Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920

Volume 1, Issue 3, July 2022

Design and Implementation of a Home Intelligent Controller

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Abstract In order to improve the high-power consumption and insufficient security of traditional home electric heaters, an Android-based electric heater intelligent controller was developed. The intelligent controller is composed of the controller body (referred to as the body) and the Android APP (referred to as the APP), the body can realize the manual adjustment of the electric heater, the temperature balance adjustment, etc., the APP can realize the scanning code automatic connection WIFI, remote control, and other functions. After testing, the controller can realize the energy saving and safety regulation of electric heating, and is a controller with good control effect, friendly and concise human-computer interaction, and potential promotion value.

Keywords Intelligent controller APP energy saving safety ontology human-computer interaction

1 INTRODUCTION

In recent years, with the continuous advancement of the major national strategy of coal to electricity, the home electric heater led by electric energy has ushered in great development, and the household penetration rate has increased year by year. At the same time, in the context of national green and low-carbon, energy conservation and environmental protection have become hard indicators in the energy industry, and problems such as high-power consumption, cumbersome use of traditional household electric heaters, and lack of safety have become increasingly prominent, becoming key problems that need to be solved urgently.

This article is based on the Android platform to design and implement a smart controller for home electric heaters. It aims to transform the traditional electric heater control mode, and use modern embedded technology and mobile Internet technology to realize the functions of multi-user sharing of equipment, APP remote control, anti-forget-off function, temperature balance adjustment, energy-saving assessment and other functions, and then solve the problems of high energy consumption, insufficient security and poor interactivity of electric heaters.

2 CONTROLLER ARCHITECTURE

The controller is composed of two parts, the main body is embedded in the surface of the heater, the APP is installed on the user's mobile device, the body mainly realizes the local adjustment of the heater, and the APP realizes remote adjustment, and its schematic diagram is shown in Fig. 1.

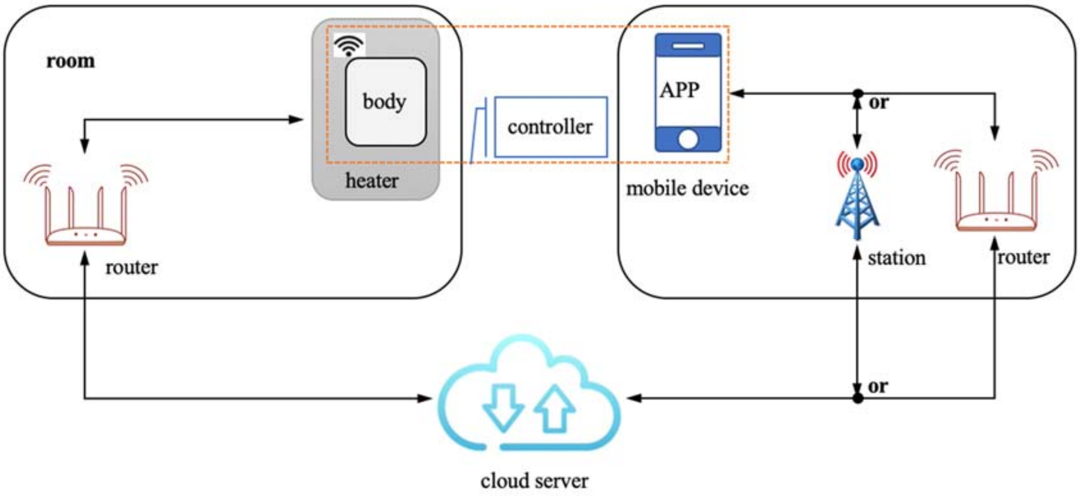

Fig. 1 Schematic diagram of the intelligent controller

As can be seen from Fig. 1, the heater is installed in a room, the body communicates with the server in both directions through WI-FI, and the APP communicates bidirectionally with the server through WI-FI or the base station (operator traffic), so as to realize the communication and control of the APP and the body in the intelligent controller.

3 DESIGN AND IMPLEMENTATION OF THE BODY

3.1 ONTOLOGY HARDWARE FRAMEWORK

Based on the home heating products of Asahi Heating Group Co., Ltd. Guizhou Branch, this study develops and designs an electric heating intelligent controller suitable for users in the southwest region. In the past two years, Zunyi Normal University - Guizhou Asahi Science and Technology Carbon Fiber Research Institute has been conducting research on electric heaters and intelligent controllers, sample production, testing and other work. The main body is mainly composed of a control-display module and a power-temperature control module. Among them, the control-display module includes microcontrollers, WI-FI modules, LCD displays and touch buttons; The power-temperature control module consists of a temperature sensor, a track device, a transformer, a rectifier and a voltage regulator. According to the size of a home heater in Asahi, the control module size is designed as L*W*H: 1380mm*760mm*170mm, and the power module size is designed as: L*W*H: 1380mm*650mm*320mm, weighing about 256 grams.

The core controller of the body adopts Microchip's low-cost, low-power microcontroller PIC16F76, the real-time clock chip adopts the low-power chip DS1302 of THE American DALLAS company, the LCD adopts jining Zhongke Zhicheng's MTW38266GE, the LCD driver chip adopts the TM1621B of Shenzhen Tian microelectronics, and the WIFI module adopts Espressif Technology's integrated ESP8266 The thyristor chip adopts HXW-BTA41-800B of Guangdong Keshengmei Company, the temperature sensor adopts MF52D-103-3950 (B25/50) (referred to as MF 52 D) of Shenzhen Hart Sensor Company, the transformer adopts MA-LFB35180 of Zhongshan Meiya Electronics Co., Ltd., and the rectifier adopts db207 bridge rectifier of Jiangsu Changzhou Galaxy Microelectronics Company. The voltage regulator is L7805 of ST Corporation. Most of the core chips used in the hardware part of the body have been localized, and the hardware structure of the body is shown in Fig. 2.

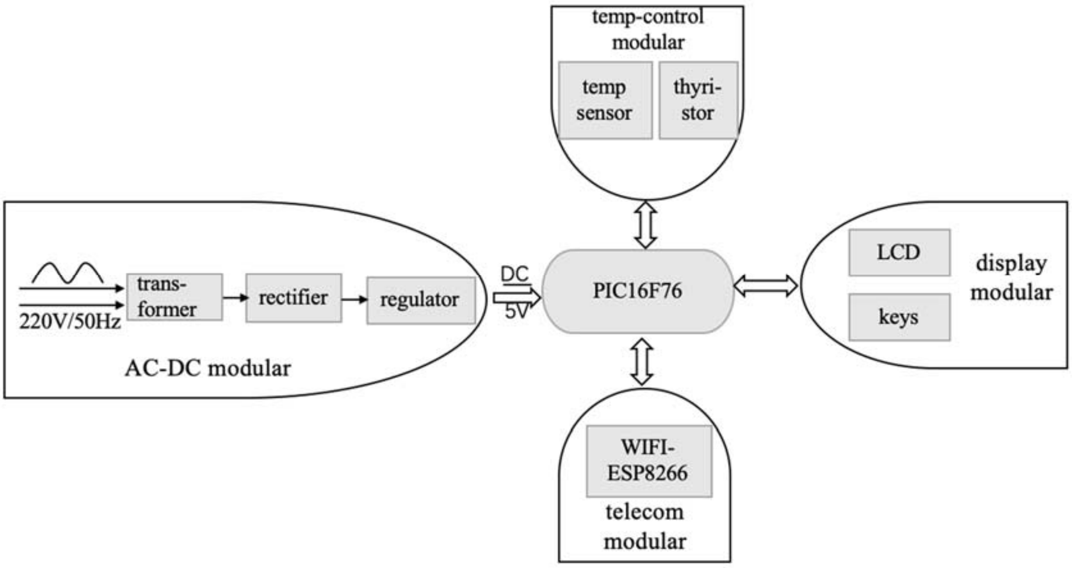

Fig. 2 Ontology hardware structure diagram

3.2 HOW THE ONTOLOGY WORKS

As shown in Fig. 2, the AC-DC conversion module converts the household Vin=220V/50Hz ALTERNA through the transformer LBF35180 into an AC (AC) output of Va.out=9V/350mA, and then converts Va.out to DC(DC)Vd.out through the bridge rectifier DB207, RC filter circuit, etc., and finally converts Vd.out into a 5V/DC output through the voltage regulator L7805, and then converts Vd.out to a 5V/DC output to the microcontroller, Temperature sensors, etc. provide stable power supply. The PIC16F76 microcontroller reads the ambient temperature value T1 measured by the temperature sensor MF52D and compares it to the set temperature threshold T0. When T1-T0-<0,0< T1-T0-<2, the microcontroller controls the thyristor BTA41 on when T1- T0->2, the microcontroller controls the thyristor BTA41 and disconnects. The microcontroller can display T1 and T0 directly through the LCD in real time, and the user can also set and adjust the T0 by touching the buttons. At the same time, the body can interact with the APP through the WI-FI module ESP8266 to achieve remote control of electric heating.

3.3 ONTOLOGY CORE MODULE DESIGN

Temperature measurement - control module design

The temperature measurement-control module of the body is mainly composed of temperature sensor MF52D, optocoupler-thyristor MOC3023, triac BAT41, microcontroller PIC16F76, etc., and its circuit diagram is shown in Fig. 3 shown.

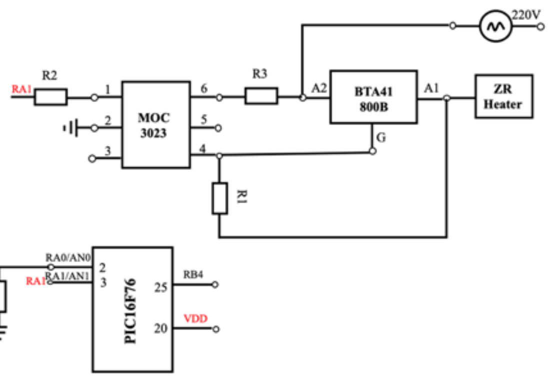

Fig. 3 Schematic diagram of the circuit of the temperature control system

Combined with Fig. 3, it can be seen that the anode of MOC 3023 is connected to GPIO-RA 1, and the cathode is grounded. The PIC microcontroller implements control of the MOC3023 via GPIO-RA 1, and when RA1 is high, the MOC3023 turns on, thus driving the BTA 41 on, so that BTA41 A 1 and A2 are connected, the household power supply begins to supply power to ZR Heater (Day YT heater), the electric heater begins to heat, and the ambient temperature continues to rise;

The temperature sensor MF52D is connected to the PIC's GPIO-RA0, and the PIC microcontroller reads the temperature value of the MF 52 D in real time by passing the GPIO-RA0 T1. When the difference between T1 and the set temperature threshold T0 is T1-T0->2, the PIC microcontroller sets RA1 low, MOC3023 disconnects, BTA41 Disconnected, the household power supply is disconnected from the ZR Heater, the heating element stops heating, and the ambient temperature begins to drop; When the

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920

Volume 1, Issue 3, July 2022

difference between T1 and the set temperature threshold T0 is T1-T0-<0,0< T1-T0-<2, the PIC microcontroller will RA 1 is set high, ZR Heater is heated again, and the ambient temperature is raised again. So, the cycle repeats to ensure that the ambient temperature is maintained within a certain range and to achieve the purpose of saving electricity. When the temperature in the process of rising, beyond the threshold of 30C, the buzzer issued a first-level alarm, exceeded the threshold of 50C, the buzzer issued a second-level alarm, exceeded the threshold of 100C, forced to cut off the power supply, and reminded the user on the APP, so as to ensure the safety of ZR Heater use. The procedural flow of the temperature control system is shown in Fig. 4.

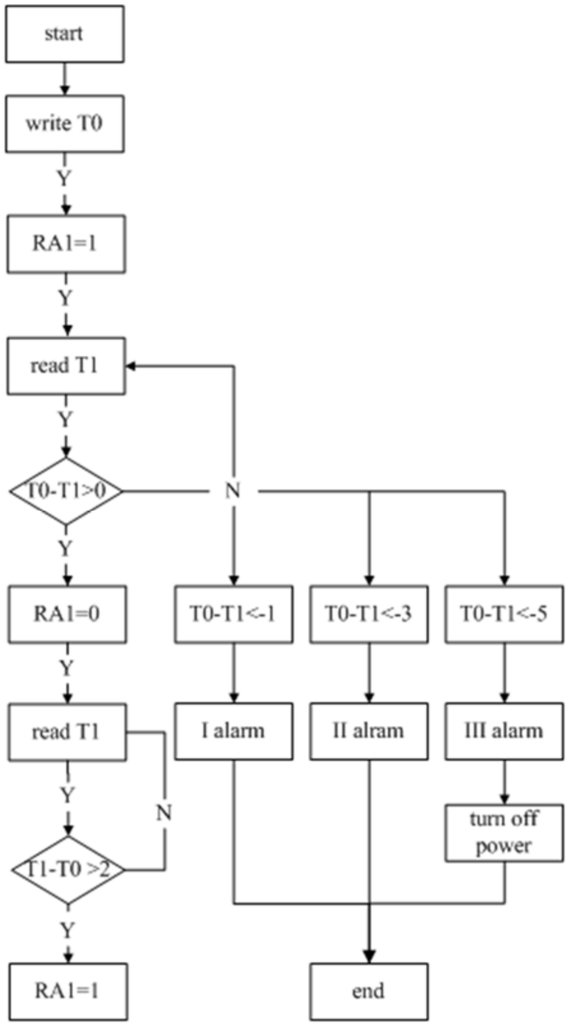

Fig. 4 Temperature control module program flow chart

Wireless communication module design

ESP8266 is a professional, low-power, high-performance, IoT-oriented WI-FI solution, as shown in Fig. 5, and its operating modes are three, as shown in Table 1.

Fig. 5 ESP8266 Physical image

Table 1 ESP8266 operating modes

Mode	**IS**	**AP**	**STA+AP**
Function	The WI-FI module is networked via a router	Wi-Fi module as a hotspot	Both modes coexist

In this study, the STA mode is used to realize the remote control of ZR Heater by mobile devices, and the AT (transmitted) mode is used to achieve data transmission. The PIC microcontroller communicates with the ESP8266 through a serial port to transmit control instructions and data, and its circuit is shown in Fig. 6.

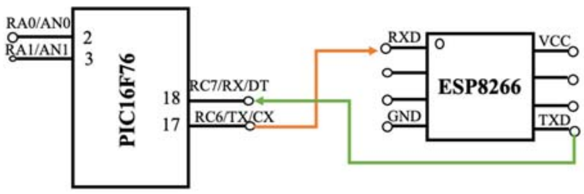

Fig. 6 ESP8266 circuit diagram

ESP8266 is a bridge between the ontology and the APP, that is, the bridge between the PIC microcontroller and the cloud server and the APP, and its program flow chart is shown in Fig. 7.

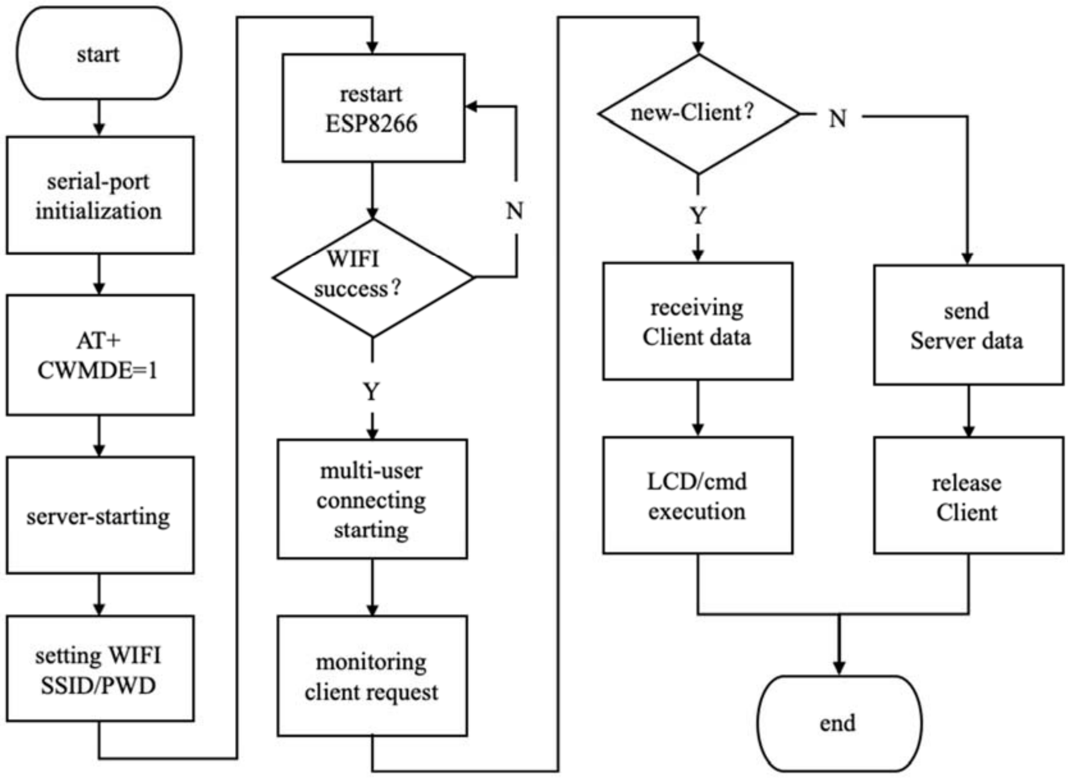

Fig. 7 ESP8266 program flowchart

4 CONTROLLER APP DESIGN

Intelligent controller APP is the intelligent embodiment of the controller, is an important aspect of the heater market competition, this design to the mainstream open-source mobile device operating system Android APP design and implementation, does not involve another mainstream system iOS.

This APP mainly involves the design of Android Activity (single screen of the user interface), which contains two aspects of UI interface design and programming, of which UI is mainly designed to be user-friendly interface, and the interface layout is realized through xml language; The programming is based on the Android Platform 8.0 in the Android Studio development environment and implements the internal logic of user operation through the Java language. This design does not involve the Android libc library and driver layer, nor does it involve the middle layer JNI.

Activity inherits from ContextThemeWrapper, starting with the onCreate() callback function and ending with the onDestroy() function, whose life cycle is shown in Fig. 8.

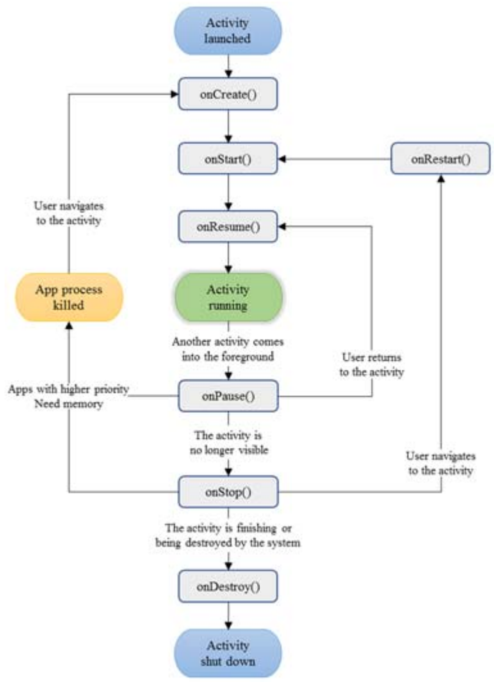

Fig. 8 Activity lifecycle diagram

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920

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APP Activity (interface) has Login Activity (login interface), Register Activity (registration interface), Main Activity (main interface), Home Activity (home interface), Intelligence Activity (smart interface), My Activity (My interface), ON/OFF Activity (Switch Interface), Mode Activity (Mode Interface), Timer Activity (Timer Interface), etc., the logical hierarchy is shown in Fig. 9.

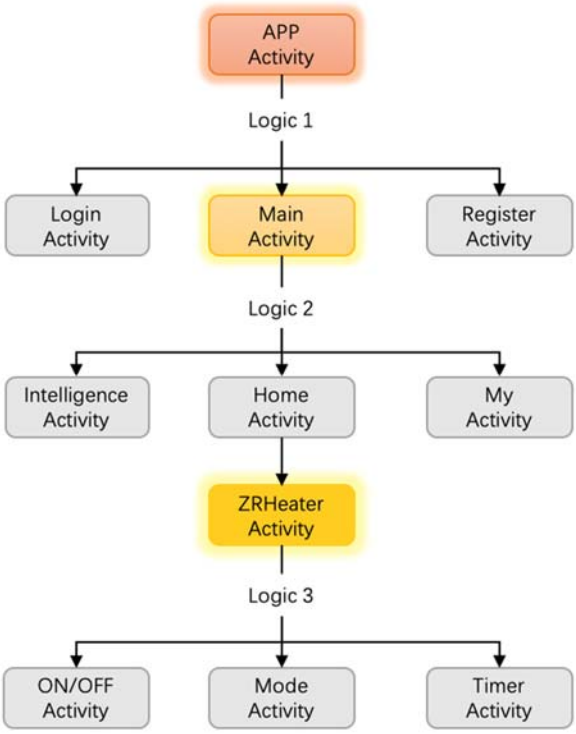

Fig. 9 APP Activity hierarchy diagram

From Fig. 9, it is easy to know that the APP interface design is divided into three logical levels, Logic 1 includes Login Activity (login interface), Register Activity (registration interface), Main Activity (main interface), Logic 2 The main interface layer contains home activity (home interface), Intelligence activity (smart interface), My Activity (my interface) 3 interfaces, Logic 3 is the asahi heater remote control interface, which contains ON/ OFF Activity interface, Mode Activity interface, Timer Activity interface, where Layers 2 and 3 are the core interfaces of the APP.

5 EXPERIMENTS AND CONCLUSIONS

5.1 *EXPERIMENTATION AND ANALYSIS*

The excellence of the intelligent controller lies in whether its control is convenient, whether the response is real-time and accurate, and whether the performance is stable.

This product is easy to use, Wi-Fi once set, permanent use, no need to set multiple times, and the operation is simple, the user only needs to operate the upper and lower keys to increase or decrease the temperature threshold after selecting the mode, and the other does not need to operate, its substance is shown in Fig. 10.

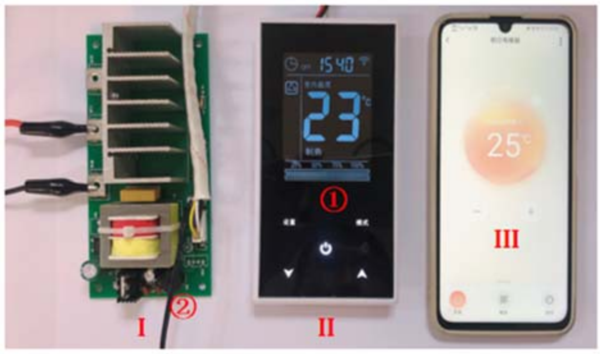

Fig. 10 Intelligent controller physical display diagram

As shown in Fig. 10, the intelligent controller contains I., II., III., 3 modules. I.+II. is the intelligent controller body, wherein I. is the power supply-temperature control module, (2) is the small blackhead temperature sensor, II. is the control-display module, (1) is the heating power progress bar; III. is a mobile APP module. From Fig. 13, it can be seen that the current room temperature is 230C, the temperature threshold is 250C, and the signaling transmission between III. and II. can be achieved through the network, including temperature adjustment, mode selection, switching on and off, etc.

The wireless transmission module of this product only realizes the upload and release of signaling, the amount of data is small, the real-time is high, and the time calculation can be performed in the program by signaling, and then rounded, and the signaling transmission time is shown in Table 2.

Table 2 The timetable consumed by the controller to upload and issue signaling under normal network (unit: ms).

Signaling / Transmission direction	dev_on	dev_off	threshold_adjust
Uplink	10. 53	11.26	10.81
Downlink	11.00	10.95	10.23

If the average transmission time of the signaling can be calculated in the table, the maximum error of the signaling transmission
is
$10.83ms = (10.53 + 11.26 + 10.81 + 11.00 + 10.95 + 10.23)/6$
: The minimum error is$5\% = (10.83 - 10.23)/10.83$. It can be

Journal of Research in Multidisciplinary Methods and Applications http://www.satursonpublishing.com/
ISSN: 2957-3920
Volume 1, Issue 3, July 2022

seen from the data that the time of signaling transmission is at the ms level, and the error fluctuation is not large under normal network conditions, which can realize real-time signaling transmission. Intelligent controller according to the temperature change to adjust the heating power, so as to achieve the purpose of energy saving, the controller by controlling the current size to achieve the adjustment of heating power. The table is the difference between the room temperature and the set threshold temperature, P% is the percentage of heating power, according to the temperature change, the heating power varies between 0% and 100%, and the relationship is shown in Table 3.

Table 3 Relationship between temperature change and heating power (unit: 0C).

T_1-T_0=ΔT	-2	-1	0	1	2
P%	100%	75%	50%	25%	0%

In this experiment, the temperature threshold is set as T0=250C, and the percentage of electric heating power at different temperatures is tested, as shown in Fig. 11 as shown.

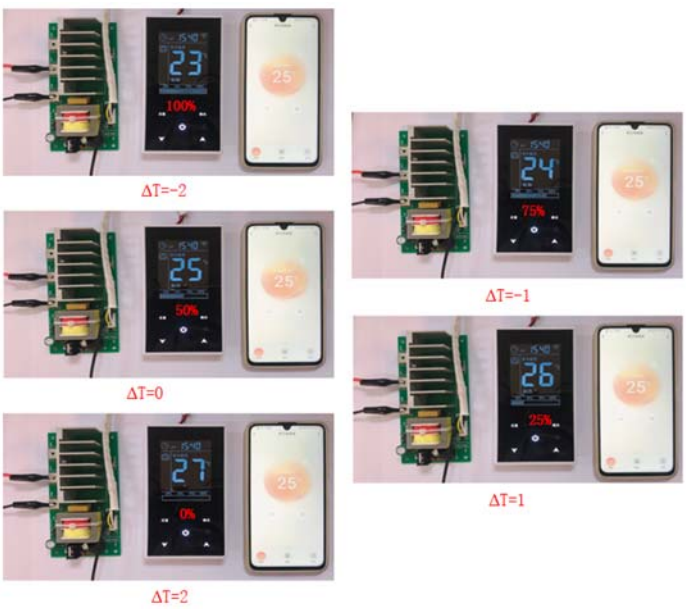

Fig. 1 1 Experimental diagram of temperature difference and heating power

From Fig. 14, the results shown in Table 4 can be obtained.

Table 4 Table of relationship between room temperature and heating power (unit: 0C).

T_1	23	24	25	26	27
ΔT	-2	-1	0	1	2
P%	100%	75%	50%	25%	0%

From Table 7 and Table 8, it can be obtained that the actual test results of the temperature change and heating power of the intelligent controller are consistent with the predetermined design results.

5.2 Conclusion

This article is based on asahi technology electric heater products, detailed design and implementation of electric heater intelligent controller, mainly based on its body and APP software and hardware design. Among them, the main body contains power supply - temperature control module, communication module, display module, etc.; The APP mainly includes the logical design of each functional interface and the communication with the ontology. The intelligent controller realizes real-time remote control, energy saving and safety and other functions, and achieves the purpose of safety, convenience and energy saving and environmental protection.

The further features to be improved and added in this design are:Add the control of the external humidifier by the intelligent controller to solve the problem of heating up in the room; Air drying problem.Add real-time storage of room temperature on the APP side and plot temperature curves, stored data; It is used for background big data analysis to further provide a reference for energy saving.The smart controller should reserve the relevant interface to access the home smart home. The power-temperature control module of the body part is further optimized, the size is reduced, and the body safety is reduced. Installation difficulty to adapt to more types of electric heater products.

Funds

Zunyi Municipal Science and Technology Bureau, Zunyi Normal University Joint Science and Technology Research and Development Fund Project (Zunshi Kehe HZ Zi No. 2 82); Zunyi Municipal Science and Technology Bureau and Zunyi Normal University Joint Science and Technology Research and Development Fund Project (Zunshi Kehe HZ Zi No. 2 79); Zunyi Normal University Academic New Seedling Training and Innovation Exploration Special Project (Zunshi XM [2020] No. 1-10).

References

[1]LI Ting. Thermal comfort and thermal efficiency of electric heater[D].Instructor: Bai Li. Jilin Jianzhu University, 2020

[2]Lei Yan. How to use electric heaters is safer[J].Farmer Staff Officer, 2017(04):70.

[3]HU Yuan. Design and research of electric heater[D].Supervisor: Wang Huabin; LIAO Zhiwen. South China University of Technology,2014.]

[4]MOU Ying,WANG Jie. The design of intelligent electric heater controller[J].Journal of Eastern Liaoning University (Nature Science Edition),2011,18(02):118-120+124.]

[5]Chen Hui,Wang Shuxin. Optimization design of intelligent thermostat for carbon fiber electric floor heating system[J].Measurement and Control,2016,35(05):149-152.

[6]MU Yuanjie, ZHAO Qingzhu, SHANG Minghua, et al. Design of intelligent controller for greenhouse roller shutter based on dual control of time[J].Anhui Agricultural Sciences,2021,49(22):209-212+216.]

[7]Shang Chuan,Gao Junwei. Design of Train Axle Temperature Monitoring System Based on ZigBee and Cloud[J].Sensors and Microun,20-21,40(08):110-112+120.

[8]Wang Jianxia,Li Xiang. Design of intelligent control system for infrared radiation electric heater based on single-chip microcomputer[J].Intelligent Computer and Use,2014,4(03):74-76+80.

[9]Ding Chengjun, Hu Bo, Liu Yunfan, etc. Design of dust monitoring system for construction site based on Internet of Things[J].Sensors and Microsystems,2022,41(02):101-104.

[10]Xie Xiaozhong. Intelligent electric heating controller with Wi-Fi function[J].Fujian Agricultural Machinery, 2016(03):28-30+46.

[11]Chen Jianjun,Xie Feng,Wang Xiaowu,etc. Design of Digital Torque Wrench Control System Based on PIC Microcontroller[J].Sensors and Microsystems,2022,41(03):72-75.

[12]Wang Penghui,Fang Suping,Li Qi. Design of low-cost IoT connected greenhouse control management system based on ESP8266[J].China Journal of Agricultural Machinery Chemistry,2019,40(12):53-58.

[13]Yan Hanting, Du Xuan, Sun Tiancheng, et al. Development of smart home system based on ESP8266[J].Computer Knowledge and Technology,2021,17(27):136-138.]

[14]Zhang Xiaosi, Zhao Deying, Zhao Li, et al. Design of data communication between Android and SQL Server based on JDDS[J].Automation and Instrumentation, 2018(11):82-84

[15]JIA Yangjing, ZOU Nianyu, LEI Dongming, et al. Smart home system design based on Android and WIFI communication[J].Journal of Dalian Polytechnic University,2016,35(01):67-71.]

[16]ZHANG Xiaohong. Design and research of wireless smart home system based on Android[D].University of Electronic Science and Technology of China, 2016.