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Design and Implementation of a Wireless Control Intelligent Humidifier

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Abstract—A wireless-controlled intelligent humidifier is developed based on the STC89C52 microcontroller. It can effectively monitor the current environment and automatically adjust the humidity level. The hardware mainly includes the STC89C52 control system, sensor circuit, alarm circuit, display circuit, keypad circuit and so on. The software is developed using Keil. It mainly includes main program, data acquisition subroutine, display subroutine, alarm subroutine, communication subroutine, etc. It not only achieves automatic detection and adjustment of indoor temperature and humidity, but also automatic detection of water level and turbidity with over-limit alarm. In addition, A mobile APP is developed to monitor and control the humidifier remotely.

Keywords: Microcontroller; Wireless control; Intelligent humidifier

I. INTRODUCTION

With the rapid development of technology, people's demands for quality of life are increasing. In our living environment, heating or cooling equipment such as air conditioners may result in insufficient skin moisture and the risk of colds and coughs because of the dry air. The humidifier is an essential device for creating a comfortable living environment to meet people's needs for relative humidity. However, conventional humidifiers have many problems in controlling and adjusting humidity. For example, they cannot detect the water level inside the humidifier, which can easily lead to dry burning. So, a wireless control intelligent humidifier with multiple functions is designed and implemented based on the STC89C52 microcontroller. Firstly, the humidifier can detect indoor humidity in real time and intelligently adjust it to ensure a comfortable indoor living environment. Secondly, the intelligent humidifier is also equipped with water level detection and turbidity detection to prevent safety hazards caused by improper operation of the humidifier. Thirdly, through intelligent control systems, the device can automatically adjust the humidity level, which eliminates the annoyance of manual operation. Fourthly, it can also adjust the working time of the humidifier, making it more intelligent. Finally, it can be remotely controlled by a mobile phone APP via WIFI, which provides the convenience of user operation.

II. SYSTEM HARDWARE DESIGN

A. OVERALL IDEA OF HARDWARE DESIGN

The STC89C52 microcontroller is the main control chip of the wireless intelligent humidifier. It receives temperature and humidity information of the current environment from DHT11. At the same time, the detection results of water level and turbidity also need to be digitized by ADC0832's analog-to-digital conversion and transmitted to the microcontroller; DS1302 is responsible for timely updating the current time; independent buttons are used to execute various operations; data analyzed by the microcontroller will be displayed in the form of LCD1602 screen;

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when the value exceeds the preset threshold, the sound device (buzzer) will be activated to issue an alarm; relay is used to adjust the working gear of the humidification equipment; ESP8266-01S communicates with the microcontroller through a serial interface. The overall hardware design is shown in Figure 1.

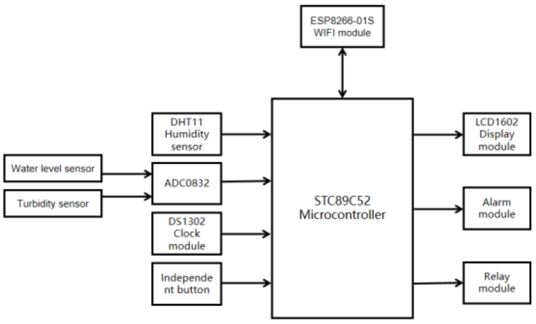

Fig. 1.Hardware overall design diagram

B. Microcontroller Module

This project adopts the STC89C52 microcontroller as the core processor. The STC89C52 is a high-performance, widely used microcontroller with a 40-pin DIP package, and it can also be selected with PLCC44 or QFP44 package. Its usage includes writing programs, burning programs into the internal Flash, and connecting external devices for APPlication development. The schematic of the STC89C52 microcontroller is shown in Figure 2, where the STC89C52 microcontroller is connected to the reset circuit and crystal oscillator circuit. The P0 port is connected to the pull-up resistor array to pull the signal to a high level, and the pull-up resistor array also serves as a current-limiting resistor.

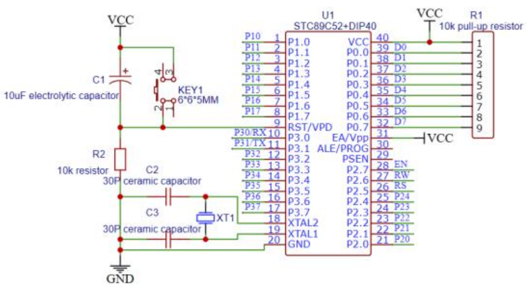

Fig. 2.STC89C52 microcontroller schematic diagram

C. Sensor Module

In the implementation of this design, the DHT11 digital temperature and humidity sensor were chosen as the data acquisition device. This type of sensor is well-known for its wide usage and is available in three-pin or four-pin interface modes, which include VCC (power supply terminal), signal output terminal, and GND (ground terminal). Typically, the VCC and GND terminals are connected to the power supply and ground respectively, and then the signal output terminal is connected to the digital input of the microcontroller. Specific programming techniques are then employed to obtain the digital information emitted by the sensor, thereby analyzing the corresponding temperature and humidity data. Its core performance indicators include: a temperature measurement range of 0° C to 50° C and a minimum humidity detection range of 20% to 90% RH, with excellent measurement accuracy and rapid response capabilities. As shown in Figure 3, the DHT11 is connected to the microcontroller via the Data port, transmitting real-time collected digital signals to the microcontroller for analysis.

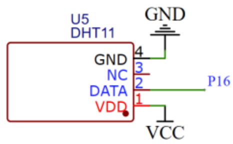

Fig. 3.Schematic diagram of DHT11 temperature and humidity sensor

Utilize the D3B pressure sensor to perform real-time monitoring of the water level inside the humidifier. Its operating voltage is 4.2V, with a pressure range of 0-1000mm water column. Use a transparent tube in conjunction with the D3B pressure sensor for water level measurement. This method is based on the principles of liquid statics. By connecting the transparent tube to the D3B pressure sensor and immersing one end of the tube into the liquid, the pressure of the liquid is conducted to the sensor through the tube. The height or water level of the liquid is then

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indirectly calculated based on the pressure values obtained by the sensor.

Employ the TS-300B sensor for turbidity detection. The principle involves utilizing the light emitted by a light-emitting diode (LED), which is then received by a phototransistor after passing through the wastewater. By measuring the intensity of the received light, the turbidity of the water can be calculated. As illustrated in Figure 4, the turbidity sensor and water level sensor are respectively inserted into the CH0 and CH1 ports of the ADC0832 analog-to-digital converter. After converting the analog signals into digital signals, they are then output to the microcontroller.

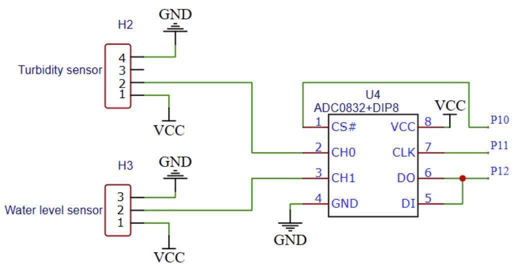

Fig. 4.Schematic diagram of turbidity sensor and water level sensor

D. DISPLAY MODULE

In this project, the LCD1602 is chosen as the display screen to showcase various monitoring data. It is a widely used character-based liquid crystal display module, with a standard operating voltage of 5V and a normal operating temperature range from 0 to 50° C. The module features a display area of 16x2 in size, capable of accommodating a maximum of 16 characters of information. As shown in Figure 5, the LCD1602 module typically includes 16 pins, which are used for connection to external circuits for controlling display and data interaction. The VSS and VDD pins are connected to ground and power supply, respectively. The V0 pin is used to adjust display brightness by connecting to a potentiometer. The RS pin indicates whether to send instructions or data, while the RW pin indicates read or write operations, typically connected to ground to set it to write mode. The E pin is used to trigger the execution of data or commands. The D0 to D7 pins are used for transmitting data and commands, allowing communication with the controller in parallel. Among them, the D0 to D3 pins are available in 4-bit mode, while the D4 to D7 pins are used for transmitting the high four bits of data.

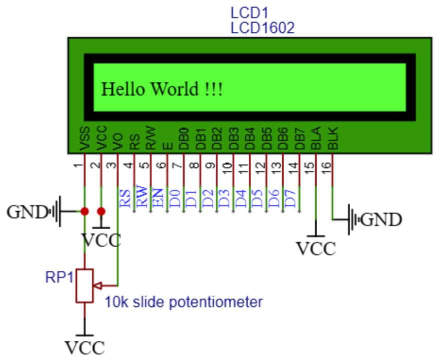

Fig. 5.Schematic diagram of LCD1602 display

E. RELAY MODULE

The relay used in this design is the SRD-05VDC-SL-A model. This relay controls the on-off state of the relay by controlling the high and low levels of the control signal. The main technical parameters include a rated voltage of 5V, a rated current of 10A (AC), a maximum load voltage of 30V DC / 250V AC, an operating time of the relay of 10 milliseconds, a release time of 5 milliseconds, a contact resistance less than 100mΩ, and a relay life of over 100,000 times.As shown in Figure 6, the main function of the relay module is to adjust the humidifier's gear position. By sending effective signals to the control pin, the relay's switch operation is achieved, thereby controlling the on-off state of the external circuit. This allows for the adjustment and control of the humidifier's gear position.

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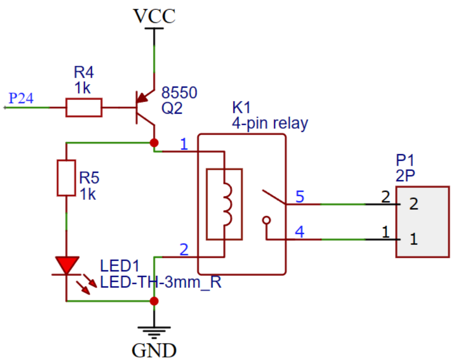

Fig. 6.Schematic diagram of relay

F. Alarm Module

The alarm module in this design utilizes an active buzzer as its primary component for alarm purposes. As shown in Figure 7, an active buzzer typically comes with three interfaces: power supply positive (+), power supply negative (-), and control signal input terminal, which are used to control the activation and deactivation of the buzzer. The power supply positive terminal is used to connect to the positive power supply, the power supply negative terminal is connected to ground or negative power supply. The control signal input pin receives the control signal, and when the signal is active, the buzzer emits sound.

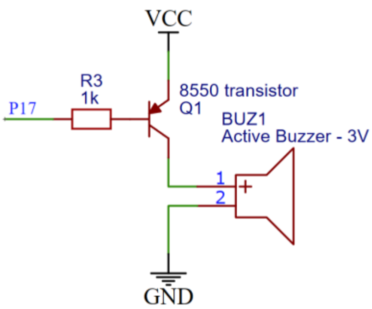

Fig. 7.Schematic diagram of active buzzer

G. Communication Module

In this design, the ESP8266 is utilized as the primary component of the communication module. The circuit diagram of the ESP8266 is shown in Figure 8, which includes power supply pins (VCC, GND), UART communication pins (RX, TX), reset pin (RST), GPIO pins, etc. This integrated circuit enables serial data transmission and reception with a microcontroller.

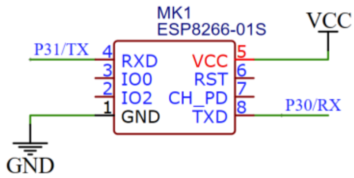

Fig. 8.Schematic diagram of ESP8266 circuit

III. System Software Design

A. Main Program Design

The main program flow is illustrated in Figure 9, which depicts an integrated flowchart of the software system. Once the system starts running, each component will undergo initial configuration before entering the while loop. At this point, sensors collect real-time air humidity, liquid level, and turbidity data, while DS1302 captures current clock data and displays it on the LCD1602. Simultaneously, button scanning occurs to identify their statuses, determining which buttons have been triggered. Subsequently, the system jumps to the processing function to analyze whether any information exceeds predefined thresholds. If so, an alarm is triggered, and the humidity adjustment process is terminated by resetting the gear to zero. Conversely, if the condition is not met, the system further determines whether it is in automatic or manual mode. In the former case, the gear is automatically adjusted based on the current air humidity, while in the latter case, predefined manual gear settings are utilized. Finally, the data is transmitted to the mobile APP.

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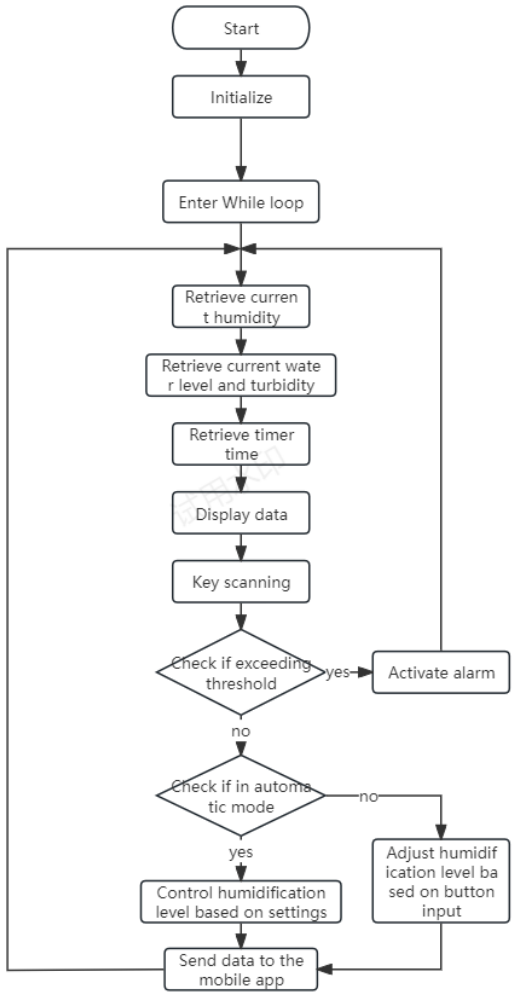

Fig. 9.Main program flowchart

IV. CONCLUSION

After extensive testing, the wireless control smart humidifier designed in this project meets the design objectives and requirements in terms of data acquisition, data display, timed operation, threshold modification, overlimit alarm, and manual/automatic adjustment. There may be some errors in water level measurement and occasional delays during operation. These shortcomings can be addressed through continuous optimization and testing to improve stability and functionality. With ongoing improvements, I believe this wireless control smart humidifier will continue to evolve and become more refined.

REFERENCES

[1] Roland Y N D ,Karen R ,Yuzo T , et al.Smart home cybersecurity awareness and behavioral incentives[J].Information Computer Security,2023,31(5):545-575.

[2] Xin J Y,Zhong W,Hong L. Smart Gate System Design and Implementation Based on Cloud Platform[J]. Procedia Computer Science,2019,154(C)：65-72.

[3] Yuhang X. Design of Intelligent Voice Greenhouse System Based on STM32 MCU[J]. Journal of Physics: Conference Series,2023,2562(1)：86-92.

[4] Jialong C,Jingjing X. Design of intelligent temperature and humidity monitoring system based on STM32[J]. Journal of Physics: Conference Series,2023,2493(1)：34-38.

[5] K.O. A M,Caffiyar Y M,B.A. H M, et al. Smart bin: Waste segregation system using deep learning‐Internet of Things for sustainable smart cities[J]. Concurrency and Computation: Practice and Experience,2022,34(28)：56-60.

[6] Ge Yaqi, Liu Jianfen. Intelligent Humidifier Design [J]. Technology Horizon, 2020 (15): 103-105.

[7] Li Kangdong, Cao Fangyu, Li Yan, et al. Preliminary Design of Intelligent Humidifier Based on Single Chip Microcomputer and Sensors [J]. Computer Products and Circulation, 2020 (8): 92.

[8] Gu Wen, Yan Junjie. Research and Design of Intelligent Humidifier Control System [J]. Computer and Telecommunications, 2020 (8): 51-54.

[9] Ni Danyan. Design and Implementation of Temperature and Humidity Environmental Monitoring System Based on Proteus [J]. Industrial Science and Technology Innovation, 2020, 2 (20): 58-59.

[10] Wang Li, Lu Anjiang. Design and Simulation of Intelligent Humidifier Based on AT89C51 [J]. Electronic Design Engineering, 2023, 31 (04): 169-173.

[11] Duan Xiaoli, Zhang Jiachao, Jia Zhiyuan, et al. Design of Intelligent Humidifier Based on Single Chip Microcomputer [J]. Shanxi Electronics Technology, 2022 (04): 46-48.

[12] Ren Weihong, Shi Juncheng. Design of Temperature and Humidity Control System Based on Single Chip Microcomputer [J]. Mechanical and Electronic, 2021, 39 (6): 48-51.

[13] Li Zhiwei, Dong Wei, Huang Shuangcheng. Design of Agricultural Greenhouse Temperature and Humidity Monitoring System Based on DHT11 [J]. Industrial Instrumentation and Automation, 2021 (1): 39-43.

[14] Hua Houqiang, Dai Kui. Design of Intelligent Home Controller Based on STM32 [J]. Digital Technology and Application, 2021, 39 (02): 31-34.

[15] Zhu Yuxuan, Chen Liqiong. Design of Air Humidifier System Based on STM32 [J]. Wireless Interconnection Technology, 2022, 19 (03): 56-57.

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