressor Monitoring System Based on Modbus Protocol,” 2010 International Conference on Electrical and Control Engineering, China: Wuhan, IEEE computer society June 2010,pp.710–713.

[3] PENG Dao-gang,ZHANG Hao,YANG Li and LI Hui. “Deisign and Realization of Modbus Protocol Based on Embedded Linux System,” The 2008 International Conference on Embedded Software and Systems Symposia (ICESS2008), Sichuan, IEEE computer society July 2008, pp. 275–280.

[4] Thomas Morris,Rayford Vaughn and Yoginder Dandass, “A Retrofit Network Intrusion Detection System for MODBUS RTU and ASCII Industrial Control Systems,” 2012 45th Hawaii International Conference on System Sciences,IEEE computer society,pp:2338-2345.

[5] Antonio Heronaldo de Sousa,Valmor Adami Jr and Alcindo do Prado Junior, “Monitoring,Parameterization and Supervision of Industrial Equipments with Handled Computers over Modbus,” IEEE ISIE 2006, July 9-12, 2006, Montreal, Quebec, Canada, pp. 2908–2913.

[6] Valdes,A.,Cheung,S, “Intrusion Monitoring in Process Control System.Proceedings of the 42nd Hawaii International Conference on System Sciences,2009.

[7] BAO Ke-jin, WU Jian-yong. Implementation of remote monitor for power system with embedded web server[J].Computer Engineering and Design, 2007,28(13):3178-3180.

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