STM32-based intelligent healthy drinking thermos system design

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ABSTRACT

Between the current fast-paced lifestyles, many people do not pay attention to the healthy way of drinking water, can not replenish the daily amount of water is detrimental to the health of the body, and for some of the insulating cups on the market, their function is only able to heat the hot water, as well as display the temperature, and to develop a good habit of drinking water on time, for a person's health is very important. Therefore, designing an intelligent healthy drinking thermos that can remind users to refill water on time can enable them to develop good healthy drinking habits. The aim of this paper is to develop an intelligent healthy water jug based on STM32 microcontroller, through the water volume detection, water temperature detection, display, Wi-Fi and so on, and the development of mobile phone client. To sum up, you can improve them through this intelligent insulating cup, more convenient life, work busy to develop a good drinking habits, to maintain their own health status. This article adds is the shortcomings of the insulation cup in general, for the user to develop a good drinking habit provides great help.

Keywords: Physical Health; Smart Healthy Drinking Thermos; STM32 Microcontroller; Mobile Client; Drinking Habits

1 INTRODUCTION

Water is the source of life, and research has shown that if the body is chronically dehydrated, this can lead to electrolyte disturbances, metabolic abnormalities and, more seriously, cardiovascular disease, kidney stones and other problems. Therefore, drinking a sufficient amount of water every day is conducive to good health. So, this paper designs a set of intelligent healthy drinking water thermal cup, which not only has the traditional function of keeping water warm and measuring temperature, but also can remind the user of the importance of drinking water, It could even be combined with modern Internet of Things (IoT) technologies, so that users could set their own water-drinking routines on their phones, for example, have their phones vibrate when they drink water [1]. To achieve "intelligent" support users to develop good drinking habits, to maintain their own health. Therefore, the intelligent healthy drinking water insulating cup has good prospects for research and application.

2 RESEARCH WORK AND CONTENT

The main research work of this paper is the design of an intelligent system for a healthy drinking thermos flask, which will be used to improve the drinking habits of the users and to maintain their health status. The overall scheme of the study is shown in Figure 1:

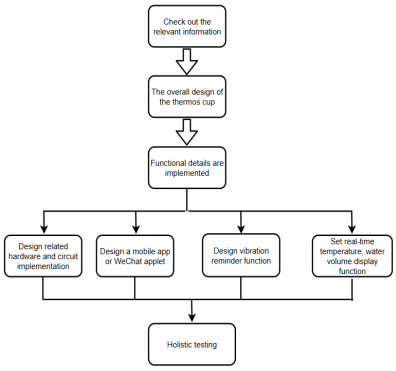

Fig.1: System research overall plan

The specific functional module contents of the Intelligent Healthy Drinking Water Insulation Cup are as follows:

MCU control module. In this paper, STM32F103C8T6 minimal system is selected as the MCU control module.

Water quantity detection module. In the hardware design of the thermo-cup, we want users to know the amount of water remaining in the thermo-cup at any time, so we use the HX711 pressure sensor module to detect the amount of water in the thermo-cup in real-time;

Water temperature detection module [2]. Now people want to be able to real-time understanding of water temperature in the insulation cup, drink the self-set temperature of water. To meet this demand, this paper chooses the use of DS18B20 temperature sensor module, real-time detection of water temperature in the insulation cup, but also display it on the display of the insulation cup shell;

Vibration motor module. To remind the user to drink water at the set time, this paper explores the installation of vibration motor module on the insulation cup, then the user can automatically vibrate to remind the user to drink water when it arrives [3].

Display module. In order to visualise the water volume and water temperature and other parameters in the insulation cup, this paper chooses to install OLED module in the insulation cup shell, so users can understand the various parameters of the insulation cup in time;

WIFI module. By designing APP or WeChat applet and insulation cup circuit for WIFI connection, real-time display of water temperature and volume on mobile phone, set drinking time and drinking reminder message;

For this thermos, one of the main problems to be solved is the uncertain setting of time and amount of water to be drunk by different people at first time every day. In order to solve these issues, the thermos flask can be adjusted automatically according to the default time and amount of water to be drunk by the user, and can be adjusted manually according to the automatic default time and amount of water to be drunk by the user, and can be reminded to drink healthy water by the vibration of the insulating cup.

3 INTRODUCTION TO THE PRINCIP AND REALISATION OF THE RELEVANT MODULES

3.1 MCU control module

In this paper, STM32F103C8T6 minimal system is selected as the MCU control module.

STM32F103C8T6 microcontroller is a low-power, high-performance microcontroller introduced by STMicroelectronics. STM32F103C8T6 microcontroller has a cost-effective feature in its series, with more complete functionality and lower price, which is suitable for this paper's intelligent healthy drinking water thermal cup circuit design [4]. The schematic diagram is shown in Figure 2:

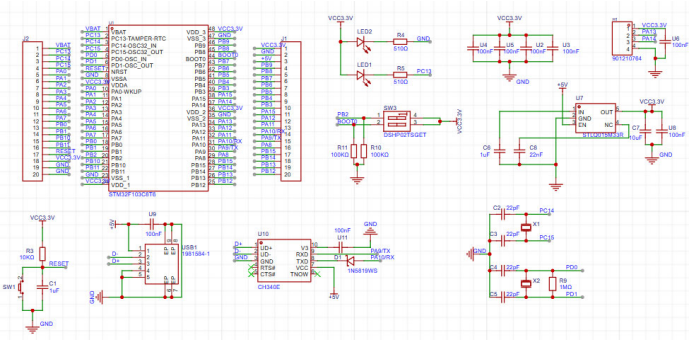

Fig.2: STM32F103C8T6 minimum system

In this paper, the STM32F103C8T6 minimum system is used as the main control chip to integrate various modules, and the overall system design diagram is shown in Figure 3:

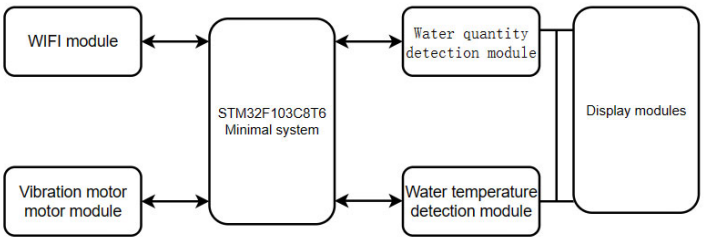

Fig.3: System overall design diagram

3.2 Water detection module

In this paper, we choose to use the pressure sensor HX711 module to detect the amount of water in the thermos in real-time, and the results are displayed on the thermos cover display.

HX711 module is a commonly used pressure sensor module, mainly used in detecting weight or pressure, has the advantages of fast response speed, strong anti-interference ability, easy programming, etc., so this paper chooses to use the HX711 module for detecting the amount of water in the insulating cup [5]. The schematic diagram is shown in Figure 4:

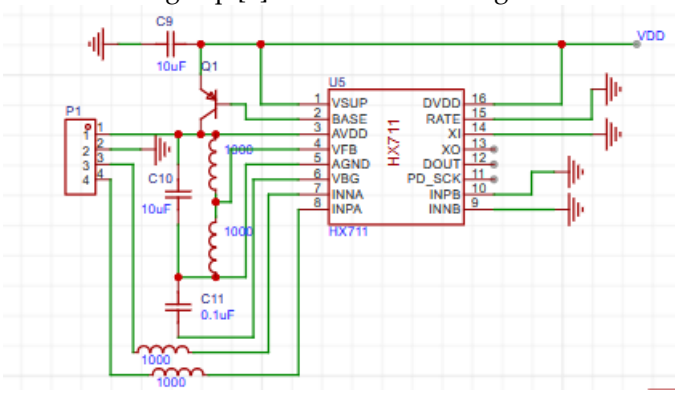

Fig.4: HX711 module

The following describes how the HX711 module computes the amount of water. Then the

value of the 24 bit AD conversion is sampled and output, and the microcontroller reads out the 24 bit data by the specified timing. The formula for calculating the supply voltage VAVDD of the HX711 is as follows:

$$VAVDD = VBG(R1 + R2)/R2 \quad (1)$$

Where VBG is the reference voltage of HX711. Then you need to calculate to get the maximum output voltage Vmax sent to the AD module, in this paper, let the amount of water is x Kg, the measured AD value is y, then its calculation formula is as follows:

$$V_{max} = VAVDD * 1.0mV/V \quad (2)$$

HX711 module A channel comes with 128 times signal gain. The voltage after gain is 128*Vmax,the maximum value after conversion to 24bit digital signal, then its calculation formula is as follows:

$$y_{max} = 128 * V_{max} * 24/VAVDD \quad (3)$$

Then the formula for the amount of water x is as follows:

$$x = y/y_{max} \quad (4)$$

After introducing the method of calculating the amount of water in a thermos cup, this article describes the role of the HX711 module pins for hardware connection to the microcontroller and code design [6]. The HX711 module typically has four pins, which are: VCC, GND, DT and SCK.The specific functions of these four pins are shown in Table 1 below:

Table 1: HX711 Module Pins

Pin Name	Pin Description
VCC	Chip power input, generally connected to 3V3 or 5V power supply
GND	Grounding wire
DT	Data pin, connect to microcontroller
SCK	Clock pin, connect to microcontroller

After understanding the pin function of the HX711 module, this paper will connect the VCC pin to the 5V power supply, the GND pin to ground, the DT pin to the PA0 pin of the microcontroller, and the SCK pin to the PA1 pin of the microcontroller. Having completed the hardware connection between HX711 and microcontroller, this paper uses keil5 to configure the water detector. The steps are shown in Figure 5 below:

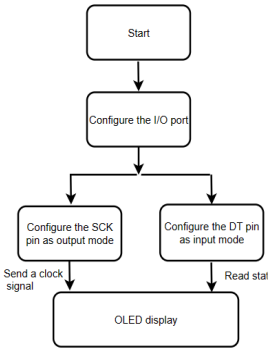

Fig.5: Flowchart of water detection module

Enable the GPIO clock;

Configure the SCK pin for output mode;

Configure the DT pin for input mode;

Read the data from the HX711. The specific content is: Send a clock pulse to read the status of the DT pin;

Calibrating the HX711 by measuring different weights and recording the output values of the HX711. To ensure accurate weight measurements, the programme is then adjusted based on this data;

Outputting the results and displaying them on an OLED.

Display modules must be configured to display the calculated water quantity on the OLED. A 0.96-inch four-pin OLED screen is used in this article [7]. The OLED panel is able to display information like text and images and is very cost effective and efficient. This module has four pins. Its specific functions are shown in Table 2:

Table 2: OLED Module Pinout

Pin Name	Pin Description
VCC	Chip power input, generally connected to 3V3 or 5V power supply
GND	Grounding wire
DT	Data pin, used for transmitting data
SCK	Clock pin, used for transmitting clock signals

Then, by connecting VCC to the 3V3 power supply, GND to ground, SCL pin to PB6 pin of the microcontroller and SDA pin to PB7 pin of the microcontroller, the OLED screen is connected to the microcontroller in hardware [8]. The OLED screen uses the IIC communication protocol to display the calculated amount of water from the thermos on the screen.

3.3 Water temperature detection module

In this paper, we choose to use the DS18B20 temperature sensor module real-time detection of the amount of water in the insulation cup, and the results will be displayed on the display of the insulation cup shell.

DS18B20intelligent temperature sensor is a novel type of intelligent temperature sensor with a "single-line bus" connection, which simplifies wiring, ST32microcontroller uses communication to read DS18B20temperature information. In addition, the normal operating voltage of DS18B20 temperature sensor is 3,0V-5,5V, low measurement error, more accurate data, low cost [9]. Therefore, we choose DS18B20 temperature sensor for real-time measurement of water temperature in thermos cup. The schematic diagram of DS18B20 temperature sensor is shown in Figure 6:

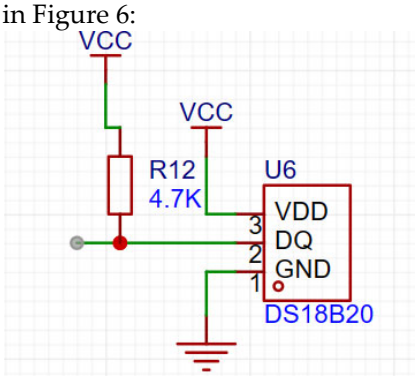

Fig.6: DS18B20 module

Then introduce the DS18B20 temperature sensor's temperature reading and conversion.

DS18B20 temperature sensor memory temperature is the use of 16-bit complementary code. The unit is degrees Celsius. The first five bits for the sign bit, used to distinguish between positive and negative temperature, where the positive value is 1, the negative value is 0; the remaining 11 bits for the temperature data bit, used to determine the temperature value [10]. For a positive temperature, convert 11-bit binary to decimal and multiply with .0625 to obtain temperature value.

The following article introduces the pins and functions of DS18B20 temperature sensor module, DS18B20 temperature sensor module usually has three pins: The specific functions of these three pins are shown in Table 3:

Table 3: DS18B20 Temperature Sensor Module Pinout

Pin Name	Pin Description
VDD	Power cord
GND	Grounding wire
DQ	Digital signal inputs/outputs

After understanding the pin functions of the DS18B20 temperature sensor module, we connect it in hardware. We connect the VDD pin to the 3V3 power supply, the GND pin to ground, the DQ pin to the PA8 pin of the microcontroller, and set the PA8 pin to the float input mode [11]. The software implementation steps of the water temperature detection module are shown in Figure 7:

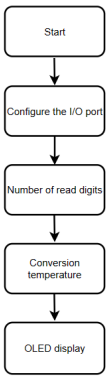

Fig.7: DS18B20 module implementation

First enable the GPIO clock and set pin PA8 to float input mode;

Read the number of bits and return the received data;

Conversion of received bits to temperature, including assessment of positive and negative temperatures and return of temperature values;

OLEDs use IIC communication protocol to read converted temperature value from microcontroller, realizing real time display of temperature of jug on display.

3.4 Vibration Motor Module

In this paper, we use a DC motor to implement the function of reminding the user to drink water by timed forward and backward DC motor rotation. DC motors can convert electrical energy into mechanical energy. However, DC motors are high-performance devices that cannot be driven directly by a microcontroller's GPIO port, requiring a motor driver circuit. Common DC motor driver modules are L298N and TB6612. In this paper, we will use the TB6612 motor driver because the TB6612 motor driver has the advantages of better heat dissipation and lower

loss in comparison with the L298N. The TB6612 motor driver module is shown in Figure 8:

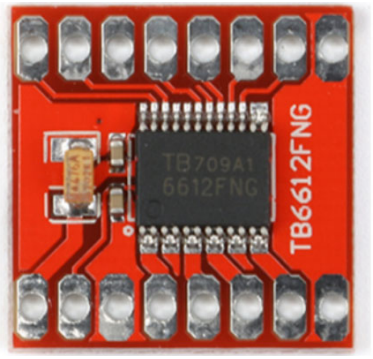

Fig.8: TB6612

The schematic diagram of the TB6612 is shown in Figure 9:

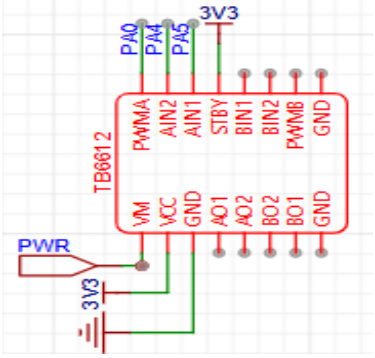

Fig.9: TB6612 schematic

The TB6612 pin names and specific functions are shown in Table 4:

Table 4: TB6612 Pinout

Pin Name	Pin Description
VCC	Logic level inputs
GND	Grounding wire
VM	Drive voltage input
STBY	Normal operation/standby status console
PWMA/PWMB	PWM signal input
AIN1/AIN2/BIN1/BIN2	Motor control inputs
AO1/AO2/BO1/BO2	Motor drive outputs

Now that we have an understanding of the pin functions of the TB6612, we connect it to hardware. We connect VM pin to 12V power, VCC pin to 5V power, GND pin to ground, AO1 and AO2 pins to access the motor, PWMA to access microcontroller pin PA1, AIN1 and AIN2 to access microcontroller pins PA4 and PA5 respectively, and STBY to access high level. The software implementation steps of the vibration motor module are shown in Figure 10:

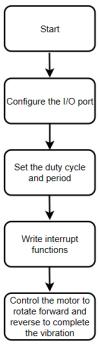

Fig.10: Vibration motor module realisation

3.5 WIFI module

In this paper, we choose ESP8266 WIFI serial communication module to achieve data transmission to mobile phone. ESP8266 generally has six pins, of which RXD pin must be connected to TXD of USB-to-TTL module, TXD pin must be connected to RXD of USB-to-TTL module, and the rest of GND and VCC are connected to GND of USB-to-TTL module and VCC pins respectively. The sequence of ESP8266 to achieve data transfer is as follows:

Set the operating mode;

Perform reset;

Connect the hotspot;

Set single connection mode

Establish mqtt connection

Set pass-through mode and transmit data.

The software implementation steps of the WIFI module are shown in Figure 11:

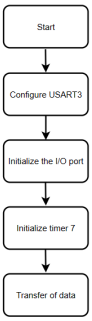

Fig. 11: WIFI module implementation

Through the connection of hardware and the corresponding module code writing, the microcontroller can be calculated in front of the thermal insulating cup water volume and water temperature real-time transmission to the mobile phone terminal, which through the MQTT communication protocol, the thermal insulating cup on the monitoring of various types of data in real-time display in the mobile phone client, so that the user fast and timely to learn about the specific information of the thermal insulating cup.

3.5 MQTT communication principles

MQTT (Message Queuing Telemetry Transport) is a client-server based message publish/subscribe transport protocol. The main advantage of MQTT is that it can provide

remote real-time messaging services for hardware devices with very little code and limited bandwidth, without adding redundant features, more convenient message push and subscribe, and higher transmission efficiency, etc.

3.5.1 Data transfer realisation

This project uses the MQTT protocol to build the push and subscription of messages between the mobile phone client and the hardware device. The mobile phone client generates a request to the server, and the server receives the request and returns the data to the hardware device, so as to achieve the push and subscription of the messages. message. To String() function is used to get the messages and data pushed by the mobile phone client to the server, and finally Use the send function to push the message and data to the server, so as to send the mobile phone client's operation commands and data to the server. And note that the quality of service (QoS) messages published by MQTT are not from client to client, but between client and server. The QoS of the published message and the QoS of the topic subscription is to determine the QoS level of the subscriber to receive the MQTT message, this procedure uses the QoS level of 0 to operate the use of the definition of the topic as watercup. through the above, to achieve the hardware device to obtain the mobile phone client's operating instructions and data from the MQTT server.

3.5 APP page operation function

The application is mainly written in four languages: HTML5, CSS3, JavaScript and JAVA. Next, we use JS for the function of each control in the application and JAVA for the storage of the users inputs.

This is followed by top analogue status bar, user information, notifications, preferences, bottom bar, water interval time setting, first drink time setting, real-time water volume and water temp monitoring, water volume per time setting, water volume per time setting, weekday drinking water condition indicator, and voice recognition for different operating elements. Next, CSS is used to write the style of each control. Finally, JS is used to complete the writing of each control function. One of the main functions - setting the interval between water fills - is briefly explained below. To set the drinking interval, JS setTimeout() is used to implement the timer function, so the application can repeat the remindToDrink() function at each specified interval. When the button is pressed, the system will automatically remind the user of the time interval that has been programmed.

4 CONCLUSION

According to the introduction of each module above, we take our STM32F103C8T6 minimum system as the main control chip, connect each module in hardware, and write the code on keil5 software.

Physical Performance Test: In the designed circuit, the amount of water in the insulated cup and the water temperature are displayed on the OLED display in real time. When the drinking time set on the mobile phone comes, the thermos will vibrate to remind the user. The user can view the water volume and temperature in the thermos in real time on the mobile phone, and can adjust the drinking time setting. The final physical tests are depicted in Figure

12, the APP tests are depicted in Figure 13.

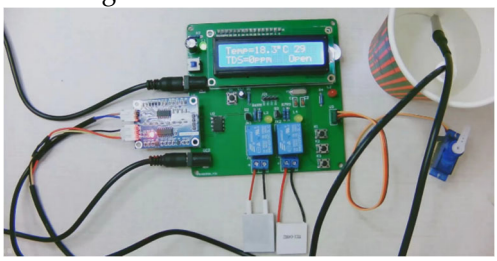

Fig. 12: Physical test chart

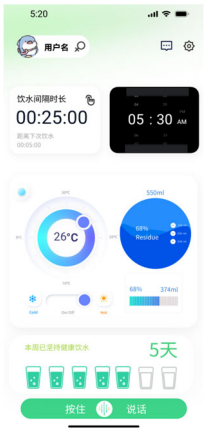

Fig. 13: APP test chart

5 DISCUSSION

Developing a good habit of drinking water on time is important for your health. Intelligent healthy drinking cup not only retains the traditional function of keeping water warm and temperature measurement, but also implements some intelligent and humane module functions. This paper uses STM32F103C8T6 as the main control chip, and several modules are designed on the thermal mug, such as the water detection module to realize the real-time display of the water volume of the thermal mug on the OLED display, the water temperature detection module to realize the real-time display of the water temperature of the thermal mug on the OLED display, WIFI module to realise the visualisation of the water temperature and water volume of the thermos cup in the mobile phone and to facilitate the user to perform the water saving function. The WIFI module can visualise the water temperature and volume of the thermos in the mobile phone. It is also convenient for users to set the drinking time. An intelligent healthy drinking cup composed of these modules will certainly be conducive to forming good drinking habits of modern people.

To sum up, the future of intelligent healthy drinking cup will become a necessity of human daily lives, will be widely used, and its innovation and mobility will be greatly enhanced, intelligent healthy drinking cup will become the future of human healthy lives of the hottest topic.

6 ACKNOWLEDGEMENTS

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