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Research on Indoor Air Monitoring System Based on STM32

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Abstract: *Adults spend 80% of their time indoors every day, so the quality of indoor air is closely related to people's health and quality of life.In this project, an indoor environment monitoring system is designed for indoor air quality. Data interaction between the system and the indoor air monitoring system is carried out by means of wireless transmission, so as to monitor indoor PM2.5 concentration, temperature and humidity in real time through mobile phones.Realization function: For the collection of various parameters of the home environment, the collected environmental parameters will be transmitted to the main control device through the RS-485 circuit, using the RS-485 circuit to transmit data, can collect data for different positions of the indoor, aiming at faster and more accurate detection of indoor air condition.*

Keywords: *STM32, air monitoring, air quality, monitoring system*

1. Introduction

Adults spend 80% of their time indoors every day, so the quality of indoor air is closely related to people's health and quality of life[1].In this project, an indoor environment monitoring system is designed for indoor air quality. Data interaction between the system and the indoor air monitoring system is carried out by means of wireless transmission, so as to monitor indoor PM2.5 concentration, temperature and humidity in real time through mobile phones[2].Realization function: For the collection of various parameters of the home environment, the collected environmental parameters will be transmitted to the main control device through the RS-485 circuit, using the RS-485 circuit to transmit data, can collect data for different positions of the indoor, aiming at faster and more accurate detection of indoor air condition[3].

2. Research objectives

In order to solve the problem of air pollution in the indoor living environment, can be collected to the cause of air pollution index, these indicators include particulate matter, such as formaldehyde, carbon dioxide and stupid, you can through the indoor living environment monitoring system for monitoring and early warning of the air index, on the Internet of things terminal equipment to cloud storage of huge amounts of data collected, In order to be able to real-time monitor the impact of indoor living environment indicators, and to exceed the indicators for early warning[4].

More important is to collect carbon monoxide, methane and other flammable gases and smoke in indoor air, prevent gas poisoning and family fire and other sudden accidents, real-time monitoring of these indicators affecting the safety of indoor residents, and timely warning and alarm of these indicators exceeding the standard.So as to prevent sudden accidents and ensure the safety of indoor residents[5].

Design of this system to consider the use of advanced integrated sensor technology, through the built-in microprocessor, detector and internal curing operation procedure, automatic collection and calculation analysis of the external environment air composition, help the user to monitor PM2.5 and PM10, a variety of material such as formaldehyde concentration and temperature and humidity indicators, such as high precision, at the same time cooperate with mobile phone display, Ensure access to air quality information anytime and anywhere, so as to solve the monitoring and control of indoor temperature, humidity, smoke concentration and other problems.

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3. Air monitoring system design

This project is designed based on STM32F103RCT6, which consists of upper computer, master control system, monitoring module (temperature and humidity monitoring, PM2.5 and indicators monitoring module), communication module (WIFI, Bluetooth and standby Ethernet module), power supply, indicator light, LCD screen and buzzer.STM32 is mainly connected with each monitoring module, and the data obtained by the monitoring module is transmitted to the upper computer (mobile phone, PC, etc.) through Bluetooth and WIFI, and then the data is recorded and counted by the supporting program of the upper computer, so as to achieve the monitoring and analysis of air quality.

3.1 Data acquisition circuit

(1) Temperature and humidity Collection

Considering data acquisition accuracy, sensor price, data processing difficulty, complexity of peripherals and other factors, the temperature and humidity acquisition scheme we adopt this time is to use an independent temperature and humidity measurement device, temperature acquisition using DS18B20, humidity acquisition using DHT11.Then, in order to connect with the master controller to form the physical topology of the RS-485 network, we parallel two RS-485 communication modules (from the two acquisition modules).

The following figure shows the typical connection circuit of temperature acquisition using DS18B20 and humidity acquisition using DHT11:

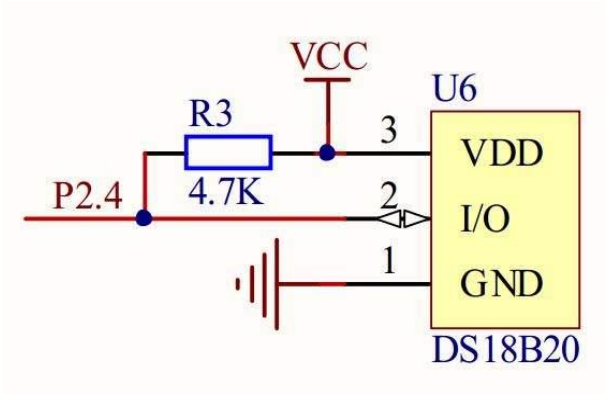

Figure 1: Connection circuit of DS18B20 for temperature collection

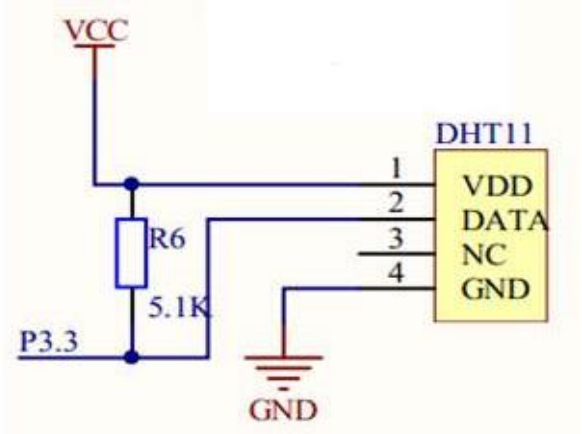

Figure 2: Connection circuit of DHT11 for humidity collection

(2) Smoke concentration acquisition module

As the name implies, the main function of the smoke acquisition module is to monitor the concentration of various indoor gases identified as polluting gases, and collect the concentration as data.In this project, MQ-2 smoke sensor has become our preferred module to be applied to the system to realize acquisition function.Mq-2 type smoke sensor is used in the clean air (does not contain the air that the sensor can detect the gas) in the conductivity of relatively low tin dioxide as a gas sensitive

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material, when the detected environment appears a certain concentration of propane, hydrogen, liquefied hydrogen, natural gas, carbon monoxide and other gases, The conductivity of gas-sensitive materials will increase gradually with the rise of the concentration of various pollution gases, and then through a series of processing circuits will be converted into voltage output, and finally the data will be transmitted to the master chip processing.Similarly, the data collected by the MQ-2 smoke sensor is connected in parallel with the RS-485 communication module to form the physical topology of the RS-485 network together with the master controller.

Smoke module acquisition circuit:

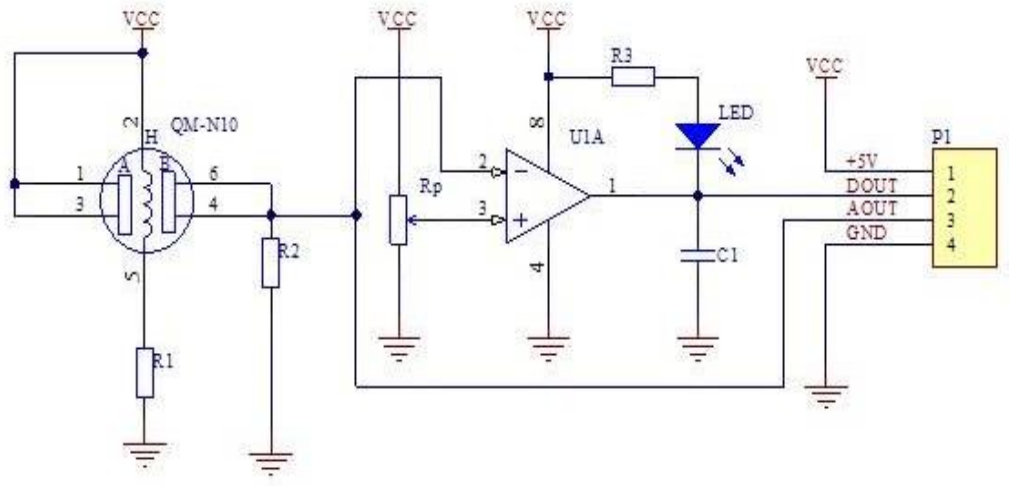

Figure 3: Smoke module acquisition circuit

3.2 RS-485 communication module

Based on the proposed RS-232 protocol and RS-422 protocol, rS-485 communication protocol is not unexpected.In 1962, RS-232 was officially released by the Electronics Industry Association as an industry standard, which guarantees the compatibility of products made by different manufacturers.Subsequently, in order to make up for some shortcomings of RS-232 (short communication distance, low speed), RS-422 communication protocol was proposed and published on the basis of this protocol.The rs-422 defines a communication interface that, unlike the previous one, is "balanced," allowing transmission rates of up to 10Mbps and distances of up to 4,000 feet.In 1983, EIA developed and published the RS-485 communication protocol on the basis of RS-422. It added multi-point and bi-directional communication capability on the basis of RS-422, allowing multiple transmitters to be connected to the same bus, and also increased the driving ability and conflict protection characteristics of the transmitter, expanding the common mode of the bus.The RS-232 protocol, RS-422 protocol and RS-485 protocol only specify the electrical characteristics of the interface, they do not involve connectors, cables, or protocols, high-level protocols can be personalized by the user on this basis.The rS-485 communication standard uses Differential Driver Mode, also known as balanced transmission.It uses A pair of twisted pair cables and names the two cables A and B respectively.

Generally speaking, if the transmitter A and B are in A positive logical state, the level between them is in the range of +2V to +6V, which is the positive level.In another logical state, the level is negative between -2V and -6V.In addition, there is signal ground C.

In general, an "enable" control signal terminal is indispensable in RS-485 devices, and the disconnection/connection between the control transmitter and the transmission line is controlled by the "enable" signal.If the Enable port is in effect, the transmitter is in a high resistance state that is neither logical 1 nor logical 0.Similarly, the receiver has corresponding requirements: The receiver and sender connect A to A and B to B through A twisted pair cable.When the level difference between AB received by the receiver is greater than +200mV, the receiver outputs "1";When the level difference ratio between AB is -200mV, the receiver outputs "0". Rs-485 is often used as a relatively economical communication platform with high noise suppression performance, wide common mode radius, relatively high transmission rate and relatively long transmission distance.The rS-485 circuit automatically controlled by the enabling end is shown in Figure 4.

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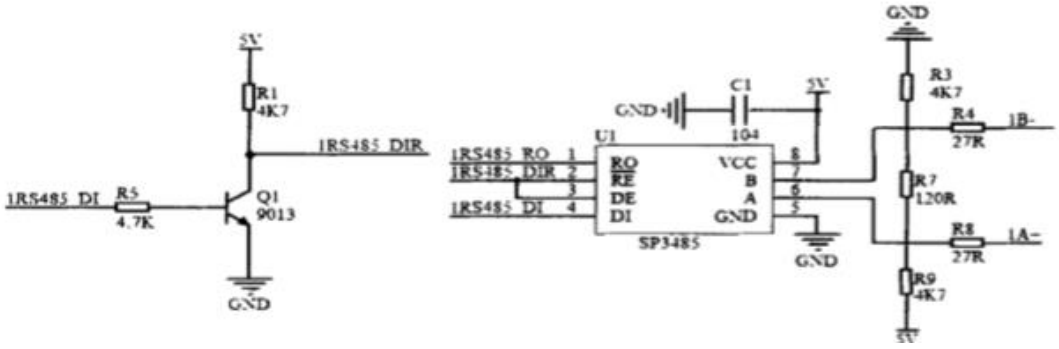

Figure 4: RS-485 circuit with automatic control of enable terminal

As the bottom part of the whole system module, the acquisition circuit is the main source of the system to obtain the target parameters.The main function of the acquisition circuit is to collect and display the indoor temperature and humidity and other target information, and then transmit the effective information to the master control through rS-485 communication protocol.Requirements determine the function. According to the underlying requirements, the acquisition circuit module should contain the following parts:

Minimum system: as the most basic part of the module, the minimum system ensures the operation of the acquisition module.It includes power supply circuit (to supply power to the system), crystal oscillator circuit (to provide shock to the system), high level reset circuit (for restarting the circuit) and so on.

Acquisition circuit: micro control unit and DHT11 (humidity), DSl8B20 (temperature), MQ-2 (smoke concentration) and other sensors are connected to the circuit, as well as the simple processing circuit responsible for some signals.

Display circuit: LCD1602 is used in this project to display data.

Rs-485 communication circuit: responsible for collecting effective information at the bottom, the information transmission to the main control module circuit.The circuit block diagram of acquisition module is shown in Figure 5.

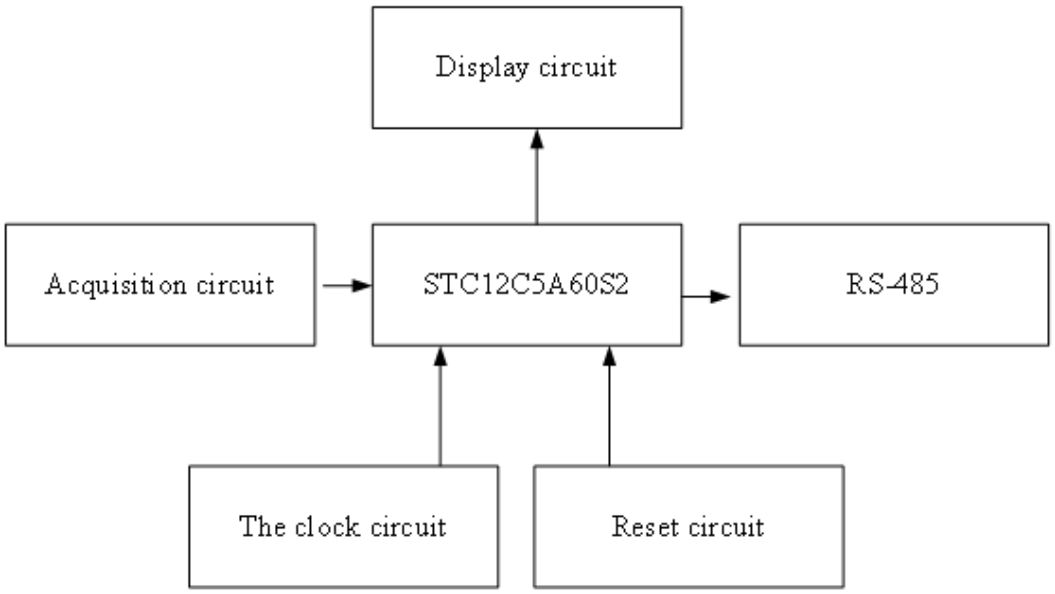

Figure 5: Block diagram of acquisition module circuit

3.3 Main control Chip

The main control chip of the project is STM32F103RCT6 single chip microcomputer, which is quite advanced and perfect in the design of power consumption and supports various working modes such as sleep, shutdown and standby.In sleep mode, all peripherals are still working, but the kernel is

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asleep.In shutdown mode, all clock sources stop working, while the contents of the SRAM and registers remain.In standby mode, the backup power is also turned off, and the contents of the SRAM and registers are lost.STM32F103RCT6 is very rich in peripherals, such as five-channel USART, two-channel I2C, dual-channel 12-bit ADC conversion circuit, three SPIs, USB2.0, etc. Its superior peripherals can effectively reduce the development cost to a large extent.In addition, the STM32F103RCT6 also features a large clock system (called clock tree), which has three different clock sources for driving system clock (SYSCLK), namely high speed internal clock (HSI), high speed external clock (HSE), phase locked loop frequency doubling clock (PLL). The low-speed internal RC (40kHz) is used to drive the independent "watchdog" and the low-speed external clock (32.768khz) is used to drive the RTC.The STM32's universal I/O port is controlled by two 32-bit configuration registers that can be configured in eight different modes.

The master control circuit is responsible for the realization of the data interaction function between the RS-485 communication network module and the wireless module, and it is also responsible for the feedback of temperature and humidity in the control environment.It obtains effective information in the environment from the bottom through the RS-485 communication network module, and transmits the information to the upper computer through the wireless module. At the same time, it controls various indicators in the environment according to the feedback data in the upper computer.

The block diagram of the main control device is as follows:

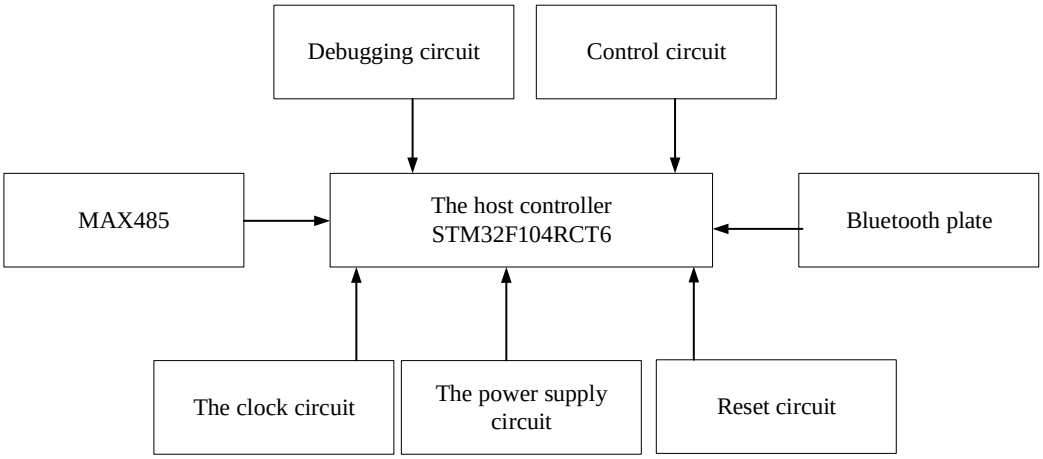

Figure 6: Block diagram of main control part

3.4 Human-computer interaction module

LCD1602 liquid crystal display is used in this product design to display the temperature, humidity and smoke concentration collected by the acquisition module in real time. At the same time, the wireless module HY-254101 V1 low power Bluetooth, which is Bluetooth BLE4.2, single mode compatible, supporting host mode, slave mode, master-slave mode, and Bluetooth low power consumption, built-in programmable ARM support bridge mode (serial port transparent transmission), or direct drive mode (no additional CPU);The direct drive mode supports UART/IIC/SPI interfaces.(Bridge mode: the user CPU can communicate with the mobile device through the universal serial port of the module. The user can also manage and control some communication parameters through specific SERIAL port AT instructions. The specific meaning of user data is defined by upper-layer applications. Mobile devices can write to the module through APP, and the written data will be sent to the user's CPU through the serial port. When the module receives the data packet from the user'S CPU serial port, it will automatically forward it to the mobile device. For the development in this mode, the user must be responsible for the code design of the main CPU and the APP code design of the smart mobile device.

Direct drive mode: Users simply extend the module and APP directly drives the module through BLE protocol to complete the supervision and control of intelligent mobile devices on the module. In this mode, users are only responsible for APP code design on smart mobile devices.[1], communication distance 30m (0Dbm), antenna type: PCB antenna can check the current temperature, humidity and smoke concentration in real time on the phone as long as the corresponding APP is installed on the phone.The module physical drawing and pin drawing are as follows:

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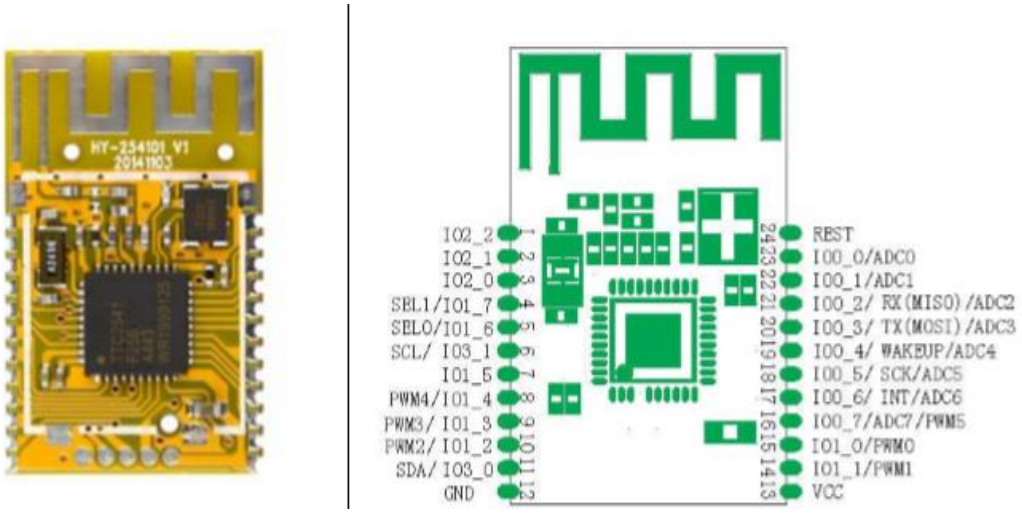

Figure 7: Module physical drawing and pin drawing

3.5 Auxiliary peripheral modules

After receiving the specified control range sent by the terminal, the master controller will compare the current collected value with the specified control range. If the collected value is not within the control range, the master controller will drive the relay circuit and start the control circuit to make it work, so as to achieve the purpose of control.The 220V AC live wire is connected to the normal beginning and the common end of the relay. The power input of the humidifier, fan and alarm is directly controlled by these two terminals.If input low level, PNP triode conduction, LED light, at the same time the relay suction.

The following figure shows the circuit principle of relay module:

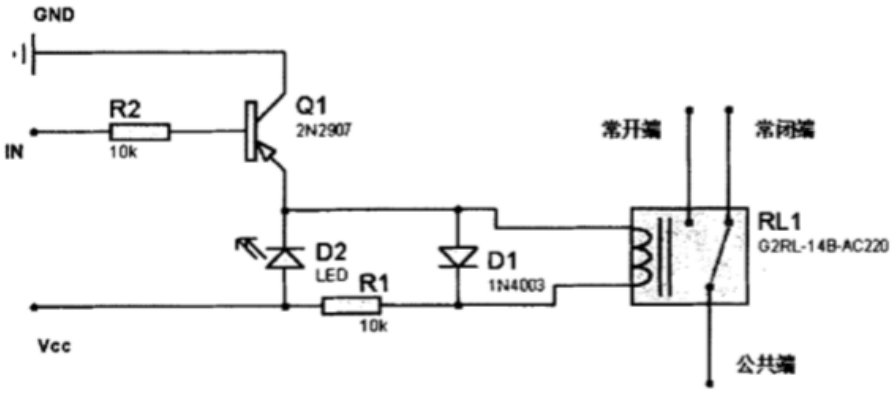

Figure 8: Circuit principle of relay module

Auxiliary peripherals include fan, humidifier, and alarm.

This product design in addition to the temperature humidity and smoke concentration detection, but also design other related functions, when the sensor detects the current humidity is higher than the concentration range set, the main control chip gives a signal drive relay, so that the fan started, strengthen indoor ventilation;When the sensor detects that the current humidity is lower than the set concentration range, the main control chip gives a signal to drive the relay, so that the humidifier starts, improve the indoor humidity;When the sensor detects when the current smoke concentration is higher than the set concentration range, the main control chip gives a signal, drive the alarm alarm, remind the indoor personnel to open the window for ventilation.

4. Conclusion

This design breaks through the previous limitation of independent collection of multiple parameters and creatively integrates air quality parameters such as temperature, humidity and smoke concentration

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into an Internet of Things system, which can provide effective reference for research in this field.

Combined with the above investigation and experiment, this project aims to design a new intelligent indoor air monitoring system based on STM32 to solve the three core technical problems in the field of indoor air monitoring: all kinds of data collection should ensure high accuracy;It is necessary to calibrate the collected data;The communication between acquisition module and master chip should not only ensure the quality of communication, but also improve the speed of communication.Further improve the new intelligent indoor air monitoring system based on STM32, compile papers, try to apply for patents, and promote it.Can first test its effect in a small range, if the effect is significant, then promote to the society, if there are new problems, timely adjustment and modification.Based on the existing research results, we try to develop entrepreneurial projects and realize technological transformation.

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