Smart Home Security Design Based on STM32 Microcontroller

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Abstract: This paper addresses the needs in the field of smart home security, based on STM32 microcontroller for smart home security design. Firstly, the background and research significance of smart home security are introduced, and the current situation and development trend of smart home security are briefly summarized. Then, the basic concepts and classifications of microcontrollers are introduced, and the applications and roles of microcontrollers in smart home security are elaborated. Next, the STM32 microcontroller was selected, the system hardware circuit and software program were designed, and the system was implemented and tested. Finally, the research work of this paper is summarized, problems and shortcomings are pointed out, and future research directions and prospects are discussed. Through the research and realization of this paper, the security level of smart home can be effectively improved, and make some contributions to the development of smart home.

Keywords: STM32 microcontroller, smart home, security design, embedded system, sensor technology

1. Research background

With the continuous development of technology, microcontroller, as a commonly used embedded system chip, has been widely used in smart home security system. However, there are still some problems and challenges in the development process of smart home security system. First, traditional home security systems mainly use wired connections, which have high installation and maintenance costs. Second, the accuracy and stability of sensors are also challenges that need to be addressed in smart home security systems. In addition, the development of smart home security systems requires the comprehensive use of a variety of technologies, such as sensing technology, network technology, artificial intelligence technology, etc., which puts forward higher requirements on the ability and technical level of developers.

2. Overview of smart home security system

Smart home security system is a system that uses Internet of Things, Internet, microcontroller, sensors and other technologies to network and intelligently manage home equipment, home appliances, security equipment, etc. in the family. A smart home security system usually consists of multiple subsystems, including door and window monitoring, smoke monitoring, gas leakage monitoring, video surveillance, smart door locks and so on. Through the cooperative work of these subsystems, the smart home security system can realize comprehensive monitoring and intelligent control of the home environment[1].

In the design of smart home security system, microcontroller plays an important role as the core component of smart home control. Through the program control of the microcontroller, real-time monitoring and control of each subsystem can be realized, and intelligent management of the home environment can be achieved. At the same time, the microcontroller can also realize remote control through the Internet, so that the system can communicate with each other and the cell phone terminal to realize the remote monitoring and control of the user. Help users to monitor the home environment anytime and anywhere, to protect the safety of family members.

3. The application of STM32 microcontroller in the smart home security system

3.1 Introduction of STM32 microcontroller

STM32 microcontroller is a high-performance microcontroller launched by ST (STMicroelectronics) company, which adopts ARM Cortex-M series core, and can play a variety of roles in the smart home security system, such as: collecting all kinds of sensor data, controlling home appliances, realizing intelligent door lock control, temperature and humidity monitoring, smoke alarm, etc. STM32 microcontroller is used with other modules such as sensors, WiFi modules, etc. work together to realize the networking control of the smart home security system. Its high performance, low power consumption, powerful data processing capability and high reliability make STM32 microcontroller an indispensable core component in the smart home security system[2].

3.2 Synergy between STM32 microcontroller and other components

The cooperative work between STM32 microcontroller and other components is the key to realize the function of smart home security system.STM32 microcontroller can communicate with various sensors and actuators through serial port, I2C, SPI and other communication modes to realize the real-time collection and control of environmental parameters. In addition, STM32 microcontroller can also communicate with cell phone APP and cloud database through WiFi module and Bluetooth module to realize remote control of home equipment and security alarm and other functions.

4. Hardware design of smart home security system

This section describes in detail the hardware design of the smart home security system based on STM32 microcontroller, including the system hardware circuit design, the selection and design of the security system sensors, and the design of communication between the system and the cell phone. In order to realize intelligent and convenient home security applications, the hardware design of this system adopts advanced electronic technology and modular design ideas[3].

4.1 System hardware circuit design

The design of the system circuit is a key part in the design of the smart home security system, which directly affects the stability, performance and reliability of the whole system. In the system circuit design, the circuit design and connection of components such as microcontroller controller, sensor module, communication module, relay and power supply need to be considered. In this design, the STM32F103C8T6 microcontroller controller is selected as the main controller, the sensor module includes temperature and humidity sensors, gas sensors, human infrared sensors and smoke sensors, and the communication module uses ESP8266 Wi-Fi module and Bluetooth module[4].

4.2 Security system sensor selection and design

Sensors are the core component of the smart home security system, which are used to detect environmental information and convert it into digital signals to be input into the microcontroller for processing. In the selection of sensors, this system mainly considers factors such as accuracy, stability and versatility to ensure the reliability and practicality of the system. In the selection of temperature sensors, the system adopts the DS18B20 digital temperature sensor with high precision, fast response speed and wide temperature range, which can directly transmit the digital signal to the microcontroller; in the selection of humidity sensors, the system adopts the DHT11 digital humidity sensor with high stability, high precision and small size; in the selection of smoke sensors, the system adopts the DHT11 digital humidity sensor with high sensitivity and stable performance; in the selection of smoke sensors, the system adopts the DHT11 digital humidity sensor with high stability and high precision and small size. In the selection of smoke sensor, the system adopts MQ-2 type smoke sensor with high sensitivity and stable performance; in the selection of human infrared sensor, the system adopts AM312 type human infrared sensor with ultra-low power consumption and high sensitivity, which can realize the accurate detection of human body movements[5].

4.3 System and cell phone communication design

The smart home security system designed in this paper needs to use a reliable wireless communication method to realize the remote control of intelligent devices, so this system chooses to use WIFI module and Bluetooth module to realize communication. In the development and design of WIFI module, this system needs to focus on the following aspects.

4.3.1 Selection of WIF module

When selecting the WIFI module, this system needs to consider a variety of factors, including the reliability of the module, communication speed, power consumption, applicable environment and other factors. Therefore, when selecting the module, combined with the actual application scenarios of the project, this system chooses an ESP8266 WIFI module with relatively stable performance.

4.3.2 Technical realization

In the technical realization, it mainly includes the solution of key technologies such as network access and protocol stack. Therefore, this system adopts the TCP/IP protocol based on the three-layer structure and uses C language for code development.

Remote control and data transmission:

In practical applications, the WIFI module will serve as a core communication component, undertaking the important tasks of remote control and data transmission. Therefore, this system pays special attention to and optimizes the communication protocol between the modules during the design process, and realizes fast and stable data transmission to ensure the efficiency and stability of the system[6].

In the smart home security system, the WIFI module has a wide range of application scenarios. We can realize remote control of security equipment at home through cell phone APP, computer and other remote terminal devices, such as re-al-time control and data transmission of door locks, cameras and so on.

In summary, the design of WIFI module based on ESP8266 WIFI module is an extremely important part of the smart home security system, and its selection and technical realization will be directly related to the reliability and stability of the system, so in the process of design and realization, we need to give full consideration to the actual application scenarios of the system, and to ensure that the stability and efficiency of the technical solutions.

5. Software design of smart home security system

The software design of the smart home security system is an important part of the system implementation. This section introduces the software design of the system, including software architecture design, algorithm design, user interface design and so on[7].

5.1 Software architecture design

In the system software design section, software design and programming of the smart home security system are required to realize the functions of the system. In order to improve the scalability and maintainability of the system, the system as a whole is divided into three layers, which are the application layer, the control layer and the bottom layer. In the bottom layer hardware driver design, the HAL library was used to initialize the STM32 microcontroller as well as the DSP library to process the audio signals. In the design of the control layer, FreeRTOS real-time operating system is used to schedule, manage and optimize the system tasks, based on which the core code and functions of the system are implemented. In the design of the application layer, GUI and TCP/IP protocols are used to enable the system to perform good user interaction and remote control.

5.2 Algorithm design

In the smart home security system, algorithm design is the key to realize intelligence. In the process of system software design, this system also uses some common algorithms and techniques, such as image recognition algorithms, machine learning algorithms, deep learning algorithms and so on, in order to improve system security and recognition accuracy. Among them, the face recognition algorithm is one of the core algorithms of the system, which obtains face information through the camera and compares it with the face information in the database, so as to realize the authentication and author-ization of the user's identity.

5.3 User interface design

User interface design is an important part of the smart home security system to realize user interaction. The system adopts a graphical user interface (GUI) design to facilitate user operation and management of the system. The user interface of the system adopts intuitive graphical display and operable controls, which can realize various operations and management of the system.

5.4 Software realization

The software implementation of the system is mainly developed by using C language and embedded operating system (RTOS), which realizes various functions of the system, including security monitoring, intelligent control, remote manage-ment and so on. At the same time, the software of the system also has strong scalability and compatibility, and can adapt to different hardware platforms and software environments.

In view of the actual application scenarios and functional requirements of the smart home security system, we also need to consider the performance and reliability of the system in the process of system software design. In terms of system performance optimization, this system adopts multi-threading technology and optimization algorithms to test and optimize the performance of the system, so that the response speed and execution efficiency of the system have been effectively im-proved. In terms of the reliability of the system, through the testing and verification of the system, the system can be finely designed and optimized to ensure that the system can run stably for a long time and can automatically detect and correct faults and abnormalities during operation.

6. Summary and prospect

The smart home security system designed in this paper successfully realizes a number of functions, including remote monitoring, intelligent door locks, smoke alarms, human infrared sensing and so on. With the continuous advancement of

intelligent development, the market demand for smart home security equipment will continue to expand.

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