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Discussion on Design of Intelligent Temperature Measurement System in Sports Environment Laboratory

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Abstract:

The temperature measurement system is one of the most important systems in the sports environment laboratory (artificial climate laboratory). Temperature changes in the sporting environment are characterised by non-linearity, large delays, high accuracy and complex mathematical models. Traditional control methods have limitations in terms of accuracy and model complexity. In this paper we explore the design and production of an intelligent multi-point temperature measurement system often used in modern society. The multi-point temperature measurement system is based on an AT89C51 microcontroller, C language and DS18B20 sensors and a simulation of the Proteus platform. The system has the advantages of simple circuitry, low cost and good control accuracy. The solution is applied to the temperature control of the motion environment and has good prospects for application in motion testing.

Keywords: *Sports, Artificial climate laboratory, Intelligent temperature detection system, C language, Proteus*

I. INTRODUCTION

The exercise environment laboratory is a laboratory that has been used in recent years to study human exercise in an artificial climate [1]. Temperature is one of the most important parameters and the temperature measurement system is one of the most important systems. As one of the most basic environmental parameters, temperature is required to be measured in real time at all locations in the environment [2,3]. Intelligent multi-point temperature measurement systems are widely used in sports environment laboratories to effectively, instantly and accurately measure the temperature at all points in the room and feed back to the control system so that the system can make immediate temperature adjustments to reach the target temperature and achieve accurate laboratory temperature control [4]. Therefore, it is important to design and manufacture intelligent multi-point temperature measurement systems. This paper describes the design and operation of the intelligent temperature measurement system, which has great advantages and broad application prospects compared with various other general measurement systems.

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II. DESCRIPTION OF COMPONENTS

2.1 AT89C51

AT89C51 is a low-voltage, high-performance CMOS 8-bit microprocessor with 4K bytes of FLASH memory (FPEROM-Flash Programmable and Erasable Read Only Memory) low voltage, high performance CMOS 8-bitmicroprocessor. The AT89C2051 is a low voltage, high performance CMOS 8-bit microprocessor with 4K field flash memory, stable performance, low price and wide adaptation. The device uses ATMEL high density non-volatile memory manufacturing technology, is compatible with the industry standard MCS-51 instruction set and output pins, and has a versatile 8-bit CPU and flash memory combined on a single chip. The AT89C2051 is a microcontroller with 2K bytes of flash memory and is a lite version of the AT89C51. This microprocessor is a common and efficient microcontroller, it is widely used in many embedded automatic control systems and is readily available on the market [5].

2.2 DS18B20

DS18B20 is a commonly used digital temperature sensor, its internal memory includes a high-speed temporary RAM and a non-volatile electrically erasable EEPRAM, the latter holds high and low temperature triggers TH, TL and structure registers. Its output is a digital signal, with small size, low hardware overhead, strong anti-interference capability and high accuracy. The DS18B20 digital temperature sensor is easy to wire and can be packaged into a variety of applications, such as pipeline, threaded, magnet adsorption, stainless steel package, a variety of models, such as LTM8877, LTM8874, etc. The DSl8B20 is the first digital temperature sensor to support a single bus interface, which can instantly and directly read the temperature of the object to be measured, with very stable performance It can achieve 10, 11, 12 and 13 bit resolution temperature data, corresponding to 0.25°C, 0.125°C, 0.0625°C and 0.03125°C. In addition, it has a relatively large measurement range, measuring ambient temperatures from -30 °C to 125 °C. It also has a measurement accuracy of ±0.25 °C and a stability of 0.75%. The measuring range, accuracy and stability meet the basic requirements of an artificial environment laboratory [6,7].

III. HARDWARE DESIGN OF THE TEMPERATURE CONTROL SYSTEM FOR THE SPORTS ENVIRONMENT LABORATORY

3.1 General Structure of the Temperature Control System

Using the characteristics of the microcontroller DS18B20 and AT89C51, the system uses 10 DS18B20s to form a sensor network system, connected in parallel to the general purpose I/O ports of the microcontroller. Once the microcontroller has obtained the ambient temperature conversion data, it will be converted to temperature data on the display by a specific algorithm, and the temperature data will be uploaded to the host computer for backup processing.

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3.2 Operation Commands (Type 33H, 55H, COH, F8H, ECH in Sequence)

Operation initialization. Initializes all operations on the bus in the system. MCU first resets the signal, then DS18B20 issues an online signal and waits for the command. ROM operation commands: After receiving the online signal from DS18B20, MCU issues 4 ROM operation commands, which are 8-bit.

1. Read command: When a single DS18B20 is online, the MCU can read the specific product code, CRC code and serial number of the DS18B20 in ROM. When multiple DS18B20s are online, we will generate a line with the transport bus to create a data conflict.

2. Select position command: MCU sends command when there are more than one DS18B20 online, 64 1-bit columns. The internal ROM of DS18B20 is in the same order as the host, and the other DS18B20s wait for reset when the host sends the command.

3. Skip ROM serial number detection command. In a single DS18B20 system, this command allows the MCU to skip the ROM sequence number and detect the register operation directly. In multiple DS18B20 systems, this can cause data conflicts.

4. Query command: At the start of the system, the MCU looks for the device and its 64-bit serial number.

5. Alarm query command: The DS18B20 should be ordered when the last temperature measurement is set as a warning flag. When the measured value changes in TH, TL, TL, TH, the temperature value is in the new range and the flag will be invalidated if the DS18B20 is in the electric state. If the DS18B20 is in the electric state it will remain valid.

If the command successfully causes the DS18B20 to complete a temperature measurement, the data is stored in the DS18B20's memory. A control function command instructs the DS18B20 to perform the temperature measurement. The measurement results will be placed in the DS18B20 memory and can be made read by issuing a memory function command to read the contents of the on-chip memory. The temperature alarm triggers TH and TL both have one byte of EEPROM data. These registers can be used for general user memory purposes if the DS18B20 does not use the alarm check command. A configuration byte is also contained on-chip to ideally resolve the temperature digital conversion. Writing the TH, TL instructions and the configuration byte is done using a memory function instruction. The registers are read via the buffer. All data is read and written starting from the lowest bit.

3.3 Memory Operation Commands

1. Write (4EH): Data is written from the second byte (TH) to the second to fourth bytes of the register before the reset signal is issued.

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2. Read out (BEH): Reads the register contents, starting from the first byte and going to the ninth byte. If only part of the content is available, the MCU will send a reset command.

3. Copy (48H): 2 to 4 bytes are transferred to the EERAM DS18B20. If the DS18B20 is powered by the signal line, the bus must be guaranteed to be pulled for at least 10ms. When the signal is given, the host will issue a read timing to read the bus. The result is 0 if the memory in progress is opened and 1 when the read is finished.

4. Start of conversion (33H): The DS18B20 will perform a temperature conversion as soon as it receives the command. If the DS18B20 is idle, the MCU read bus will receive a 0 and convert to a 1 when the temperature conversion is performed. if the DS18B20 is powered by the signal line, the MCU will provide at least the temperature conversion time for the corresponding resolution.

5. Callback (B4H): This command is to bring the content of EERAM back to TH and TL and set the register cell. The DS18B20 can callback automatically after power on, so valid data exists in TL and TH after the device is powered on. After this command is issued, the MCU reads the bus. Read 0 means busy, 1 means end of callback. When the MCU issues the read power flag command, the DS18B20 will send power. 0 indicates signal line power and 1 indicates external power.

IV. VIRTUAL SIMULATION

Proteus is the famous EDA tool (simulation software) from Labcenter UK, from schematic layout and code debugging to co-simulation of microcontroller and peripheral circuits, switching to PCB design with one click, truly realising the complete design from concept to product. It includes modules such as ISIS and ARES, with ARES used to complete PCB design and ISIS used to complete circuit schematic drawing and simulation [8]. It is the only design platform in the world that combines circuit simulation software, PCB design software and virtual model simulation software in a single package. Its processor models support 8051, HC11, PIC10/12/16/18/24/30/DSPIC33, AVR, ARM, 8086 and MSP430, etc. In 2010, the Cortex and DSP series were added processors, and other families of processor models continue to be added [9]. The Proteus software enables easy access to a fully functional, practical and convenient microcontroller experimental environment.

The circuit is simulated using the EDA platform's Proteus virtual simulation technology and the temperature data is collected and displayed in real time. The main program execution flow is shown in Figure 1. All DS18B20s are first initialised, and then the write command and read data modules are repeatedly called. Once the circuit design and software programming is complete, the program is edited, put into the microcontroller, run the computer and simulated. Observe the implementation of the temperature detection system [10-12]. The components in the simulation test are normal. In the test, the measured data agrees with the thermometer and with the simulation results. On this basis, we can also add a control switch and a buzzer alarm over, the whole system has an abnormal self-test process, and feedback

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to the user, can realize a real-time monitoring of the temperature of the whole movement environment laboratory, to achieve the specific requirements of the artificial simulation of climate on temperature control.

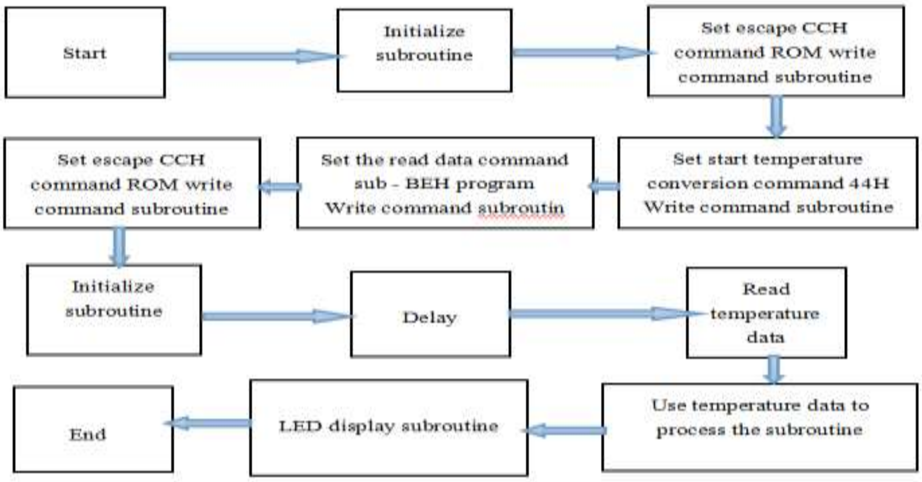

Fig 1: System software design

V. CONCLUSION

The structure of the motion environment intelligent temperature measurement system is relatively simple, the program design is reasonable, virtual simulation experimental results show that the operation effect is good, the temperature measurement speed is faster, the temperature measurement is more accurate, the actual temperature difference is not large, and the actual motion is more similar to the motion, can be used for the temperature monitoring of the motion environment laboratory. Using the Proteus platform simulation experiments, the temperature data acquisition and display of multiple DSl8B20 sensors is achieved, the function of the alarm is improved and monitoring abnormalities can be instantly alerted and corrected immediately. The design time and efficiency are improved, and the system is stable in terms of accuracy in practical applications. The system has the advantages of simple circuitry, low cost, good control accuracy, safety and stability. The solution is suitable for temperature control in sports environments and has good prospects for practical application in sports environment control.

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