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Design of Temperature Monitoring System Based on Micro-controller

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Abstract. Temperature is one of the most basic environmental parameters. The measurement and control of temperature are of great significance and application value in people's daily life and industrial production. So, this paper realizes the temperature monitoring system based on STC MCU. The DS18B20 temperature sensor is used in the hardware, and the display circuit, temperature overrun alarm circuit and key input circuit are set up. Finally, according to the design of the system, the temperature measurement accuracy and stability are tested, and the results show that the measurement error of the system can be controlled within 1℃. in addition, the system has the characteristics of simple measurement, low cost and easy to use, good market prospects.

Introduction

Temperature is one of the most basic environmental parameters. The measurement and control of temperature are of great significance and application value in people's daily life and industrial production[1,5]. In the temperature measurement methods, the traditional mercury or kerosene thermometer has the character of low accuracy, slow speed and not convenient. While non contact infrared temperature measurement has relatively low accuracy, and the sensor is expensive, the price is not high[6,12]. In contrast, the digital temperature sensor developed in recent years has been widely used in industrial measurement, environmental temperature detection and other fields because of its high precision, low price and easy to measure[13,15].

Based on this, the STC microcontroller and DS18B20 digital temperature sensor, LCD display and expended keyboard, are used for the design of the digital temperature measuring system, and the experimental tested for the measurement system is executed.

The design for the Whole System

The overall design of the system is shown in Figure 1, which is composed of a single chip microcomputer minimum system, a temperature sensing module, a temperature display module, an expansion key module and an alarm module. The MCU minimum system consists of STC51 microcontroller, clock circuit and reset circuit, and is charge for the realization of the whole system control and temperature acquisition, processing and display. The temperature sensor is used for sensing the subjects of temperature; the temperature display module is charge for display on system operation and human-computer interaction; extension buttons for the 4×4 matrix keyboard is the input device for human-computer interaction; alarm module is used for measuring object temperature alarm.

When the system works, first set the temperature of the upper and lower limits, and then read the temperature sensor through a digital interface.The measurement data in the single chip computer is filtered and displayed at the same time measuring whether the temperature exceeds the limit value, to determine whether alarm prompt action.

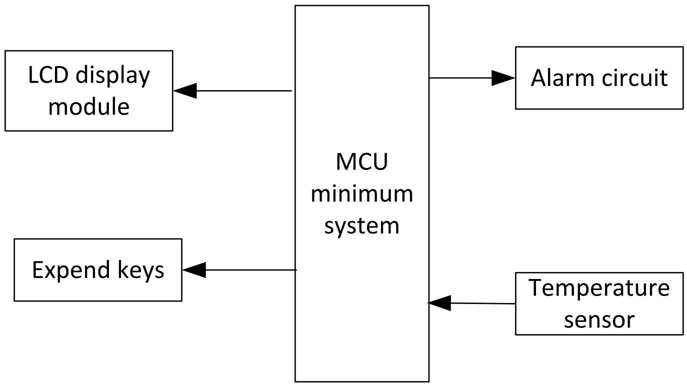

Fig. 1 diagram for the Temperature measurement system

The Description for The Microcontroller. STC12C5A60S2 is a single-chip microcontroller based on a high performance 1T architecture 80C51 CPU, which is produced by STC MCU Limited. With the enhanced kernel, STC12C5A60S2 executes instructions in 1~6 clock cycles (about 6~7 times the rate of a standard 8051 device), and has a fully compatible instruction set with industrial-standard 80C51 series microcontroller. In-System-Programming (ISP) and In-Application Programming (IAP) support the users to upgrade the program and data in system. ISP allows the user to download new code without removing the microcontroller from the actual end product; IAP means that the device can write non-volatile data in Flash memory while the application program is running. The STC12C5A60S2 retains all features of the standard 80C51. In addition, the STC12C5A60S2 has two extra I/O ports (P4 and P5), a 10-sources, 4-priority-level interrupt structure, 10-bit ADC, two UARTs, on-chip crystal oscillator, a 2-channel PCA and PWM, SPI, a one-time enabled Watchdog Timer.

The Temperature sensing module. The temperature collecting sensor in this paper is the Digital Thermometer DS18B20 Which provides 9 to 12-bit temperature readings [6] [7] and the interface circuit for sensor and microcontroller is shown in figure 2. Because of the Information sent to/from the DS18B20 over a 1-Wire interface, only one wire (and ground) needs to be connected from a central microprocessor to a DS18B20. Power for reading, writing, and performing temperature conversions can be derived from the data line itself with no need for an external power source.

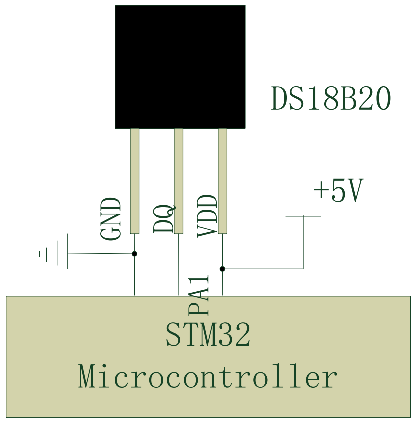

Fig.2 interface circuit for sensor and microcontroller

The Flow Chart for the Designed Software . System implementation process is shown in Figure 3, after the initialization of power, the system first entered the initialization state, and initialize the timer, IO port, clock and other peripherals. then judge whether to set the temperature, set accordingly if needed, otherwise, directly read the subjects of internal temperature, and then determine whether exceeds the limit value after calculation. if exceeded, alarm and sent to display; otherwise, the measurement results will be displayed directly.

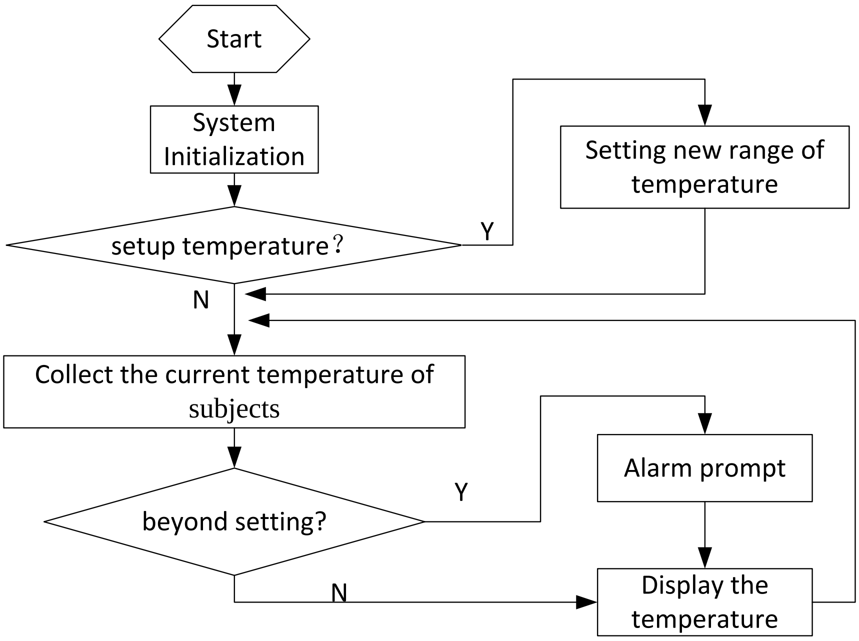

Fig. 3 the execution flow of System algorithm

Experiment and Result Analysis

To verify the stability of the system design and master the performance of temperature control, the experiment for temperature measurement has been done and the recorded data is shown in Table 1. The experimental results show that the precision of temperature mesurement is very high, and the total relative error can be controlled within 2%.

Tab. 1 experimental data for temperature control

Setting value/ ℃	Stabilized value /℃	Relative error
20	20.2	1%
30	29.5	1.67%
40	39.6	1.5%
50	51	2.0%
60	58.9	1.83%
70	71.2	17.1%
80	81	1.25%
90	89	1.11%
100	99.2	0.8%

Conclusions

The temperature measurement system is designed and realized by using the C51 single chip microcomputer, with the sensor, display module, and the expanded keys. The experimental results show that precision of the designed system is very high, and the total error can be controlled within 2%

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