Designing and Developing Mountain Unmanned Station Supervising System with Digital Microwave Circuit in Hangyongwen, Zhejiang province

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Abstract: Here is an example for computer supervising system. The software for Supervisor Computer is developed by KingView Tools, and the slave one is developed by the library functions integrated with 7188 system.

Keyword: Monitor and Control, Supervisor/Slave Computer, KingView Software, Industrial Control computer

1 Background

The system is used for supervising microwave stations in Hangzhou, Wenzhou and Ninbo, etc. The supervisor stations generally locate in urban computer room and slave stations in mountaintop near the sea with a very harsh environment. There are 6 supervisor stations. Each of them controls a slave station. Data transmission between supervisors is carried out via microwave channels (as shown by bold black line in figure 1). However at a specific

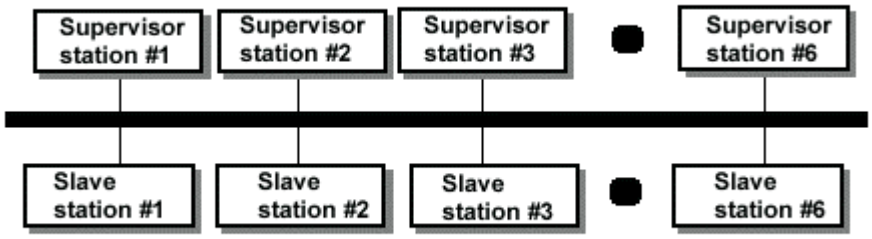

Figure 1 System architecture

time, only one supervisor can poll it's slave computer, the slave computer should respond accordingly. All other supervisors must retain in listening mode. After the supervisor finishes polling it's slaves, it will yield the polling privilege to the next supervisor and the polling process is similar to that of the first supervisor. The items that are monitored include working status of the diesel generator, switch power supply, mains, storage battery etc., and environment temperature, humidity and guard against theft. The system architecture is shown in figure 1.

2 Hardware Design

Oil engine monitor with double on-line backups is specially designed for working with large diesel oil generator. 1600 and 2800 are also dedicated monitors for original facilities. 1600 is mainly used to monitor the mains and environmental parameters and 2800 is used to

monitor two sets of storage battery (each with 12 sections). 7041 is used for alarming digital signal input module, 7067 for controlling digital signals and 7188 for supervisor module. 7188 has four serial ports which include 2 RS-232 ports (only Rx, Tx, GND signal lines are used), 1 RS-485 and 1 full-signal 9-pin RS-232 port which can be changed to RS-485 by internal jumper. 7188 module has provided many interfaces and can operate under harsh environment and provide many built-in functions that can help to fast develop reliable supervising system program for field computers. The hardware architecture of the slave stations is shown in figure 2. Since all monitoring modules use RS-485 ports, two

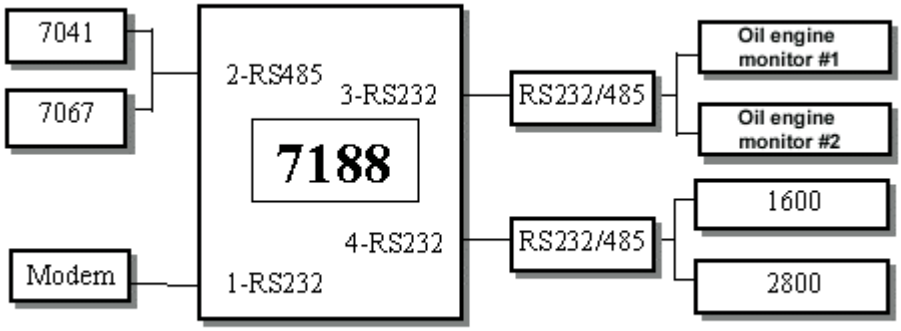

Figure 2 slave station hardware architecture

RS-232/RS-485 conversion ports are required. Port COM1 is full-signal RS-232 port that is connected to a dedicated Modem to transfer data through microwave channels. The supervisor stations are connected to a dedicated modem via RS-232 port to transfer data through microwave channels.

3 System Software

3.1 Supervisor software

The supervisor software is developed with KingView 5.1 and runs under Win98/NT platform. It is featured with real-time multiple tasks, multi-threading, high sampling speed, high reliability, supporting distributed history database and dial-up network and many ActiveX controls. The software has been extensively used in steel, chemical industry, environment protection, national defense and aeronautical and astronomical field.

It is easy and convenient to develop real-time computer supervising system using KingView software. Firstly it is required to define device and load communication driver. The system, for example, communicates with slave computer through RS-232 port. The facilities are defined in following sequence: Smart module--I-7000 series, I-7188--Modbus RTU Extention. Secondly to specify working parameters of RS-232. After that we need to define data dictionary and variable name, data type and relationship between registers. For the

variables in data dictionary, the corresponding linear target value can be calculated automatically based on the original values. Finally you can design user interface with primitive controls provided by KingView software. "Animate link" can be built for both string and primitive so as to integrate data variables and data display. Data can be displayed in two ways: text format and animation display such as alarm, green indicating normal and red indicating alarm.

3.2 Slave computer software

3.2.1 Slave computer main program design scheme

I-7188 provides extensive library functions which include watchdog, related data sending and receiving functions and time clock interrupt function, etc.. In addition it also provides many example programs. All of these make it easy and convenient to develop slave computer software and to integrate with modules provided by other company. Each serial port of 7188 can control two smart devices that can be distinguished by their addresses. The working parameters and module addresses for ICP I-7000 series are adjustable and can be set before system installation, while working parameters and addresses for smart modules from other manufactures have been preset and can't be changed.

Since I-7188 has built-in DOS environment, the slave computer program can be written in TC2.0. The main program should first initializes the system, including serial ports initialization and operating parameters initialization, and install the user timer interrupt. Because the interrupt interval is preset as 1ms, the data receiving and sending routines should not be used within the interrupt service function. The reason for this is because transmitting 1 byte at 9600 bps, which is typical in a supervising system, will need about 1ms. If the speed is too high, the data transmission will become unreliable. And typically at least 2 bytes will be transmitted one time, this will result in DOS re-entry error and makes the system unreliable. Therefore time clock interrupt program should be

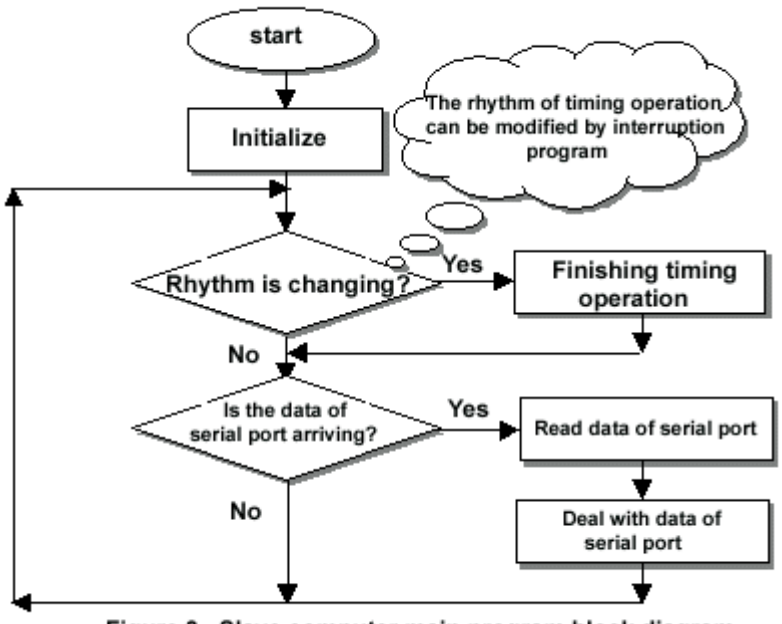

Figure 3 Slave computer main program block diagram

as short as possible and only handle the coordination of different jobs. The main task can be implemented in the main routine. When it's time for polling, it will send inquiring command to the smart modules or devices, and when data is ready, the program will read data and deal with them. The software system diagram is shown in figure 3.

3.2.2 Communication problems and solutions

Data communication reliability is the most important for computer supervising system. Industrial computer I/O devices provided by ICP can transmit data steadily and connect reliably with I-7188. However data transmission between modules provided by other companies is not as continuous as expected, and the waiting time depends on different modules. Too short will result in data loss and too long may lead to system failure or receiving of the next data package. Data receiving program can be found in subroutine ReadDataDelay of program 1. After many times of debugging, the delay time for the system should be greater than 0X140. If it is less than 0X130, data error rate will be about 1/4 and 1 to 2 bytes will be lost each time. The delay time between 0X130 and 0X140 is critical value. Data sending is implemented in a subprogram shown in SendData subprogram of program 1. The first byte of data group is used to store the number of bytes received and the following is the content of data.

```
/*****************************************************/
/*     ReadDataDelay:read data in serial port nPort and place in    */
/*           in bData, nDealy is waiting time      */
/*****************************************************/
void ReadDataDelay(int nPort, unsigned char *bData, int nDelay)
{
    int nData=0;   /*received bytes*/
    int iCount=0;  /*wait timing*/
    while(iCount < nDelay)
    {
        if(IsCom(nPort)==QueueIsNotEmpty)   /*nPort need to transmit data*/
        {
            nData++;
            bData[nData] = ReadCom(nPort);  /*read one byte of data*/
            iCount = 0; /*has data, timer is reset*/
        }
```

```
            else iCount++; /*hasn't data, wait timing*/
        }
        /first byte of *bData data is placed the number of received bytes and other bytes are data content*/
        bData[0] = nData;
        ClearCom(nPort); /*clean data in serial port for the next receiving */
    }

    /************************************************************/
    /*   SendData: nPort is serial port number, ComData is data need to send   */
    /************************************************************/
    void SendData(int nPort, unsigned char *ComData)
    {
        int nlength, i;
        nlength = ComData[0];
        if(2 == nPort)  Set485DirToTransmit(nPort);
        for(i=0; i<nlength; i++)
        {
            ToCom(nPort, ComData[i+1]);
            if(2 == nPort) WaitTransmitOver(nPort);
        }
        /*Com2 is 485 port, should adjust the direction of data transmission.*/
        if(2 == nPort) Set485DirToReceive(nPort);
        return;
    }
```

Program 1 Data receiving and sending

4 Comparison with Panasonic PLC system

The large-scale pump station supervising system for Qiantang river, Zhejiang province is a national irrigation

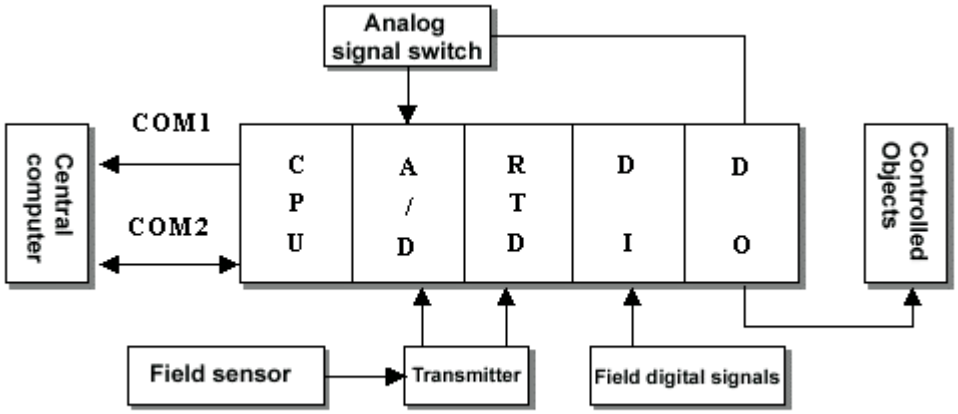

Figure 4 Panasonic PLC hardware architecture

works created with a loan from the World Bank. The central computer uses industrial computer, and the front-end computer uses Panasonic PLC, model FP10SH. The hardware architecture is shown in figure 4. The central computer communicates with front-end computers via two RS-232C serial ports: COM1 is used for sending interrupt signals such as real-time alarm to the central computer; COM2 is programmable port with which the central computer can send PLC program to front-end computer and read/write data. In figure 4, from left to right displayed: CPU module, A/D converter, temperature module, digital input module and digital output module.

All modules are inserted in the motherboard of the system. Main CPU module only has two RS-232 serial ports, which is so expensive that the price of FP10SH CPU module is up to RMB10,000 in 1997. In respect of software the central computer doesn't provide configuration software and the front-end computer software is implemented by "ladder diagram". It is difficult for developers without electrical knowledge to understand ladder diagram. In addition there is no sample program provided with diskette. PLC operating system automatically scans "ladder diagram" program repeatedly. But a problem occurred during numeral conversion. After many times of debug, it is found that only one data can be converted each loop of system scan, the multiple-byte conversion can not be implemented with this system. I consulted technical support from Panasonic and left written materials about this problem at the Shanghai automation technology international exhibition. But up to now we haven't received any solutions they have promised.

On the other hand, it is very easy to integrate using I-7000 series. 7188 has four RS-232/485 serial ports and it's price is as low as about RMB2000. Moreover it can also work reliably under harsh environment, for example when its surface temperature increased to above 50 ℃. The central computer program can be developed quickly and reliably with configuration software provided by the central computer; the front-end computer software is featured with

simple logic and watchdog resetting system by using many library functions and example program. In addition ICP technical support department provides comfortable services for customers and answers many questions in programming.

5 Debug and Conclusion

"General multifunctional computer supervising system test software" is designed specially for testing supervising system or related smart devices through RS-232 or RS-485 (published in *Industry Automation Electronics 1999・48*). The software can be used not only as a slave computer to test supervisor program but also as a supervisor computer to test slave computer programs, which have been verified in many supervising systems. I-7000 series modules can transmit data steadily during debugging the system. Supervisors provided by other company have 25 data transmission errors and I-7000 series modules have no error when they have been tested continuously for 48 hours (testing one time per 5 seconds). There is no error during the test of supervisor computer (configuration software) with the test software as slave computer. Now the system has passed the debug in laboratory and can operate successfully. Using ICP configuration software and 7000 series modules make it possible to reduce development time and improve reliability. In a word it deserves to be used extensively (**bjmyc@263.net**).

Reference:

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