A Remote Temperature Monitoring System Based on GSM

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***Abstract*—This paper has discussed the home and abroad 's current situation of temperature monitoring system and compared the advantages and disadvantages of several common methods .According to cold storage, container, medicines library and greenhouse's requirements on temperature, this thesis has analyzed the advantages and significance of the system and elaborated each module's function and implementation based on hardware and software's introduction and demonstrated the pictures of its practical application and the alarm information saved in the SD card which extracted from the database.**

***Keywords*—DS18B20; GSM（Global System for Mobile Communications）; SD card; Database**

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1 Introduction

With the rapid development of agricultural and food processing industry, in-season food, frozen food and fresh food are very popular with consumers. The most suitable temperature and humidity for biological diversity's growth are different. Therefore the operators of greenhouse, aquaculture or livestock market always control the temperature in the best range to obtain the maximum economic benefit. Therefore container and cold storage have both played more and more important roles in food safety.

At present, numerous temperature control equipments have been made to solve the problems of food storage. Most of them are low-end close-measuring instruments or high-end distance measuring instruments. It limits the management to the cold storage area or culture zone greatly. In this system, users only need a GSM (Global System for Mobile Communications) mobile phone card; they can communicate with the system with a telephone, achieving real-time remote monitoring of the controller object conveniently.

Meanwhile, when the temperature value exceeds the warning range, the system will automatically alarm and send alarm signal to the user in the form of messages. The system uses a 1G SD (Secure Digital Memory Card) card to store historical temperature data and alarm data. To facilitate viewing, data extraction can be achieved by PC-specific software as well. Users can obtain the temperature data and generate a curve by setting a specific period of time according to their needs. These studies are helpful to the research of optimal temperature for animals and plants' growth and grasp the temperature's changing rate of the cold storage and the container.

This thesis focuses on the elaboration of hardware and software's design and debugs results done in details.

2 Hardware design

Hardware system includes: DS1302 time module, temperature measurement module, Flash memory module, SIM300C wireless module, SD card storage module and microcontroller control module. The system's hardware block diagram is shown in Fig.1:

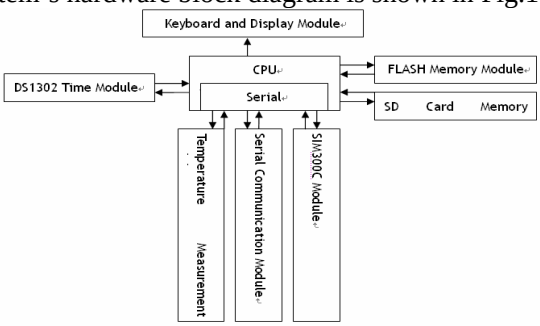

Fig. 1 The overall block diagram of hardware

Each module's function:

SD Card Memory Module: Used to store historical temperature value, alarm data, and query data. Considering the CPU — STC89C58RD+[1], s load capacity and the needed memory capacity, we selected the SD card with 1G memory capacity. At the same time, as the CPU needs +5 V power supply, however the SD card needs a +3.3 V power supply, they will not be able to have normal communication if they have Direct communication in SPI mode. Therefore, the system uses resistor divider circuit to achieve the

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MCU[2] and the SD card's connection. As the CPU pin internal pull-up resistor is 10KΩ and the partial pressure resistance of the circuit is 1.8KΩ and 3.3KΩ, we needs to add a 510Ω pull-up resistor to the SD I/O pins to add to ensure the SCM and SD card's communication.

In order to ensure the stable voltage supply to SD card Memory Module, the system uses a voltage converter chip ASM1117-3.3.

The specific circuit is shown in Fig. 2.

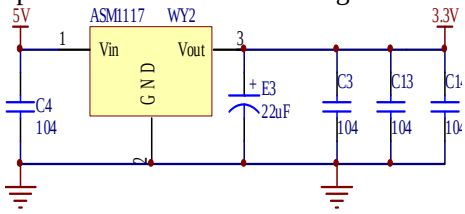

Fig. 2 The ASM1117-3.3's voltage converter circuit

FLASH Memory Module: used to store the parameters offered by the keyboard. The system uses AT24C08 as the memory chip. It has a strong power-down memory function. After restarting the system, we can directly fetch the initial parameters in the AT24C08 stored last time conveniently and time-Saving.

Keyboard and Display Module: System select the 4 * 3 determinant keyboard, using seven I / O pins of the Microcontroller, using scanning way to judge the button is pressed or not. The module is used to set the user's mobile phone number which will be used to receive the messages sent by the system, alarm interval, the temperature alarm's range and time. The display module use static display and use a serial-in parallel-out shift register 74LS164 and an 8-bit LED digital tube to achieve its function.

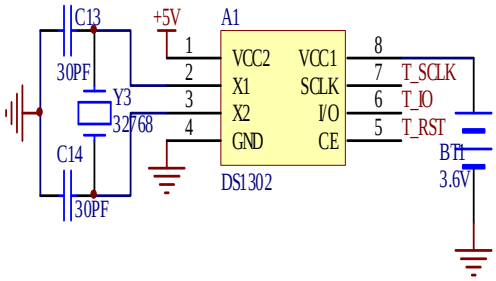

Fig. 3 DS1302 time module

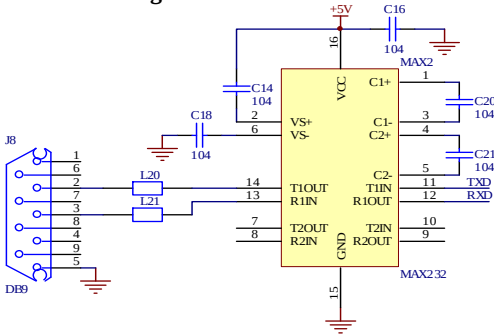

Fig. 4 The communication module between PC and the system

DS1302 Time Module: providing with exact time for the system. DS1302 does not only use +5V power supply in the system, but also can be recharge by the battery. When VCC2 is +0.2V higher than VCC1, DS1302 adopts VCC2 battery for supplying power; while VCC2 is lower, VCC1 is adopted by DS1302, which gets the system have the function of protecting power losing.

Temperature measure module: The system uses digital temperature sensor DS18B20 to gather temperature, which, with higher stability and accuracy, can accurate the gathering temperature to 2 decimal places and is a single-bus digital temperature sensor saving I/O ports. However, that the DS18B20's data transmission mode uses single-bus TTL level severely restricts the transmission range of the signal (The experiment tests that the actual secure distance is 20meter.). This module adopts RS485 as the data transmitting bus between DS18B20 and the system. RS485[4] transmits in differential mode and the threshold of its receptor is ±200mV, which causes to greatly extend the transmission range, 1200m in theory but the measured valid is 300m.

Serial communication module: Considering the local applied distance, the system adopts MAX232[2] communicating with PC[5]. The physical circuit is in Fig.4.

SIM300 module: The user can set each parameter of the system and get the current temperature of the refrigeration house by the communication between GSM and this module.

3 Software design

The system software design uses modularizing program design flow and the software modules mainly include main program, determinant keyboard scan program, digit on showing program, FLASH memory program, temperature gathering program, SD card access program, SIM300C sending alarm program, DS1302 time module program and serial interrupt program. The main program and SD card access program are separately shown as Fig.5 and Fig.6.

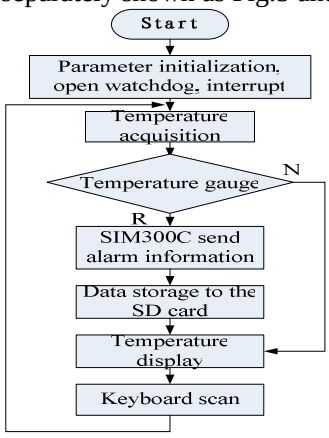

Fig. 5 Main program flow chart

3.1Main program design.

The main program should aim for conciseness, modularization, being orderly and using nesting as little as possible.

The main function of main program contains opening watchdog, initializing gotten FLASH data and calling other sub-module program. The timer/counter in the main program plays an important role in receiving serial port interrupt and sending temperature gathering command in time. The most important function of timer/counter is calculating the exact initial value as needed. For example, the system adopts Timer0 for timing to ensure the transmitting integrity of the serial data in the serial interrupt, serial port baud rate selected 9600bpS, that is the number of transmitting bit is

$$N=9600/8=1200$$

The time the serial port transits a bit is

$$T=1/N=1/1200=8.3*10\text{-}4s=0.83ms$$

Therefore, in order to ensure the data transmitting integrally, the timing time of timer0 must be larger than 0.83ms.So the initial value of timer0 can be set TL0=0xF5，TH0=0xF5, timing time is 2.8ms.

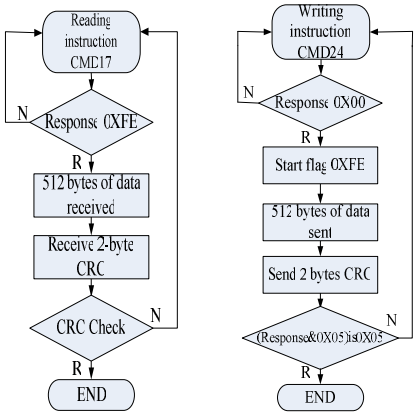

Fig. 6 SD card read and write flow chart

3.2 SD card read/write program design

The most important use of SD card is initialization. Only making the correct initialization, each operation behind can go on well. When initializing, at first send 74 clock signal to SD card to ensure the clock synchronization between microcontroller and SD card, then write CMD0 and CMD1 and make SD card into SPI mode. In the process of initialization it should be assured the clock of SPI can not be too fast, or else it will cause the failure of the initialization.

4 Experiment results

After more than a year's application we can conclude that the system is stable, Well-Behaved. The physical map is shown in Fig. 7.

Fig.7 The physical map

From the database the temperature alarm range, the alarm exact time, phone number and other details can be seen clearly. Fig. 8 shows the specific details.

ID	Content	SysTime	Dest	category	Address
1	当前的温度为27.41,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 2:30:07	13573887173,13573887173	1	0
2	当前的温度为27.51,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 2:40:07	13573887173,13573887173	1	0
3	当前的温度为27.51,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 2:50:08	13573887173,13573887173	1	0
4	当前的温度为27.47,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 3:00:08	13573887173,13573887173	1	0
5	当前的温度为27.45,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 3:10:09	13573887173,13573887173	1	0
6	当前的温度为27.51,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 3:20:12	13573887173,13573887173	1	0
7	当前的温度为27.37,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 3:30:13	13573887173,13573887173	1	0
8	当前的温度为27.26,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 3:40:16	13573887173,13573887173	1	0
9	当前的温度为27.2,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 3:50:17	13573887173,13573887173	1	0
10	当前的温度为27.14,设置的温度下限为24.7上限为25.超出了温度阈值!请及时调整!	2010-5-4 4:00:19	13573887173,13573887173	1	0

Fig.8 Data in the SD card

We can get the temperature curve by the system based on the acquired temperature value.

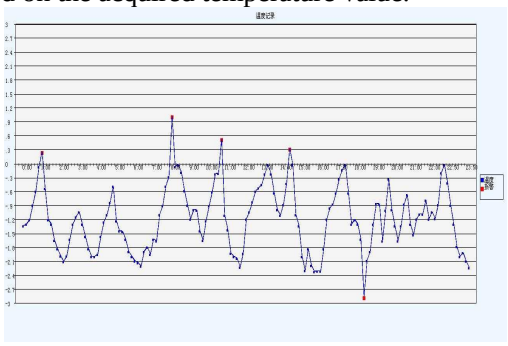

Fig. 9 Temperature curve

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(From P.201)

Running time, that is to say, the improved algorithm can reach the end point by passing fewer nodes, and can tend to the goal point quickly.

5 Conclusions

The traditional Dijkstra algorithm is widely used in the route optimization process, but it has limitation in practical application because of its own shortcomings. This paper adopts the way of combination of adjacency list and circular list to store data. At the same time, it uses the improved Quick Sort Algorithm to sort the weight number, realizing the quick research of adjacent nodes and getting the improved Dijkstra algorithm. At last, there is an experiment to show that the improved Dijkstra algorithm not only saves the storage space but also improves the efficiency, so it has certain practical value.

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