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Smart Home System Based on STM32

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Abstract

With the continuous development of the economy, traditional homes cannot fully meet people's needs, which requires us to achieve certain goals according to the needs of modern people. The emergence of smart homes has greatly changed people's lives, making them more convenient. This design is based on an STM32 smart home system, which uses the STM32 microcontroller as the core. The system collects environmental parameters through temperature and humidity sensors, detects the presence of smoke through smoke sensors, and detects the presence of flames through flame sensors. The detected parameters are displayed in real-time through OLED, and the user sets parameter thresholds. If abnormalities are detected, an audible and visual alarm will be triggered. At the same time, the system has a defense function. After defense, if the sensing door is opened, an alarm reminder will also be triggered. In addition, in order to achieve intelligence, the system also has time display function and remote WIFI transmission function.

Keywords

STM32 microcontroller, Multiple parameter collection, OLED display, Abnormal alarm, WIFI transmission.

1. Introduction

This design is based on an STM32 smart home system, which uses the STM32 microcontroller as the core. The system collects environmental parameters through temperature and humidity sensors, detects the presence of smoke through smoke sensors, and detects the presence of flames through flame sensors. The detected parameters are displayed in real-time through OLED, and the user sets parameter thresholds. If abnormalities are detected, an audible and visual alarm will be triggered. At the same time, the system has a defense function, and if the sensing door is opened after defense, an alarm reminder will also be triggered. In addition, in order to achieve intelligence, the system also has time display function and remote WIFI transmission function.

After designing this system, it is possible to achieve indoor temperature, humidity, and smoke testing, allowing people to grasp the current indoor conditions in real time. At the same time, its threshold setting and alarm function can detect abnormalities and give an alarm in the first time, making it convenient for people to quickly handle. Meanwhile, its remote data transmission function allows users to remotely monitor indoor conditions in real-time. In addition, its anti-theft alarm function can prevent strangers from entering.

The core of this design is the STM32 microcontroller, which uses a high-performance and low-power microcontroller to process the entire design information. Temperature and humidity parameters are collected through temperature and humidity sensors, smoke is collected using a smoke sensor machine, flame detection is performed using a flame sensor, DS1302 timing is used, OLED display is used for display, buttons are used for input, door magnetic sensor is used

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to detect whether the door is open, buzzer is used for alarm, and WIFI module is used for remote transmission of its hardware.

When designing the software solution for a smart home system based on STM32, the overall system should be considered first. Then, starting from the task book, logical control should be carried out through the coordination with hardware to achieve system functions. After the system is powered on, the microcontroller will send instructions to initialize the temperature and humidity sensors, smoke sensors, flame sensors, door magnetic sensors, and clock chips. Then, the parameters will be collected through the sensors. After the collection is completed, the data will be displayed through OLED and transmitted to the mobile app through WIFI for judgment. If there is any abnormality, an alarm will be triggered.

2. Hardware system design

In this design, the system adopts a high-end low-power STM32 microcontroller, The STM32 microcontroller is a high-performance 32-bit processor designed by ST company. It is designed using the ARM architecture, which makes it run at a very high frequency, low power consumption, and fast processing speed. In addition, it also includes many internal modules, such as a timer module, serial communication module, multi-channel ADC conversion module, and interrupt module, CAN bus module, USB communication modules and numerous communication IOs are used for the development of external devices. Physical design of STM32 core board. When designing an STM32 control system, the first step is to design an STM32 minimum system, which is necessary to ensure the normal operation of the STM32 microcontroller. The minimum system generally includes the microcontroller itself, power circuit, clock oscillator circuit, reset circuit, etc.

According to the power supply requirements of the STM32 microcontroller, 3.3V is used for power supply, but the system uses 5V USB for power supply, so its voltage needs to be converted to 3.3V to supply power to the STM32 microcontroller, ensuring the normal operation of the system. There are various forms of resetting the STM32 microcontroller, including power on reset, watchdog reset, and button reset. In this design, when designing the smallest system, a button was designed, which is connected to the reset pin of the microcontroller. When the user presses this button, the system resets and the program runs from scratch. When STM32 is working, an external clock signal is required. In this design, an external 8M crystal oscillator is designed, which is connected to the input and output pins of the microcontroller to provide a clock signal for the microcontroller.

In smart home systems, it is necessary to detect environmental parameters, and temperature and humidity are the most important environmental parameters. When designing DHT11, it integrated temperature and humidity sensors internally, enabling simultaneous measurement of temperature and humidity. At the same time, it has a digital processing function internally, which can output the collected temperature and humidity data in the form of digital signals. This way, the microcontroller can directly connect to the output pin of DHT11 through IO for data reading. The humidity measurement range of DHT11 is 20% -99% RH, achieving humidity measurement in commonly used environments; The testing accuracy is ± 5.0% RH. Temperature measurement range: 0 to+100 ℃; The testing accuracy is ± 0.1 ℃. The sensor is powered by 5V, and there is no need for voltage conversion when designing the power supply. The temperature and humidity test speed of DHT11 is 2 seconds, which is relatively fast. DHT11 has a total of 4 pins, one VCC power supply pin, one GND pin, the other is DATA, which is a data input/output pin, and there is also one pin that is unused. The circuit design is shown in Figure 3.4. Its output pin is connected to the PB10 pin of the microcontroller to achieve data transmission.

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In this design, it is necessary to achieve indoor fire prevention function, so it is necessary to collect the smoke concentration in the current environment to determine whether a fire has occurred. In this design, MQ-2 smoke sensor is used. In this design, the MQ-2 smoke sensor module is used, which includes a probe for smoke detection, resistors and capacitors for power supply and filtering by the user. There are two output modes: analog signal output and digital signal output. The MQ-2 smoke sensor is a gas detection sensor that uses tin dioxide as its internal material. This material has a low conductivity in clean environments, but in environments with combustible gases, its conductivity increases with the concentration of combustible gases, including smoke, liquefied gas, coal gas, natural gas, etc. By using the MQ_2 smoke sensor probe and adding appropriate external components, it is possible to convert the concentration detection of combustible gases into electrical signals, which are then output in the form of electrical signals. The higher the concentration, the greater the output voltage. This module has strong reliability, stable use, strong anti-interference ability, and fast response speed to combustible gases.

Due to the fact that the MQ-2 smoke sensor has two output methods when detecting smoke, one is digital signal output and the other is analog signal output. When digital signal output is used, it can only determine whether there is smoke and cannot determine smoke concentration. When analog signal output is used, the current smoke concentration in the environment can be determined by judging the voltage. Therefore, in this design, the analog signal output method is used, and the PB15 pin of the microcontroller is the input pin of the ADC conversion module inside STM32. Therefore, in this design, there is no need to add any additional analog-to-digital conversion module, and the conversion module inside STM32 can be used directly. In this design, the flame sensor used can accurately detect flames within a range of 80CM, and its sensitivity can be adjusted. When the sensor detects flames, it outputs a low level, while the microcontroller outputs a high level. The system determines whether there is a flame by judging the high and low levels. In this design, a door magnetic sensor is used to determine whether the door is open. This sensor is similar to a button, when the door is opened, the corresponding IO of the microcontroller is pulled down. In this design, in order to achieve intelligence, the system has the function of displaying time. The DS1302 clock chip is used for time calculation in this design. BT1 is a backup 3V button battery to prevent clock data loss in case of power failure of the main power supply, The crystal oscillator with an AL of 32.768KHZ provides a reference frequency for the clock circuit inside the DS1302 chip. The clock chip is connected to the microcontroller through three wires, and there are generally two types of control for the microcontroller DS1302: reading data and inputting data. Reading data means reading the date, time, and other information from the chip's RAM, while writing data means modifying this information.

OLED display screen, also known as organic light-emitting diode screen, has the characteristics of clear display, low power consumption, bright brightness, and stable output, OLED display screens have a large viewing angle and self luminous characteristics, with thin thickness, wide visual range, fast response speed, and a wide working temperature range. It is possible to control the contrast and brightness of OLED display screens through instructions controlled by a microcontroller. In terms of interface display function, it can display patterns, Chinese characters ASCII, etc. In this design, in order to achieve system intelligence, users can set alarm threshold parameters according to their own needs. In this design, the buttons used are mechanical touch buttons. The button is made of metal and is usually connected to different pins on both sides by two non-contact shrapnel pieces. When external force presses the button, the two shrapnel pieces will come into contact, making both sides conductive. In this design, a total of 4 buttons are designed, which can be used for parameter adjustment and defense. When a button is pressed, the IO of the microcontroller will recognize it, and then by reading the high and low levels of different IOs, it can determine which IO has been pressed, thereby achieving

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different input judgments and executing different functions. In this design, when the system detects abnormalities, it will provide an audible and visual alarm reminder composed of a buzzer and LED. In terms of sound reminders, this design uses a buzzer, which is a commonly used alarm reminder device. When a voltage is applied at both ends, the buzzer will emit a sound. The other is an LED light, which also applies a voltage at both ends, The LED light will light up. In this design, the ESP8266 WIFI module is used, which is a wireless transmission module that can achieve serial communication with the microcontroller. It comes with a built-in MCU, which can store program firmware. It can be operated by sending simple AT commands, such as starting WIFI, sending data, receiving data, etc. The WIFI module uses a low voltage of 3.3V for power supply, As a system module, EPS8266 integrates a 32-bit MCU with built-in TCP/IP communication protocol. It also has modules such as switching power supply, power amplifier, signal modem, etc. After integrating these modules together, it is particularly convenient for development.

3. Software design

After the system is powered on, the microcontroller will send instructions to initialize the temperature and humidity sensors, smoke sensors, flame sensors, door magnetic sensors, and clock chips. Then, the parameters will be collected through the sensors. After the collection is completed, the data will be displayed through OLED and transmitted to the mobile app through WIFI for judgment. In this system, the temperature and humidity sensor DHT11 is used to collect temperature and humidity. After power on, the temperature and humidity sensor sends instructions to initialize. After initialization is completed, the sensor is started, and then the sensor collects the current temperature and humidity. The microcontroller reads it and performs conversion and display.

In this design, after the smoke sensor collects smoke, its output is an analog signal, which is then converted from voltage to digital signal through the ADC832 conversion module. The microcontroller reads the returned voltage value and converts it to complete the smoke display. In this system, OLED is used for data display as an interactive interface. When the microcontroller operates on it, it first initializes, then sends instructions to determine which position to display, and then sends information to display data, completing the final display. In this design, after collecting data, data is transmitted through the WIFI module. The microcontroller communicates with the WIFI module through a serial port. The microcontroller sends instructions through the serial port for initialization, and then sends data to the WIFI module, The WIFI module is transmitted to the mobile app for display. By debugging the actual application and functionality of the product, the predetermined design requirements were achieved; In the future, we can further refine the details of the design and improve it by adding more intelligent features, such as voice control, voice broadcasting, video monitoring, etc.

4. Conclusion

This design is based on the STM32 smart home system, which has the advantages of complete functionality, user-friendly interaction, outstanding safety performance, high degree of intelligence, strong practicality and scalability. It can meet the needs of modern homes and offices for smart home systems, and has high market promotion value and application prospects.

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