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Temperature and Humidity Control System of Vegetable Greenhouse Based on Single Chip Computer

Guoyong Liu*

Xi'an Fanyi University, Xi'an, China

26146593@qq.com

**corresponding author*

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Abstract: It changes all year round. In the north, in order to satisfy the public's desire to eat fresh vegetables in winter, vegetable greenhouses came into being. With the rapid development of society, people have put forward higher and higher requirements for the quality of vegetables. The temperature and humidity of the greenhouse have a great influence on the quality of vegetables. Therefore, in order to ensure the quality of vegetables, the temperature and humidity of the greenhouse must be kept within the range most suitable for the growth of vegetables. Therefore, the design of the temperature, room temperature and humidity control system are particularly important. The temperature and humidity control system based on single-chip microcomputer designed in this paper monitors and tempers the greenhouse temperature in real time through the DS18B20 and DHT11 temperature and humidity sensors, respectively, and displays the monitoring results on the liquid crystal display. The single chip microcomputer adjusts the greenhouse temperature and humidity through the monitoring results In order to keep the temperature and humidity of the greenhouse in a constant range. The temperature control system in this paper can achieve a measurement accuracy of ± 0.3 ℃ and a display accuracy of 0.1 ℃. It can also manually adjust the temperature and humidity within a certain range to suit the growth conditions of different vegetables. The results show that the temperature measurement system has the characteristics of high accuracy, high sensitivity, stable operation and so on, which meets the performance requirements of the design. It is a reliable digital temperature measurement control system.

1. Introduction

With the continuous development of society, related agricultural technologies are also developing rapidly. Horticultural facilities engineering has the characteristics of multiple disciplines, new technology, high technology content, and close to people's livelihood, etc., which are increasingly valued by countries around the world. This provides a good opportunity for the development of large-scale modern greenhouses in China, and has played a great role in promoting it. China continues to develop in the process of adhering to independence and absorbing advanced foreign experience [1-3]. The greenhouse is the ideal place to create the best space and conditions for plant growth, eliminate temperature changes caused by seasonal changes, and block the effects of severe weather conditions. In order to achieve the goal of greenhouse intelligent environment control, it is necessary to actively adjust the environmental factors such as temperature, sunshine, humidity, and carbon dioxide concentration to achieve the best growth environment for crops. At present, because China is in the development stage, the construction and working equipment of the greenhouse are relatively simple, the control of the environment in the greenhouse still needs to rely on manual and empirical management. The study of environmental factor control and automatic control is still in its infancy, and it has greatly affected the development of facility agriculture. Especially in the northern alpine region, due to its high latitude, climate change in all seasons, large temperature difference between day and night, and the cold and long winter, which is not conducive to the growth of crops, we should develop greenhouse technology. At present, most greenhouse temperature detection systems still use traditional temperature detection methods. The greenhouse can protect the constant temperature in the greenhouse, block the influence of adverse weather conditions on the crops, and ensure the supply of fresh vegetables throughout the year, so it is necessary to develop the greenhouse [4, 5]. In northern China, due to the high latitude, the temperature difference between day and night is large in the four seasons, and the winter is long and cold, which is not suitable for the growth of crops. Therefore, it is very important to develop a complete temperature information detection system, especially a multi-point temperature measurement system. Just relying on experience and labor costs are too high, and it does not have the scientific ability to be easily interfered and affected, which is not conducive to the controller to make correct decisions. The design of this thesis is to use single chip microcomputer and digital temperature and humidity sensor for design. The system can realize automatic adjustment and measurement of indoor temperature and humidity, which can reduce the labor intensity of many workers [6-8].

In the past temperature control system, analog temperature device is usually used. Although it can help to complete the temperature control work to a certain extent, but in the process of temperature detection, it is easy to produce large errors, and the operation is complex. Therefore, some researchers have proposed that the use of single-chip microcomputer in the temperature control system can directly connect the two and replace the measured temperature with digital signal [9], which can effectively ensure the accuracy, safety and reliability of temperature control. The single-chip microcomputer integrates CPU, ram, ROM and many other interface and terminal components into a very powerful integrated single-chip microcomputer. Although its external volume is very small, it can process all kinds of digital information quickly and accurately in power supply and crystal. The temperature sensor is one of the important carriers of the temperature measurement and control system. It transmits the collected temperature data information to the circuit and directly converts it into electrical signal [10-12]. But because the initial signal is relatively small, so you need the influence of the amplification processing of the primary voltage amplification circuit. At the same time, use the band-pass filter of the clutter signal filtering circuit, amplify the electrical signal through the final amplification circuit, and pass the temperature signal voltage requirements of the single chip microcomputer. The temperature control system based on single chip microcomputer will use Da amplifier. The voltage signal can be directly converted into digital signal, and then the digital signal can be directly displayed on the electronic display screen by programming program, so as to help employees understand the real-time temperature value accurately. The system and PID algorithm will get different output of temperature and temperature difference through the I / O interface of single-chip microcomputer, making it a value. The single-chip microcomputer controlled by temperature and direct control controls the temperature time and environment of the circuit power supply by controlling the heating power supply, so as to achieve the ultimate goal of accurate temperature detection and control.

The research of greenhouse environmental control technology began in 1970s. For the first time, the combined analog instrument is used to collect field information and instructions for recording and control. At the end of 1980s, distributed control system appeared. At present, a multi factor computer data acquisition and control system integrated control system are under development. At present, the greenhouse control technology is developing rapidly in the world. Some countries are moving towards the direction of complete automation and unmanned driving on the basis of automation. Holland is the world leader in greenhouse technology and highly industrialized in greenhouse industry. Dutch greenhouse is a kind of glasshouse vegetable greenhouse. It is energy-saving irrigation, intelligent temperature control, lighting control, climate control. All operation data of climate test function are input into computer. Vegetable production is limited by land and weather. Israel is famous for its efficient and energy-saving solar greenhouse technology, and its Mediterranean coast is cold in winter. Israeli technicians have developed a series of computer hardware and software to automatically control the water, fertilizer and gas in the greenhouse temperature control system of vegetable greenhouse. In the past five years, it began to export its greenhouse materials to all over the world. The area south of the Great Wall promoted the use of its technology in China, but there was no scale application in the cold northern area. American greenhouses are mainly used for growing flowers. Greenhouse heating equipment can be used for heating steam, hot water, fuel oil, natural gas and other heat sources. In winter, coil heating and spray are combined for indoor heating. Wet mat or spray cooling is used in summer. The auxiliary light source in winter is multi-purpose high pressure sodium lamp or metal halide lamp [13]. According to the parameters collected by various sensors installed inside and outside the greenhouse, the environment control computer system automatically controls the above items through computer analysis, decision-making and instructions. The University of London agronomy, developed by the greenhouse computer remote control technology, can observe the light, temperature, humidity, gas and water environmental conditions outside the greenhouse and carry out remote control.

At present, most of the temperature detection systems used in greenhouse are transmission systems composed of analog temperature sensors, multi-channel analog switches and converters. This kind of temperature acquisition system needs to place a large number of temperature measurement cables in the greenhouse, so as to send the signals of field sensors to the acquisition card. At the same time, the analog signal transmitted on the line is easy to be interfered and lost, and the measurement error is large, which is not conducive to the controller making timely decisions according to the temperature changes. Therefore, it is necessary to develop a real-time, high-precision, multi-point temperature information integrated processing measurement and control system. This paper designs a temperature and humidity control system based on 51 single chip microcomputers. Combined with single chip AT89C51, temperature and humidity sensors are used to collect temperature and humidity, and the collected temperature value is transmitted to the LCD screen for display [14, 15]. Cooling or heating is then automatically operated by fans or wires to achieve a constant temperature. The experimental results show that the system can monitor the temperature and humidity in real time and control the temperature and humidity effectively.

2. Hardware Design of Temperature and Humidity Control System

2.1. Hardware Composition of the System

This design is an automatic temperature detection and control system, the hardware part of the system mainly includes: AT89C51 single chip microcomputer, sensor, LCD display, motor, buzzer alarm LED device. The combination diagram is shown in Figure 1.

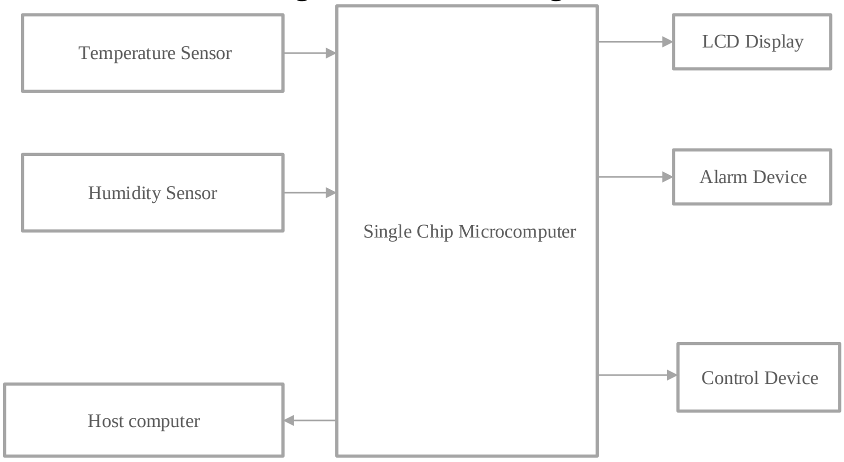

Figure 1. Hardware structure diagram

This system takes AT89C51 as the center, first uses it to detect the temperature, then uses the result to realize the automatic control and result display of the motor. If the monitored temperature is higher than the set value, the alarm will start the motor and start the corresponding control device

2.2 Single Chip Microcomputer Part

2.2.1. CPU Structure

CPU as the control center [16-18] is also the most important part. The CPU directly reflects the functions and main features of the single chip microcomputer, and executes commands and operations. Functionally, the CPU consists of two basic parts: an arithmetic unit and a controller. The controller and arithmetic unit are as follows.

(1) Operator

The arithmetic logic unit in ALU mainly includes arithmetic ALU, register B, temporary registers TMP1 and TMP2, accumulator ACCC and so on.

(2) Clock Circuit

The AT89C51 chip has a high gain inverting oscillator. The input and output parts of the inverting amplifier. The most important determinant is the calibration frequency of the quartz crystal itself, which is the oscillation frequency of the microcontroller. Frequency is about 1MHz ~ 12MHz

2.2.2. I / O Structure

(1) Program Memory

For the chip in this article, the ROM / EPROM on the chip contains 4000 bytes, and the maximum ROM / EPROM outside the chip can reach 60kb. The program memory on the chip, whether on-chip or off-chip, will be addressed uniformly. In the program memory, there are 6 address locations reserved for specific addresses.

(2) Data Storage

The data storage space of AT89C51 MCU is divided into internal and external slices, that is, RAM memory of internal slice data and RAM memory of external slice data storage chip.

2.2.3. Timer

There are two 16-bit timer 0 (T0) and timer 1 (T1) in AT89C51. These two parts of time or event counting function, that is, control delay, external event counting and detection occasions. The timer has counting, timing and four working modes. Timer T0 has four working modes: Mode 0, Mode 1, Mode 2 and Mode 3. Mode 0, mode 1 and mode 2 are the three working modes of T1.

2.2.4. Interrupt System

This design contains 5 interrupt request sources. If interrupt requests from multiple interrupt sources are sent to the CPU at the same time, it is necessary to ensure that the CPU interrupt service and the CPU need to distinguish interrupt requests, so some microcontrollers and microprocessors will be assigned to each interrupt source first.

2.2.5. Reset Circuit

AT89C51 single chip microcomputer usually adopts two methods of manual reset [19-21] and automatic reset. This design uses a power reset circuit, power reset means that as long as the microcontroller has power, it automatically enters the reset state. When the circuit is closed, the resistor R charges the capacitor C, and there is a positive pulse at the first end, thereby recovering.

2.2.6. Pin Function

The AT89C51 contains 40 pins, two of which are dedicated to the main power supply. In addition to the four pins that control other power supplies, the remaining 32 pins are used to control input / output.

(1) Main power supply pins VCC and VSS

VCC: connected to + 5V power supply.

VSS: ground the power supply.

(2) Clock circuit pins xtal1 and xtal2xtal1: form on-chip oscillator. When the external clock circuit is adopted, the pin is used as the driving end of the single chip microcomputer used in this paper. The pins on the HMO MCU must be grounded [22, 23] and connected to the external crystal according to xtal2. In the internal structure of MCU, the output frequency conversion amplifier oscillator is obtained, and the frequency of crystal oscillator is the frequency of oscillator. If the external clock circuit, the MCU pin needs to be suspended; on the MCU of HMO, it is used to connect the external clock pulse.

(3) When the power control signal pin of single chip microcomputer is powered on, the width of the upper pin is only input into two machine cycles (24 oscillation cycles), and the single chip microcomputer reset is completed; if the capacitance VCC and RST between single chip microcomputers are connected to the single chip microcomputer, and the 8.2k Ω pull-down resistor is connected, the single chip microcomputer can complete the automatic reset.

(4) P0.0-p0.7: P0 is two-way input. P0 port input command byte EEROM programming; when the verifier is connected to the resistance, the output command byte. P0 port driver 8 input channel LSTTL load current is absorbed in [11]. P1.0-p1.7: P1 is an 18 Bit quasi bidirectional I / O port. P1

port drives LSTTL to load, EEROM will input the next 8-bit address in the program or when it is programmed. P2.0-p2.7: P2 is an 18 Bit quasi bidirectional I / O port. When the CPU is accessed from external memory, it outputs a high 8-bit address. When checking EEROM programming and programs, it inputs a high 8-bit address. P3.0-p3.7: as the first function, P3 can be considered as a normal I / O port, with the same function and operation as P1. When used as a second function, the following table gives the definition of each foot [24-26]. These two functions can be defined as independent functions at the first or second import and export.

(5) The single-chip microcomputer works normally, and it is reset after power on and fault. There are two kinds of manual reset and power reset. Manual reset requires manually holding the first pin at a high level for at least one machine cycle. If the clock frequency of the system is a machine cycle, a higher duration is required. The system adopts the combination of manual reset and power on reset. There is an indirect button between the end and the power supply. When the user presses the button, the voltage will be directly applied to the other end [27]. Even if the user releases the button quickly, the connection time will be kept within a few milliseconds to ensure that the reset time requirements are met.

2.3. Digital Temperature Sensor DS18B20

DS18B20 is an improved intelligent temperature sensor developed by American semiconductor company. Compared with the traditional temperature resistance, it can directly read the measured temperature, and carry out simple programming to realize the bit value output according to the actual needs. Only one line is needed to read or write information. The temperature conversion power comes from the data bus. The bus itself can supply power to the connected power supply without additional power supply. Therefore, the system structure can be simpler and more reliable by using [28].

DS18B20 has the following main features:

(1) Only one I / O line is needed for communication;

(2) Distributed DS18B20 can communicate through one line;

(3) No external components are required;

(4) Data line power supply;

(5) The detection temperature range is about - 55 ~ + 125 ℃, and the accuracy is 0.5 ℃;

(6) 9-digit indicating temperature;

(7) It usually takes 200ms to convert the temperature into digital quantity each time;

(8) Define a constant temperature as the alarm temperature;

(9) There are two packaging methods, SSOP and pr35t.

2.3.1. DS1820 Internal Structure

(1) The laser system memory stores the DS1820 serial number, which is unique. The serial number is unique from the 9th digit, followed by the check code, which is used to check the first 56 digits. Multiple DS1820 can be used to communicate on this line.

(2) Temperature sensor, this instrument is the total component that converts the temperature into digital quantity.

(3) The memory of DS1820 consists of high-speed memory eeram and ram, and the data is written into high-speed memory RAM. The eeram command program is composed of 8 bytes' ram. The first two bytes store the temperature value for no detection. 1 (MSB) represents the value of storage temperature, and the number 0 (LSB) represents the value of storage temperature. If the temperature is negative, the memory 1 is 1. Otherwise, they are all 0,9-bit temperatures, which can

be represented by this reason. The last one is read from the beginning. If 1 is the lowest LSB, it means 0.5 degrees, according to the additional value of msblsb, and convert it to binary decimal number assignment to divide by 2 to get the value of measured temperature. The second and third bytes are copied from the second and TL values, if the power is updated; the fourth and fifth bits are useless, read 1; the next two bytes are the count register; the eighth byte is used to check the CRC.

2.3.2. Working Principle of DS18B20

From DS18B20 pin diagram. I / O bit data input / output is an open drain output, which is usually high if connected to an external pull resistor. Udd5v power terminal can be equipped with external power supply, which is often required to be grounded when not in use. GND is the connecting foot, NC is the suspended foot.

Temperature measurement technology is used, which is the result of DS18B20 temperature measurement method, while DS18B20 temperature measurement method rarely uses temperature measurement technology. The count pulse oscillator is affected by the temperature. The smoother it goes through the gate circuit, the lower the temperature is. On the contrary, the higher the temperature is, the pulse of the high temperature oscillator is blocked in the gate circuit.

2.4. Introduction to LCD1602

There are two common character LCD1602 for LCD pin. Due to the large number of GND grounded and backlight power line VCC (15 feet), there are 14 or 16 pin lines. In principle, VCC and character LCD1602 (14 pin) are the same.

Pin 1: VSS is power ground. Pin 2: connect the VDD to the positive pole of the power supply. Foot 3:VL is adjusted in the LCD contrast at the bottom of the screen. When it is grounded, the contrast is the highest, and the contrast with VDD is the worst. When the contrast is not enough, the potentiometer can be adjusted (usually 10K). Foot 4: RS is to select registers, and select instruction register and data register at the same time. Pin 5: R / W read-write signal line, high level and low level respectively complete the read-write operation. If RS and R / W are both low, the address or write command can be displayed. When RS is high R / W, RS low can be written. When RS is low R / W, RS busy can be written. Foot 6: the terminal is the enabling end. When the enable end is from high to low, the LCD module executes the command. Foot 15: backlight positive pole. Foot 16: backlight negative pole.

LCD1602 liquid crystal display module has a controller in memory, which has 11 programmable control commands. LCD1602 liquid crystal module operates according to instructions. In the figure above, the low level is 0 and the high level is 1. Instruction 1: clear the display, 01h is the instruction code, and the cursor position is reset to 00h address. Instruction 2: reset the cursor, the cursor changes to address 00h instruction 3: cursor and display mode settings I / D: cursor movement, high level moving right, low level moving left, s: all text on the screen moves left or right. High level is effective, low level is invalid. Command 4: display switch control. D: In general, the display is off during the control process, while the on / off display is represented by high level and low level. C: Control the opening and closing of the cursor. High- and low-level means there is no cursor. B: The control cursor flashes, and the high and low level indicates no flashing. Instruction 5: cursor display s / C: indicates the mobile displayed text and text respectively. Instruction 6: function setting instruction DL: high and low represent four-bit bus and eight-bit bus respectively. Note 7: character generator RAM address setting. Note 8: DDRAM address setting. Instruction 9: read busy signal and cursor address. BF indicates busy or not, and the module can receive commands or data.

2.5. Alarm Circuit

The alarm is the main part of the circuit alarm. Its main advantage is to judge whether the line is broken by continuously sending out the alarm sound. In addition, the buzzer alarm circuit generates about 3Hz vibration sound, which can be realized by connecting to 3V ~ 5V DC power supply.

2.6. Serial Communication Standard

In the serial communication, both sides must adopt the unified interface, so that all kinds of equipment can be connected conveniently. RS-232C is the EIA approved serial communication standard. RS stands for recommended standard. IEEE standard interface is widely used in peripheral serial asynchronous communication interface and computing system.

RS-232C level adopts negative logic system, logic "0" means + 5 ~ + 15V, logic "1" means - 5 ~ - 15V. Rs-232cttl is a positive logic level signal commonly used in smart meters and computing systems. The negative logic of RS-232C is not compatible with TTL level, so it must be switched. Level switching can usually be done using mc1489, MAX232, and other chips. This paper uses MAX232 chip. RS - 232 baud rate standards are: 50 / 75 / 100 / 150 / 9600 / 1200 / 4800 and 300 / 600 to 19200 bps.

Hardware connection circuit and serial communication protocol

The field measurement and control system are connected with the upper measurement and control system through the serial port. Because TTL level is not compatible with RS232 level, this design realizes the conversion from TTL level to RS232 level through MAX232 chip, which is suitable for any 232-serial port.

In order to make the data transmission between the field measurement and control system and the upper measurement and control system error free, this design uses the communication protocol to adjust the data transmission. The communication protocol between the field measurement and control system and the upper measurement and control system is as follows: baud rate: 9600bps; data format: a total of 8 bits of data, including stop bits, without parity. Transmission mode: in this paper, the field measurement and control system and the upper measurement and control system use query mode to send and receive data, and the data format is binary format. After receiving the handshake signal of the upper control system, the on-site control system respectively instructs the sensor to convert the temperature, humidity and illumination. The upper control system displays the received data in a specific area.

2.7. Power Module

The stable voltage obtained is used in the power module circuit, and the input voltage is provided by the external power supply. The capacitor is used as the low-frequency filter to make the input and output voltage smoother and more stable; the capacitor is used to filter out the high-frequency signal components and reduce the impact of high-frequency signal on the circuit.

3. Software Design of Temperature and Humidity Control System

If we want an application system to perform all the functions, then we must make sure it has good hardware. It should also be supported by appropriate software design so that most of the work done by the device can be done by software rather than programming. Even though it's considered a very complex hardware circuit to do it, it's easy if you use software to build it. On this basis, we should make the best use of its internal software and hardware resources.

3.1. Main Program Design

Generally speaking, general software can be divided into four categories: the first category is measurement software, which is mainly used for temperature monitoring. The second is the display content part, which is used to display the temperature detected at that time. The third is the control part, which is used to control the speed of the motor. Fourth, when the temperature and humidity exceed the set temperature threshold, the buzzer will automatically send out an alarm signal [29].

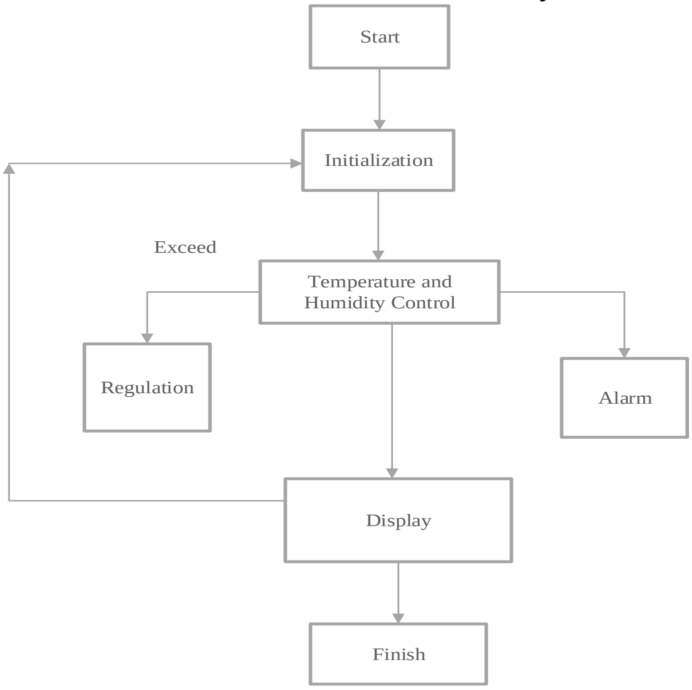

Figure 2. Software flow chart

3.2. Time and Temperature Display Subprogram

The clock chip used in the clock circuit is 1302, so it only needs to read the month, day, hour, minute and second from each register, and then process them. Before the first operation, it must be initialized, and then read data from and display buffer after processing. Refresh once per second, call month, day, hour, minute and second, read the time information from the reader writer program, and write the completion time display. After refreshing the time information, read and process the temperature data, get the ten, one and decimal places of the temperature, and then write the completed temperature information display

3.3. Read Temperature Subroutine

DS18B20 automatically copies and stores the upper and lower temperature limits to. DS18B20 can read the temperature value from the temperature conversion after receiving the read temperature command. The main function of reading temperature subroutine is to read the first byte of low temperature value, high temperature value, upper temperature limit and lower temperature limit, and temporarily store the upper temperature limit and lower temperature limit. The lower value of temperature and higher value of temperature can be converted to the decimal temperature data value calculation, and the upper and lower temperature limit of temperature upper limit can be used to modify the upper and lower temperature limits and set the value of temporary storage temperature to judge that the temperature value exceeds the setting range. Each time the temperature is measured, the calculation and processing of the temperature data must first convert the binary value read to the decimal value before it can be used for character display. Since the conversion accuracy is optional from 9 to 12 bits, 12 bits are used to improve the accuracy. This design adopts the default 12-bit conversion precision. When using 12 conversion precision, the value of temperature register is 0.625 step, that is, the binary value of temperature register multiplied by 0.625 is actually a decimal value.

3.4. LCD LCD1602

1602LCD displays characters, numbers, symbols, etc. The 1602LCD consists of several character bits, such as 5x7 or 5x11, one of which can be displayed in any character. There is a gap between adjacent rows, because of which the graph cannot display perfectly. In order to drive LCD1602, it must be realized by the code written by single-chip microcomputer. The specific idea is to write characters from three control ports of LCD to high level or low level, and then realize the display function ·

3.5. Motor Control

When the temperature and humidity are lower than a certain threshold, the output signal of P1.7 is 1, and the motor does not rotate. When the temperature is between 28 ℃ and 40 ℃, the motor starts to work and the duty cycle is 0.5. When the temperature is between 25 ℃ and 30 ℃, the duty cycle is 0.75. When the temperature is between 30 ℃ and 35 ℃, the duty cycle reaches 0.9375. The higher the temperature, the easier it is to reach equilibrium. Therefore, the programming is very simple, by constantly judging the port level to confirm whether the temperature exceeds the standard, when the temperature exceeds the standard, the motor will increase the speed to cool down.

3.6. Alarm Module

When the alarm of the buzzer reaches a certain temperature and humidity, it will be triggered. In this test, the explosive temperature is 28 ℃, and when it reaches this temperature, the instrument will send out 2Hz alarm sound. The programming idea of this program is to constantly judge the port voltage. When the temperature exceeds the set value, the MCU will drive the buzzer to give an alarm

4. Results Analysis

Greenhouse environment is a complex distributed parameter system. Because of the complexity of the automatic control system and the strong influence of the external climate, it is difficult to control it to a certain index. Therefore, the traditional control algorithm cannot achieve the ideal control effect. However, because greenhouse crops are not very sensitive to the changes of various parameters, it is not necessary to control the parameters accurately, as long as the control is within a suitable range. Because this design uses single chip microcomputer as a general intelligent terminal controller, its resources are limited, all kinds of greenhouse crop growth models are different, so that the controller contains all kinds of crop growth models. If the controller directly uses advanced control strategies, such as fuzzy control, neural control, genetic algorithm (GA) to control the temperature accurately, it is more difficult to achieve. In addition, considering the universality of the intelligent terminal, this design adopts a simple two bits' control algorithm, and can get the temperature distribution diagram as shown in Figure 3.

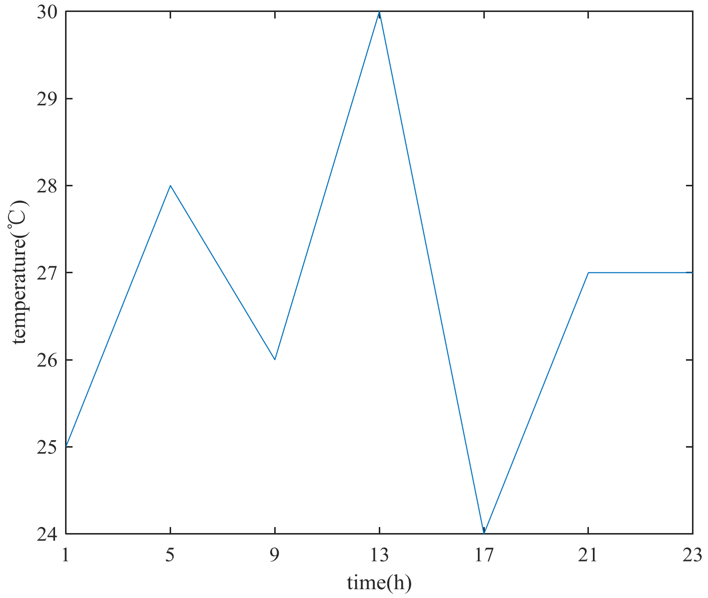

Figure 3. Temperature distribution

The temperature of the greenhouse is measured 24 hours and 7 times a day, which are 1:00, 5:00, 9:00, 13:00, 17:00, 21:00 and 23:00 respectively. A temperature curve is obtained as shown in the figure. From Figure 7, it can be seen that the temperature is basically stable at 24-30 ℃, basically meeting the growth conditions of greenhouse vegetables, indicating that the temperature control system designed in this paper has played a regulatory role.

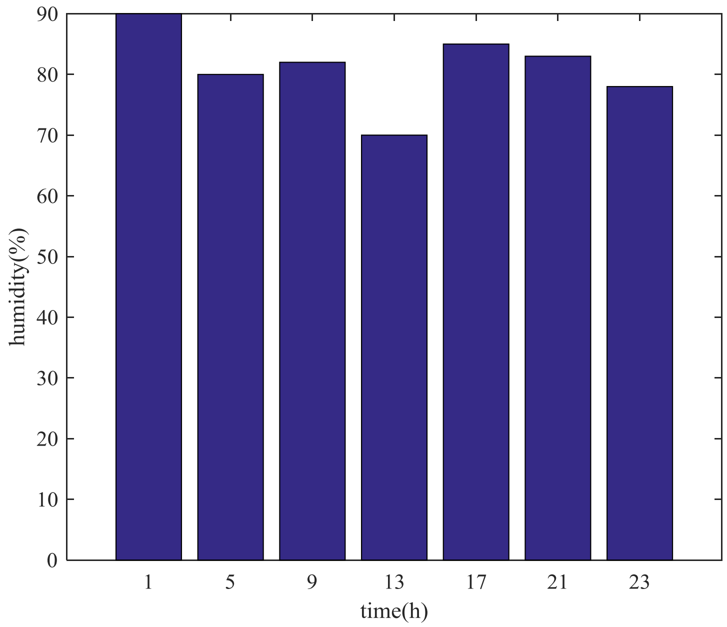

Figure 4. Humidity profile

It can be seen from Figure 4 that the humidity of the greenhouse is always kept in a stable range (70% - 90%) by the same analysis method, and this humidity condition is also consistent with the growth of vegetables.

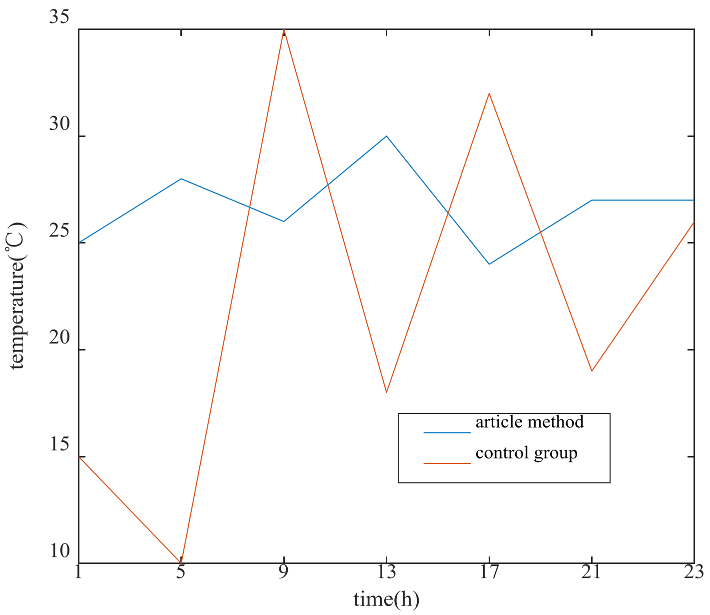

Figure 5. Comparison diagram

It can be seen from Figure 5 that one vegetable shed is not equipped with a temperature and humidity control system, and the other vegetable shed is equipped with a temperature and humidity control system designed in this paper. It can be clearly seen that the temperature fluctuation of the shed without the temperature and humidity control system is very intense. It should be due to the good light transmittance of the film. In the absence of temperature regulation, the temperature change is relatively large. On the contrary, because of the temperature regulation, the temperature is kept in a stable range.

Table 1. Comparison table

Group	Variance
Control group	10.8
Test in text	2.3

It can be seen from table 1 that the temperature variance of the two greenhouses is calculated respectively, and the data in the above table is obtained. Through analysis, it can be seen that the temperature fluctuation of the greenhouses equipped with the temperature and humidity control system is smaller, and the stability of the greenhouses is better.

5. Conclusion

With the development of China's economy and the improvement of people's living standards, the market of greenhouse vegetables in winter is expanding day by day. Greenhouse is to establish the climate conditions to simulate the growth of organisms, create artificial meteorological environment, and eliminate the constraints of temperature on the growth of organisms. In addition, greenhouse can overcome the restriction of environment on biological growth, and can produce different crops in the season that is not suitable for growth, so that the impact of season on crop growth is small, and part or all of the crops can get rid of the dependence on natural conditions. Therefore, it is very important to keep the temperature and humidity of greenhouse constant. This paper designs a temperature control system based on 51 single chip microcomputers. Combined with single chip AT89C51, the temperature and humidity sensor is used to collect the temperature and humidity sensor properly, and the collected temperature and humidity value is transmitted to the LED display screen for display. Cooling or heating is then automatically operated by fans or wires to achieve a constant temperature. This paper sets up the experimental group and the control group, the experimental group is the greenhouse with the temperature and humidity control system installed, the control group is the greenhouse without the temperature and humidity control system installed. The temperature and humidity of the two greenhouses are sampled seven times in 24 hours every day, and the obtained data are drawn, thus a series of graphs are obtained. By comparing the two groups, we find that the temperature and humidity fluctuation of the experimental group is much smaller than that of the control group, which also shows that the stability of the control system designed in this paper is better. Therefore, the experimental results show that the system can monitor the temperature and humidity in real time, and achieve the purpose of effective control of temperature and humidity.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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