Design of voice temperature control faucet based on STM32 MCU

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Abstract. Everyone has a different perception of water temperature. Considering the living needs of people today, a faucet that can adjust the water temperature intelligently has a good research value. Different from traditional products, the voice temperature control faucet designed in this paper can not only automatically regulate the temperature, but also keep a constant temperature. When the hot water supply is insufficient, it can give an alarm in advance to remind the customer to complete the water use as soon as possible. This design uses the existing speech signal module, it can convert the speech signal into the single chip microcomputer input signal, and then through the single chip microcomputer control of the motor rotation, so as to control the opening of cold and hot water very well. Through the effective combination of temperature sensing technology, speech recognition algorithm and MCU, the goal of intelligent temperature control can be achieved.

1. Introduction
Intelligent faucet, also known as intelligent induction faucet, is produced in the 1970s. At the beginning, it only appeared in Japan, Europe and the United States and other economically developed countries. It was used in public places to prevent secondary pollution after washing hands. At that time, the technology of induction faucet was not mature, so it was not plain sailing in the process of development and popularization. With the development of science and technology, the function of induction faucet has been improved and perfected. However, the intelligent faucet in the stage of realizing intelligence is only the superposition of intelligent functions, without a good combination of intelligent technology and functional experience, ignoring the convenience of the intelligent faucet, and the product is not user-friendly enough. This is also a major reason why domestic intelligent faucets are not suitable for home use[1]. Therefore, this paper designs an intelligent faucet which is more suitable for home use.

2. Hardware design
The hardware module of the faucet designed in this project includes[2]: (1) two pumps to realize the exchange of hot and cold water and the mixing of hot and cold water; (2) Stepper motor module L298N, which can control the electromagnetic water valve to rotate a certain angle when receiving the voice control signal, so as to achieve the purpose of temperature regulation; (3) Buzzer. With the increase of hot water consumption, when the handle rotation angle reaches the maximum opening of the hot water pipe, voice prompt will be issued in time to remind the user to stop using water as soon as possible, or when the temperature required by the user is too high or too low, the alarm will be sent out automatically; (4) Display module LCD12864: display real-time water temperature and the user's...
control instructions; (5) Temperature sensing module DS18B20: used for temperature detection; (6) Speech recognition module LD3320: after receiving the speech recognition signal, it is converted into the computer signal, and the control command is recognized by single chip microcomputer; (7) Power module, which is used to provide power to each module; (8) Control module STM32 MCU, used to realize the centralized control of each module.

2.1. STM32 microcontroller
STM32 MCU is a series of high cost performance MCU, which has specially designed ARM Cortex-M kernel for embedded applications requiring high performance, low cost and low power consumption. At the same time, it has first-class peripherals, 1μs double 12 bit ADC, 4 Mb/s UART and so on. It also has good performance in power consumption and integration. It is economical in price and excellent in function. Therefore, this design chooses this single chip microcomputer.

2.2. Speech recognition module
The speech recognition module LD3320 used in this design is a speech recognition module produced by ICRoute Company. The chip integrates the speech recognition processor and some external circuits, including AD/DA converter, microphone interface, voice output interface, etc. Therefore, it can realize speech recognition, voice control and human-machine dialogue function by integrating directly into existing products without any auxiliary chip. The advantage of the chip is that it can set its own wake-up words, and the recognition rate is still up to 95 percent in noisy and disturbing environments.

2.3. Motor drive module
This design selects the stepping motor module L298N, which is a motor driver chip produced by ST Company. It contains two full bridge drivers, which can drive two DC motors at the same time or a two-phase four-wire stepping motor. The logic input part is designed with photoelectric isolation module to protect the controller. The maximum input voltage of the module is 40V, the single-channel peak current is 3A, and the maximum power is not more than 25W. The logic input terminal adopts standard TTL level control and is connected to VCC by default.

2.4. Temperature sensing module
In this design, the temperature sensing module DS18B20 is used to automatically detect the temperature, so that the single-chip microcomputer can control the constant temperature of the solenoid water valve or automatically adjust the corresponding temperature. DS18B20 is a commonly used digital temperature sensor[3]. Its output is digital signal. It has the characteristics of small volume, low hardware overhead, strong anti-jamming ability and high precision. DS18B20 digital temperature sensor is easy to connect, can be used in a variety of occasions after packaging. It is wear-resistant, impact resistant, small size, easy to use, so it is suitable for all kinds of digital temperature measurement and control equipment working in narrow space.

2.5. Security alarm module
Buzzer is a kind of electronic buzzer with integrated structure[4]. It is powered by DC voltage. It is widely used in various electronic products as a sound device. It can be divided into two types: piezoelectric buzzer and electromagnetic buzzer. It has the advantages of small volume, economical price and good durability. In this design, with the increase of the amount of hot water used by users, when the handle rotation angle reaches the maximum opening of the hot water pipe, the buzzer can give a prompt in time to remind users to stop using water as soon as possible, or give an alarm signal when the temperature required by users is too high or too low.

2.6. Power module
The design of the power module choose lithium battery, small and light, can greatly reduce the weight of the faucet. At the same time, it can meet the operation needs of each module, and large capacity
lithium battery can extend the power supply time. In addition, the heavy metal content of lithium battery is far less than other types of power, more environmental protection.

3. Software design scheme

The voice temperature control faucet designed in this paper is based on STM32 MCU as the core. The functional code is compiled by Keil software, and finally burned into the MCU.

3.1. Temperature sensor identifies temperature

1. The hot water and cold water in this design are connected in series through two pumps respectively. The temperature sensor DS18B20 detects the water temperature through the temperature probe and then converts it into an electrical signal and sends it to the SCM, and then the temperature is displayed by LCD12864 through the MCU. The coding flow chart is shown in Figure 1.

2. When the temperature sensor DS18B20 detects that the water temperature is lower than 25℃ or higher than 60℃, the microcontroller controls the rotation angle of the stepper motor, so as to control the rotation of the solenoid water valve to reach the constant temperature, and displays the real-time temperature on LCD12864. Its coding flow chart is shown in Figure 2.

3.2. Speech recognition module controls water temperature

The designed product receives the user's voice signal, and the voice recognition module converts the voice signal into a level signal for the MCU to recognize, so that the MCU can control the rotation angle of the stepping motor, then control the solenoid water valve to reach the target temperature required by the user. The working principle of the speech recognition chip is as follows: perform spectrum analysis on the voice input by MIC - extract the speech features - match the key words in the key word list - output the key words with the highest score in the key word list as the final result of speech recognition. Its coding flow chart is shown in Figure 3.
3.3. Safety alarm prompts

The user's voice is processed by internal microprocessor and converted into control signal. On the one hand, the switch of the faucet is controlled by the electromagnetic water valve, on the other hand, the angle of the handle is adjusted by the electric control valve, so that the outflow of the cold and hot water pipes can be adjusted, and the purpose of controlling the water temperature is finally achieved. With the increase of hot water consumption, when the handle rotation angle reaches the maximum opening of the hot water pipe, prompt will be issued in time to remind the user to stop using water as soon as possible. The coding flow chart is shown in Figure 4.

Figure 4. Flow chart of Security
4. Experiment and conclusion
Finally, the system designed in this paper is verified through the simulation experiment. Proteus is used to build the hardware model and keil is used for system debugging[5]. In the experiment, the MCU can receive the external temperature signal through the temperature sensor DS18B20, so as to control the rotation of the motor and ensure the constant temperature[6] (when the temperature is higher than 45 ℃, the forward rotation is accelerated; when the temperature is lower than 10 ℃, the reverse rotation is accelerated; when the temperature is 75 ℃, the forward rotation reaches full speed; when the temperature is 0 ℃, the reverse rotation reaches full speed; when the temperature is between 10 ℃ and 45 ℃, it stops gradually). The experimental results show that the system designed in this paper can control the rotation angle of the electromagnetic water valve to realize the constant temperature of the water outlet.

![Simulation system diagram](image)

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