

Development of a Smart Home Control System Based on Mobile Internet Technology

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Abstract

With the rapid development of mobile internet technology and the continuous improvement of our living standard, our demands for smart home are also increasing. In order to design a smart home control system, we design the topological structure through the analysis of the requirement of smart home control system. Then we select hardware devices; build IP network and communication network to achieve the system function. At last we develop Pad and smart phone software. The system has multiple functions like monitor house, open and close curtains automatically, give an alarm, etc. The smart phone, PC and other devices link the residents and community service center to our houses.

Keywords: *Mobile internet technology; Smart Home; Topological structure; IP network; Communication network*

1. Introduction

As one of the core technologies of the new generation information technology, mobile internet technology has been fully applied in every field like agricultural production, consumer electronics, commercial circulation, social services and other industries. It is forming a vigorous development trend and becoming the new breakthrough in the global economy. From domestic to foreign companies of various types, all are eager to research and implement the relevant technology and develop communication standards. We can see that smart home market has an infinite potential for future development [1].

Smart home takes a house as the platform, combines the mobile communication technology, automatic control technology and internet technology [2]. According to the demand of home life it integrates related subsystems such as lighting control system, information appliance system, curtain control system, security system *etc.* Smart home not only includes all residential functions of the traditional home, but also provides a more comfortable, safe, convenient, high-tech family living space. It also optimizes people's lifestyles and is effective in helping people manage their home appliances from afar, strengthen the security of their homes. It even saves energy costs for people [3].

2. System Function

2.1. System Requirements

Smart home control system not only can meet the needs of home intelligence, but also can improve a community's level of service. When a resident is in any kind of dangerous situations such as fire, water inflow, *etc.*, it will notify the residents and the community service center in time. When the sensor perceives day or night it will automatically adjust the residential curtains. Through a Pad or smart phone residents can control the switches of residential exhaust fan, water heater and other appliances. Pad and smart phone can

view the real-time video of a house at any time. They can also check the use of the electricity meter and so on.

2.2. Topological Structure

Smart home control system uses sensor, actuator, smart phone, Pad, smart terminal, PC, web camera and other devices to form a network via TCP/IP, WIFI, ZigBee, Bluetooth, RF433 and other communication technology. See Figure 1. The whole network is composed of IP sub-network and communication sub-network.

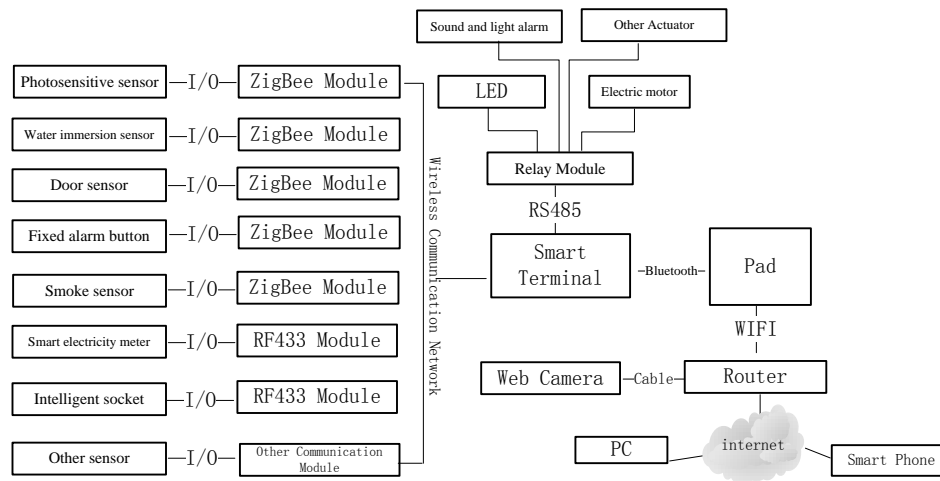


Figure 1. System Topology Diagram

2.2.1. IP Network: Pad, PC of community service center, smart phone, web camera and other devices build IP network using wireless router. It gives each device a fixed IP to make these devices interconnect in the same network. Pad and smart phone can view real-time video of home via web camera.

2.2.2. Communication Network: Sensor modules connect ZigBee modules or RF433 modules. ZigBee modules or RF433 modules connect smart terminal via communication network. Smart terminal connects relay module through RS485 serial port. Relay module connects alarm, fan and other devices. Smart terminal communicates with Pad via Bluetooth.

2.3. System Flowchart

Sensor receives external signal in the Smart home control system. Sensor connects ZigBee module, ZigBee module sends signal to smart terminal via communication network. Smart terminal is the core of the whole system. When smart terminal receives signal, it processes the signal and sends signal to the paired Pad via Bluetooth. Pad is the brain of the whole system. It does logical processing of the received signal. For example, if someone presses the fixed alarm button, ZigBee module receives the signal and sends a signal to smart terminal. Smart terminal processes the signal and then sends signal to Pad via Bluetooth. Pad sends start sound and flash alarm signal to smart terminal. Smart terminal receives the signal then sends signal to relay module via RS485. Relay module receives signal and then jumps the switch to start the sound and flash alarm. At the same time, Pad sends signal to smart phone and notifies resident of the alarm. Pad sends signal to community service center's PC to notify of the alarm. See Figure 2.

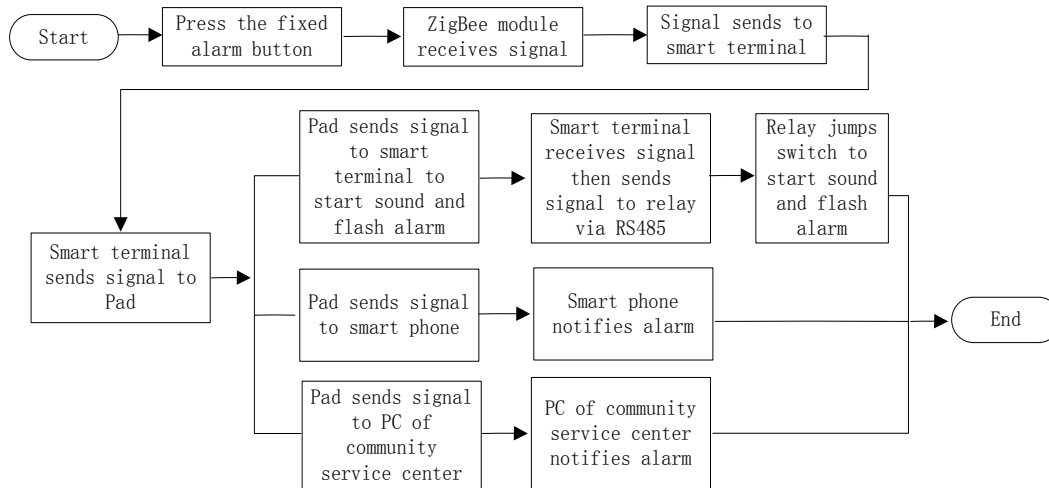


Figure 2. Fixed Alarm Flowchart

2.4. Security and Privacy

In order to protect the security and privacy of residents, smart home control system designs network security and system security control. For network security it uses devices certification. Only the devices that match the condition we set can connect to the network. For example set MAC address filtering for router. Only the MAC address that registered in the router MAC filtering lists can login the network. In this way it can prevent unauthorized user connect to the network. For system security users must use account and password to login the software installed in Pad and smart phone.

3. System Hardware

3.1. Control Module

Smart terminal: Smart home control system has complex functions and real-time processing. Multiple events may appear simultaneously. To avoid the delay and disorder of events it needs an embedded real-time operating system kernel to arrange task's execution order and realize the core functions of smart home control system [4]. It uses Cortex-M3 processor, integrates mobile internet related communication interface, such as ZigBee, Bluetooth, RS485, RF315M, RF433M, RS232, CAN *etc.* Smart terminal can perform a variety of complex and intelligent tasks.

Pad: Pad is the control center of the whole system. It communicates with smart terminal via Bluetooth. Software is designed for Pad to process signal and control related actuator to execute task via smart terminal.

Smart phone: Residents use smart phones to view real-time video of home, check electricity meter and so on. It can control related actuator to execute task by communicating with the Pad.

3.2. ZigBee, RF433 Module

ZigBee is a kind of two-way wireless network technology which has the generic standards of short range, low power consumption, low speed, low complexity and low cost. It is a wireless communication technology based on the IEEE802.15.4 protocol's physical layer and MAC layer standard for networking, data transmission, security, *etc.* [5].

RF433 is a micro transceiver for high-speed transmission of data signals. It can package, detect error and correct error of transmitted data. Components of RF433 are industry grade standard, small size, easy to install and are stable and reliable. It can be applicable to security alarm, wireless automatic meter reading, home and industrial automation, remote control, wireless data transmission and other systems [6].

3.3. Relay Module

The relay is an electrical control device. When the change in the amount of input meets the prescribed requirement, the controlled variable jumps predetermined step in the electrical output circuit. It interacts between the control system (also known as the input loop) and the controlled system (also known as the output loop). Normally it applies to the control circuit of automation. It is actually an automatic switch that controls the operation of a large current with small current. Therefore, in the circuit it plays the role of automatic adjustment, safety protection, circuit conversion and so on.

3.4. Sensor Module

Smoke sensor: It achieves fire prevention by monitoring the density of smoke. Smoke detector uses ion smoke sensor. The ion smoke sensor is a technologically advanced, stable and reliable sensor. It is widely used in a variety of fire alarm systems. Under normal circumstances the current and voltage of internal and external ionization chamber are stable. Once smoke enters the outer ionization chamber which interferes with the normal movement of charged particles, the current and voltage will be changed. It causes an imbalance between the internal and external ionization chamber. The wireless transmitter will send out the wireless alarm signal to notify the remote host and an alarm will be relayed.

Water immersion sensor: It is divided into contact water immersion detector and contactless water immersion detector. Contact water immersion detector uses liquid conductive principle to detect the level of water. Normally the two pole probes are insulated by air. They will conduct in immersion state and send out a signal.

Door sensor: It consists of a wireless transmitter, a magnet and a steel reed. When the magnet and steel reed are at a distance less than 1.5 cm the steel reed is in disconnected state. When the distance of separation is over 1.5 cm the steel reed will be closed then it will cause short circuit which makes alarm indicator turn on and transmits the alarm signal to host.

Fixed alarm button: Press the fixed alarm button to generate a closed signal and send alarm signal to host.

Photosensitive sensor: It can convert light signal into electrical signal by using light-sensitive component. It can sense the brightness of light and send relevant signal.

Smart electricity meter: Traditional electrical meters only measure total consumption, and so provide no information of when the energy was consumed at each metered site. Smart meter provides a way of measuring this site-specific information, allowing utility companies to introduce different prices for consumption based on the time of day and the season [7]. Smart electricity meters enable two-way communication between the meter and the central system. Unlike home energy monitors, smart meters can gather data for remote reporting.

3.5. Actuator Module

Sound and flash alarm: It is a device to send out warning signal to people via sound and flash.

Electric motor: It is an electromagnetic device for converting or passing electric energy according to the law of electromagnetic induction. It can realize forward and reverse turn through exchange the positive and negative pole. It is used to open and close curtains.

3.6. Network Camera Module

The network camera is a new generation product of the traditional camera and network video technology. In addition to the general traditional camera image capture function, the digital compression controller and web based operating system are also built in it. After the video data is encrypted, the video data is delivered to the end user via network. According to the IP address of the network camera, the remote users can use the standard web browser on the PC to access the network camera and monitor the target scene real-time. The remote users also can edit and store the image data in real-time and control the holder and the lens of the camera to realize full range monitoring.

4. System Software

The software of smart home control system is developed for Pad and smart phone. Pad is the control center of the whole system. It communicates with smart terminal via Bluetooth and communicates with smart phone and PC via UDP protocol.

4.1. Pad Software Development

After the software of Pad login in, there is a button that can connect to smart terminal via Bluetooth. When connection is established, Pad and smart terminal can communicate. The software of Pad creates message process handler object to process the message that received via Bluetooth.

```
private final Handler mHandler = new Handler() {
    public void handleMessage(Message msg) {
        switch (msg.what) {
            case MESSAGE_WRITE://sends message via Bluetooth
                byte[] writeBuf = (byte[]) msg.obj;
                String writeMessage = new String(writeBuf);
                ...
                break;
            case MESSAGE_READ://receives message via Bluetooth
                // gets data from message object
                byte[] readBuf = (byte[]) msg.obj;
                String readMessage = new String(readBuf, 0, msg.arg1);
                // 1. judges which device the message come from
                if (readMessage.contains("message receive from smart terminal")) {
                    // 2.notifies smart terminal
                    MainActivity.sendMessage("command send to smart terminal to
start alarm");
                    // 3.notifies smart phone
                    UDPClientSocket.send("fixed alarm button pressed",
```

```
        Configuration.PHONE_HOST,  
        Configuration.PHONE_PORT);  
    // 4.notifies PC  
    UDPClientSocket.send("fixed alarm button pressed",  
Configuration.PC_HOST,Configuration.PC_PORT);  
    // 5.saves alarm message  
    writeNewsToSql("fixed alarm button pressed");  
    // 6.alerts alarm notification  
    if (!isDialog) {  
        setDialog("fixed alarm button pressed ", "command send to  
smart terminal to close alarm");  
    }  
    }  
    }  
};
```

Start UDP server, receive message from PC and smart phone. Build message process handler to process the message received from UDP.

```
Handler UDPHandler = new Handler() {  
    public void handleMessage(Message msg) {  
        if (msg.what == 0x123) {  
            String msgstr = msg.obj.toString();  
            //processes the message receives from smart phone  
            if(msgstr.equals("message from smart phone")) {  
                //sends to smart terminal via Bluetooth  
                MainActivity.sendMessage("command send to smart terminal to  
close alarm");  
            }  
            //processes message receives from PC  
            else if(msgstr.contains("message from PC")) {  
                //sends to smart phone via UDP  
                UDPClientSocket.send("message from PC",  
Configuration.PHONE_IP, Configuration.PHONE_PORT);  
            }  
        }  
    }  
};
```

4.2. Smart Phone Software Development

Smart phone and Pad communicate via UDP protocol. Pad performs logical function and sends an alert to a smart phone. For example notify alarm message. Smart phone send message to Pad, Pad does corresponding process and sends result to smart phone. For example read the data of electricity meter. Build message process handler to process the message received from UDP protocol.

```
Handler UDPhandler = new Handler() {
    public void handleMessage(Message msg) {
        if (msg.what == 0x123) {
            String msgstr = msg.obj.toString();
            //shows notification according to the message from Pad
            if (msgstr.equals("message from Pad")) {
                writeNewsToSql("message from Pad");
                setDialog("message from Pad ", "command send to Pad");
            }
        }
    }
};

public void setDialog(String content,final String deleteOrder){
    final Builder builder = new AlertDialog.Builder(MainActivity.this);
    builder.setTitle("alarm notification");
    builder.setMessage(content+"is alarming...");
    builder.setPositiveButton("close alarm", new AlertDialog.OnClickListener() {
        public void onClick(DialogInterface dialog, int which) {
            // sends close alarm command to Pad
            UDPClientSocket.send(deleteOrder,Configuration.PAD_IP,
            Configuration.PAD_PORT);
        }
    });
    builder.create().show();
}
```

5. Conclusion

Using the smart home control system, resident can view real-time home video and communicate with devices and appliances in the house. When danger occurs it timely notifies the resident and community service center. Residents can control home appliances such as water heater via smart phone. Sensor perceps the environmental changes and controls the living room's curtains and lighting automatically. In the future, this system will control more appliances and will be more security.

With the advancement of the quality of life the rapid development of science and technology the smart home is no longer a dream of the people or a scene from sci-fi movies. It will be as common as today's mobile phone.

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