Design and Implementation of Automatic Control System for Intelligent Water Dispenser

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Abstract. In this paper, an intelligent water dispenser automatic control system is designed by using a microcontroller as the core. Relevant signals are collected through temperature sensor, liquid level sensor and other sensors, then send them to the microcontroller for processing and control, and use the liquid crystal display for display. Temperature, effluent and liquid level can be controlled according to their own needs, so as to realize the intelligent control of the water dispenser. The intelligent water dispenser automatic control system designed in this paper has low hardware cost and easy operation in the use process.

Keywords: Water Dispenser, Intelligent Control, Microcontroller

1. Introduction
In our daily life, water dispenser is essentially used, not only at home, but also in some shopping malls, office buildings, public places, people are inseparable from the water dispenser. The common control of water dispenser will design different products according to the requirements of application and performance index. This kind of control object has large inertia and lag, and there are many uncertain factors, it is difficult to establish an accurate and good mathematical model, which leads to poor control system performance, and even unstable control. Ordinary water dispensers can only heat water, which can not meet the individual requirements of people.

The automatic control system of drinking water dispenser is designed in this paper, each module of the whole control part will be adjusted according to the actual situation. For example, the temperature detection module can turn off the power when it reaches the preset temperature, prevent the drinking water from being heated for many times, in order to save energy and protect health. Bluetooth is also be used, so we can use mobile phone to realize remote control of the water dispenser. It is very convenient and simple. This is a great extent to reduce the possibility of harm in people's daily life. Compared with the control system made of analog circuit, special chip and digital circuit, the water dispenser controlled by microcontroller has a great improvement in all aspects of function and integrity. The system uses the microcontroller through the comprehensive design of hardware and software, so that the controller has stable performance, fast response speed and high reliability [1].

2. Overall scheme of the system
2.1. The structure of automatic control system of intelligent water dispenser

In this paper, the microcontroller is used as the core controller, in order to design the hardware and software of the automatic control system of the intelligent water dispenser. The system includes multiple chips and modules to realize the detection of temperature, liquid level and flow, real-time control, display, Bluetooth transmission and other functions. The system can display the temperature and water level in real time, set the temperature alarm threshold and lack of water alarm, and use the display circuit shows the current water temperature and water level. At the same time, it can also monitor the situation of the water dispenser through the Bluetooth module, the data is transmitted to the mobile phone to realize the control of the water dispenser. The block diagram of the system is shown in Figure 1.

![Figure 1. System structure block diagram](image)

2.2. Basic functions of automatic control system of intelligent water dispenser

The hardware design includes microcontroller, detection module, display module, Bluetooth module, keyboard module, status indicator module and power module.

In this paper, DS18B20 sensor is used, which has great improvement in measuring temperature, conversion, transmission distance and so on. It is widely used in various temperature control systems of temperature acquisition and processing [2].

The control circuit controls the on-off of the relay through the high and low level of the output of the microcontroller, so as to determine the resistance wire and the cold and hot separation outlet. When the output is low, the heating resistance is energized and the temperature rises, so does the temperature value measured by DS18B20; when the output is high, the heating circuit is disconnected and the temperature drops.

The ATK-HC05 module is selected as the Bluetooth serial port module. It is a master-slave module with high performance. It can be paired with mobile phones, computers and other Bluetooth enabled devices. The module supports a wide range of baud rates, and is compatible with 3.3V or 5V microcontroller systems, so it is convenient and flexible to use [3].

3. Hardware design of the system

3.1. Design of temperature detection circuit

DS18B20 is used in the automatic control system of intelligent water dispenser to collect the environmental temperature data, then send the data to the microcontroller to processing. In the hardware circuit design of the temperature sensor, the DS18B20’s bus must be connected with a 4.7K pull-up resistor to ensure that enough output power is on the DQ data line, so that the working current of DS18B20 can reach 1.5mA and the state is high when it is idle. The circuit diagram of DS18B20 temperature sensor is shown in Figure 2. In the circuit diagram of DS18B20 temperature sensor, R2 is the pull-up resistor, and the data output DQ of DS18B20 is controlled by P1.3 port of microcontroller to realize temperature acquisition [4].

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3.2. Design of data display circuit
LCD1602 is used in the display part of the intelligent water dispenser. It can display two lines of characters and numbers. In the system, it can display the temperature value detected by the temperature sensor in real time, and refresh it according to a certain frequency. It is connected with the I / O port of the microcontroller. The microcontroller converts the data into 8-bit binary numbers, and sends it to the internal register of the LCD through the parallel port, the register receives it and display the information. The backlight can be adjusted by a potentiometer, and the read-write command is also controlled by the I / O port of the microcontroller. Moreover, the driver is convenient, and there is no need to add a control circuit in the middle part. It is easy to use, and the data expression is intuitive. The working voltage is generally 4.5-5.5v. In this design, 5V power supply is used, the working current is 2mA, and the capacity is 16 × 2 characters. The temperature display circuit is shown in Figure 3.

![Figure 3. Data display circuit diagram](image)

3.3. Design of flow control circuit
The flow control circuit of the intelligent water dispenser control system uses relay control, which is divided into cold water control and hot water control. The current can reach 2A. The state of the triode is controlled by the microcontroller, and then the relay is controlled on or off. The flow control circuit is shown in Figure 4.

![Figure 4. Flow control circuit diagram](image)
Figure 4. Flow control circuit diagram

3.4. Design of Bluetooth communication circuit
The intelligent water dispenser automatic control system uses Bluetooth module to communicate with the mobile phone. The Bluetooth module can be paired with the mobile phone. After the pairing is successful, the mobile phone can realize the wireless control of the intelligent water dispenser and the data interaction. Through the APP on the mobile phone, the temperature and water level can be monitored, and the temperature setting can be input by the mobile phone to control the water outlet. The Bluetooth module can connect with the mobile phone safely, it send and receive data through the wireless communication protocol of Bluetooth. The circuit diagram of Bluetooth communication is shown in Figure 5.

Figure 5. Bluetooth communication circuit diagram
The Bluetooth module used in the system is HC-06 Bluetooth module, which sets the mode of the Bluetooth module through the microcontroller, sends commands and receives data through the serial port. The Bluetooth module is connected with P3.0 and P3.1 of the microcontroller, and uses 5V DC voltage. After the module is powered on, it uses the AT mode when it is not paired [5].

3.5. Design of keyboard circuit
The intelligent water dispenser automatic control system sets the temperature by pressing the key, and then the system automatically controls the water temperature according to the set temperature value. The circuit diagram of the key is shown in Figure 6.
The keyboard circuit is composed of four elastic keys. The pull-up resistor is used to improve the output capacity of the keyboard. The microcontroller detects the output end of the key to determine whether a key is pressed. The microcontroller scans the interface all the time. Once a key is pressed, the level of the key can be detected directly.

3.6 Design of alarm circuit
The intelligent water dispenser automatic control system sets the temperature by pressing the key, and the system uses the temperature sensor to detect and control the temperature, but the system needs a device that can visually remind the system state, through the buzzer alarm circuit can realize the temperature alarm. When the water level of the water dispenser is too low, the microcontroller control alarm circuit to remind the user that the water is lacked. This circuit control is simple, through the IO port of the microcontroller can directly control the machine, it uses the triode to amplify the driving signal of the microcontroller, and then realize the alarm of low water level, the alarm circuit is shown in Figure 7.

3.7 Design of power circuit
Microcontroller is powered by 5V DC, so stable power supply is the basis of microcontroller, otherwise the ripple will affect the accuracy of the system. Using linear power supply can reduce the ripple, and provide enough working current, so choose linear power supply as the power supply circuit of the system is necessary, its structure is simple and stable, after filtering through the capacitor, it can output stable voltage. The power supply circuit is shown in Figure 8.
Figure 8. Power supply circuit diagram

4. Design of system software
The main control program of the intelligent water dispenser control system is the core part of the function realization, which will control all the function modules in the hardware. After sending and receiving the control instructions, it runs and analyzes in the main control program, and transmits the final results to other functional modules in the form of data. Other functional modules play their roles under the action of the main control. After the main control module completes the initialization, it will enter the while cycle state. After the whole process of the main control program is completed, the system process ends, and finally the data is sent to the user's mobile phone through the Bluetooth module. The main program flow chart is shown in Figure 9.

Figure 9. System main program flow chart

5. Conclusion
The intelligent water dispenser control system designed in this paper reflects the advantages of convenient operation, simple and convenient. The intelligent water dispenser control system can meet the needs of individual drinking water in actual use. The hardware design uses microcontroller, temperature sensor, display and other components to design, and finally achieves the expected purpose through debugging and testing.

The automatic control system of intelligent water dispenser designed in this paper is reasonable and convenient. In the overall structure, the control is very flexible, it can solve the inconvenient problem is people’s life. In the design of mobile phone control interface, the linked list form of data storage and correction also provides a new idea. Considering the requirements of humanization in the use process,
it is no longer a simple key in the upper computer operation interface. It can customize and embed different operation instructions to meet the needs of more flexible use of water dispenser.

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