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Remote Monitoring System for Communication Base Based on Short Message

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Abstract

The automatic monitoring system of communication base which is an important means to realize modernization of mobile communication base station management. In this paper, we implement a monitoring system for communication base with three essential functions which are telemetry, remote control and communication. In this system, data acquisition unit, data transmit unit and monitoring centre unit are combined to form this monitoring system. The system can check the communication base status anytime through GSM SMS (short message service), and can send predefined command to perform remote data collection and monitoring in the special conditions. It is suitable especially for the alarm of unusual situation, the monitoring of environmental information and entrance guard information. The paper, firstly, proposes the architecture of the monitoring system; secondly, proposes the terminal of monitoring system. The data collection terminal is studied and designed, including hardware design based on embedded system and software design. Finally, presents implmentation and results. The monitoring system can improve the integrity, reliability, flexibility and intellectuality of monitoring system. The system with modular structure, which is low-cost, fitter and easier to move and operate, can be expanded according to practical need and is reliable and effective through field test.

Keywords: *Short Message, AT Command, Communication Base, Monitoring System, GSM*

1. Introduction

Nowadays, with the rapidly development of mobile communication business, the number of communication base is increasing day by day. The present monitoring methods include wired method and artificial method. The wired method challenge by trouble connected up, abominable working environment, information transmission in time, operation cost and so on. it is not suitable for the plentiful and widespread medium-mini bases [1]. The artificial method has two disadvantages: low efficiency of implementation and large consumption of resources. In order to reduce the maintaining cost and guarantee the communication quality, the operating information of communication bases and the information of entrance guard must be watched in time.

In the paper, the monitoring system on communication bases is designed which is based on Short Message. As the lower running cost and more steady function, SMS based on GSM networks provide us a ideal platform to develop the mobile commerce. Monitoring center and monitor terminal combined to the monitoring system, this system could run without artificial intervention, once some base occur exception or fault, monitoring terminal would automatically upload the exception information to monitoring center and maintenance man by SM (short message). This paper presents the design and realization of data acquisition, communication and monitoring system for communication base station.

2. Proposed Architecture of the Monitoring System

The system functions relying on mobile communication between computer and microcontroller based on GSM technique. The system comprises a control center and monitoring terminals. The control center consists of a server, a GSM module and a database system and the terminal consists of microcontrollers, sensors, a MF RC500 module and a GSM

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module in base station. The overall design of the monitoring system is shown as in Figure 1. We focuses on the implement of monitoring terminal in following text.

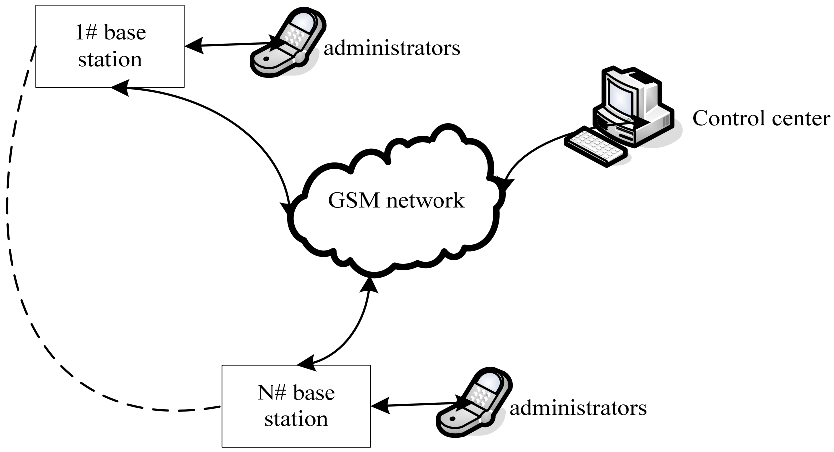

Figure 1. Overall architecture of the monitoring system

3. Design of the Monitoring Terminal

The monitoring terminal consists of microcontrollers, sensors, the circuit of MF RC500 and a GSM module. Once the abnormal parameter data appear, processor will arrange the abnormal message, initiate the data transmission and then send them out to control center [2]. Microcontroller module is W77E58, which is used as a master chip. The W77E58 is a fast 8051 compatible microcontroller with a redesigned processor core for no waste of clock and memory cycles. As a result, the execution of 8051 instruction is faster than the original 8051 at the same crystal speed. Typically, the instruction execution time of W77E58 is 1.5 to 3 times faster then that of traditional 8051. Also, the W77E58 contains 32 KB Flash EPROM, two enhanced serial ports and provides operation voltage from 4.5V to 5.5V [3].

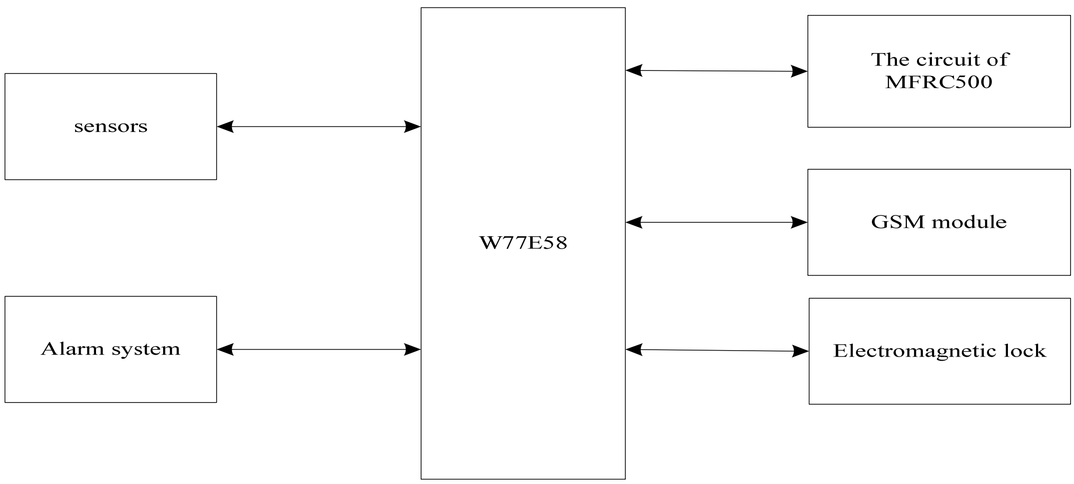

Figure 2. The block diagram of monitoring terminal

The value of parameters is measured in the system including air temperature, air humidity and information of entrance guard etc. The sensors and MFRC500 are combined to collect the real-time environment parameter data and hand over these data to microcontroller processor for further handling and storage. The microcontroller determines whether the data are normal or not. Once the abnormal parameter data appear, processor will arrange the abnormal message, initiate the data transmission, and then send them out to control center. C51 language is adopted according to the features of data and C language for system development. Software design mainly includes three parts: collecting and displaying temperature and humidity of base stations, reading and decoding short messages, encoding and sending temperature and humidity. The block diagram of the monitoring terminal is shown as in Figure 2.

3.1. Sensor Design

SHT10 is Sensirion's family of surface mountable relative humidity and temperature sensors. The sensor integrates sensor elements plus signals processing on a tiny foot and provides a fully calibrated digital output. A unique capacitive sensor element is used for measuring relative humidity while temperature is measured by a band-gap sensor. The sensor is seamlessly coupled to a 14bit analog to digital converter and a serial interface circuit. This results in superior signal quality, a fast response and insensitivity to external disturbances (EMC). A unique capacitive sensor element is used for measuring relative humidity while temperature is measured by a band-gap sensor [4]. It has output of standardized digital signal, small size and low power consumption. This sensor can measure in the range of -40-123.8℃ and 0%-100% relative humidity. Under the conditions of 25℃ and 3.3V, the relative humidity accuracy can reach ±4.5%R.H., while temperature accuracy is ±0.5℃.

In the paper the measurement resolution of is 14 bit for temperature and 12 bit for humidity. Because of nonlinear relation between digital output and relative humidity (RH) for the sensor SHT10, the data from SHT10 must be processed before being converted to actual physical quantity. For compensating non-linearity of the humidity sensor, it is recommended to convert the humidity readout (SORH) with the following formula [4]:

$$RH_{linear}=c1+c2*SO_{RH}+c3*SO_{RH}^{2}(\%RH) \quad (1)$$

The values of humidity coefficients are given in Table 1:

Table 1. SHT10 humidity conversion coefficients

SQ_{RH}	C1	C2	C3
12bit	-4.000	0.0405	-2.8000E-6

In case of temperature, the following formula is used to convert digital readout (SOT) to temperature value [4]:

$$T=d_1+d_2*SO_T \quad (2)$$

The values of temperature coefficients are given in Table 2:

Table 2. SHT10 temperature conversion coefficients

VDD	SOT	d1(℃)	d2(℃)
5	14bit	-40.1	0.01

Table 3. Temperature compensation coefficients

SQ_{RH}	t1	t2
12bit	0.01	0.00008

RH value is calculated at 25℃ in the formula (1), but actual test temperature is variable in a certain range. Therefore the temperature coefficient is considered for the sensor SHT10 according to the following formula [4], namely, coefficients for the temperature compensation are given in Table 3.

$$RHtrue=(T-25)*(t1+t2*SO_{RH})+RH_{linear} \quad (3)$$

The values of temperature compensation coefficients are given in table3. The flow diagram of SHT10 software design is shown in Figure 3. Temperature and humidity are calculated with the following programs:

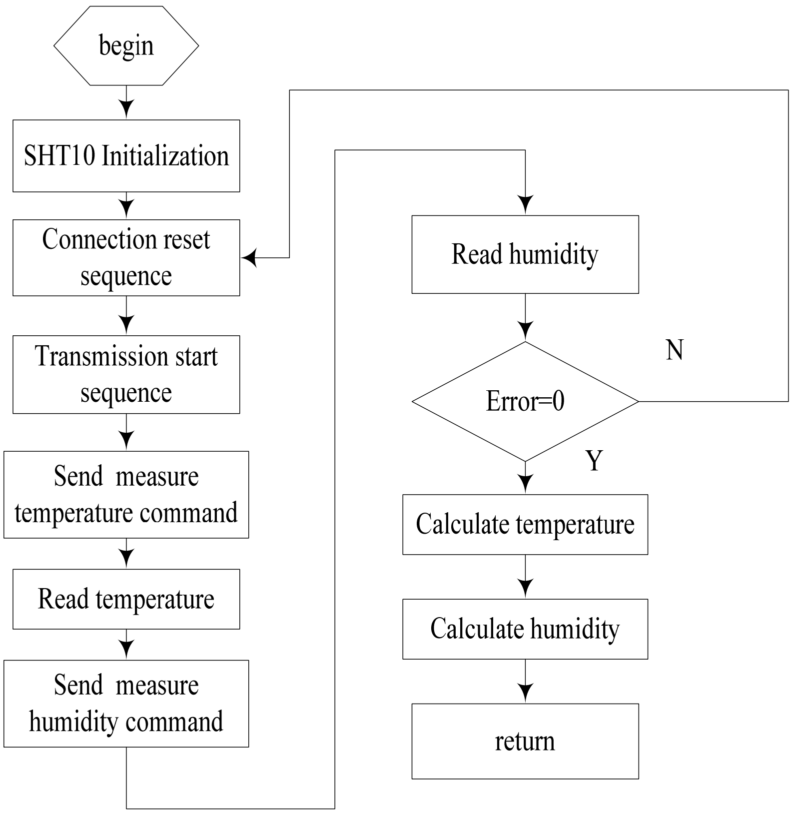

Figure 3. Flow diagram of SHT10

3.2. Proposed Circuit of MFRC500

MFRC500 is a member of a new family with highly integrated reader ICs for contactless communication on 13.56MHz which supports all protocol layers of the ISO 14443A [5]. The paper gives a solution of design and implementation for RFID R/W device based on the key character and internal structure of MF RC500 chip, the R/W operating to Mifare1 card is processed by the control and communication between P89C51 and MF RC500. The aim is to provide the required understanding of the MIFARE RF interface (ISO 14443A) to design application specific antennas and matching circuits to achieve the best performance for a communication with a contactless MIFARE card [6]. Receiving circuitry and EMC filter are as shown in Figure 4 [7]. As well as antenna circuit shown in Figure 5 [8]. The flow diagram of read card operation is shown in Figure 6.

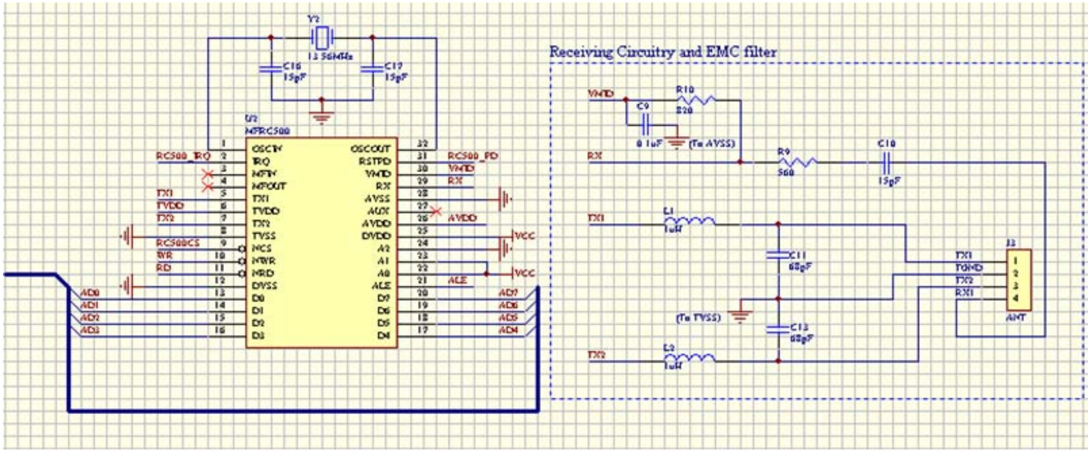

Figure 4. MFRC500 Receiving circuitry and EMC filter

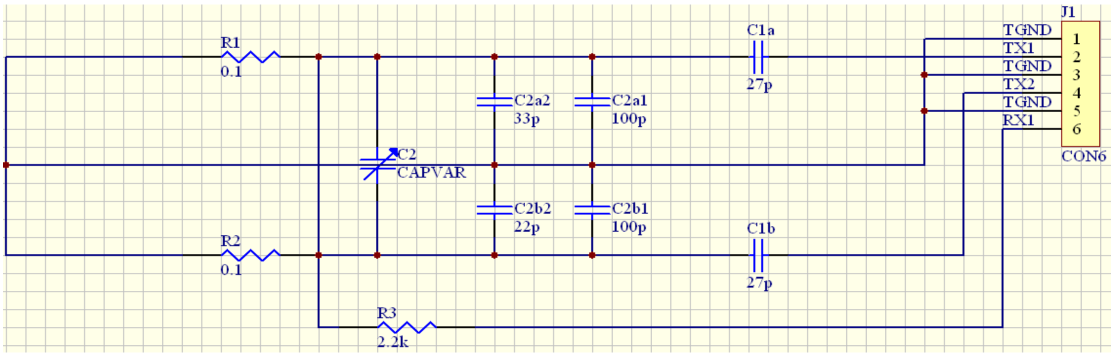

Figure 5. Design of antenna circuit

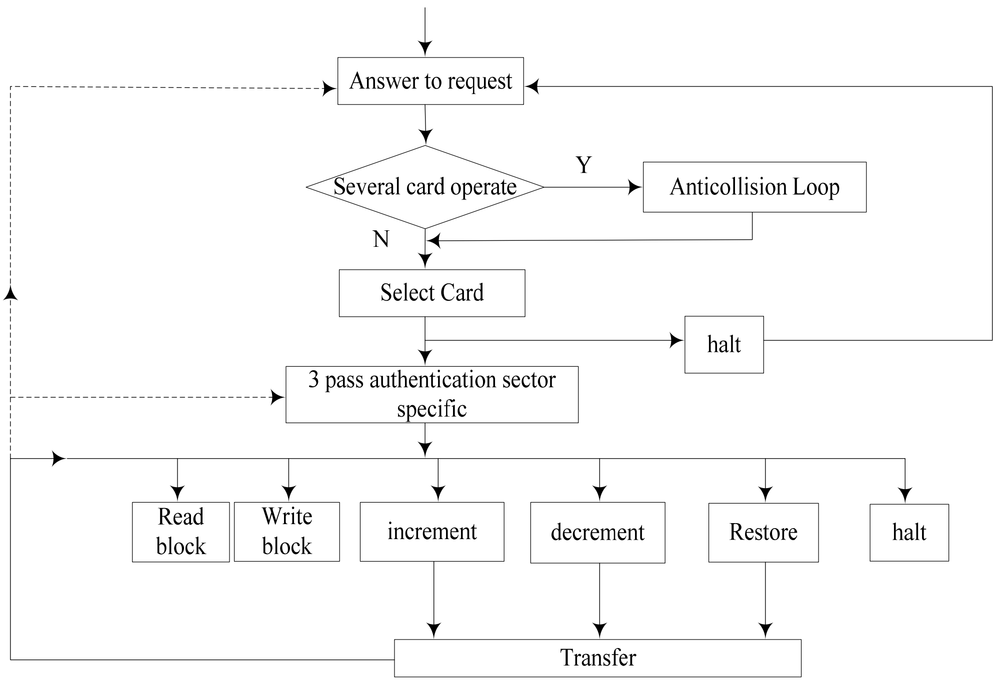

Figure 6. The flow diagram of read card

3.3. Circuit of GSM Terminal

Sony Ericsson GR47 is selected which belong to a new generation of Sony Ericsson Mobile Communication GSM/GPRS modules. The GR47 module provides Chinese language, and provides four transmission modes including voice, data, short message, and FAX. The module works in frequency bands EGSM 900/1800 MHz, power voltage 3.3-3.5V [9]. The product can be used in machine-to-machine applications and man-to-machine applications where there is a need to send and receive data (by SMS, CSD, HSCSD, or GPRS), and make voice calls by the GSM network [9].

Microcontroller presents a pulse to the ON/OFF signal connection of GR47, which is designed to exceed 0.5 seconds but less than 1.0 second [8]. When SM is prepared to be sent, the microcontroller sends AT commands to the radio device via serial interface ports. The digram of GR47 design is as shown in Figure 7. In order to reduce electrical current, R1 and R2(R1=R2=3.6kΩ) are used. (R3=3.6kΩ, R4=12kΩ) [10].

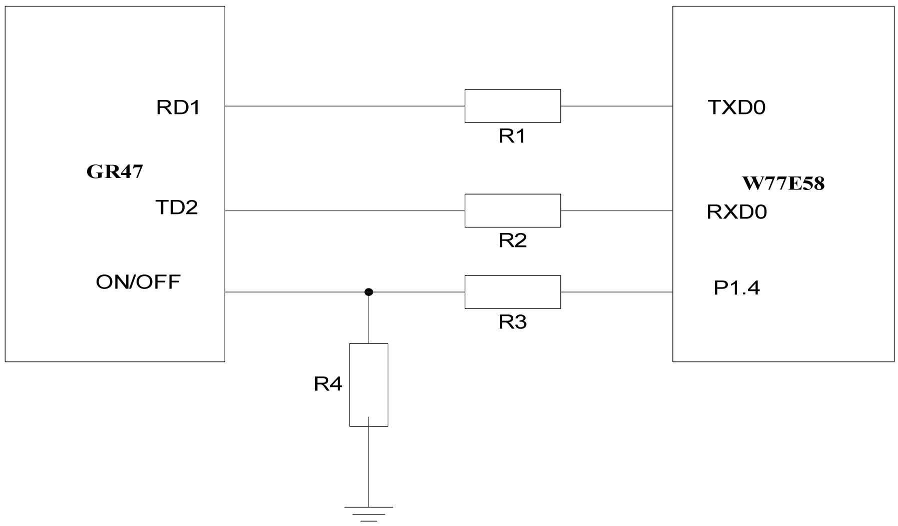

Figure 7. The diagram of the GR47 and W77E58

At present, there are two usual modes: Text and PDU (Protocol Data Unit). It is easy and simple to receive and send for Text mode, but Chinese short message cannot be received and sent. However these can be realized for PDU mode which includes three codes: 7-bit, 8-bit and UCS2. Among these codes, ordinary ASCII characters are sent for 7-bit code, data information for 8-bit code, Unicode characters for UCS2 code. In this paper, PDU mode is adopted, whose data frame structure is as in Table.4.

Table 4. PDU data package structure

SMSC	PDU type	MR	DA	DIP	DCS	VP	UDL	UD

In PDU data frame structure, SMSC field stands for short message center address; as well as PDU type for data package type, MR data package for sent information, DA for destination address, DIP for protocol identifier and DCS for short message code mode. Code of digit or character is ‘00’, and code of Chinese is ‘08’ for Unicode adopted in this paper. VP stands for valid time of short message as well as UDL for the length of data and UD for the content of specific short message [11].

4. Implementation and Results

The realizations of proposed system functions rely on mobile communication between computer and microcontroller based on GSM. The system comprises a control center composed of a server, a GSM module and a database system, and monitoring terminal composed of microcontrollers, sensors, a MF RC500 and a GSM module in the base station. The value of parameters is measured at every base station, including air temperature, air humidity, the information of entrance guard etc. The sensors and MFRC500 are combined to collect the real-time environment parameter data and hand over these data to microcontroller processor for handling and storage.The microcontroller determines whether the data are normal or not. Once the abnormal parameter data appear, processor will arrange the abnormal message and initiate the data transmission and send it out to control center. The flow diagram of the monitor terminal is shown in Figure 8.

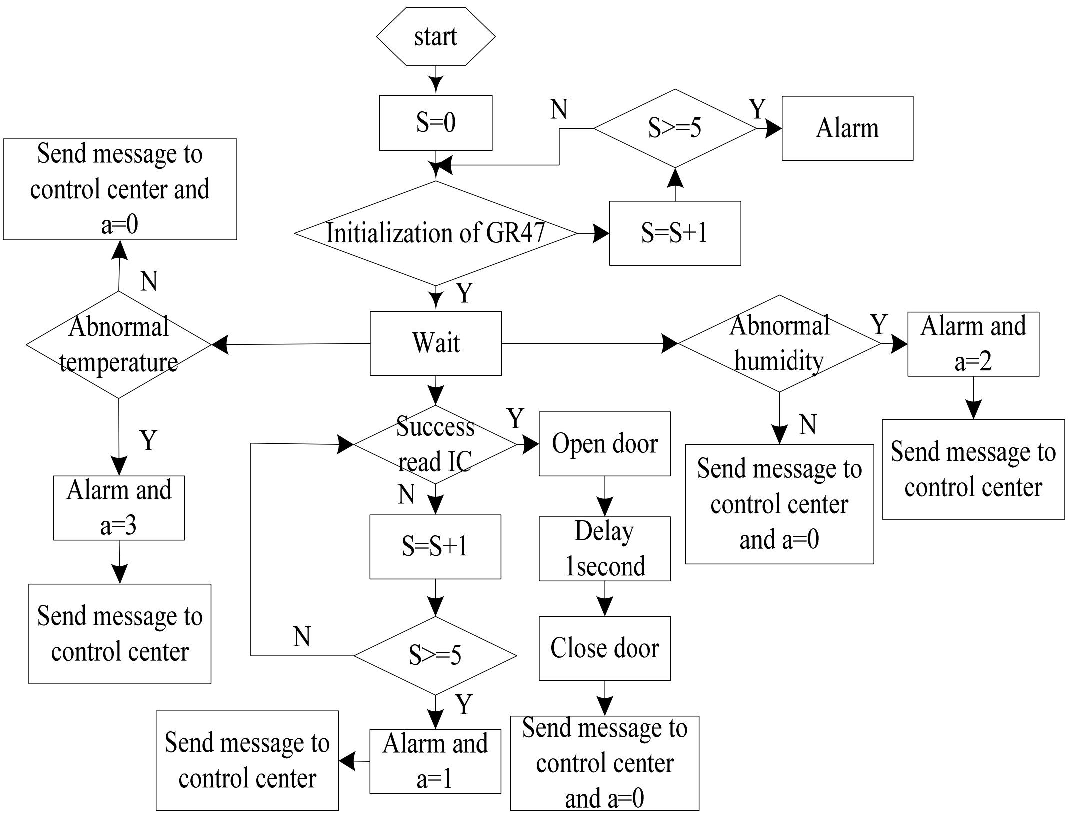

Figure 8. Flow diagram of monitor terminal software

5. Conclusion

This paper proposes a remote monitoring system base on SM. The most significant features of the system are applications of RF and GSM technology. The results show that it can meet the basic requirements of sensor accuracy, communication and so on. In addition, the system has good extensibility and compatibility. The operation and implementation cost of the system has been reduced by the use of SMS. Besides, it is easy to install and upgrade. For example, when the number of monitoring information increases, the communication mode of system can be designed based on GPRS. Because the GR47 module can support GRPS, the hardware of system does not need to change. There are wide application prospects because of limitlessness of terrain and being suitable for remote monitor.

Acknowledgment

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