Design and Implementation of Remote Monitoring System Based on GSM

Chen Peijiang, Jiang Xuehua
School of Engineering,
Linyi Normal University, Linyi, Shandong, 276000, China
chenpeijiang@163.com

Abstract

Because the wireless remote monitoring system has more and more application, a remote monitoring system based on SMS of GSM is presented. Based on the total design of the system, the hardware and software of the system is designed. In this system, GSM network is a medium for transmitting the remote signal. The system includes two parts which are the monitoring center and the remote monitoring station. The monitoring center consists of a computer and a TC35 communication module of GSM. The computer and TC35 are connected by RS232. The remote monitoring station includes a TC35 communication module of GSM, a MSP430F149 MCU, a display unit, various sensors, data gathering and processing unit. The software of the monitoring center and the remote monitoring station is designed by using VB. The result of demonstration shows that the system can monitor and control the remote communication between the monitoring center and the remote monitoring station, and the remote monitoring function is realized.

1. Introduction

Remote monitoring is on-line real-time monitoring and controlling the field equipment, and transmitting the real-time picture and test data to the terminal to forecast or diagnose\cite{ref1}. The remote monitoring system is an effective method to obtain, analyze, transmit, manage and feedback the remote goal information, and it combines the Most advanced science and technology field of satellite positioning technology, communication technology, Internet technology and other areas, and it is the comprehensive usage of instrumentation, electronic technology, modern communications technology, computer software and so on.

According to the transmission methods of monitoring information, the remote monitoring system can be divided into two kinds, wired and wireless. Wired monitoring system can be used for the situation which has high real-time performance, large quantity of data, centralized controlling fields. Wireless monitoring is suitable for the occasion which has random monitoring scope, difficult wiring, small data, low real-time requirement and so on.

GSM is a digital mobile communication network which develops rapidly in recent years. Short Message Service of GSM is a value-added service based on data packet switching provided by mobile communication company using GSM network besides of all sorts of telecommunication services and bearer services based on the circuit-switched\cite{ref2}. Because the GSM network can be interconnected and roamed all over the country, it has strong network ability, the users has no need to organize another network. The coverage of the network is improved and the expensive network building and maintenance cost can be saved for users\cite{ref3}. At the same time, the number of its users is not limited. Wireless communication of Using GSM has some features such as two-way data transmission function, stable performance and so on. GSM network provides a strong platform for remote data transmission and monitoring the communication of equipment, and it is an important method of wireless remote monitoring system.

The paper uses SMS as a method of information transmission, the collected data of the remote monitoring station is transmitted to the central monitoring station by means of the SMS through the GSM network. The central station analyzes the data and sends the controlling orders to the remote stations in the same way. Thus the remote monitoring function between the monitoring central station and the remote monitoring station is realized.

2. Structure of the remote monitoring system based on GSM

2.1 Structure of the remote monitoring system

The system is mainly composed of the central monitoring station, remote monitoring station and GSM network. Central monitoring station is divided of monitoring central server and GSM modem, and the remote monitoring station is divided by MSP430F149 MCU, peripheral circuit and GSM modem. The wireless remote communication between central monitoring station and remote monitoring station is realized by the GSM network, and the remote monitoring system based
on the GSM network is implemented. The structure of the system is shown as Figure 1.

Figure 1 Structure of remote monitoring system

2.2 Hardware design of central monitoring station

The main hardware equipments of the central monitoring station include central monitoring station server, GSM wireless communication module TC35 and the serial ports lines between the above equipments.

Central monitoring station server can be implemented by using ordinary computer servers, workstations and so on. Its main functions have:

1. to receive, classify and save the real-time data collected by the remote monitoring stations;
2. to control the remote monitoring station, to deal with the emergent alarm from the sub and to set the sub-station;
3. to management database and display real-time situation of the monitoring station, and to print the backup database.

GSM module is another very important terminal equipment of GSM mobile communication system besides of the GSM mobile phone, and it is a date terminal equipment that combines the traditional modem and GSM wireless mobile communication system, then it is also called wireless modem. Receiving and sending of the data in the central monitoring station is achieved by using the GSM wireless communications module TC35. TC35 is introduced by SIEMENS which is a dedicated modem, the module integrates the radio frequency circuit and base-band circuit, and it provides the standard AT command interface to users. The module provides fast, reliable and secure transmission for data, voice, short messaging and fax, and it can convenience the application development and design for users.

2.3 Hardware design of remote monitoring station

Major hardware of remote monitoring station mainly includes MCU, its peripheral circuits, GSM wireless communications module TC35 and the serial ports lines between them. The MCU of the system is the MSP430F149 produced by TI[4]. MSP430F149 MCU is one of the MSP430 Series which are mixed single chip microcomputers of 16 bit and have reduced instruction set, ultra-low-power. It is suit for usage fields of needing extremely low power consumption, and it has rich addressing methods, facilitate and efficient development methods and support simulation and programming online. Its peripheral circuits include liquid crystal display, keyboard functions, A/D converter and so on.

3. Design of the system software

The system is focused on resolving the remote wireless communication between the central monitoring station and remote monitoring station. The data communication between the above equipments is realized by using GSM wireless communications module TC35 which is controlled by AT commands. Short message mode is adopted to transmit data.

3.1 Control command of the GSM communication module

AT instruction set is dedicated to the modem command sets, GSM07.07 agreement on the AT commands to do a detailed introduction[5]. Computer and AT SCM can send commands to control the modem.

Setting Short Message Center:

AT+CSCA="+8613800270500"

Accept short message:

AT+CMTI

AT+CMGR=X

AT+CMGD=X

Send short message:

AT+CMGF=1 (Adopt the text format, the value is 0 if the format is PDU)

AT+CMGS="+8613xxxxxxxxx" Return > (Input short message)

Set up sound call:

AT+CREG= Return (Registering is for network?)

ATD13xxxxxxxx: Return(The difference between the sound call and data call is the sub-number of the called number)

Modify and store parameter:

AT+IPR=2400 Return (Modify the rate of the RS232 to2400bps) AT&W Return (Store the modified parameter)

Input the PIN code:
3.2 Software design of central monitoring station

The developing tool of the program design of central monitoring station is Visual Basic 6.0, and the software includes the controlling interface and initialization program of monitoring center, the program of accepting and sending short messages, data processing and preserving program. The most of important of those is the serial communication between the central monitoring center servers and GSM wireless communications module TC35, and the communication is the key of accepting and sending short message. Visual Basic 6.0 provides a serial communication control MSComm which can facilitate the realization of serial communication.

The software design tasks of the central monitoring station include sending instructions to remote monitoring stations (in the form of short message), accepting the monitoring data from the remote monitoring stations (in the form of short message), store and deal with database, and print historical data. Adopting VB to design the software of central monitoring station has many advantages. For example, it has a good man-machine interface, it can provide serial communication control MSComm which can facilitate realization of serial communication, the programming method is very and the operation is simple, connecting to database and its management are very easy. The following sections are the software design of the central monitoring station.

3.2.1 Design of man-machine interface

Firstly, we start VB and new a project, and then add a communication control (MSComm1) to the form which is used to access the serial port. There are two frames, they are short message sending area and short message accepting area. There are four text boxes and two buttons:

1. Txtcen is used to configure the number of short message center;
2. TxtPhon is used to input the telephone number of the accepter (for the sequence number of the remote monitoring station);
3. Txtcon is used to input the content of the short message;
4. Txtpdu is used to display the content of the PUD format of the short message (for the ASCII code);
5. Button of Generation Short Message can convert the short message to PDU format;
6. Button of send a text message can send the short message to the accepter.

There are three areas in the accepting text box, they are used to display Caller ID, call time and call content. A Timer control is used for inquiring serial port termly, when there is a short message, it is read and coded, and then, the short message number, sending time and short message content are displayed in the text boxes, at the same time, they are stored in the database.

3.2.2 Design of key function modules

Central monitoring station has includes several functions, they are initialization of serial port, sending and accepting short message, database interface and so on. There are there important modules.

1. Initialization of serial port
   Central monitoring station can accept and send short message by controlling GSM wireless communications module TC35. VB provides a communication control MSComm.

2. Send short message
   The sending and accepting of short message is implemented by AT command controlling GSM wireless communications module TC35[6]. The process of sending short message is as follows: Firstly, we code the number of short message center, the other number, the content of short message into PDU format, and then calculate the length of the short message, send AT + CMGS = <length> <CR>, <CR> representatives Return, that is, 0x0D of ASCII code. When TC35 module returns the characters “>” of ASCII, the PDU data can be input. PDU data is ended as character of <Z>. The module returns <CRLF> OK <CRLF> if the sending process of short message is completed.

3. Accept short Message
   Accepting short messages uses a timer to inquire the serial port periodically. When the short message is arrived, the computer can accept an instruction that is <CRLF> + CMTI: "SM", INDEX (storage location of short message) <CRLF>. Read PDU data for the AT command AT + CMGR = INDEX <CRLF>, and when the instruction is implemented, the module returns the content of the just received short message which is PDU format Then the short message is coded, the phone number of the caller, sending time of short message, the content of short. Finally, the three elements appear in the interface, and they are stored in the database.

3.3 Software design of remote monitoring station

The main tasks of the remote monitoring station include:

1. to convert and deal with the data collected by the through the A/D converter;
2. to show the received short message (control orders);
3. to send the real time data to the central monitoring station or manager by triggering the keyboard keys

The MSP430F149 series MCUs support C programming language. The C430 integrated development environment which is developed for MSP430 series MCUs by IAR company and C language
debugger are the developing tools of the system software. Software design adopts the modularization programming, the form of the function modules is sub-function. Then, these measures can reduce the software development time and the program is easy to modify and transplant.

The MSP430F149 MCU itself provides ADC12, then, single-channel multi-sampling is made an example to explain the method of setting the various controlling register of the ADC12.

```c
#include "msp430x14x.h"    // include head file extern void ADCnum(void);  //define the name and type of the sub-function int i=0, kp=0;            //define global variable unsigned int sumall;        //data sum of the sample int ADC_Result;           //data value of the single sample void ADCnum(void)
{
    ADC12CTL0 &=~ ENC;       //reset the conversion function
    ADC12CTL0 = ADC12ON+REF2_5V+SHT0_8;   // adopt 2.5v voltage
        // open the port10
    ADC12CTL1 = SHP+ADC12SSEL_2;   // sample when Rising edge comes
    ADC12MCTL0 = EOS + INCH_0+SREF_1;  //select channel 0
    ADC12CTL0 |= ENC;            //conversion function of the ADC
    while (kp<16)     // sample 16 times
    {
        ADC12CTL0 |= ADC12SC;        // start to convert
        while (!(ADC12IFG & BIT0));   //read data when
            //conversion is complete
        ADC_Result=ADC12MEM0;         // store the data to
                     //ADC_Result
        sumall=sumall+ADC_Result;     //accumulate the
                     //value of the ADC_Result
        kp++;
    }
    sumall=sumall/16;            // average of the 16 samples
}
```

The MCU is responsible for further processing the sample data, and codes the data into PDU format so that the data is sent to the central monitoring station monitoring by the mode of short message, and the remote monitoring is realized.

4. Conclusion

The system aims at establishing remote monitoring platform based on a GSM short message mode that can monitor and control the remote communication between the central monitoring station and remote monitoring stations. The Central monitoring station can receive the monitoring data of remote monitoring stations and stores them in the database, and also can call and print then at any time. At the same time, the system can on-line monitor the status of the remote monitored object, and it can send setting commands to the remote monitoring station by the mode of sending short messages. Remote monitoring station can be able to send the measured data dealt with by the MCU of the monitored object and send them to central monitoring station by the mode of the short message. The remote monitoring station can send the short message in time or timing through the keyboard operation, and it can receive the setting command from the central monitoring station and complete the setting operation. Because GSM network can interconnect and roam all over the country, and its network ability is very strong, the user will no need another network. The system can improve the network coverage for customers greatly, and it not only can save expensive network building cost and maintenance costs but also the user number is not limited.

References