The Application of Wifi Technology in Smart Home

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Abstract. With the continuous maturity of WiFi technology and the growing development of smart home, the use of WiFi technology to control home systems on smartphones will become an important part of people's lives in the future. More and more enterprises have joined the industries of developing smart home devices. More and more enterprises have joined the ranks of developing smart home devices. Firstly, this article introduces the concept of WiFi technology and the concept of smart home, and expounds its development trend. Secondly, it introduces the overall structure design of the system. Finally, it describes the hardware and software design of the system.

1. Introduction
With the rapid development of science and technology, the world has stepped into the era of informationization. Due to the continuous improvement of technology, people are more comfortable with home conditions and are more convenient and safer. As a result, smart buildings and homes are spawned. Smart home is through a home network of bus home devices connected to the information related to the implementation of network monitoring and control in order to manage centralized or off-site. At present, the development trend of smart home is from centralized control to distributed control. There are four mainstream wireless technologies currently used in smart home: Bluetooth, WiFi, Z-Wave, Zig-bee. The most competitive technology is WiFi technology and Zig-bee [1]. Therefore, this article will introduce the smart home control system based on WiFi.

2. WiFi technology principle
The full name of WiFi is Wireless Fidelity, it is 802.11b wireless network specification and a short-range wireless transmission technology that aims to improve the interoperability of wireless network products based on the IEEE802.11 standard. WiFi typically uses 2.4G UHF or 5G SHF ISM RF bands. Wireless LAN connections are usually protected by password, but they can also be open, passwordless, and network-wide devices can be connected.

The principle of the smart home control system based on WiFi is that a number of wireless smart nodes form a home area network, each smart sub-node includes a WiFi receiving module, and the home gateway has a wireless WiFi transmitting module. Receive and transmit module communicate through WiFi.

The advantages of WiFi are as follows:
• It covers a wide area and has a long effective distance. The communication distance in the open area is up to 305m, and the communication distance in the closed area is 76-122m. It can be applied not only to the local rooms but also to the entire buildings.
Transmission speed is very fast, up to 54Mbps. In addition to the low cost, it has low power consumption, in line with the modern "green low-carbon" appeal. According to the research, the WiFi signal belongs to a kind of microwave and has little impact on the human body. The impact of the radiation generated by Wi-Fi on the human body is negligible within a safe range. However, since WiFi uses RF technology, air is used as a medium to transmit and receive data, signals that transmitted through radio waves are easily disturbed by external environments, and the security is not high, so they are not suitable for smart home control systems that require high security.

3. Smart home

3.1. Concept and development process
The concept of smart home originated in the United States in the early 1980s, calling it Smart Home. It has undergone four generations of development: the first generation completes home networking through coaxial lines and two cores to achieve lighting, curtains and a small amount of security control; The second generation is through bus and IP technology networking, to be able to complete the video intercom and security business; The third generation is a centralized intelligent control system, by the central control computer to complete security, measurement and other functions; The fourth generation that is based on the Internet of things technology can be based on user needs to achieve personalized features [2].

Smart home should be integrated into four parts: building automation systems, communications systems, room automation systems, computer-aided equipment management system [3]. Smart home control system has intelligent, information-oriented functions, control functions, communication functions, monitoring functions, timing functions and abnormal protection, leakage protection [4]. China introduced the concept of smart home from the late 1980s. China started to promote the construction of intelligent residential quarters through the concept and technology of intelligent buildings. Adopting the intelligent residential district system mode of "smart residential as the basic unit, intelligent building's management center as the central node, and Hybrid Fiber Coax (HFC) network as the data transmission medium", it has the functions of Safety Automation (SA), Communication Network (CN) and Management Automation (MA) and other functions that Satisfy residential needs.[5]

3.2. Development Opportunities
Thanks to socio-economic progress, government support and technological development and business competition, smart home has been able to develop rapidly in recent years.

3.2.1. Social and economic progress. Under the influence of the reform and opening up and economic globalization, the economy of our country has shifted from a high-speed growth stage to a high-quality development stage. As the economic level continues to rise, people's demands for living quality are getting higher and higher. Nowadays, the younger generation is more receptive to advanced technologies, which provides a solid foundation for the development of smart home.

3.2.2. Support of the government. Since 2010, the state and the government have promulgated many policies to promote the development of the smart home industry. In 2010, the State Council passed the "Decision on Accelerating the Fostering and Development of Strategic Emerging Industries" issued by the State Council in 2011, and the Ministry of Industry and Information Technology promulgated the "Twelfth Five-Year Plan for Development of the Internet of Things" in 2011, explicitly including smart home in the demonstration projects of 9 major key areas. It is precisely because of state support that smart home as a new industry can be developed so rapidly, largely to help improve the technology and increase the popularity of smart home.
3.2.3. Business competition. In other countries, Apple, Google and other leading enterprises have long been put into the smart home industry. In China, Alibaba, 360, Xiaomi and Jingdong started to think of smart home as an important area for future development. The emergence of many competitors in some ways to promote the development of the industry has a positive lead role.

4. The overall design of the system

It takes Android system as a platform, the system includes CPU, WiFi module, a smart phone as a carrier control terminal and intelligent control system. Intelligent control system includes home lighting intelligent control system, home appliances intelligent control system, audio-visual equipment intelligent control system and video real-time monitoring system, and finally by Android system smart phones through WiFi network to achieve the purpose of controlling home appliances.

The function of this system is to send the control command to the CPU by the smart phone through the WiFi network. The processor receives the command and parses it to remotely set the door, air conditioner, monitoring probe and light. Users can also use the smart phone to gather real-time data sent by the central processing unit.

Hardware platform is an important part of determining system performance and stability. This article chooses STM32 core controller as the central processor, QUALCOMM's QCA9531 chip as the WiFi module, the smart phone based on Android system as the control terminal.

The control terminal transmits the information to the WiFi module connected to the same network via WiFi. The WiFi module transmits the received signal to the CPU through the serial port, and the CPU realizes control over the home appliance according to the received instructions. The overall structure of the system shown in Figure 1.

![Overall structure diagram of the system](image)

Figure 1. Overall structure diagram of the system

5. The hardware design of System

STM32F107 processor module's main role is to communicate with the host computer to receive real-time operation from the mobile phone side instructions, and then analyze the operation of instructions and perform the appropriate work; The OpenWrt firmware is embedded in the QCA9531 WiFi wireless communication module, and the data forwarding and transmission of the QCA9531 WiFi wireless communication module is realized by configuring the network serial port function and the push function of the OpenWrt system. The STM32F107 processor mainly realizes the data communication with the WiFi wireless communication module through the serial port and provides 5V power for the WiFi wireless module.

5.1. STM32 processor module

The STM32F107 microcontroller uses the Cortex-M3 core with CPU speeds up to 72 MHz. They target applications requiring connectivity and real-time performance with 64-256KB of on-chip Flash memory, 64KB of SRAM and 14 communications interfaces. The STM32F107 Interconnect has a built-in USB OTG full-speed (12Mb / s) device, host and OTG mode control module. The biggest
highlight of the STM32F107VCT chip is the integration of most of the mainstream peripheral networks, CAN, USB, UART, motor control and so on.

Compared to using more STM32F103VB series, the STM32F107VCT series has an interconnection interface and more internal resources, the F107 increases the number of the IEEE Ethernet interface, it has two IIS audio interface, and all 64kb SRAM cache.

5.2. WiFi wireless communication module

The WiFi wireless communication module in this system adopts Qualcomm QCA9531 chip. QCA9531 frequency will be higher, up to 650MHZ. QCA9531 supports MINIPCIE interface and can be extended to 5G dual-band and LTE data module applications, QCA9531 increases the number of external interfaces and increases memory that is up to 128MB, QCA9531 improves performance and expand memory, and optimizes for radio frequency. Compared with the AR9341, there will be no restricted situation, and it has more associated users, supporting the concurrent number of up to 50 users, with a measurement of 150 people. QCA9531's block diagram shown in Figure 2.

6. The software design of System

The software design of the system is based on the Andriod system above the Linux system. Andriod operating system with high degree of freedom, openness, wide range of applications, and has great potential for development, it is also very competitive in the future. This article chooses Andriod operating system as a platform to develop the intelligent home control system. By installing the APP interface on the smart phone, the user can realize the switch control of the home appliance, the centralized control of the home lighting, and real-time monitoring of the home situation, it not only can control the electrical equipment in the house centrally, but also can realize the remote management, reduce the potential safety hazard and apply the modern advanced technology to people's life truly.

APP software interface is mainly consisted by welcome interface, login interface, the main interface. User interface design is shown in Figure 3. Firstly, the user needs to register an account in the APP, set a password, and log in to the main interface of the management through the registered account to ensure the privacy of the user. The main interface contains settings interface, you can set the switch tone, the interface style and so on. It can increase the users’ experience and personalization. Home control interface has four sub-modules: smart home appliances control interface, smart home lighting control interface, audio and video equipment control interface and video surveillance interface.

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This article uses MATLAB GUI user interface to simulate the design of the interface. For example, take home appliances control interface to introduce its subroutine flow chart shown in Figure 4. There are two "connect" and "exit connection" control buttons respectively, click the connect button to connect the device, after the success of the connection, it can choose to open and close the home appliances; click the exit button can choose to exit whether to disconnect, if so, then Disconnect the device and exit the current interface and return to the main interface; If not, do not disconnect the device and return to the main interface to control the other sub-modules; If canceled, it stay in the current interface. The main interface is shown in Figure 5, the subsystem interface is shown in Figure 6.
This article firstly introduces the WiFi technology principle and the development overview of the smart home. Secondly, the design of hardware and software of this system is described. The STM32F107VCT chips and QCA9531 is used to control the home system through Android platform. Finally, the APP of Matlab software is designed based on GUI of Matlab.

The system has the following advantages:
- The system structure is simple, the user interface is concise, cost-effective and easy to operate.
- Choose STM32 processor to be the central processor, the selected STM32F107VCT series is an Internet-connected products for Internet of things, it is cost-effective. Choose QCA9531 as WiFi wireless communication module, QCA9531 not only increases the number of interfaces and has more memory, but also increases the number of concurrent users, associates more users, optimizes the overall performance.
- The system uses Matlab GUI interface for app design, it can realize the appropriate functions, users can easily control smart home appliances to realize the function of equipment.

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