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Design of intelligent window system based on cloud platform

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Abstract. This paper designs and develops intelligent window system based on the cloud platform of Newland Group. The system designed can be divided into two parts: monitoring host and remote monitoring platform. The monitoring host controls a variety of sensors to monitor noise, rain, burglary, carbon monoxide concentration, etc. At the same time, two motors are used to realize automatic control, and data is uploaded to the cloud platform through the WIFI module, and functions such as monitoring and logical control are realized. Through the remote monitoring platform, users can obtain real-time data, switch window on and off, adjust the percentage of window open, or judge that someone turns over the window and automatically closes the window, and inform the householder by text message, etc. Actual test results show that the system developed in this paper can work normally and the hardware cost of the system is less than 500 RMB, which is worthy of promotion and application.

1. Introduction

Since the 1990s, smart home has received extensive attention at home and abroad, and a large number of literatures have been published on it [1-5]. Literature [6, 7] proposes an overview of current research on smart home; Literature [8, 9] studies the problems related to smart home from the perspective of energy; Literature [10-13] has studied smart home from the perspective of safety, etc.

As an important part of smart home, intelligent windows will become the main demand and development direction for windows in the future [14]. In recent years, there have also been some research papers on intelligent windows [15-18]. However, in general, there are still many problems worth studying on intelligent windows.

2. Overall system design

2.1. Schematic diagram of the system

The system proposed in this paper takes the development board of raspbian-jessie (ARM Cortex-A53, v8 processor) as the control core, and monitors the data generated by sensors such as sound sensors, raindrop sensors, human infrared sensors, smoke sensors and ultrasonic sensors in real time. The wireless sensor network composed of the WIFI module of the development board and sensors can transmit the sensor data obtained to the cloud platform of Newland Group, so as to achieve real-time update and display of data. By changing the window opening ratio on the cloud platform, driving the motor transmission module to synchronize the local window opening percentage with the cloud platform. The automatic monitoring function of the cloud platform can control the opening and closing of the window, raise the alarm when smoke and infrared trigger, and send SMS notification.

The schematic diagram of the system is shown in figure 1.

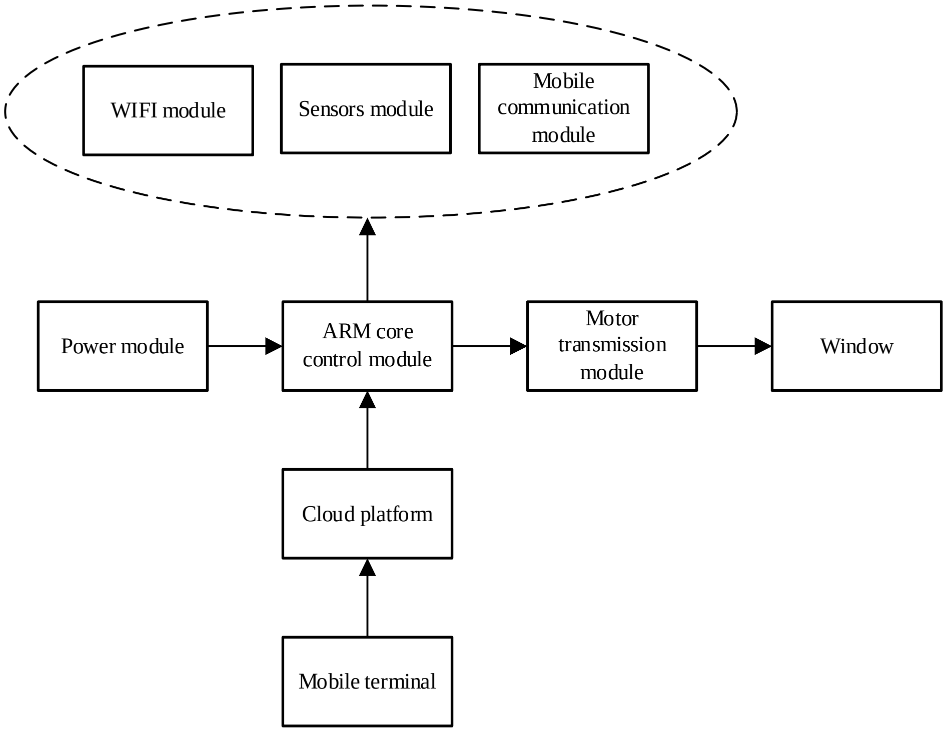

Figure 1. Schematic diagram of the system.

2.2. Main module functions and specific implementation methods

2.2.1. Cloud platform. Users can realize two operations through the cloud platform, one is remote control, and the other is real-time data monitoring.

- Remote control

By setting up the socket client on the development board and calling the cloud platform interface, users can connect the client to the server side of the cloud platform. Users can add actuators of a switch and the opening percentage of the window and sensors to the platform and build applications. Users switch the local window on and off on the cloud platform by clicking on the two actuators, the window opening percentage and the switch of the window.

The specific implementation method is as follows: When the user clicks on the actuator in the operation application, the server will issue the command of the corresponding actuator to the client in the development board. The development board receives the command and parses it to get the data of the window opening percentage and drives the motor transmission module to open or close the window. Real-time distance calculations are made using ultrasound and converted to the percentage of windows that is switched on and off. Until the actual percentage is synchronized with the percentage of the cloud platform, the motor stops rotating.

- Real-time data monitoring

By adding sensors to the cloud platform and adding sensors to the application, the data collected by local sensors can be correlated with the sensor module of the cloud platform, so that the data of the cloud platform can be updated in real time, and users can get the information of the indoor smoke, outdoor rainfall, sound and infrared induction of windows, etc.

The specific implementation method is as follows: Data from sound sensors, smoke sensors, and rainfall sensors are converted into analog data through the PCF8591 module. After judgment, the infrared data will be changed to “true” or “false”, and a thread will be opened on the client side to send the data collected by the local sensor and send the data in a specific format, so that the data can be

IOP Conf. Series: Materials Science and Engineering **490** (2019) 042046 doi:10.1088/1757-899X/490/4/042046

associated with the sensor of the cloud platform, so as to realize the real-time update and real time view of the data.

2.2.2. Emergency SMS notification sent. It is impossible for users to log on the cloud platform to monitor the window situation at any time. Therefore, for emergencies, the system proposed has designed an emergency SMS notification function.

The specific implementation method is as follows: There are two triggering modes. One is when the smoke sensor detects that the indoor smoke value reaches a certain value, and the other is when the human infrared sensor on the window detects that there is human induction. In both cases, the program will trigger a call to the SMS interface and send a message to the user in order to notify the user urgently. Previously, the user needs to bind the phone number to receive the message.

2.2.3. Noise processing. The sound sensor on the window is used to detect the noise. When the noise exceeds a certain value, the window will be closed.

The specific implementation method is as follows: The local noise is detected and the data is synchronized to the cloud platform by converting the analog data to the sound volume. By adding a strategy to the cloud platform, judging the noise in the safe condition of indoor smoke value and the noise in a few hours at night, the program designed will drive the motor to close the window if the noise is greater than a certain value. The specific flow chart of noise processing is shown in figure 2.

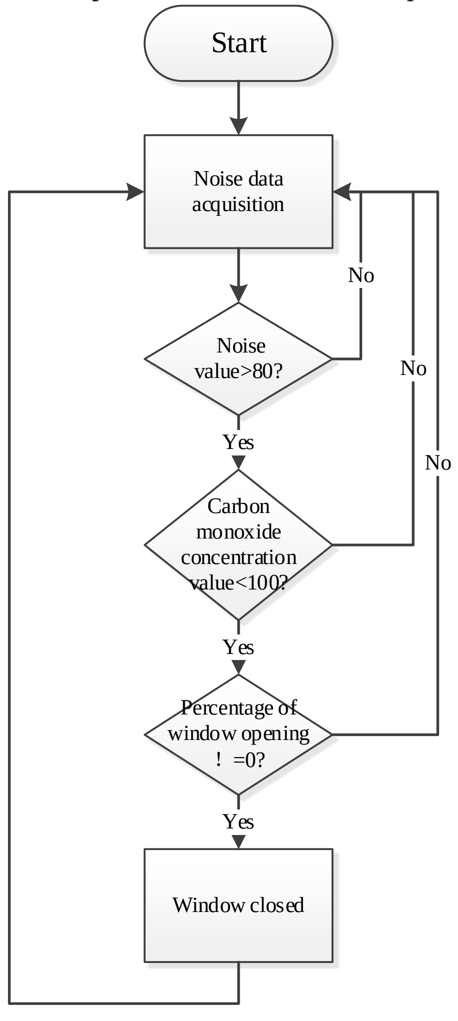

Figure 2. Flow chart of noise processing.

IOP Conf. Series: Materials Science and Engineering **490** (2019) 042046 doi:10.1088/1757-899X/490/4/042046

2.2.4. Intelligent anti-theft. The intelligent window designed has anti-theft function. When someone is detected coming in through the window at a certain time, infrared sensors can sense it and activate buzzers and text messages.

The specific implementation method is as follows: The data detected by the infrared sensor are changed to "true" or "false" under the logic processing of the program, indicating whether a human body is detected or not. In order to prevent error detection, the author lowered the infrared detection range and put obstacles around the sensor to reduce the probability of error detection. The specific flow chart of anti-theft processing is shown in figure 3.

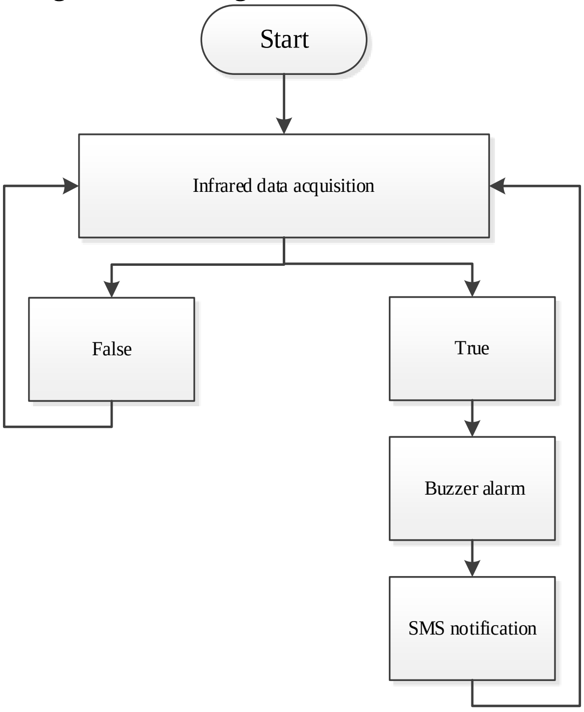

Figure 3. Flow chart of anti-theft processing.

2.2.5. Close the window when it rains. The intelligent window designed will be closed according to the outdoor rainfall.

The specific implementation method is as follows: The data detected by the raindrop sensor are converted to the analog data by the PCF8591 module, and the value range is from 0 to 255. The lower the value is, the smaller the rainfall is, and the higher the value is, the higher the rainfall is. In the case of indoor carbon monoxide safety, if the rain value reaches 100 and the window is not closed, the motors will be driven to close the window. The motors can be driven either by policies added to the cloud platform or by the local program. The specific flow chart of the rainfall processing is shown in figure 4.

IOP Conf. Series: Materials Science and Engineering **490** (2019) 042046 doi:10.1088/1757-899X/490/4/042046

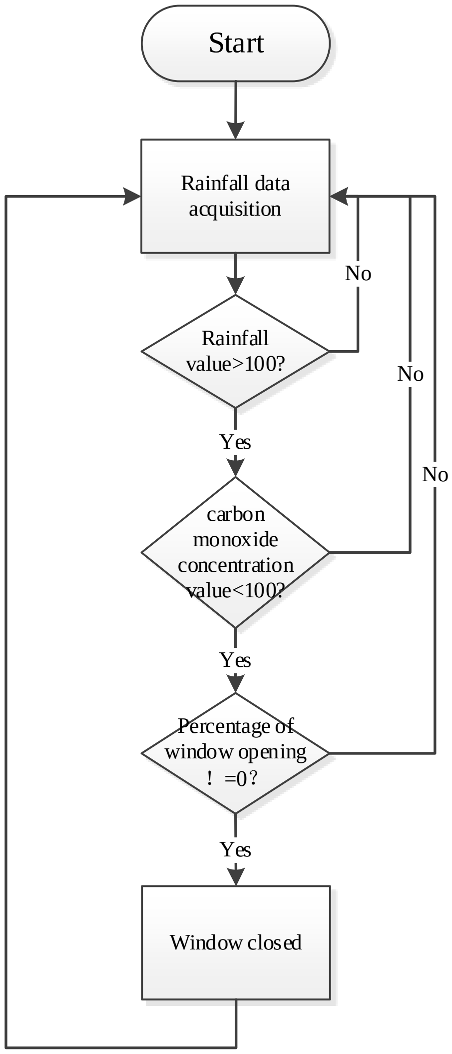

Figure 4. Flow chart of the rainfall processing.

2.2.6. Carbon monoxide leak monitoring. The intelligent window designed can automatically detect the concentration of indoor carbon monoxide. If the concentration exceeds a certain value, the buzzer will emit an alarm, making the user aware of the danger. In addition, the window can be opened automatically for ventilation to reduce indoor carbon monoxide concentration and eliminate danger. When the homeowner is not at home, he (she) can be notified by SMS.

The specific implementation method is as follows：Carbon monoxide leak monitoring function can be realized either by policies added to the cloud platform or by the local program. If the cloud platform is unable to log in timely, the local program can independently determine whether the window should be opened or not, and it can turn on the buzzer and send text messages to inform the user if it is needed. The data detected by the smoke sensor are converted to the analog data by the PCF8591 module. The lower the value is, the smaller the indoor carbon monoxide concentration value is, and the higher the value is, the higher the indoor carbon monoxide concentration value is. The indoor carbon monoxide concentration value greater than 100 is considered as the trigger condition. At the same time, the function of rainfall shutoff and noise processing should be based on the safety of indoor carbon monoxide concentration. The specific flow chart of carbon monoxide concentration processing is shown in figure 5.

IOP Conf. Series: Materials Science and Engineering **490** (2019) 042046 doi:10.1088/1757-899X/490/4/042046

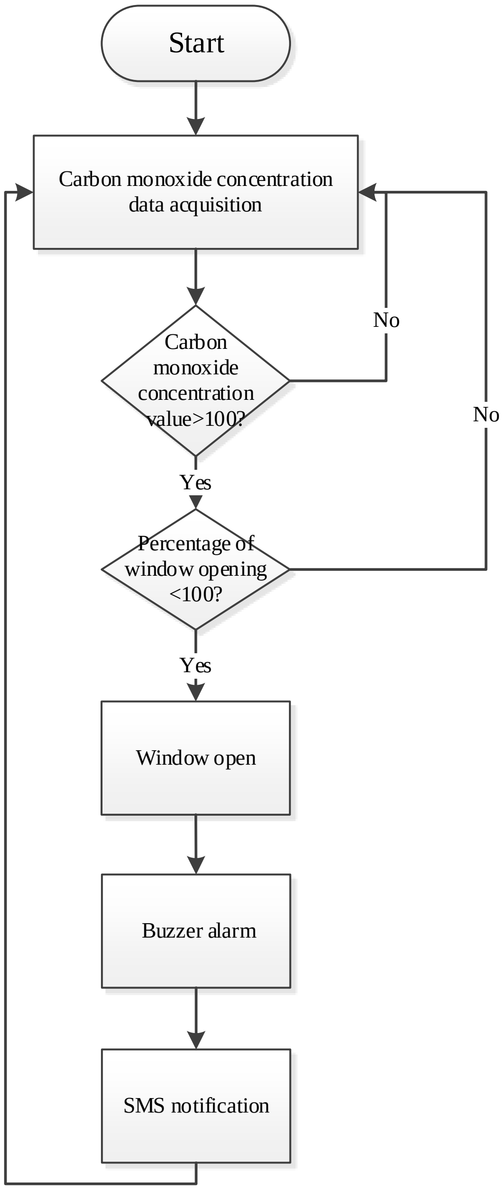

Figure 5. Flow chart of carbon monoxide concentration processing.

3. System software design

In this paper, PyCharm is used as a development tool and Python language is used that helps to develop efficiently.

The specific software development process is as follows: First, Users program on PyCharm; Then, the program is written to the development board of the same local area network with the FileZilla Client; Finally, by connecting the development board via VNCViewer and displaying the visual interface on the development board, the developer can operate on the program in the development board on his laptop. The specific working process of the system software is shown in figure 6.

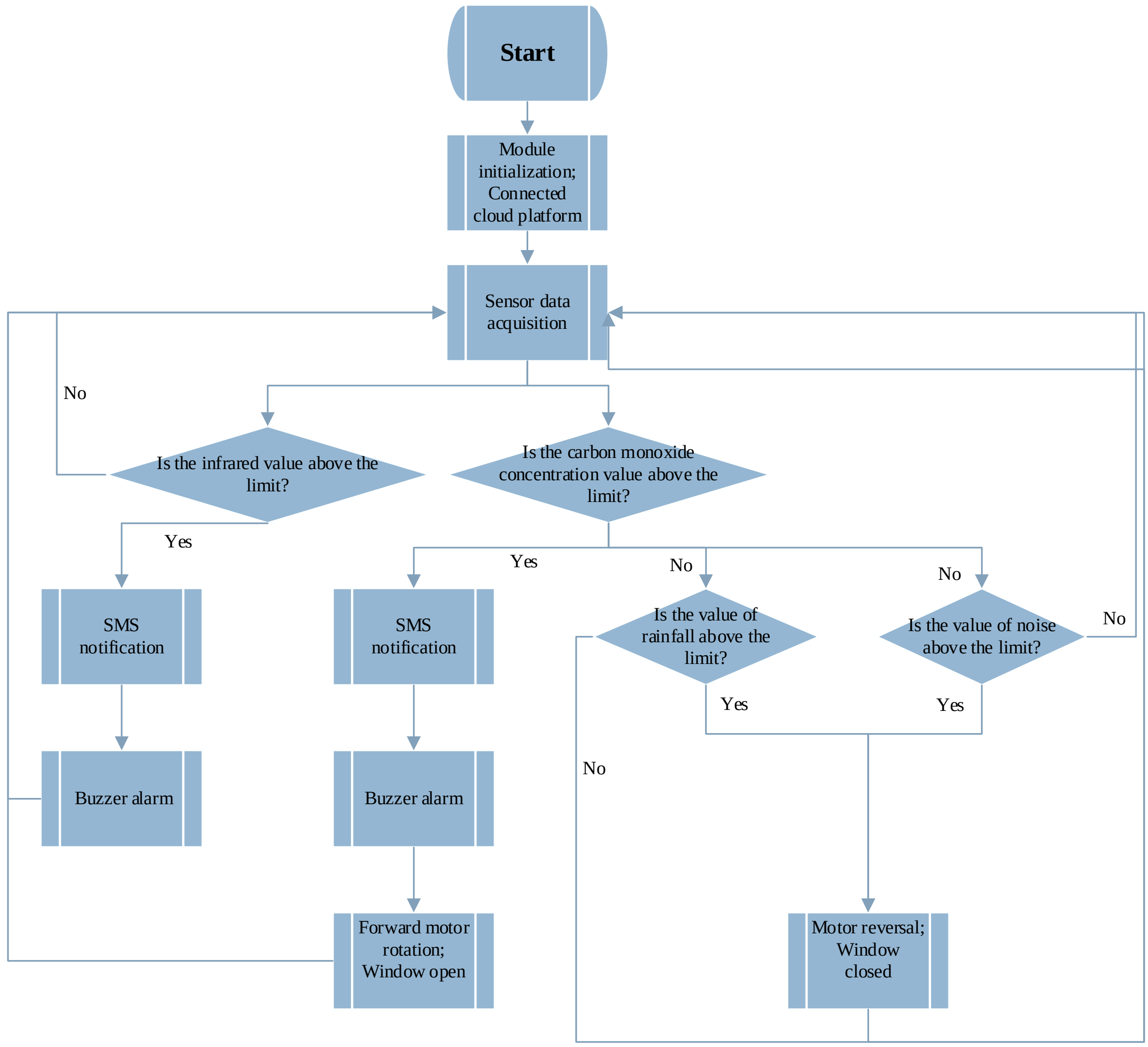

Figure 6. Specific working process of the system software.

4. Mechanical structure design

Window designed in this paper adopts parallel moving mode similar to literature [16]. Through the cloud platform, two double-way motors are controlled forward and backward rotation. Motors turn the belt wheel, which drives the belt, and finally the window, so as to realize the open and close of the window. The window model designed in this paper is shown in figure 7.

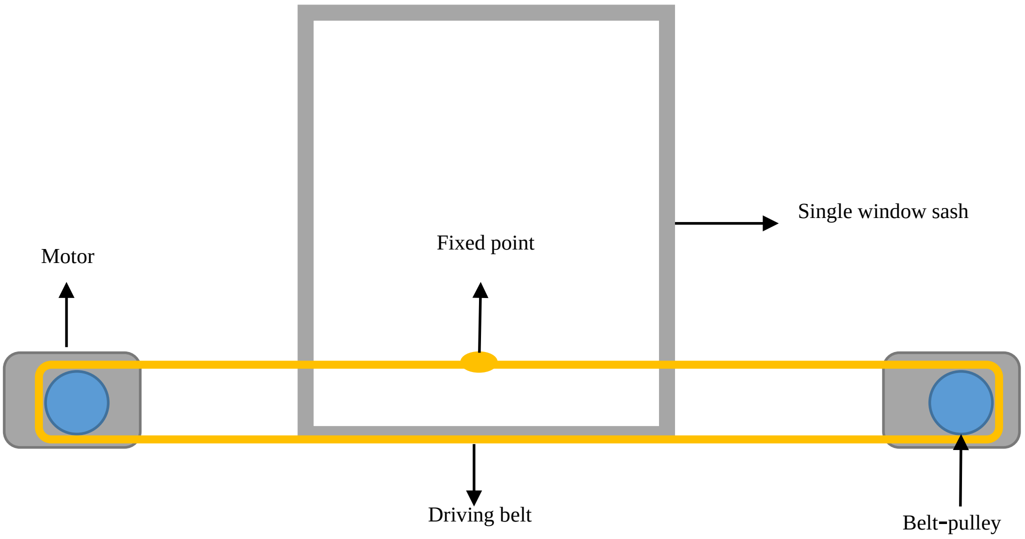

Figure 7. Window model designed.

5. Conclusion

This paper designs the intelligent window system based on the cloud platform of Newland Group and proposes an intelligent window model. Test results of the whole system designed show that the system can work normally. The work of this paper provides some references for the design of intelligent windows and has certain practical application value.

Acknowledgments

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