Data Acquisition and Transmission System Based on Short Message Service

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Abstract

The data collection and transmission system based on single chip microcontroller (SCM) uses the LCD screen to display the real-time data, and employs the button matrix as the interactive interface to enter the preset alarm value, the target cell phone numbers and the control signals. TC35i is used as the GSM module to transmit data and control information. The alarm short message (SMS) will be sent automatically when the data exceeds the preset alarm value. And user also can order the SCM to send the real-time data and complete the remote control by sending a SMS of specific format.

1. Introduction

At present, RCD (Residual Current Device) widely used domestic is the electronic ones of fault current operated type. Their operation depends on the detection and judgment of the electrical parameters of the protected circuit. Because of the complicated application condition of RCD, there are a lot of potential safety hazards for the power lines. And abnormal operations are likely to cause equipment damage and property losses. Therefore, automatic control and remote monitoring are required. The operator can readily acquire the operating status of equipments and control them. With the continuous development of wireless communication technology, there is increasing demands of industrial control for the wireless monitoring. Wireless transmission technologies widely used today include microwave, Bluetooth, infrared, etc. The transmission distance of microwave is dependent on the weather and other conditions, and the cost of establishing their own base station is quite high. Thus its application on the wireless monitoring is...
limited. Infrared is transformed in lines, while the Bluetooth transmitting distance is typically only 10 meters. Therefore they cannot meet the demands of industrial remote monitoring. With the improvement of GSM (Global System for Mobile Communication) network, its coverage area is increasing rapidly, and its signal strength is stable enough. Short message service as a basic service of GSM network is made as the best solution for these problems because of its low cost and easily realization.

2. Hardware design of the system

The real-time dynamic data is sent and alerted by the system via SMS, and the SMS of controlling equipments or requiring data sent by the user is also received and dealt with. SCM (Single chip microcontroller) is used to implement the data operation, process SMS, control GSM module and LCD screen. LCD screen is applied to display the local real-time data. The keyboard is used as a human-machine interface for the user to enter the default alarm value, the user’s phone number and the local control signals. Data acquisition circuit is used to capture voltage, current and temperature by A/D chip. TC35i as the GSM module implements sending and receiving SMS under the control of SCM. The system block diagram is shown in Figure 1.

![System Block Diagram](image)

Fig.1 System Block

A. Data Acquisition Circuit

RCD can be divided into voltage operation type and current operation type. The design circuit of RCD is mainly used to acquire voltage and current of the system, and make action according to those data. The internal temperature of the RCD can exceed the normal value if there is a short circuit or chip destroying in it. Therefore, voltage, current and temperature of the system are acquired and sent to the SCM in order to provide a basis for operation of the controller. ADC0809, an 8-bit AD converter with a 256 quantization is used in the data acquisition circuit. The converted parameters to be measured such as voltage, current, temperature and so on are sent to analog input pins of the A/D chip. An address decoder can be introduced into the system to improve the utilization efficiency of the address, so multiple A/D devices can be used to monitor the status of multiple devices.

In industrial application, current and voltage are relatively high, and are usually alternating signals, so they need to be processed before the analog to digital converting. However, some relatively weak current and voltage signals, such as residual current signal are generally only tens of mill amperes, so transformers and amplifiers are used in the data acquisition circuit. The transformer cannot be too large, taking the cost and size into consideration. In order to ensure a wide linear range, a 100 Ω resistor is needed to be paralleled with the secondary output terminal in order to convert the current signals into voltage signals. The data acquisition circuit is shown in Figure 2.
B. GSM Module

The Siemens TC35i is used to send and receive short messages. As a GSM module, TC35i series are the first choice of industrial control level for their cost-effective and upgrading to GPRS module easily. This module can be connected directly with the SCM and also supports RS-232 serial communication. The test format and today’s mainstream PDU (Protocol Data Unit) format can be used to send and receive SMS through this module. In this design, interfaces connected with SCM mainly include IGT (Fire Wire), RXD and TXD. SIM card pins are directly connected with the TC35i pins of the same name via SIM card reader. CCIN pin of the ZIF block connector is used to detect whether the SIM card is inserted properly. The level of CCIN pin is high if the connection is correct, otherwise low. In addition, the power supply of the module should also be paid attention to. It will power off automatically if the voltage is below 3.3V. Since the power will become larger when sending SMS, the power supply for TC35i is generally separated and the current of the power supply must be higher than 2A. The schematic diagram of TC35i module is shown in Figure 3.
3. Software design of the system

Software section includes the format of SMS encoding, the format and methods of sending and receiving SMS, the processing flow of SMS and error handling.

A. SMS Mode

Currently, Text and PDU mode are the two modes often used to send SMS. The codes of sending and receiving SMS in text mode are simple and easy to implement, but the drawback is that Chinese SMS cannot be sent or received in this mode. However, both Chinese and English SMS are available in PDU mode. The format of sending SMS in PDU mode is comprised of service center address, protocol data unit type, originator address, protocol identifier, data coding scheme, service center time stamp, user data length and user data. And the relevant format of receiving SMS in PDU mode is made up of service center address, protocol data unit type, message reference, destination address, protocol identifier, data coding scheme, validity period, user data length and user data. Because Chinese characters can be sent in PDU format, the alarm SMS is sent in that format.

B. GSM Module Initialization

GSM module must be initialized before using. The process of initialization includes sending handshake signals, setting the baud rate of serial communication, SMS service center number, SMS operation mode and SMS encoding mode. The initialization process of TC35i module is

1. Send AT instruction and handshake signals to make the TC35i module adapt the baud rate automatically;
2. Send AT+IPR=9600 instruction to set the serial communication baud rate;
3. Send AT+CSCA=+8613800220500 instruction to set the SMS service center number (here is the SMS center number of Tianjin mobile);
4. Send AT+CNMI=2,0 instruction to set SMS operation mode;
5. Send AT+CMGF=0 instruction to set SMS sending in PDU encoding mode.

C. Send SMS

SMS can be sent after the GSM module is initialized, and PDU format is used here. The process of sending SMS is

1. Set the number of SMS bytes and the instruction is AT+CMGS.
2. Send SMS codes, it indicates that the GSM module is waiting for the encoding message if a “>” symbol is received. If the codes have been received successfully, the GSM module will start to send SMS.
3. Sending result test of SMS.

A string “+CMGS” will be returned while the SMS is sent successfully, where the figure followed is the SMS number. Otherwise, if this string is not returned, it indicates that the sending of SMS fails. The partial codes of sending SMS is shown as follows.

```c
Uchar Send_AT_Command( uchar type){   AT_Command_Type=type; send_count=0;
    switch(type){
        case RESET_TC35:    strcpy(uart_buff,"AT+CFUN=1,1");
            break;
```
case TC35_INIT:
    strcpy(uart_buff,"ATE0V0");
    break;
case AT_IPR:
    strcpy(uart_buff,"AT+IPR=9600");
    break;
case SMS_CMGF:
    strcpy(uart_buff,"ATE0V0+CMGF=0");
    break;
case SMS_CMGS:
    strcpy(uart_buff,"AT+CMGS=");
    strcat(uart_buff,para_temp);
    break;  }

D. Receive and Handle SMS

The received SMS in PDU format has a unique coding structure. The SMS is stored in the SIM card, after the user send it to the GSM module. SCM needs to read SMS, identify the originator address, analyze the user data, and take the appropriate operation, such as sending real-time data, making and breaking the equipments. The flow chart is shown in Figure 4 and the partial codes of receiving SMS is shown as follows.

uchar  i,r,j,t;
for(r=1;r<20;r++)
{
    timer_tmp=0;
    if(strsearch("+CMTI:"))  return;
    num_tmp1=r;
    if(READ_TEL(r)!=1)
    {
        if(strsearch("+CMTI:"))  return;
        continue;
    }
    t=2;  i=0;
    for(j=15;j<25;j++)
    {
        if((uart_buff[j]==0x22)&&(uart_buff[j+1]==','&&uart_buff[j+2]==0x22)
        break;
    }
    j=j+3;
    if(uart_buff[j]=='+') j=j+3;
    for(j<40;j++)
    {
        if(uart_buff[j]==0x22)
        break;
        para_temp[t++]=uart_buff[j];
        TEL_temp[i++]=uart_buff[j];
    }
    TEL_temp[i++]=0x0d ;
    TEL_temp[i++]=0x00 ;
An execution result of each instruction will be returned to the SCM by the GSM module. The common feedback information is as follows: (1)0D0A4F4B0D0A, i.e. the ASCII of ‘OK’ that indicates the execution is right. (2)0D0A4552524F520D0A, i.e. the ASCII of ‘ERROR’ that means the execution is failed. (3)0D0A3E20, this feedback message indicates that the AT+CMGR instruction is executed successfully, and it prompts the user to send the content of a SMS. (4)0D0A5E53595354454D20524553544152540D0A, it indicates that the module is re-booting.

If “SYSTEM RESTART” is returned, all instructions of the GSM module initialization need to be re-executed. If the feedback message is “error”, it only needs to re-send that instruction. In addition, if the send back message is “success”, it only means that SMS has been sent to the GSM network server successfully. Whether the message has been sent to user should be judged by the GSM mobile network report.

4. Results

The alarm SMS will be sent in PDU format if the real-time data exceeds the preset alarm value. As shown in Figure 5, the format of the alarm SMS is

\text{WARN: U}
The source of alarm data is followed “WARN”, and it can be voltage, current, temperature or several of these signals. The values of voltage, current and temperature are after that. Data acquisition and operation are implemented by the SCM so that the relevant equipments can be controlled automatically. The remote control of the equipment can be implemented by sending and receiving SMS. It has the advantages of low cost, automatic control and remote control at the same time. And it also has a good practicability.

Fig.5 The results of sending SMS

References