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Design and Implementation of Intelligent Shoe Cabinet Based on Internet of Things Technology

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ABSTRACT:

With the development of the Internet in the new era, from the initial interconnection of four computers in 1969, to the packet switching network, and then to the current Internet, the development of the Internet is the general trend, and the products under the Internet will follow. In view of the fact that traditional shoe cabinets cannot solve the problems of long-term dampness, smelly, bacterial growth and other problems of shoes placed in the dormitory, and the status of dirty shoes in the dormitory, a control unit with STM32 as the overall control unit is designed, and it also integrates dampness, mildew, A smart shoe cabinet system that integrates functions such as sterilization and deodorization, monitoring of environmental temperature and humidity, data display, automatic control, and mobile phone App control. The smart shoe cabinet system is mainly divided into two parts: the development board entity with the STM32 single-chip microcomputer as the main control unit and the user's mobile phone App. The user can monitor the temperature and humidity of the shoes placed in the smart shoe cabinet in real time and monitor the shoe cabinet through the mobile client. The internal temperature and humidity are threshold set, so as to mobilize the relay module to sterilize, deodorize, remove dampness and mold according to the user's independent needs. It can also achieve automatic control by setting the temperature and humidity threshold of the smart shoe cabinet in advance. To achieve the purpose of real-time monitoring and protection of shoes and remote control. The experimental results show that the function of the system is relatively stable and the operation is simple, which can effectively realize the user's purpose.

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I. INTRODUCTION

In recent years, with the rapid development of the era of the Internet of Things, people's requirements for the functions of daily necessities have also changed from suitable to healthy, so foot health has attracted great attention. Therefore, the daily care and maintenance of the shoes closest to the foot is also becoming more and more important. However, traditional shoe cabinets only play a simple storage and storage role, and cannot maintain any shoes. In addition, people are busy with work or school every day and cannot have enough time to clean and care for the shoe cabinet, which will lead to the long-term accumulation of dust, so that bacteria can grow, resulting in a vicious circle, even if the washed shoes are placed in the cabinet. The shoe cabinet will also attract the growth of bacteria for a period of time, and the smell in the shoes will also promote the growth of bacteria and expand the threat of bacteria. If people wear such shoes for a long time, it will be very easy to cause various foot diseases, which will not only damage their own health, but also endanger the health of others if it is a contagious disease, with very serious consequences. Although there are sterilization, disinfection, deodorization, and drug sprays on the market at present, manual implementation will cause a certain amount of trouble and waste time. Therefore, it is very necessary to design a smart shoe cabinet that integrates disinfection, sterilization and deodorization, so that it cannot only provide comprehensive care for shoes, but also save a lot of time, and the market prospect is very broad.

The smart shoe cabinet based on the Internet of Things designed in this paper has obvious advantages compared with the drugs on the market. It can not only remotely monitor the environment around the shoes through the mobile phone client, but also artificially adjust the environment according to the user's personal needs. It realizes the care of shoes more comprehensively, protects the user's foot health, and meets personal needs in the era of rapid development. During the dormitory period, too many dormitory shoes were placed on the traditional shoe racks uniformly, resulting in different odors from different shoes mixed together, which greatly affected the dormitory environment, and the shoes that were placed for a long time after the season changed would be

covered with thick layers. A thick layer of ash is bound to breed a lot of bacteria, and cleaning again will inevitably take a lot of time, time-consuming and laborious, and there will be unclean cleaning, which will affect the health of the feet. The smart shoe cabinet designed in this paper can fully clean the shoes and protect the health of the feet. It can also save a lot of time and put it into study.

With the continuous improvement of people's living standards, the pursuit of life has also changed from the original food and clothing to well-fed and well-dressed, so the shoes with slightly better materials in the family enter every household. At first, shoes were always put away as they were worn, so that when more and more shoes were bought, there was nowhere to put a large number of shoes, which would take up most of the space, and would also affect the aesthetics. Based on this simple bracket, it entered the market, but with the continuous improvement of people's requirements for the quality of life, this simple bracket can no longer meet people's needs, and the wooden shoe cabinet entered the market, and then became popular for a long time. Time, until now, there are still many families using this kind of wooden shoe cabinet, which is highly respected because it not only meets the needs of storing shoes, but also solves the problem of too many shoes occupying space between them. . However, with the advancement of science and technology and entering the era of current technology support, people's requirements are not limited to the advantages brought by wooden shoe cabinets, but also dislike that they are not convenient enough, and the ventilation is not good, which leads to the breeding of bacteria in their own shoes. foot health. In this regard, electronic disinfection shoe cabinets that are more convenient and can play a sterilization purpose have gradually entered the market. This kind of shoe cabinet has added a roller-type moving method, which can be easily pushed in daily life. In order to make the disinfection and sterilization effect better, using a unique sealing technology and a unique heating module to ensure the removal effect during the disinfection and sterilization process. Although this kind of shoe cabinet has appeared on the market now, but based on its high cost, single function, and low-cost performance, it cannot meet the daily needs of most people. With the development of technology, the development of smart shoe cabinets can also Looking ahead through the development of intelligence, in this era where the Internet of Things is gradually taking the lead, the development of smart shoe cabinets can be expected in the future.

The research and design of this paper is an intelligent shoe cabinet based on STM32. As a new space for storing shoes, it adapts to the current development trend and is related to the increase of shoe cabinet functions. Based on the limitations of traditional shoes, products are endowed with new functions and meanings. The user can remotely view the temperature and humidity around the shoes in the shoe cabinet and the degree of sterilization and disinfection through the mobile client, and can independently control the temperature and humidity required by the shoes in the shoe cabinet according to the user's own needs. The temperature and humidity thresholds can also be turned on and off through the button module to the disinfection, sterilization and deodorization module of the smart shoe cabinet, so as to achieve a comprehensive cleaning of shoes. In order to ensure that multiple people use the shoe cabinet, a database is used to save User information is convenient for family members to use together to achieve the purpose of protecting the family's foot health.

II. SYSTEM OUTLINE DESIGN

2.1 Overall system design

The hardware design of this smart shoe cabinet system mainly includes a WIFI module, an OLED display module, a sensor module, a damp-proof and mildew-proof module, a sterilization and deodorization module, and a mobile phone App. As shown in Fig.1, the STM32 single-chip microcomputer receives the mobile phone user terminal. The transmitted command data is analyzed, and the relay module is controlled to adjust temperature and humidity and control the disinfection, sterilization and deodorization module. At the same time, it receives the data collected by the sensor module, analyzes it, and sends the data to the user's mobile app. The temperature and humidity display area displays the temperature and humidity in the shoe cabinet in real time, so as to exchange information through the communication network.

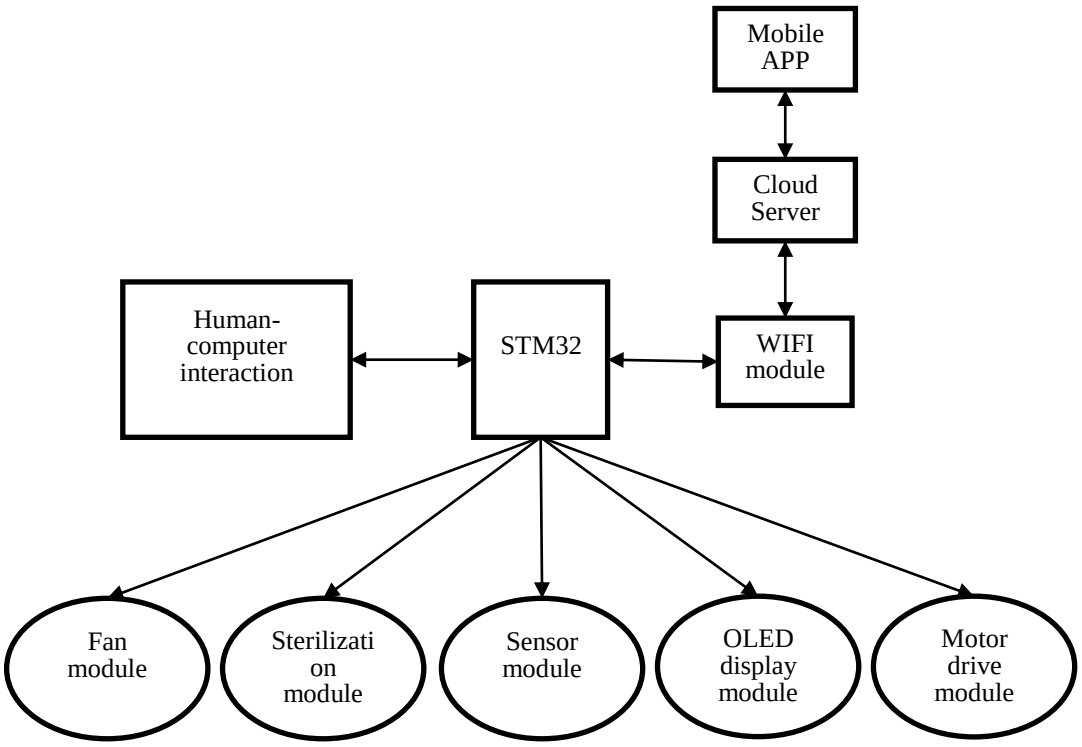

Fig. 1 Overall system design

2.2 System function design

2.2.1 Human-computer interaction module

In this design, a specific mobile phone App has been developed to realize the remote control of the shoe cabinet. It can not only grasp the environmental conditions around the shoes in the shoe cabinet at any time, but also cooperate with the sensor module and WIFI module on the shoe cabinet to realize the matching on the mobile phone App. The real-time display of the temperature and humidity data in the shoe cabinet, you can check the temperature and humidity in the shoe cabinet and the opening status of the functions in time through the mobile app, and you can also control the sterilization and deodorization module, dehumidification and mildew prevention of the shoe cabinet through the mobile app of the shoe cabinet. Open the module to achieve more convenient and quick control of the shoe cabinet to protect the health of the feet.

2.2.2 Sensor Module

This smart shoe cabinet system mainly uses the DHT11 temperature and humidity sensor, which is used for real-time monitoring and data collection of the temperature and humidity of the shoes in the shoe cabinet. DHT11 temperature and humidity sensor is an integrated digital sensor that can collect temperature and humidity data, adjust the sensor output signal, and transmit the data to the microcontroller through integrated analysis. In order to ensure that the sensor can collect data normally, a special temperature and humidity detection technology is used. DHT11 type temperature and humidity sensor adopts single bus data transmission mode, the volume meets the requirements of built-in shoe cabinet, and the power consumption is lower than that of similar products. The requirements of the module and the detection range of temperature and humidity are also applicable to this system. The DHT11 temperature and humidity sensor used in this system has 3 external pins, and its rated power supply voltage is controlled at 3.0~5.5V, which is suitable for the pin rated voltage of STM32 microcontroller. Due to the unstable process, it takes about 1 second to warm up Time during which the controller does not have to send a display to the sensor.

2.2.3 WIFI module

In order to realize the convenient characteristics of the shoe cabinet system, a wireless WIFI module is added in this design to realize the wireless data transmission between the microcontroller data and the mobile phone client. The ESP8266WIFI module is used in this design and provides three working modes. The STA working

mode is used in this system, which allows users to establish a hotspot to control the shoe cabinet through the connection of the cloud server, and transmit information in the WAN. It greatly increases the transmission distance, and has the characteristics of ultra-low power consumption and firmware programming. It can establish a pre-set hotspot name and password on the mobile phone, which can quickly realize the connection between the device and the wireless, so as to realize the statistical analysis of data through the cloud server, Functional services such as remote control are more suitable for the control of smart shoe cabinets in this design.

2.2.4 Fan Module

A heating device is installed inside the shoe cabinet. If the temperature in the shoe cabinet is too high, the rubber shoes will be easily damaged; if the temperature in the shoe cabinet is too low, the rubber material of the sole will gradually harden, and it will be easy to crack when wearing, resulting in Damage to shoes. The temperature and humidity of the environment are monitored by a module composed of a timing circuit, a microprocessor and a fan, and the shoe cabinet is intelligently heated and dehumidified. The STM32 main control is used to analyze the data signals collected by the temperature and humidity sensor, and the relay module on the microcontroller is used to control the Heating device, start or turn off the fan, to achieve the purpose of dehumidification and mildew prevention.

2.2.5 OLED Display Module

The smart shoe cabinet system uses the OLED12864 display module because its screen is small and convenient, with high display resolution, which is convenient for the design of the embedded system. It can display the real-time temperature and humidity measured by the temperature and humidity sensor in the shoe cabinet through the display screen, and display it at the same time. In the user's mobile phone client, it is convenient for the user to grasp the environmental conditions of his favorite shoes in time, so that the user can accurately control the current information of the shoes, and can send control commands in a timely manner to protect the shoes.

III. SYSTEM HARDWARE DESIGN

3.1 Selection of MCU and circuit design

This design selects the STM32F103 series single-chip microcomputer as the main controller of this design. It has several communication ports, including the IIC communication port and SPI port to be used in this design. Compared with other single-chip microcomputer chips, the STM32F103 series of single-chip microcomputers have low energy consumption and very powerful functions, which are conducive to meeting most of the personalized application requirements. They are suitable for the control of each module in this design, and are also used in life. Many places. The STM32 chip is shown in Fig.2.

Fig. 2MCU chip

3.1.1 Design of main control module

The main control module is mainly served by the STM32 single-chip microcomputer, and is mainly divided into two parts: the mobile phone App and the physical development board. The physical object of the development board is mainly the control between the OLED display screen, temperature and humidity sensor, fan, and relay module, and realizes the data exchange with the mobile app through the cloud server, receives and analyzes the control information sent by the mobile app through the cloud server, and carry out corresponding operations, and at the same time, display the collected data information [4]. The mobile app mainly converts the user's operations into control instructions, and after analysis, transmits the information to the control unit to achieve overall control.

3.1.2 STM32 pin connection description

This design uses the enhanced chip of the STM32F103 series, and the STM32 pin description is shown in Fig.3. Among them, PA3 and PA2 are the TXD and RXD interfaces of the microcontroller, which are used to connect the ESP8266WIFI module. PB12 is connected to the DHT11 temperature and humidity sensor. PB7 and PB14 are connected to the relay module and fan drive module respectively. PC14 and PC15 are connected to the OLED12864. Displays the module's SDA and SCL interfaces.

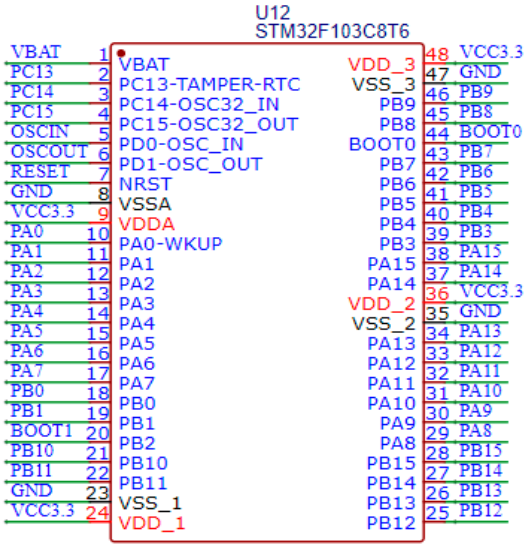

Fig. 3 STM32 pin description

3.2 Sensor Module Design

3.2.1 DHT11 pin description

As shown in Figure 3-3, this design uses the DHT11 temperature and humidity sensor. There are three pins in total, as shown in Table (1), two of which are VDD pins and GND pins, which are respectively connected to the power supply terminals of the microcontroller. And the ground terminal, and the DATA pin in the middle is the data output pin of DHT11, only need to supply 3.0-5.5V voltage to the DHT11 temperature and humidity sensor, and connect the DATA pin of DHT11 to the PB12I/O of the microcontroller. The temperature and humidity data in the shoe cabinet can be collected through the output pins of the DHT11.

Table (1). DHT11 pin description

pin	name	illustrate
1	VDD	Power supply 3-5.5VDC
2	DATA	Serial data, single bus
3	GND	Ground, power negative

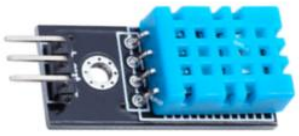

Fig. 4 Physical map of DHT11 sensor

3.2.2 DHT11 and STM32 microcontroller connection circuit

The connection circuit diagram of STM32 microcontroller (MCU) and DHT11 is shown in Fig.5.

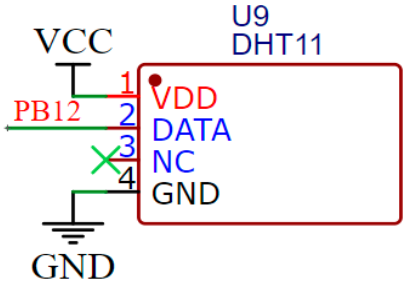

Fig. 5 DHT11 and MCU connection circuit diagram

3.3 Relay Module Design

The relays used in this design are mainly used to control the fan, UV lamp and ozone generator as shown. Among them, fresh air can be supplied to change the air humidity by controlling the switch of the fan, and ozone can be released to deodorize by controlling the ultraviolet lamp for ultraviolet sterilization and ozone generator [5]. The connection circuit of the relay module is shown in Fig.6.

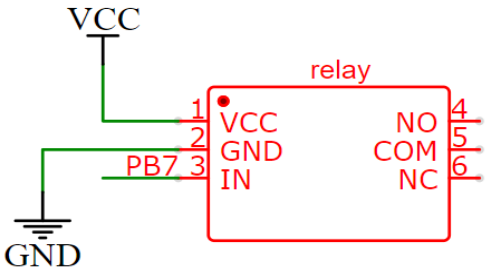

Fig. 6 Connection diagram of relay and microcontroller

3.3.1 Fan unit

This design mainly detects the temperature and humidity in the shoe cabinet in real time through the DHT11 temperature and humidity sensor. When the humidity reaches the threshold set in advance, the main control unit will give an instruction to control the relay to control the alternate operation of the heating plate and the cooling plate, so that the shoe cabinet can be operated alternately. The temperature and humidity inside is in a suitable state, and at the same time, it will drive the operation of the fan to circulate the air, so as to avoid a series of problems such as the breeding of bacteria caused by the lack of air circulation. Since the system voltage of the single-chip microcomputer cannot drive the rotation of the fan, a driver is used to connect the single-chip microcomputer to drive the fan to work. The connection circuit is shown in Fig.7.

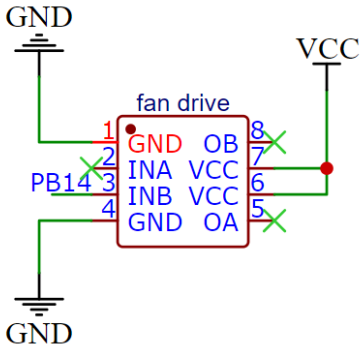

Fig. 7MCU and fan drive connection circuit

3.4 Display Module Design

3.4.1 OLED12864 pin description

As shown in Fig.8, the model of the display module selected in this design is the display screen of OLED12864. OLED12864 is a 128*64-line dot matrix OLED display module, which has a small size but has good clarity. It is better suited to be used as a built-in display for shoe cabinets. The pin description of the OLED12864 display module is shown in Table (2).

Table (2). OLED12864 pin function table

Pin	Name	Level	Pin function description
1	GND	0V	Ground
2	VCC	3V~5.5V	Positive power supply
3	SCL	H/L	Clock signal pin
4	SDA	H/L	Clock signal pin

Fig.8Physical map of OLED12864 display

3.4.2 OLED12864 circuit design

As shown in Fig.9, it is a schematic diagram of the pin connection between OLED12864 and STM32 MCU chip. Under the connection of 3.3V voltage, based on the SPI bus interface mode, by connecting with the MCU I/O ports PC14 and PC15 pins, data signals are received. and displayed on the display.

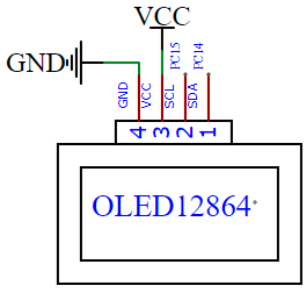

Fig.9 OLED and MCU connection circuit diagram

3.5 WIFI module design

3.5.1 ESP8266 Pin Description

This design uses the seven-pin SPI interface of ESP8266, as shown in Table (3) is the main pin description of ESP8266.

Table (3). ESP8266 pin description

Pin	Name	illustrate
1	GND	Ground;
2	VCC	Power positive (3.3V) module power supply;
3	URXD	(1) UART_RXD, receive; (2) General input/output: GPIO3;
4	UTXD	(1) UART_TXD, send; (2) General-purpose input/output: GPIO1; (3) Pull-down is prohibited when booting;
5	GPIO0	(1) Default WIFI status: WIFI working status indicator control signal; (2) Working mode: pull-up working mode; pull-down download mode;

6	GPIO2	The internal default is high level, it must be high level when power on, and hardware pull-down is prohibited;
7	RESET	Low level reset, high level work (default high);
8	EN	Enable terminal, high-level work, low-level module power supply off;

3.5.2 ESP8266 circuit design

The circuit connection between ESP8266 and MCU is shown in Fig.10. When connected to 3.3V voltage, pins RXD and TXD are connected to the PA2 and PA3 interfaces of the MCU respectively.

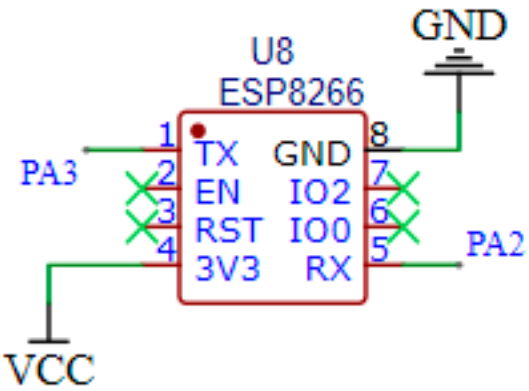

Fig. 10Connection diagram between ESP8266 and microcontroller

3.6 Overall Design of System Hardware

Fig.11 shows the working flow chart of the smart shoe cabinet system. Through the establishment and connection of the WIFI module hotspot, remote communication is realized, so that the mobile phone can control the shoe cabinet from a distance, and the WIFI module and the STM32 single-chip microcomputer are connected. The connection is established through serial communication, and the data signal transmitted by the temperature and humidity sensor is received under the condition of power supply, and the dehumidification operation is realized according to the set threshold, that is, the control of the fan, and is displayed on the OLED display screen after analysis. The overall circuit of the design of the hardware part of the smart shoe cabinet based on the STM32 microcontroller is shown in Fig.12.

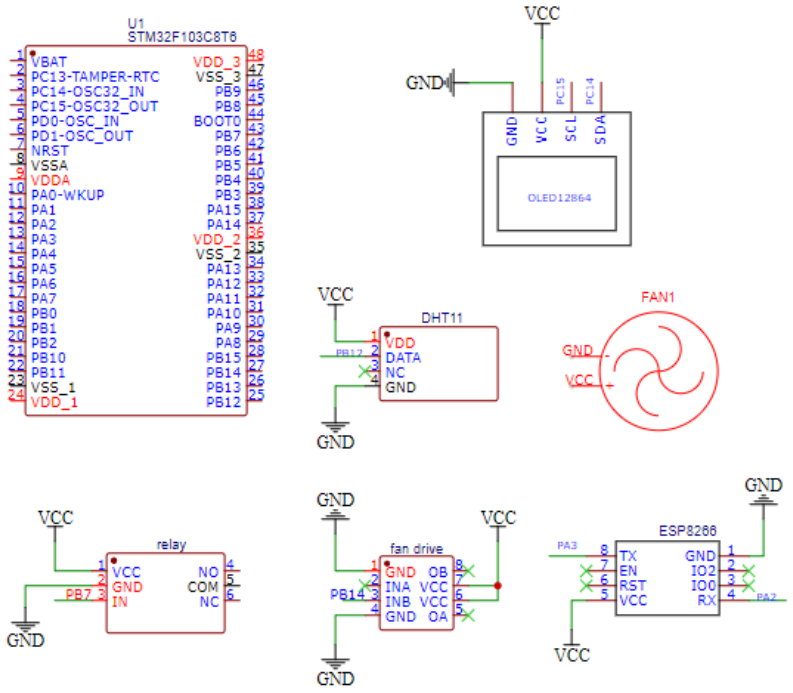

Fig. 11Overall circuit design of system hardware

The variation of productivity versus day time at different solar intensities at same flow rate at the height of a spherical dome 10, 18 and 40 in Figs. 15, 16 and 17, respectively.

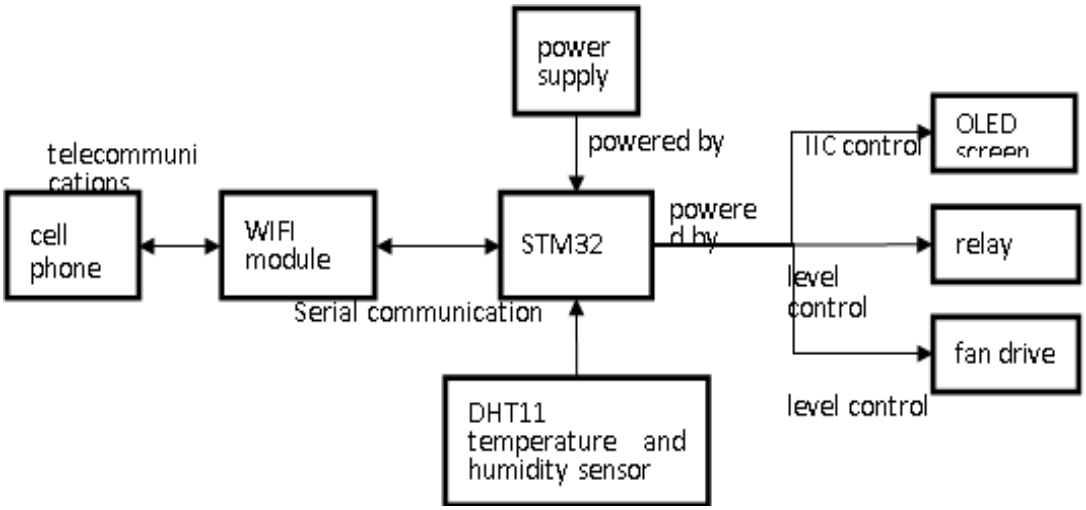

Fig.12The overall workflow of the system

IV. SOFTWARE DESIGN

4.1 Software Development Environment

The mobile client software developed in this design is based on the Android development environment and uses the Android studio software to develop the software development interface as shown in Fig.13. The reason why the applications developed by the current Android system can quickly occupy the domestic and foreign intelligent mobile terminal market is its openness. Based on this feature, the software can be compatible with most software during the development process, so that the developed software can have a larger market, and the corresponding software can be customized by the user's own wishes; at the same time, this software is equipped with the Android system. The latest hardware devices can run most of the applications on the market, and there is more room for the selection of applications, which greatly enriches the user experience.

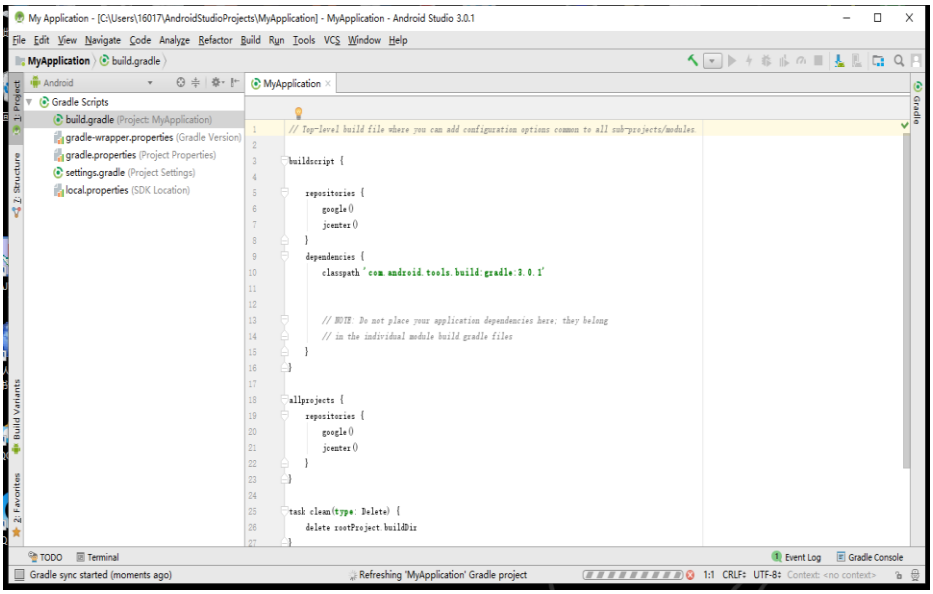

Fig.13Software development interface

4.2 APP function design

4.2.1 APP display interface

The mobile app has multiple interfaces, including the login interface, device control interface, and user management interface. Log in to the device control interface from the login interface, where you can adjust the relays, fans, and humidity thresholds, and on the user management interface, you can add, delete, modify, and query the people who use the shoe cabinet.

4.2.2 Temperature and Humidity Display Unit

In the design of the user-end App, the temperature and humidity data collected by the temperature and humidity display unit through the mobile phone DHT11 is displayed on the mobile phone App through the cloud server. The temperature and humidity display unit are set to facilitate users to check the temperature in the shoe cabinet in time during use. Humidity data in order to make subjective judgments.

4.2.3 Threshold setting unit

In order to better manage the condition of the shoes in the shoe cabinet, the threshold setting unit is set. When the humidity data collected by the microcontroller exceeds the set threshold, it will send a corresponding Instructions are used to control the drive module to drive the fan and the heating module to work to achieve the purpose of dehumidification.

4.2.4 Database Unit

In order to better allow the family to manage the shoe cabinet, the MYSQL database is specially used, so that the administrator can query, add, and delete on the user management interface., Modified operation, in which the query operation can be searched according to the user ID and user name, so that the user can more conveniently manage the personnel who use the shoe cabinet.

4.3 Design of hardware function scheme

4.3.1 Design of Temperature and Humidity Sensor Module

In order to ensure that the data transmitted by the DHT11 sensor can be received accurately and in real time, the DHT11 temperature and humidity sensor software should follow the standard single-bus communication protocol, and the MCU should use the default time sequence, first initialize the DHT11, call the delay wait, and then Send the scan command and conversion command to start the temperature and humidity conversion, wait for the temperature and humidity conversion to complete after a delay, then call the delay wait, send the read

operation command to store the data and convert it into decimal display, and repeat the above operations continuously to realize the real-time display of temperature and humidity . Its flowchart is shown in Fig.14.

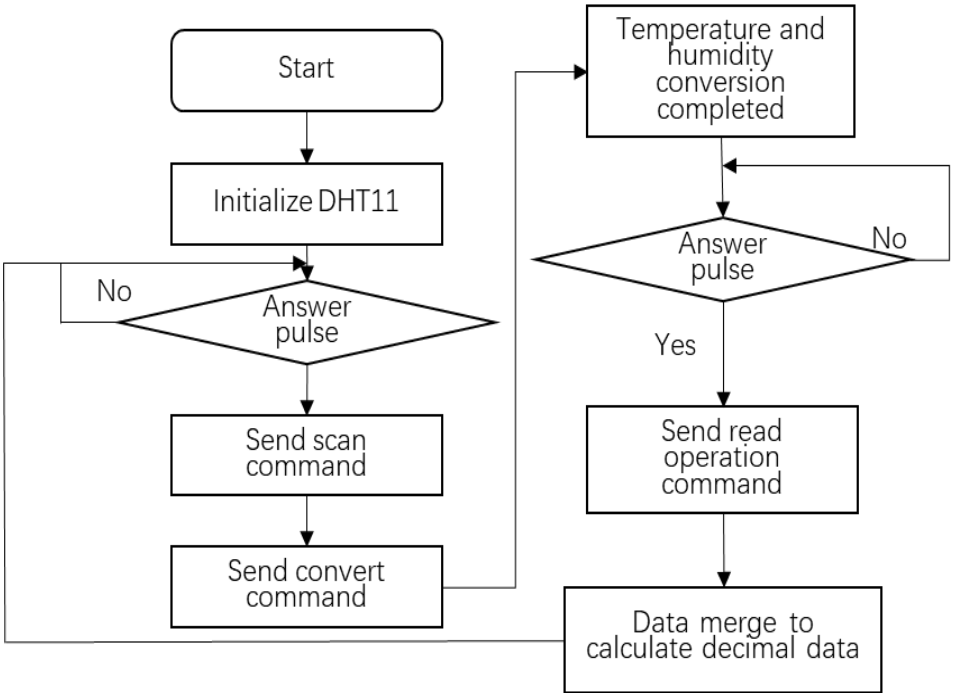

Fig.14 DHT11 data acquisition program flow chart

4.3.2 OLED display module scheme design

In the display module design of this design, the OLED12864 display module is used to display the temperature and humidity data collected by the sensor. According to the characteristics of the dot matrix display module, the coordinate setting function is used to display numbers and characters at the specified position of the display screen. The specific process is as follows shown in Fig.15.

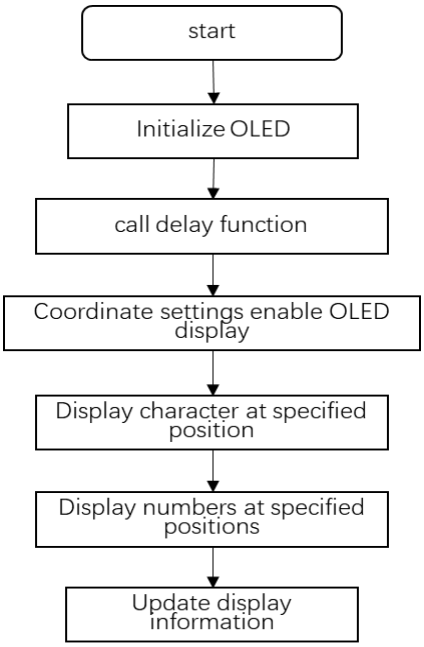

Fig.15 OLED display flow chart

The specific process of screen display is to first execute the OLED_Init(void) initialization function, after the initialization is completed, execute the OLED_Set_Pos() function to set the coordinates, then execute the

fill_picture() function to set the starting address of the data, and then execute OLED_ShowChar() respectively. The character display function and the OLED_ShowNum() digital display function are called after the delay function is continuously updated during the delay.

4.3.3 WIFI module scheme design

The ESP8266WIFI module is used in the smart shoe cabinet of this design. There are three modes: STA/AP/STA+AP. The STA Station mode is selected in this design. The WIFI module in this mode is equivalent to a client. The signal sent by the router can be connected, and the mobile phone can establish a connection with the device through the cloud server to realize remote control. The workflow of the WIFI module is shown in Fig.16. First, configure it for network access, including the name and password of the wireless to be connected, and select the STA working mode to let the WIFI module as the client. After the configuration is completed, the TCP connection is established and entered into transparent transmission. mode to realize data transmission.

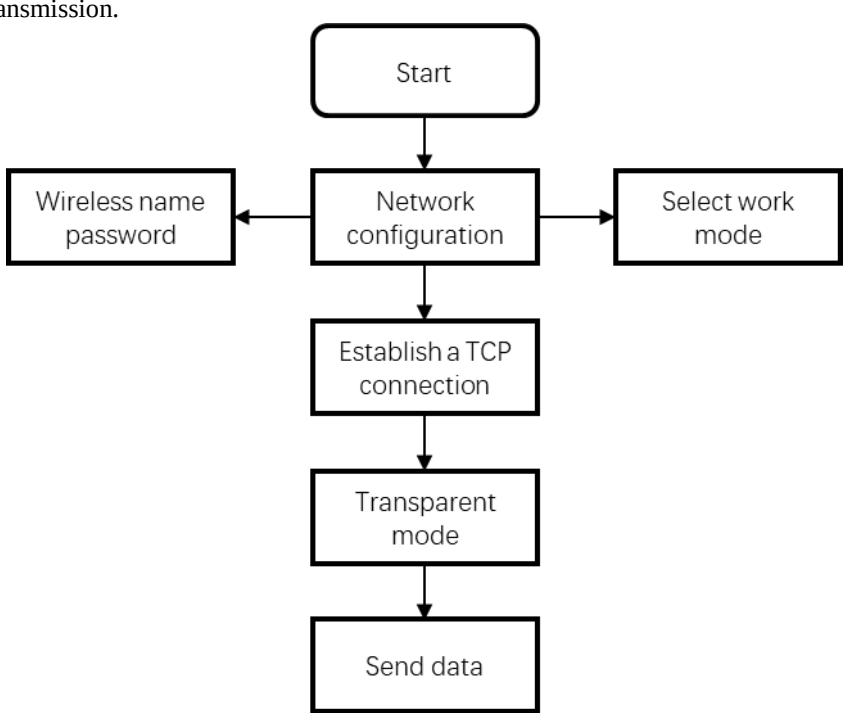

Fig.16 WIFI module workflow

V. SYSTEM DEBUGGING AND RESULTS

5.1 Commissioning steps

Step 1: Design the hardware circuit and draw the PCB, and complete the circuit connection according to the PCB.
Step 2: Connect the STM32 to the OLED12864 to ensure that the OLED12864 can normally display the data transmitted after being analyzed by the microcontroller.
Step 3: Connect the STM32 to the DHT11 temperature and humidity sensor to ensure that the collected data of temperature and humidity can be displayed on the OLED through the microcontroller.
Step 4: Connect the STM32 to the relay drive module to ensure that the fan can be driven to rotate when the relay is working.
Step 5: Set the mobile phone to set the hotspot and open the App. The connection of the WIFI module ensures that the temperature and humidity can be displayed in the mobile App in real time, and confirm whether it is consistent with the display on the display.
Step 6: Test the mobile phone App button control module to ensure that the relay module can be controlled.
Step 7: Artificially change the temperature and humidity around the temperature and humidity sensor, and check the changes in the data on the display and the data displayed on the mobile app to ensure that the changes are consistent.

5.2 Test Results
5.2.1 Hardware Test

Fig.17 shows the physical map function demonstration. According to the purpose of this design, the system is affected by human factors according to the debugging steps and the data is collected, as shown in the test data in Table (4).

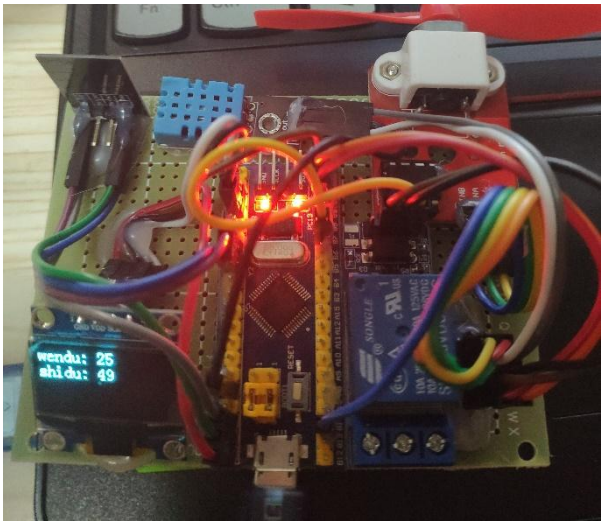

Fig.17 Physical map demonstration

Table (4). Data Test Table

frequency	Humidity Threshold（%rh）	Current Temperature（℃）	current humidity（%rh）	Fan works (yes/no)
1	50	25	44	NO
2	50	24	41	NO
3（humidification）	50	19	60	YES
4（humidification）	50	20	63	YES

5.2.2 Software Testing

The software of this design mainly realizes the rotation of the fan and the opening and closing of the relay by adjusting the threshold value by receiving the data sent by the temperature and humidity sensor. When the ambient humidity of the shoe cabinet is 45%RH, the threshold is set to 40%RH and the fan does not run. When the threshold is set to 50%RH, the fan rotates and the dehumidification module is turned on. The user's addition and deletion operations are realized in the user management interface.

VI. CONCLUSION

This design mainly includes STM32 microcontroller, DHT11 temperature and humidity sensor, relay module, OLED12864 display module WIFI module. Among them, the sensor is mainly used to monitor the environmental conditions in the shoe cabinet and the changes of environmental parameters in real time, and timely transmit the collected data to the single-chip microcomputer in real time, and then the single-chip microcomputer uses its own internal algorithm and program to judge the data. And realize the control of the relay according to the needs of users, so as to drive each module in the shoe cabinet to realize the change of the environment in the shoe cabinet. In this era of rapid development of network intelligence, the role of shoe cabinets is not just as simple as storing shoes, but more importantly, it acts as a small assistant for family foot health and protects people's foot health. At the same time, due to the intelligence of the shoe cabinet, it can also improve the user's utilization rate of time to save time and achieve the purpose of efficient life.

REFRENCES

[1]. Chen Xudong, Wei Dinghong. [2020] "Design and implementation of intelligent shoe cabinet based on HT66F2390 microcontroller". Shandong Industrial Technology,Issue 1: pp. 92-97.

[2]. Liu Jinhong, Xue Qin, He Weihong, et al. [2021]"Design of Small Rotary Smart Shoe Cabinet for Household". Modern Industrial Economy and Informationization, Vol.11, Issue 2: pp. 44-45.

[3]. Li Jianing, Cheng Dan, Dong Lu, et al. [2021] "Design of intelligent sterilization and deodorization shoe cabinet based on STC89C51 microcontroller". Electronics World, Issue 2: pp. 151-153.

[4]. Wu Yan. [2020] "Design and implementation of multi-functional smart shoe cabinet based on Wi-Fi". Electronic Production, Issue 17: pp. 36-38+92.

[5]. Bu Xuhui, Li Zhigang, Yin Cheng, et al. [2019] "Design of automated intelligent shoe cabinet". Modern Manufacturing Technology and Equipment, Issue7: pp. 59-60+64.

[6]. Ge Zhongyi, Wang Le, Wang Yuzhe, et al. [2019] "Design of energy-saving shoe cabinet system based on closed-loop feedback control of STM32 microcontroller". Energy Conservation, Vol.38, Issue 1: pp. 65-68.

[7]. Chen Jiaming, Deng Qiaoyin, Zhong Guochen, et al. [2016] "Multifunctional smart shoe cabinet based on cloud service environment". Foreign Electronic Measurement Technology, Vol 35, Issue 10: pp.58-63.

[8]. Hou Menghui.[2019] "An automatic sterilization shoe cabinet design with lifting and rotating function". Science and Technology Communication, Vol.11, Issue 2: pp.151-152.

[9]. Sun Jumei.[2018] "Innovative design of layered automatic rotating smart shoe cabinet". Electronic Testing, Issue 6: pp.19+18.

[10]. Wang Jiaquan, Wang Hao, Chen Shaoyong, et al. [2017] "Design of Intelligent Shoe Cabinet System Based on Internet of Things". Application of Electronic Technology, Vol.43, Issue 3: pp.84-87+91.

[11]. Li Xin, Han Junlei, SuYongyong, et al. [2016] "Research on the Development Status of Smart Shoe Cabinets". Electronic World, Issue1: pp.56-57.

[12]. Lin Yukun, Wang Xiaoqin, JinYachao.[2016] "Intelligent furniture from concept to reality—the design of a new type of intelligent shoe cabinet". Heilongjiang Science and Technology Information, Issue35: pp.54-55.

[13]. Wang Yilin, Wu Yufei, Lu Li. [2019] "Design and Research of a Smart Home Shoe Cabinet". Science and Technology Vision, Issue24: pp.17-18.

[14]. Jiang Yuanbin, Li Qifeng, Chen Qiwei, et al. [2019] "Integrated intelligent shoe cabinet based on PLC, single chip microcomputer and mobile APP". Modern Vocational Education, Issue22: pp.198-199.

[15]. Kuang Hao, Liang Xin. [2018] "Design of intelligent cleaning shoe cabinet". Tiangong, Issue7: pp.117.

[16]. Xu Jingfeng,CaoXuewei,WangChengzhi.[2021] "Research on intelligent integrated shoe cabinets". Journal of Physics: Conference Series, Vol.1865, Issue3.