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ARTICLE

INTELLIGENT MONITORING AND AUTOMATIC ADJUSTMENT SYSTEM BASED ON INDOOR AIR QUALITY

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ABSTRACT

The high quality air indoor automatic regulation system is designed in the paper. The system is used to detect air temperature, humidity, PM2.5 concentration, formaldehyde content, smoke concentration and other physical quantities. The system is composed of the main controller and different types of sensors. The controller can not only control the working state of each sensor, but also set the measured physical threshold. When the real-time measurement value of smoke, formaldehyde, PM2.5 concentration and temperature exceeds the set threshold, the buzzer will alarm and automatically start the air purification device. The system is used to measure the actual indoor environmental parameters. The experimental results show that the indoor air conditioning system can realize the environmental monitoring and purification of the indoor living environment of families, and provide guarantee for people to live in a high-quality air environment, which is the development direction of smart home design in the future.

KEYWORDS

Automatic detection, Automatic control, Air quality monitoring, Sensor.

1. INTRODUCTION

In recent years, with the development of national economic construction, people's living standard has been gradually improved, but various air pollution problems have followed.Indoor environment is the main place where people live and work. At least half of a person's life is spent indoors, so long exposure to polluted indoor air makes the cumulative damage to the human body more serious. Indoor air pollutants from a wide range of sources, a variety of pollutants to the human body in different degrees of harm, it affects our lives, harm to people's health. Therefore, people pay more and more attention to the air quality, but the traditional test control usually uses the hygrometer and test paper and other test equipment, manual test method is not only time-consuming and inefficient, but also it is more random, error is also very large. Therefore, an air quality detector with low cost, convenient use and accurate calculation is needed. This paper designed a kind of indoor air quality detection system, not only can realize the real-time detection of various monitoring quantities in the air, and when the content exceeds the set threshold value, automatically start alarm to remind people, at the same time open the air purification system. Data transmission and remote control can also be achieved through Wifi connection system. To achieve the effect of intelligent control, to bring people a safe living environment, so that people can be fully engaged in work, improve the comfort of life and healthy quality of life.

Indoor high quality air detection system can realize indoor PM2.5, temperature, humidity, formaldehyde and other environmental parameters detection. Once the test result exceeds the predetermined design standard threshold, the alarm circuit and air purifier device will be activated to quickly purify indoor air and make indoor air circulate with high quality. At the same time, it can also turn on and off air conditioning, open Windows, turn on lights, etc., providing technical support for further practical application of smart home.

2. SYSTEM SCHEME AND DESIGN

2.1 System structure

The main modules of the whole system include formaldehyde measurement template, PM2.5 module, temperature and humidity module, wireless interface module, USB lamp module, display module, key circuit module, buzzer alarm module, relay module and other templates to realize the requirements of the system. The main structure block diagram of the system is shown in Figure 1.

The control system circuit of indoor high quality air detection system is shown in Figure 2. STM32F407C8T6 processor is selected as the control center for data processing and electrical equipment control in the control system circuit. 2.4-inch TFT color screen displays real-time measurement data. WIFI module ESP8266WIFI and LD3320 voice recognition module are selected to transmit and receive information. Formaldehyde detection circuit, PM2.5 detection circuit, temperature and humidity detection circuit, light acquisition circuit, buzzer alarm circuit, relay drive circuit and other modules are used for data acquisition. The

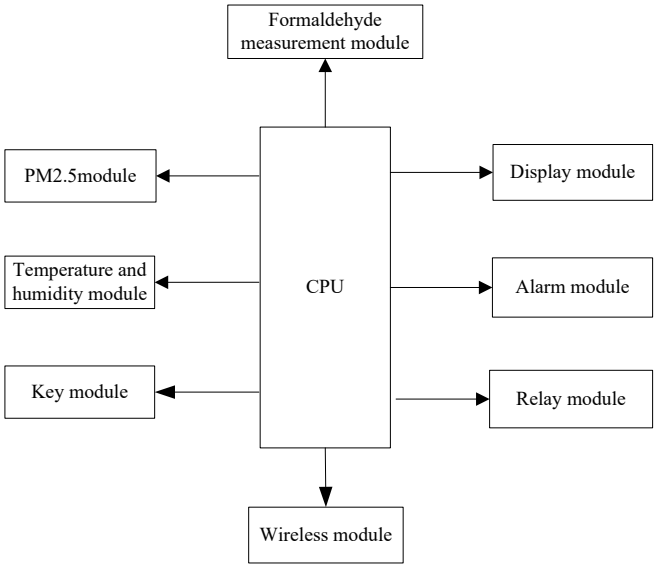

Figure 1: System structure diagram.

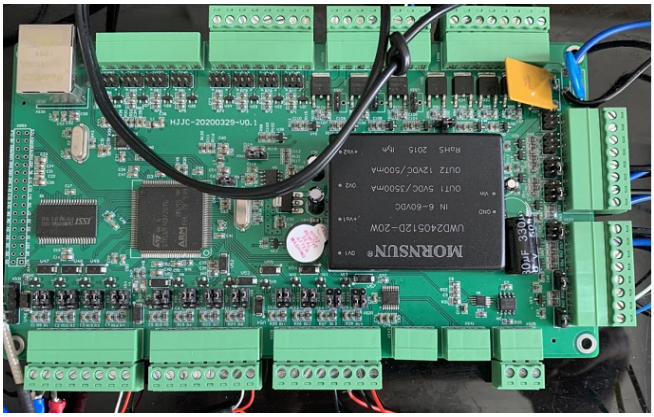

Figure 2: Main control board of the test system.

system uses STM32 controller combined with each detection module to measure air temperature, humidity and PM2.5 concentration and other parameters. Control the operation of air purification equipment, turning on and off lights to ensure the high quality and healthy indoor air.

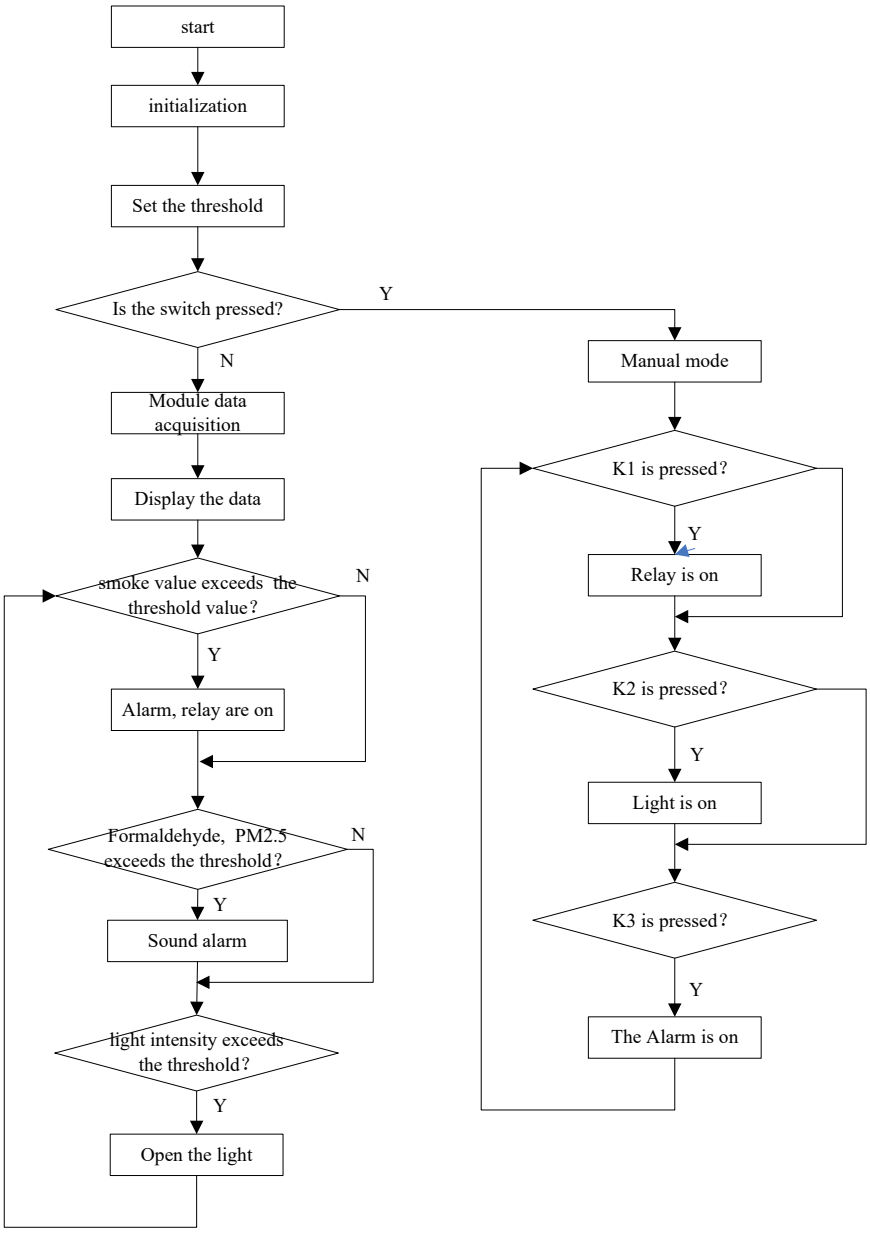

Figure 3: The program flow chart.

2.2 Basic mechanism of indoor high quality air detection system

Indoor air quality detection system is made up of PM2.5 module, temperature and humidity measurement module, wireless interface module module, formaldehyde, lighting module, display module, the key circuit module, a buzzer alarm module, relay module module controlled by CPU processing amount of monitoring in the air, and then the real-time processing, and through the display module display. The monitoring system adopts the different kinds of sensor modules to collect indoor different parameters, combined with micro control technology and network communication technology for real time detection place parameters acquisition in the air, through the operational amplifier will enlarge the weak signal sensor, filter circuit and by removing noise interference, and then through the AD sampling, and CPU computation with high precision, and then into the pollutant density real-time display on the screen. At the same time, the indoor air parameter threshold set by the processor, such as PM2.5, formaldehyde concentration, temperature and humidity, reaches the threshold. The system will automatically turn on the air purifier and turn on the air conditioner to adjust the indoor air parameters, so as to achieve the purpose of air purification.

2.3 Control process

The indoor high quality air detection system turns on the power supply, the system starts the initialization state, the system enters the main interface, and the default is "automatic mode". You can switch to "Manual mode" or "Automatic mode" by pressing K4. Under "automatic mode": press K1 to enter the threshold value of measurement parameter variables, and toggle to set thresholds of light, temperature, humidity, smoke concentration, PM2.5, formaldehyde, etc. When the real-time collection values of PM2.5, flue gas, formaldehyde, temperature and humidity exceed the corresponding threshold, the buzzer will alert and display the status of "on". When the real-time illumination acquisition value is lower than the corresponding threshold, the highlighted LED light will be turned on and the LED status will be displayed as "on". When the collected value of flue gas concentration exceeds the corresponding threshold, the buzzer will alarm and remind the relay. At the same time, the relay will start the air purifier, air conditioner and other equipment, and the monitor will show that the relay of the equipment is in the state of "on". If "manual mode" is selected, the relay, light and buzzer can be controlled by pressing K1, K2 and K3 respectively.

When the system is powered on, each template enters into initialization. In the automatic mode, each sensor template begins to collect and record corresponding parameters, and the data is displayed through the LCD screen. When the value reaches the corresponding threshold, the system will trigger the alarm template. When the indoor PM2.5 concentration reaches the threshold, the relay will trigger a command to turn on the air purifier and reduce the indoor PM2.5 concentration. When the system detects that the light intensity is too low, it will automatically turn on the LED light to increase the illumination of the room, and each parameter can be set by pressing the button. In manual mode, the data collected by each sensor module is stored and compared with the threshold data. Open and close air purifiers, air conditioners and fans by pressing buttons. The program flow chart is shown in Figure 3.

3. EXPERIMENT

3.1 Experimental scheme

In this paper, the bedroom of 26 m^2 is selected as the experimental site, which is equipped with air purifier, air conditioner and other facilities. The environmental parameters, such as PM2.5 concentration, temperature and relative humidity, were tested in real time. The test system adopts multiple sensors for data collection, and adopts data processing algorithm to process the data on average. The sampling points of the same parameter sensor are set in a space of 26 m^2, taking indoor layout structure into comprehensive consideration. The height of the sampling points is uniformly set at 1.5 m, which is consistent with the human breathing belt. The location of the collection point is away from the air vents, and the distance from the wall is greater than 1 m. The collection time interval for the same sampling point is 1 hour. On the basis of ensuring that the sampling point meets the requirements of the specification, continuous sampling is conducted for each sampling point.

3.2 Experimental results

Since the measurement data is completed within one day, the change of formaldehyde, smoke and light intensity is not obvious enough. This paper does not do research, but focuses on the change trend of PM2.5 concentration, temperature and humidity in one day.

(1) PM2.5 concentration monitoring

In this experiment, the standard value of PM2 and 5 was measured on a single day in November, and PM2.5 household instrument sold by Agres formaldehyde detector was selected as the measurement tool. The pm2.5 value measured by the indoor air quality detection system designed in this paper is compared, as shown in Figure 4. The measurements are taken every hour from 9 a.m. to 23 p.m. As can be seen from the Figure, PM2.5 value measured by two kinds of equipment in the same room changes in the same trend. The maximum value of PM2.5 is 230 μg/m³, and the minimum value is 50 μg/m³.The threshold set by this system is 80 μg/m³. When PM2.5 exceeds 80 μg/m³, the air purifier will be activated.

(2) Temperature test

In this experiment, a day's temperature measurement in November was selected, and the standard value of temperature was measured with universal thermometers available on the market. The temperature

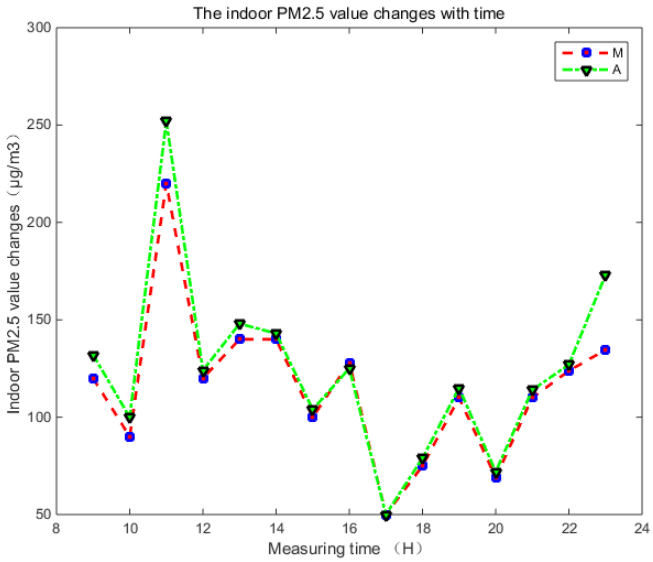

Figure 4: Change curve of indoor PM2.5 concentration and time.

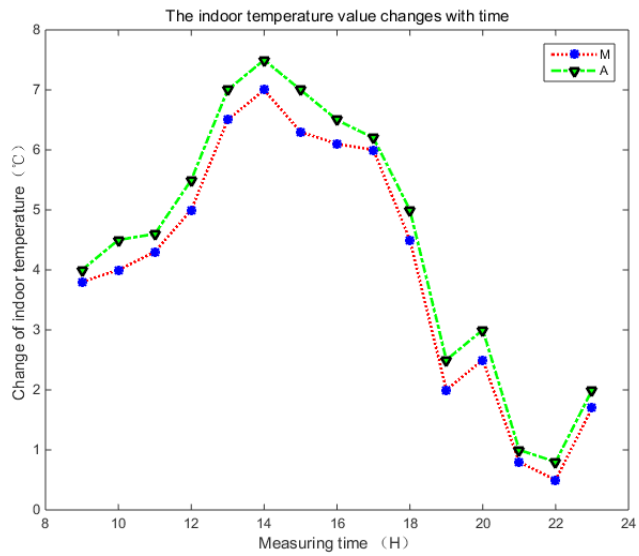

Figure 5: Changes of indoor temperature with time.

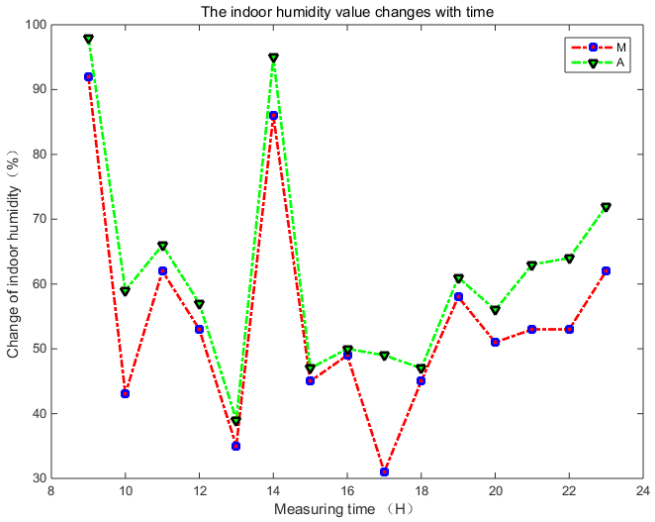

Figure 6: Changes of indoor humidity with time.

measured by the indoor air quality detection system designed in this paper is compared, as shown in Figure 5. The measurements are taken every hour from 9 a.m. to 23 p.m. As can be seen from the Figure, the temperature variation trend measured by two temperature measuring devices in the same room is basically the same. The highest indoor temperature is 7.5℃ and the lowest is 0.8℃. When the temperature is lower than 5℃ or higher than 30℃ threshold, the air conditioning can be automatically started to control the indoor temperature.

(3) Humidity test

In this experiment, the humidity was measured in one day in November. The standard value of humidity was measured by delI, an electronic thermometer on the market. By comparing the humidity measured by the indoor air quality testing system designed in this paper, the comparison is shown in Figure 6. The measurements are taken every hour from 9 a.m. to 23 p.m. As can be seen from the Figure, the temperature variation trend measured by two temperature measuring devices in the same room is basically the same. The maximum humidity was about 93%, and the minimum was 31%.The air humidifier can be started when the humidity value is less than 50%.

4. CONCLUSION

The indoor high quality air detection system is designed by using the STM32F407ZET6 control chip. Indoor PM2.5, temperature, humidity and other environmental parameters are detected. The PM2.5, temperature and humidity in the inner ring of the bedroom within 26 m^2 were collected. The experimental results showed that the test results were completely consistent with those of the traditional test equipment. The experiment on the alarm module and the start-stop module of the air purifier shows that the alarm circuit and the air purifier device will be started once the detection result exceeds the predetermined design standard threshold, so as to quickly purify the indoor air and make the indoor air circulate with high quality. The research structure of this paper provides technical support for the integration, miniaturization and practical application of smart home.

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