Intelligent Air Control System Based on Single-Chip Microcomputer

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Abstract. This article designs an intelligent air control system and regard AT89C52 MCU as control core. We can set the ideal temperature and ideal humidity through the keys. Collect signal by a variety of sensors and transmit signals to the single-chip microcomputer. The most important thing is to use PID algorithm to control. Specifically, combined with PID algorithm, the single-chip microcomputer accurately control the output of the relay. At last, the relay drives the corresponding load on the purpose of changing the indoor temperature, humidity, gas quality. Besides, there are an alarming system by sound and light.

Keywords: Single-Chip Microcomputer, Temperature, Humidity, Gas, Control

1. The Introduction
With the continuous development of science and technology, people's living standards are also improving. Accordingly, the indoor environment requirements become higher and higher. For example, almost everyone wants to enjoy the cool breeze in summer and the warm sunshine in winter. In particular, at this stage when the new type of pneumonia is rampant, in order to control the epidemic, people are required to stay at home for a long time. Therefore, They have high requirements for air quality. People hope that the indoor environment is more comfortable and healthy. In a word, in order to satisfy people's needs, this article uses a Single-Chip Microcomputer as the control core to effectively control temperature, humidity and gas.

2. The Design of System

2.1. The Design of Integrated System
The air control system consists of three parts: temperature control system, humidity control system and gas control system. Under the control of AT89C52 MCU, we implement these functions, like collecting the data, displaying the data and alarming by sound and light. Main components: AT89C52 MCU, DS18B20 digital temperature sensor, DHT21 digital humidity sensor, tpm-300e air quality sensor, LCD1602 (Liquid Crystal Display), LED (light-emitting diode), buzzer, relay, Fan motor, heater, dehumidifier, humidifier, etc.
2.2. The Design of Temperature, Humidity and Gas Control

Through DS18B20 digital temperature sensor, DHT21 digital temperature and humidity sensor, air quality sensor respectively monitors indoor temperature, indoor humidity and indoor air pollution degree. Then the sensors transmit three digital signals (the temperature, humidity and air pollution degree) to the single-chip microcomputer. The software Keil uVision4 is used for programming design. Designed by the software, single-chip microcomputer can display the data on LCD1602. In addition, if the measured value is less than or greater than the setting value, the LED will emit light. At this time, the single-chip microcomputer by using PID algorithm adjust the indoor temperature, humidity and air quality until the measured value is equal to the setting value.

3. Hardware Devices

3.1. Single-Chip Microcomputer

The single-chip microcomputer selected in this article is AT89C52. The structure of the single-chip microcomputer is simple. And the price is cheap. It is one of the most commonly used types of single-chip microcomputer. For this single-chip microcomputer, firstly, we need to connect the clock circuit and reset circuit. The clock circuit mainly uses the crystal oscillator. The reset circuit can be manually reset by pressing a button. The level and pulse are two ways to reset the key.

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**Figure 1.** system flow chart

**Figure 2.** the pins of the chip

**Figure 3.** the clock circuit diagram and the reset circuit diagram
3.2. Display Module (LCD1602)
This system uses LCD1602. The 1602 character liquid crystal, also known as the 1602 liquid crystal, is used to display letters, numbers, symbols, etc. Each time the button is pressed, the page will be switched. Press the button three times as a loop and the fourth press will enter the new loop. When I press the button at the first time, the LCD will display "set temperature: current temperature: "; When I press the button at the second time, the LCD will display "setting humidity: current humidity: "; When I press the button at the third time, the LCD will display "acceptable air pollution level: current pollution level: ".

![Figure 4. circuit diagram of display module](image)

3.3. Temperature Sensor (DS18B20)
The sensor is suitable for all kinds of small spaces because of its small size and various packaging forms. In particular, there is a unique single wire interface, which only needs one line to actualize bidirectional communication between microprocessor and DS18B20. The working power supply is 3~5V/DC. The sensor’s measurement range of temperature is -55℃~+125℃, and the resolution of the natural temperature measured is 0.5℃. What’s more, the sensor support many other functions, like multi-point networking and no peripheral components are required when it’s used.

![Figure 5. connection diagram of temperature sensor](image)

3.4. Temperature and Humidity Sensor (DHT21)
In a large part, the temperature has a great influence on the humidity of the gas. Therefore, we adopt the temperature and humidity sensor, a composite sensor, to measure the humidity. DHT21 is a kind of temperature and humidity sensor that takes digital signal as output signal. The sensor uses capacitive humidity sensor to measure humidity and NTC temperature sensor to measure temperature. The sensor’s working power supply is 3.3-5.5v /DC. The resolutions of measured temperature and measured humidity are all 16bit.
3.5. Air Quality Sensor (tpm-300e)
The tpm-300e air quality sensor is adopted in this system, which is characterized by high sensitivity, long life, low power consumption, digital signal output and simple application. The detected gases are: hydrogen, ammonia, alcohol, carbon monoxide, methane and other organic volatile gas; Lampblack, smoke which produced by burning cigarette, wood and paper, etc. According to the table below, both pins A and B output binary signals, and the final pollution level is determined by pins A and B, so there are four pollution levels in total. The higher the pollution level, the more polluted the air, the worse the air quality.

| A   | B  | Levels of the Pollution |
|-----|----|-------------------------|
| low | low| 0                       |
| high| low| 1                       |
| low | high| 2                      |
| high| high| 3                      |

3.6. The Circuit of The Alarm Module
The alarm circuit is divided into three parts in the article: temperature alarm, humidity alarm and gas alarm. Each part of the alarm circuit is basically similar. And each part is composed of a light-emitting diode and a buzzer. As for the work phenomenon, when the specified range is exceeded, the output of the single-chip microcomputer makes the transistor work. Then we can find the buzzer gives out a shrill sound and the diode gives out the corresponding color. When meeting the standard, there are no phenomenon. The differences are: Firstly, the color of the light-emitting diode in each part is different. The temperature alarm corresponds to red, the humidity alarm corresponds to yellow and the gas alarm corresponds to green. Second, the sound of the buzzer is different.
4. Software Process

The system is written in C language and compiled on Keil uVision4. In software design, we start from four aspects: the software design of data acquisition, the software design of data display, the software design of alarm circuit and the software design of control circuit. Specific steps are as follows: first of all, in the application of single-chip microcomputer, we should finish designing the circuit and connecting to the hardware circuit. Secondly, according to the connection between each device and the single-chip microcomputer, the pin is initialized. Finally, finish the software design of the above four aspects in turn.

Then the software design of control circuit will be introduced in detail.

1. When the value of the measured temperature is not within the range of the setting value, the output of the relay is controlled with PID algorithm in order to drive the equipment.
   
   If the temperature is too high, the motor of the fan will start; If the temperature is too low, the heating device will start.

2. When the value of the measured humidity is not within the range of the setting value, PID algorithm is combined to control the output of the relay so that the equipment can be drove.
   
   If the humidity is too high, the dehumidifier will start; If the humidity is too low, the humidifier will start.

3. When the measured air pollution level is not ideal, PID algorithm is combined to control the output of the relay and drive the purifier (the motor of the fan) to operate.

Figure 8. circuit diagram of alarm module
5. Conclusion
This article designs an intelligent air control system based on single-chip microcomputer, which can set the ideal temperature, ideal humidity and ideal air pollution level by pressing the buttons. Besides, the data about temperature, humidity and air pollution can be clearly presented on the LCD screen. The system is also equipped with an alarm circuit in order to achieve the function of reminding people. What’s more, it can timely drive the corresponding devices to control temperature, humidity and gas in the house. In this article, the principle of this three subsystems is similar. Their structures are clear. Because the digital sensors are used to collect the signal. Fortunately, we do not need to use A/D converter for analog-to-digital conversion. Therefore, the design is simple, clear and easy to achieve.

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Figure 9. software flow chart
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