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Design and implementation of intelligent water cup based on single chip microcomputer

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ABSTRACT

In life and work, people often use water cups to drink water to ensure the water supply of the human body. However, common water cups cannot accurately judge whether the water quality in the cup meets the drinking standard, and there is no reminder function, which cannot measure the water temperature and control the water temperature. To this end, this paper designs and implements a smart water cup. The main functions include: detecting whether the water quality meets the drinking standard, automatic heating when the temperature is lower than 30 °C, voice prompting people to drink water, and opening and closing the lid display. Using the single chip microcomputer, temperature and TDS sensor to read the data to measure temperature and water quality, realize the voice reminder through the timing interruption in the single chip microcomputer, and control the heating by the micro relay. Experiments show that the water cup achieves the expected function, provides help to ensure that the user can drink water with suitable temperature and meets the standard in time, and is beneficial to human health.

Keywords: smart water cup, temperature sensor, reminder system, water quality

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1. INTRODUCTION

With the continuous development of human information technology and Internet of Things technology [1], people's living standards have developed better and better, and more and more attention has been paid to the health of the body. At the same time, the development of water cups is gradually becoming intelligent [2]. However, the survey found that people who have regular drinking habits will reduce the occurrence of many diseases. The problem of drinking water is also a key factor affecting physical health [3]. Among them, water temperature and water quality [4] is an important reason for the health of drinking water, and drinking water with confidence has gradually become the goal that people pursue.

This design uses the Internet of Things technology, single chip technology [5] and other design and implementation of a water quality detection sensor that can detect the real-time situation of the water quality (TDS) in the thermos cup at any time, and display it through LCD12864 [6]. The water temperature in the cup is stable within an upper and lower limit range. When the temperature is lower than the set minimum value, the heating relay will be automatically activated to control the simulation to realize the intelligent heating module [7], and finally keep the water temperature within the required stable range. between. In addition, the design also adds a voice timing reminder function. When the interval timer is reached, the voice broadcast will be turned on to remind the user to drink water [8]. It can also be adjusted by pressing the keys.

2. OVERALL SYSTEM DESIGN

The intelligent water cup control system based on single-chip microcomputer takes STC15 single-chip microcomputer [9] as the core control module, which mainly includes single-chip microcomputer system circuit [10], real-time detection circuit of water quality particles, real-time detection circuit of water temperature, voice timing broadcast reminder circuit, relay analog control heating circuit, Display module circuit, button mode switching circuit. The overall design flow chart of the smart water cup system is shown in Fig. 1:

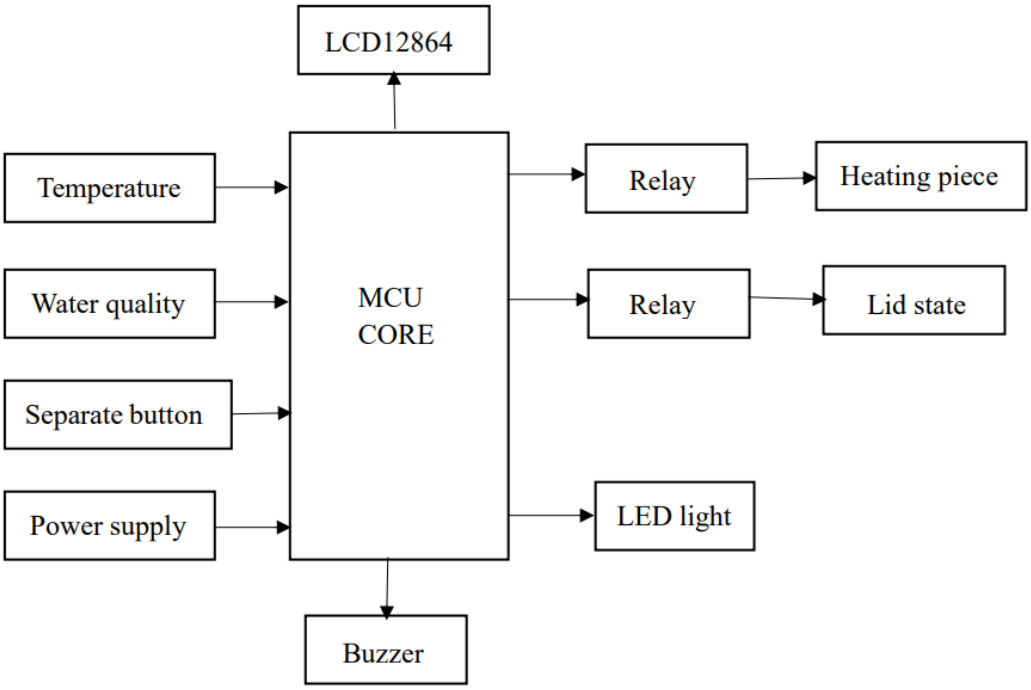

Fig.1 Flow chart of the overall design of the system

System functional requirements analysis:
(1) Design of temperature and water quality collection: The temperature and water quality collection are obtained by collecting data through the serial port through the TDS module sensor with the single-chip minimum system [11] as the control hub.
(2) Button design: This smart water cup needs to be set with four buttons corresponding to different functions, and the selected button design module form is independent.
(3) Timing circuit design: The timing mode is switched by the "Setting" button, and the value of "timing duration" can be modified by the "+" and "-" buttons. After setting the timer for half an hour, a voice broadcast will remind the user to drink water every half hour [12].
(4) Intelligent heating design: This module uses STC15 single-chip microcomputer chip as the main control system to control the relay to simulate the intelligent heating process to realize intelligent heating control [13].
(5) Voice reminder design: This module adopts the implementation of sending data to the voice module through the serial port. When the user uses the button to switch to the timing setting module, the timing stops, and the interval length of the reminder is set [14], just press the button.

3. HARDWARE CIRCUIT DESIGN

The overall circuit of the system is mainly composed of the following main parts: a single-chip core system, a USB power supply download module, a water temperature and water quality detection module, a voice timing broadcast module, a relay analog control heating module [15], an LCD12864 data display module. Among them, the water quality and temperature detection module are mainly used to detect the particle concentration and water temperature of the water in the cup [16], the voice broadcast module is mainly used to remind users to drink water regularly, and the relay control module is mainly used to simulate the lid of the cup. Turn on and simulate heating.
(1) Main control circuit design
The main control circuit is mainly composed of the main control chip and two external circuits. The simplest and most basic system that combines the main control circuit and a small number of components is called the smallest system of the single-chip microcomputer, in which each port of the core system is used to communicate with A pinout for interconnecting modules or other devices. The schematic diagram of the core circuit of the single-chip microcomputer is shown in Fig. 2:

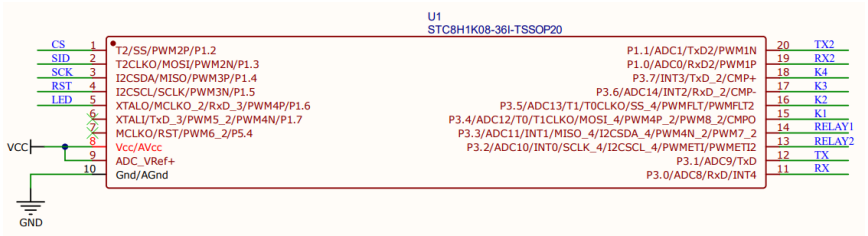

Fig. 2 Schematic diagram of the core circuit of the single-chip microcomputer

(2) Water quality measurement circuit

TDS (Total Dissolved Solids) represents the concentration of ions dissolved in water. It can measure and judge the concentration of impurities and ions dissolved in water. If the measured TDS data is larger, it indicates that the concentration of impurity ions in the water is larger and the water quality is not good, not drinkable. The water quality detection function module is realized by the microcontroller reading data from the TDS module through the serial port. The schematic diagram of the water quality measurement circuit is shown in Fig. 3:

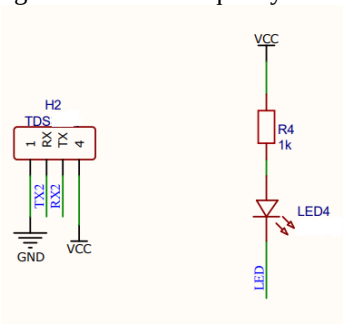

Fig. 3 Schematic diagram of water quality measurement circuit

Fig. 4 shows the dual-channel digital TDS sensor element diagram; the module is connected to the TDS probe through a 2PinXH-2.54 connector.

Fig. 4 Dual-channel digital TDS sensor element diagram

(3) Temperature control circuit

Since the DS18B20 will generate an oscillation frequency with the change of temperature, its internal subtraction counter will generate corresponding pulses according to the generated oscillation frequency to control the work. Through data processing, the temperature value at this time can be calculated, which can be very large. To improve the accuracy of the temperature measurement to a certain extent, the automatic opening of the heating module is realized by the single-chip microcomputer with the help of relay simulation. The schematic diagram of the temperature control circuit is shown in Fig. 5:

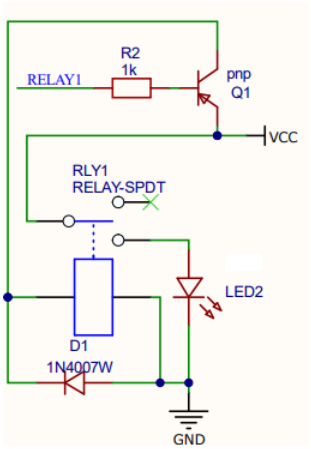

Fig. 5 Schematic diagram of temperature control circuit

The DS18B20 sensor is a sensor chip that collects temperature data with strong practicability, integration, relatively small error and relatively stable use. The DS18B90 component diagram is shown in Fig. 6:

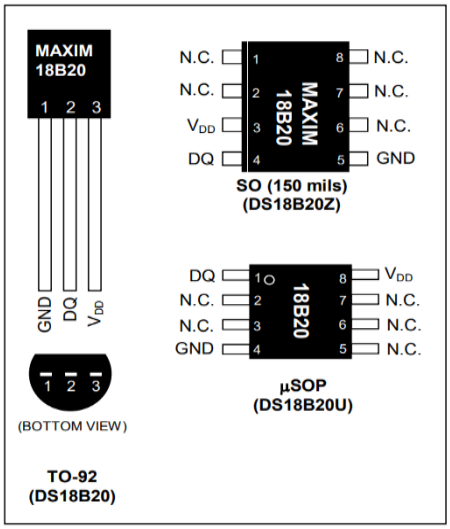

Fig. 6 DS18B20 component diagram

(4) Voice broadcast circuit

There are two kinds of commonly used JQ8400 voice modules. One is with 3W power and 4M storage capacity. You can use U disk to copy and add audio through the USB interface, and control it through the serial port of the microcontroller. The voice broadcast module is realized by the connection between the JQ8400 voice device and the small speaker. The required audio is downloaded and stored in the memory of the voice module. Under the control of the timer interrupt T0 in the single-chip chip, when the time arrives, the speaker starts to broadcast the broadcast. Audio content that reminds the user of the water glass that it is time to drink. The setting of this module is convenient for people to take in water in time, which can effectively avoid the phenomenon that drinking water is left behind in busy work. The schematic diagram of the voice broadcast circuit is shown in Fig. 7:

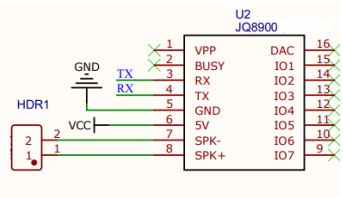

Fig. 7 Schematic diagram of voice broadcast circuit

(5) Key circuit

This system mainly designs three modes. The schematic diagram of the button circuit is shown in Fig. 8. You can use button 1 to switch the mode. Turn on/off the heating state, mode 3 is to set the state and press to enter the initial state. When it is detected that the water temperature in the thermos cup is lower than the lower limit at this time, the corresponding relay will be activated to turn on the heating. After the set time period, when the countdown arrives, the voice broadcast function will be turned on to remind the user to drink water, and observe the state of the cup lid at this time. Press button 2 to open the cup lid and start drinking.

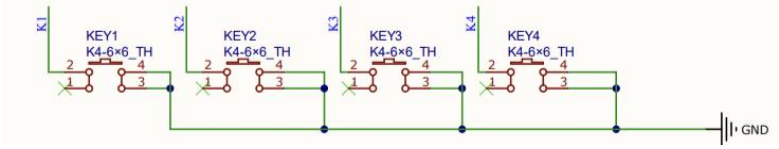

Fig.8 Schematic diagram of the button circuit

4. SYSTEM SOFTWARE DESIGN

System page design, this interface mainly displays whether the water quality in the current water cup reaches the drinkable and water temperature value, the display content is: the first line shows the water temperature value, and the display format is "temperature: ℃"; The format is "drinkable/undrinkable"; the third line shows the lid status and whether it is heated, and the display format is "open/close the lid, start heating/stop heating"; the fourth line shows the countdown timer setting, and the display format is " --Minutes and seconds".

(1) Main program design

The main program design flow chart is shown in Fig. 9. First initialize, after entering the if main loop, check whether the button is pressed. There are four buttons, the functions are mode switching button, setting timing increase button, setting timing decrease button, and restoring initial Status button. However, when the button 1 is not pressed, it enters the initial mode, temperature measurement and water quality measurement mode; when the button 1 is pressed, the screen display switches to enter the next mode, set the timing mode, and the timing time can be increased by pressing the button 2, Press button 3 to decrease the timing time; press button 1 again to enter the last mode, cup lid, heating state mode; press button 4 to return to the initial mode.

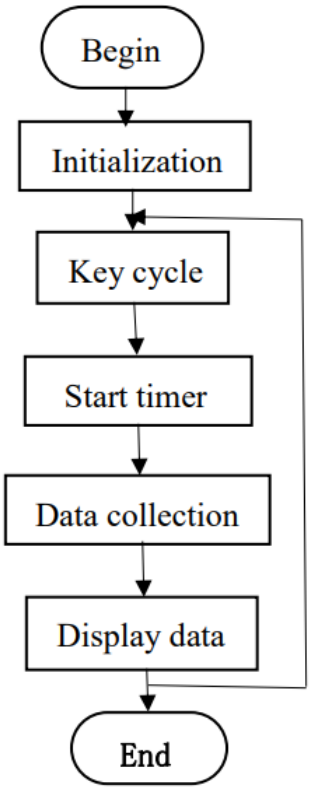

Fig. 9 Main program design flow chart

(2) Water quality, water temperature collection program design

The water quality and water temperature detection sensors used in this design send data to the single-chip microcomputer through the serial port. The water quality and water temperature acquisition program design flow chart are shown in Fig. 10: First, determine whether the received data is completed, and then verify the checksum. The sum of the water quality and water temperature data obtained is equal to the checksum, which proves that the data is received correctly, that is, the correct water quality and water temperature values are obtained.

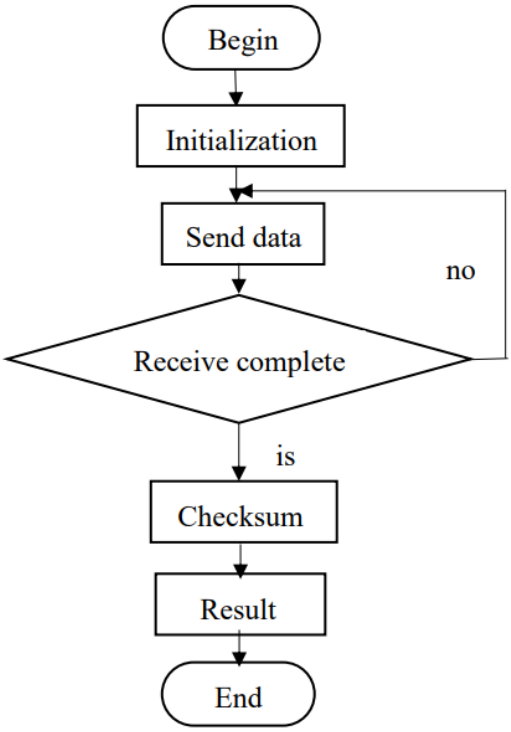

Fig. 10 Flow chart of water quality and water temperature collection program design

(3) Timing reminder program design

The countdown process, this design does not use a timer for timing, but uses a relatively simple delay timing, through each if loop to run a delay of 300ms, but there is a condition when the timing starts, only not when adjusting the time interface, the countdown will start. When the countdown is reduced to 0, and the total timing time is not 0, the voice reminder will be turned on, and the cup lid can be opened by pressing the button to drink, and the voice will be turned off after a delay of 3 seconds. The flowchart of the timing reminder program is shown in Fig. 11:

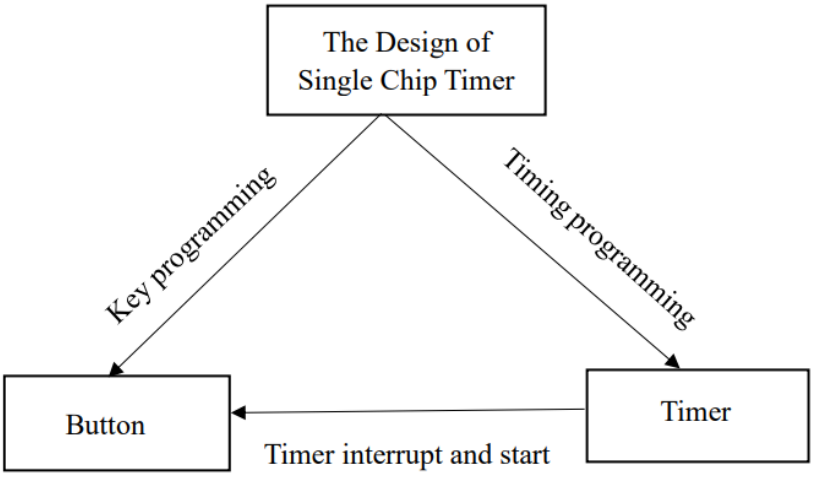

Fig. 11 Flowchart of timing reminder program

5. SYSTEM TESTING AND RESULTS

(1) Water temperature and water quality collection test
After the device is powered on, it is measured by DS18B20 and TDS sensors and displayed on the LCD1602 display module controlled by a single-chip microcomputer. At this time, the water quality in the measured water cup is up to the standard, and the temperature is 24°C. At the same time, the initial page countdown is automatically turned on. The countdown of the time adjustment mode stops, and when the temperature is lower than 30°C, the heating starts automatically. Fig. 12 shows the test results of water temperature and water quality after power-on.

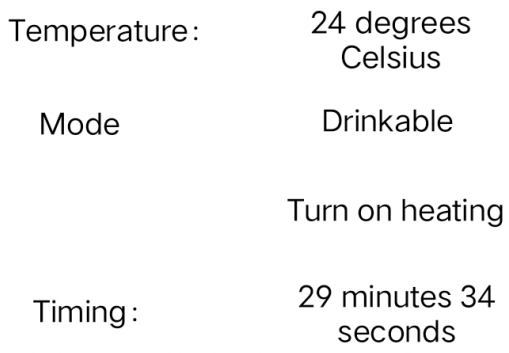

Fig.12 Test Results

(2) Timed setup test
The reminder time interval set in this design is 1 minute, and the purpose of the setting is that you don't need to wait too long for a demonstration (in actual setting, the reminder timing time is set to remind once every half an hour). When adjusting the time, it must be in the time-adjusting module. The time-adjusting mode countdown stops, and the countdown starts after the time adjustment is completed. When the time is up to one minute, you can hear the voice broadcast "It's time, it's time to drink water!", reminding the user Time to drink water. Fig. 13 shows the test results diagram of the timing module.

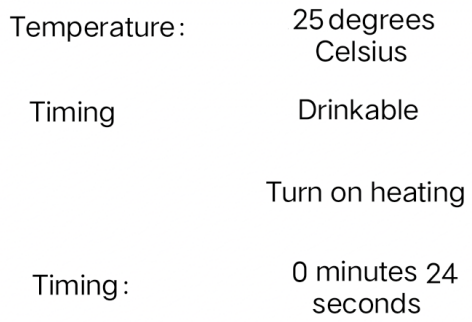

Fig. 13 Test Results

(3) Lid and heating state test
In this design, the relay is used to simulate the opening and closing of the lid. At this time, we can open the lid by pressing the button, or close the lid (only in the mode of the lid can be opened by pressing the button, otherwise), or by pressing the button. Observe the light on and off to see if the lid of the cup is open. When the temperature in the water cup is lower than the lowest temperature of 30°C, the simulated heating relay will automatically start to heat the water in the thermos cup. During the test, the lid and heating are both closed. Fig. 14 shows the lid and heating test results graph.

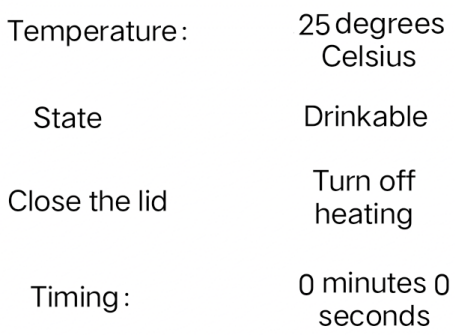

Fig. 14 Test Results

6. RESULTS AND DISCUSSION

The above is the experimental test of each module detection, and each module test is normal. When the temperature is lower than 30 ℃, the heating will be turned on when the machine is turned on. You can manually stop the heating, set the timing to be normal, and the voice broadcast will be normal. When the probe is in contact with the relevant solution, according to the software algorithm, the measured value is obtained. The obtained TDS value has high accuracy, the working voltage is stable, and the overall system is relatively stable.

7. CONCLUSION

In this paper, the STC15 microcontroller is used to measure the water quality in the water cup through the TDS sensor, the DS18B20 digital temperature sensor measures the water temperature data, the JQ8900-16P voice chip reminds the user to drink water, and the LCD12864 display screen displays the data of the system. The main results are as follows:
(1) The water temperature can be measured, and the automatic heating is turned on when the water temperature is lower than 30 °C;
(2) Set a timed voice reminder to drink water: when the time is up, it's time to drink water (for example: remind people who are busy at work);
(3) The switch cover, heating function and timing reminder setting time function can be manually controlled through the buttons;
(4) Through LCD12864 display, it can display the temperature, timing, and the status of the switch cover;
(5) The water quality detection module is realized through the dual-channel digital TDS sensor.
After experiments, the functional requirements of this design are realized, and it provides support for people's healthy drinking water.

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