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Intelligent Opening and Closing System of Doors and Windows

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Abstract. In this paper, an intelligent opening and closing system for windows and doors was developed, which solved the problems such as the lack of intelligence of traditional Windows, the high cost of rebuilding smart Windows, and the dispersing of functional devices, so as to improve user experience and the popularity of equipment. The system consists of three parts: door and window intelligent hoist, background data management center and mobile client. Door and window intelligent hoist is an independent device separated from traditional Windows, which can display indoor temperature and humidity in real time, air quality, automatically close Windows after rain, and adjust air quality and alarm. The background data management center conducts data interaction with the data server. The background can check the address, status, failure information and other functions of the intelligent door and window hoist.

1. Overall scheme design

The design and implementation of the intelligent opening and closing system of Windows and doors is mainly composed of three parts [1]: the intelligent opening and closing device of Windows and doors, the background data management center and the mobile client. The overall block diagram of the system is shown in Figure 1.

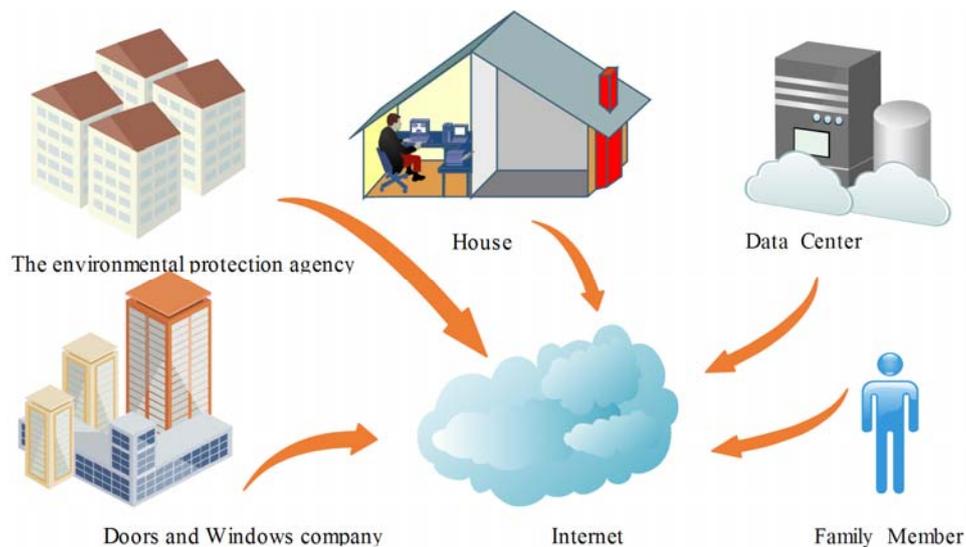


Figure 1. The overall block diagram of the intelligent opening and closing system of doors and Windows

By figure can see, Windows and doors intelligent opening and closing device installed in different families [2], through wi-fi routers connected to family connected to the data center of equipment management, after upload device of temperature [3], humidity, air quality and alarm information data to the data server, at the same time download data server control command window, open the camera (switch). The staff of door and window company login the web page, visit the data server, verify the key of different devices in each family, check the user of the device, equipment location, equipment status and equipment fault information of the device, so as to facilitate the door and window company to conduct post-service. In addition, data stored in the data center will be sent to the environmental protection bureau on a regular basis for analysis of temperature [4], humidity and air quality changes in the region. The data center collects different air quality information [5].

2. Hardware system design

The hardware design of this system is mainly composed of main controller, sensor unit, display circuit, motor drive circuit, ESP8266 serial port wifi module, bpi-d1 open source IP camera, and transmission connector design and circuit module [6].

2.1. Master controller design

ATMEGA328P chip is used as the central controller of the hardware system in this system to complete sensor data collection, motor control, external communication and other tasks. The circuit diagram of ATMEGA328P is shown in Figure 2.

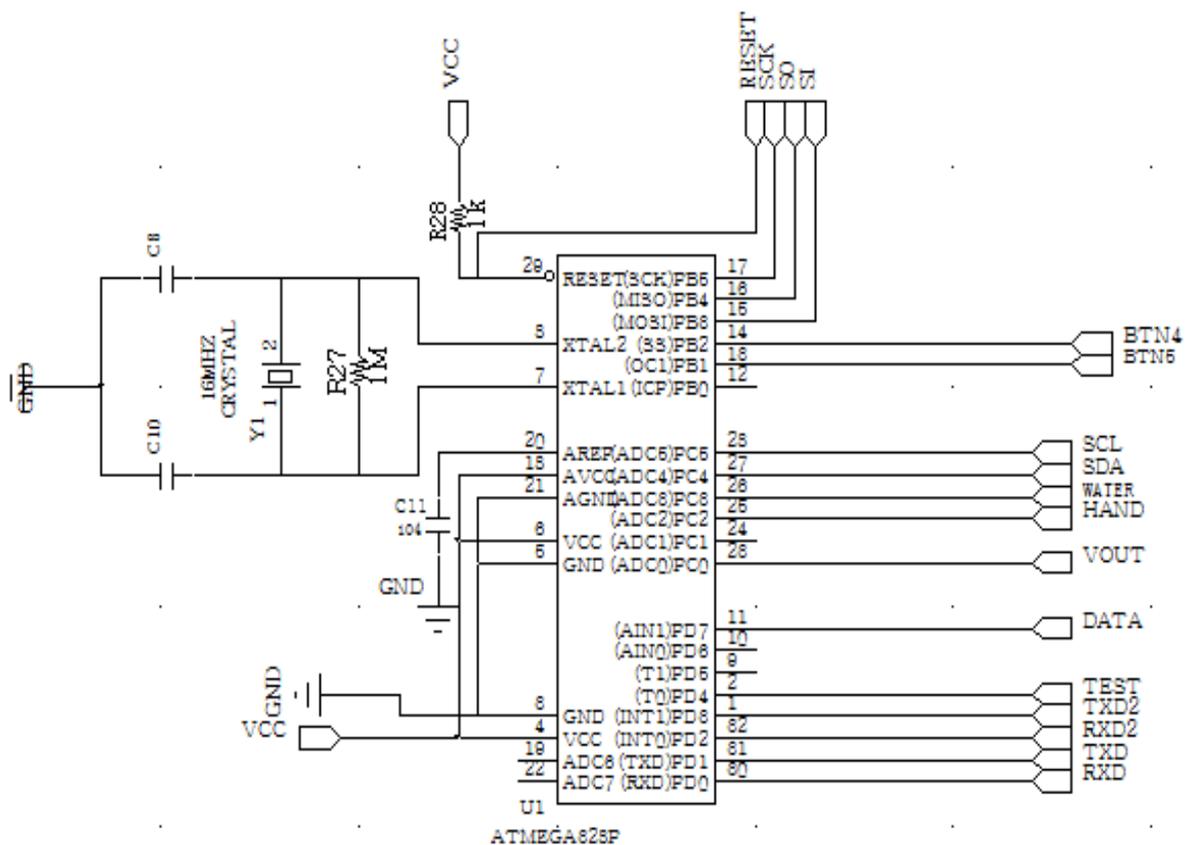


Figure 2. ATMEGA328P Circuit Diagram

2.2. Temperature and humidity sensors

This paper uses DHT11 digital temperature and humidity sensor, which includes a resistive humidity sensor and an NTC temperature sensor, and is connected with a high-performance 8-bit single-chip

microcomputer [7]. This product has excellent quality, fast response, strong anti-interference ability and high cost performance. Each DHT11 sensor is calibrated in an extremely accurate humidity calibration room. The calibration coefficient is stored in the OTP memory in the form of a program, which is called by the internal sensor during the processing of the detection signal.

2.3. Raindrop sensor and air quality sensor

In the smart skylight system, the sensor automatically closes the window once it detects rain. This paper adopts TGS2602, which has low power consumption [8]. Long life, small size, simple circuit and high sensitivity can be used for air quality test and indoor air test.

2.4. Infrared body sensor

The circuit diagram [9] of hc-sr501 and hc-sr501 sensors using infrared human sensors is shown in Figure 3.

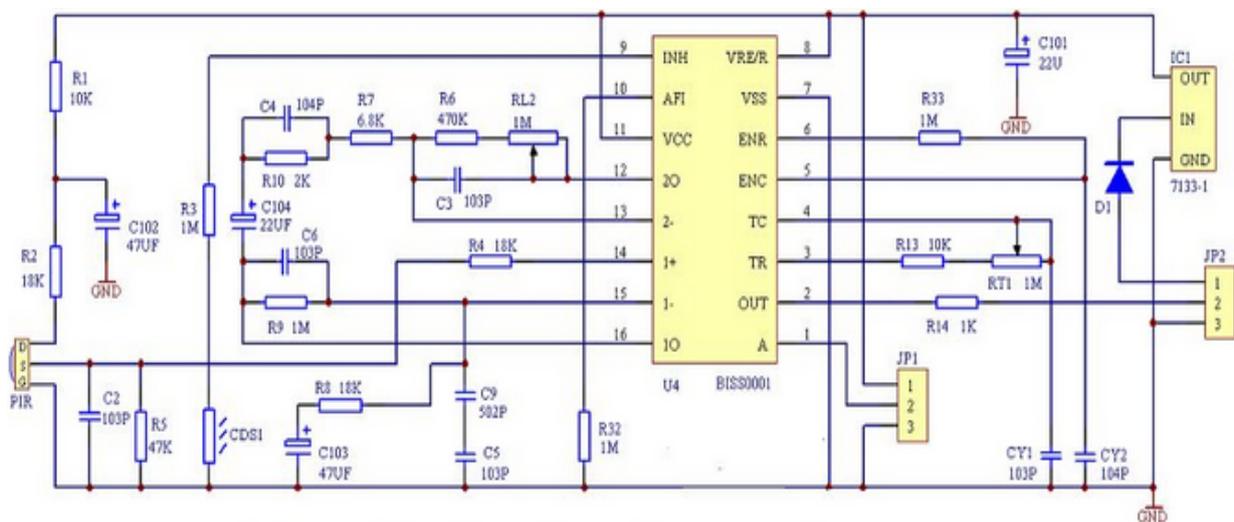


Figure 3. Circuit diagram of hc-sr50 sensor

2.5. Display circuit design

The display screen adopts digital tube and LED diode design. The display screen has multiple control commands, which can control the brightness of the display screen, switch booster circuit and other commands. Convenient operation and rich functions [10].

3. Software system design

According to the window function and the service requirements of the company, the software mainly completes the functions of equipment initialization, parameter configuration, air quality inspection, data upload, and window execution instruction. In order to improve the accuracy of the system, the air sensor uploads the data signal to the central controller, determines whether the air quality is up to standard after processing and analysis, gives work instructions and performs corresponding operations [11]. Data of each parameter is uploaded to the background server, and indoor temperature, humidity and air quality are displayed in real time through the mobile phone terminal [12]. Therefore, the software system mainly includes the design of Windows automatic opening and closing, the design of back-end data management center, the design of data server (aliyun server), and the design of mobile client [13].

3.1. Automatic window opening and closing design

Automatic opening and closing of Windows is an important part of the whole control system design. Automatic opening and closing of Windows mainly includes two functions: automatic closing of

Windows by rain water and automatic opening of Windows by air quality difference, shown in Figure 4. Since these two functions are similar, the process of automatic opening of Windows by air quality difference is mainly outlined [14].

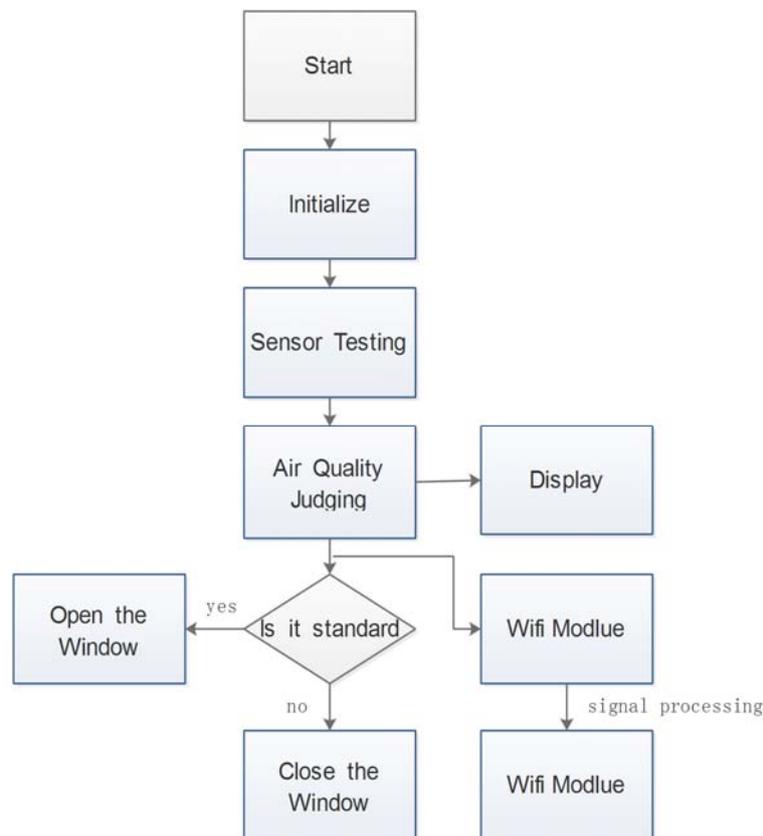


Figure 4. Automatic opening and closing of Windows design flow chart

After first to electric system initialization, initialization, including initialization, serial interface clock configuration and time delay function program initialization and wifi initialization, timer is initialized, then reads the last window state, buzzer sirens, digital tube and LED lights flashing, Windows automatically shut the window place, air quality sensor to collect data, sent to the control center to analysis, and make a reply, at the same time will determine the control instruction, through wifi to upload data to the server[15]. Among them, the data upload and switch window operations such as process, adopts double chip control design, a chip is mainly used to receive wifi sensor data and read data, another drive motor drive and display circuit and a buzzer limit switch, we prescribed as follows: the first kind of main chips, the second false from the chip[16].

The workflow and system initialization of the main chip are shown in Figure 5. After the system is powered on, the information set last time is read first, and then the buzzer is sounded, which is for the prompt that the circuit runs normally; Then the digital tube flashes several times, indicating that the system is being initialized, and the window door is automatically reset, in order to avoid the position of the window caused by the last fault or abnormal power failure. The sensor unit runs the test program to check whether the sensor is working normally. The wifi runs the test program, connects to the server, and tests the connection status and whether there is data interaction [17].

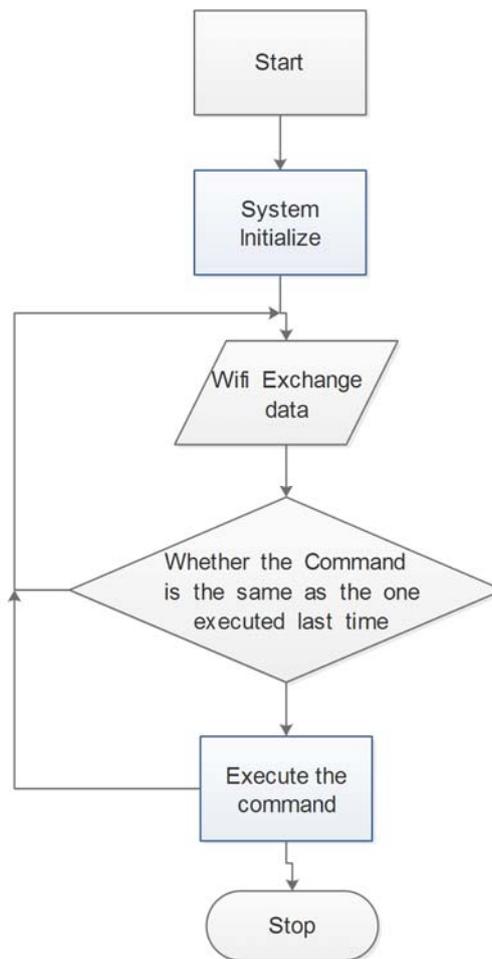


Figure 5. Main chip working flow chart

3.2. Design of background data management center

The background data management center is designed for door and window companies to meet the company's needs. The menu bar of the background data management center mainly includes five parts: equipment list, equipment data statistics, video center, equipment management center and system setting.

3.2.1. Equipment registration design. The equipment registration is the first time for the user to use the intelligent door and window hoist after leaving the factory. The equipment is connected to the backstage of backup management for verification. Meanwhile, the equipment is verified for use. The use of the intelligent door - and - window hoist is also maintained.

3.2.2. Background data interaction design. Data exchange, doors and Windows intelligent hoist key is to upload data and download commands. Therefore, it is particularly important to ensure the operation of background data exchange. The premise of data exchange is that this device must be a verified device. When the device sends a request, the background can determine whether the device is registered and whether the user's situation is normal before data exchange.

3.3. Mobile client design

The mobile client interface is designed for users, featuring simple human-computer interaction interface, simple operation and strong client software compatibility. Users can check indoor temperature, humidity,

air quality, alarm information in real time through the mobile client, as well as conduct remote control of switch Windows and switch camera operation.

4. Experiment Results

The work completed in the thesis mainly includes the following aspects:

- The control hardware circuit based on the central controller ATMEGA328P is designed on the basis of fully considering the characteristics of the intelligent opening and closing system of doors and Windows. The functional modules mainly include sensor unit, display circuit, motor drive circuit, ESP8266 serial port wifi module, bpi-d1 open source IP camera, and transmission connector design and circuit module composition.

- Design the back-end data management center and mobile client with full consideration of the needs of users and Windows & doors companies. Employees of the door and window company login the web page, visit the data server, verify the key of different devices in each family, check the user of the device, equipment location, equipment status, and equipment fault information of the device, so as to facilitate the door and window companies to conduct post-service; The data center sends the data of related equipment to the mobile client synchronously, making it convenient for the user to check the indoor temperature, humidity, air quality and warning information in real time. At the same time, the remote control instruction of the user is saved and sent to the corresponding device.

- Modularized design of most functions for later maintenance and upgrade.

Successfully logged in and entered the management main interface, where functions mainly include device management center, device information, device list, device data statistics, and video center. The manager can manage the corresponding equipment in the background, and check the equipment list, equipment users, equipment fault information, equipment address, etc., as well as watch the indoor temperature, humidity and air real-time curve of the user's home, and monitor the working condition of each equipment in real time.

Table 1. Database Display

ID	Equipment ID	Temp	Humid	Air	Warning
1	Window1	26	66	95	0
2	Window2	26	66	95	0
3	Window3	26	62	96	0
4	Window4	26	65	94	0
5	Window5	26	66	95	0
6	Window6	27	63	95	0

The main function of the database is to receive and send data and complete data docking. It mainly consists of equipment control record, equipment control task table, equipment list, equipment data upload table, equipment registry, alarm information table, user table and camera list. Equipment control record table: record the information controlled by the user, including record ID, owner, device ID, Door and window switch position, recording time.

5. Summary

With the development of economy and the continuous improvement of social informatization, the concept of smart home has gradually entered people's life and changed people's lifestyle. Intelligent window is the core part of residential intelligence, close to people's life, with a broad market, will be in improving people's quality of life play an increasingly important role. This paper designs a door and window intelligent opening and closing system.

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