



Research and implementation of smart home system based on ARM and ZigBee

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ABSTRACT

Considering the disadvantage of smart home on wiring, maintainability and mobility, a scheme for remote monitoring of smart home is proposed based on ARM and ZigBee. Internal network of smart home is constructed based on ZigBee technology, and then gateway is developed with ARM which Linux operating system is transplanted into, GPRS/GSM and Internet is adopted to be the external network of smart home finally. The experimental result show that the system is stable, easily wiring and good mobility, can realize local and remote monitoring of smart home, and has broad prospects for the application.

Keywords: Smart Home, ARM, ZigBee, Gateway.

1. INTRODUCTION

With the rapid development of computer, communication and microelectronics technology and continuous improvement of people's living standard, the environment of the smart home has attracted more and more attention. At present, foreign countries have put forward the concepts of "Smart City", "Smart Home", "Smart Community" and developed related products. At the same time, the appearance of Internet of things promotes the development and application of smart home system, the intelligence of smart home is gradually coming true.

Smart home system can be divided into 3 parts of home network, the home gateway and the network. At present, in the design of smart home system, constructing of the multi home network connected by wire bus and power line based on cable networks exist wiring difficulties and poor expansibility. With the rapid development of modern short distance wireless communication technology, the wireless network technology in the smart home system has become an inevitable trend. ZigBee is a new kind of low complexity, low power consumption, low data rate, low cost wireless network technology, and working in the 2.4GHz and 868/928MHz bands. Relative to Bluetooth and infrared, ZigBee technology is simple and flexible, form diversity, and has function with ad hoc routing, which is very suitable for a large number of terminal equipment, data transmission capacity is small and low cost requirements of home network training. It should be extensive use prospect in many areas.

To improve the reliability and flexibility of smart home control system, this paper designed and developed the home

gateway based on ARM and intelligent control system consist of home network control nodes based on ZigBee. The home gateway is conversion for ZigBee protocol, GPRS/GSM protocol and TCP/IP protocol, and is responsible for the establishment and management of wireless sensor network and the outside communication network. ZigBee network nodes are responsible for the formation of the internal network, and exchange information with the gateway.

2. FUNCTION AND OVERALL SCHEME OF SYSTEM

Smart home remote monitoring system is mainly composed of an intelligent controller and several ZigBee control modules in home; the system architecture is shown in Figure 1. The system can achieve interoperability information through the GSM network and ZigBee network. Users not only can control appliances and lighting device by mobile phone outdoor, but also get the environmental and alarm information such as temperature, humidity, brightness and gas leakage in the home. Smart home controller can control appliances and lighting devices intelligently according to the acquired environmental information.

The Structure of smart home system based on ARM microprocessor and ZigBee is shown in Figure 1, it mainly included STM32F107VCT6, ZigBee coordinator, GPRS/GSM module, Ethernet module, ZigBee terminal equipment (lighting control, curtain control, temperature and humidity acquisition, smoke gas detection, infrared detection etc.). The central control system control intelligent lighting module, intelligent temperature module, intelligent smoke module, intelligent RFID module and other multiple

functional modules through ZigBee. The central control unit can display real-time state of internal modules in smart home through Qt interface, such as temperature, LED lights, smoke. The embedded database SQLite is used to save the LED light, temperature, smoke and the other state information and RFID access records. A remote client can browse real-time query information in smart home through the application Web/CGI form; it can also be reported to the home internal information regularly to the mobile client.

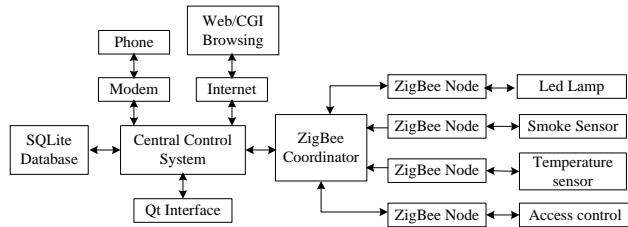


Figure 1. The overall design of smart home system

2.1 Home network

Home network is constructed by ZigBee coordinator and 4 nodes through the wireless network, the information collected by nodes is sent to ZigBee coordinator. Each ZigBee corresponds to a 16-bit short address, according to the ZigBee address to determine which one is the node transmitted information at the same time. The coordinator will send the information to the central control system through the serial transmission; the central control system can also send data to the coordinator through the serial port, the data will be transmitted to the specified node so as to control the electrical device (such as the LED lamp).

2.2 Home gateway

The communication between home network and the external network is realized through the home gateway, so as to realize the remote observation and control by the Internet and mobile phone network access. In fact, this system mainly uses ARM chip and peripheral modules as gateway. The basic development environment is to build through Linux root file system.

The build of the Web server can be the basis for BOA transplantation and simple configuration. By writing the HTML file and the CGI program to realize the remote access server. Users add access and enter to trigger the application through the browser address bar, the Web server receives the request and read the corresponding HTML file back to the browser, is returned to realize the control of the database query and the corresponding node through the control interface submit the form to call the CGI program.

3. SMART HOME WIRELESS NETWORK DESIGN

As an important part of smart home, ZigBee transmitted the information of each node by the coordinator to the home gateway on the one hand, which is convenient to the user through the browser to remotely view; on the other hand, ZigBee coordinator can receive the transmitted information from the gateway and send to a specific node, thereby allowing the user remotely control the corresponding electrical appliances.

3.1 ZigBee network node hardware design

The network nodes are divided into acquisition nodes and the master node (also known as the coordinator). Acquisition node will send the collected real-time data to the master node. The master node receives the data acquisition node and sends commands to control the indoor equipment. Nodes used CC2530 module produced by TI, the system block diagram is shown in Figure 2, which communicated with the master node through the serial port, all nodes control by the master node.

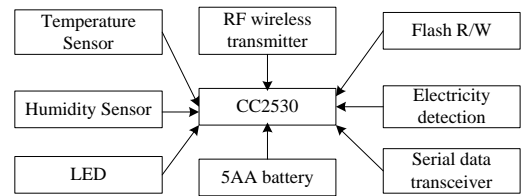


Figure 2. Node hardware system block diagram

The master node circuit is consisted of CC2530 module, reset button, the key, a standard serial port, network status indicator, switch lights and 6 indicator lights. Bottom plate is the double glass plate, feed by 5AA battery. Master node hardware diagram is shown in figure 3.

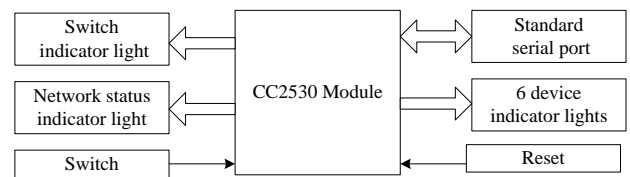


Figure 3. Hardware diagram of the master node

3.2 ZigBee wireless network software design

There are three kinds of ZigBee network mode, tree, star and mesh. Each network required at least one ZigBee coordinator. This paper adopted star network. To make changes in the application layer of ZigBee protocol stack, it used the ZStack-CC2530-2.3.0-1.4.0 protocol stack, then to download collection to acquisition node or the master node according to the type of the node. The software design of the collection node and control node is respectively shown in Figure 4 and Figure 5.

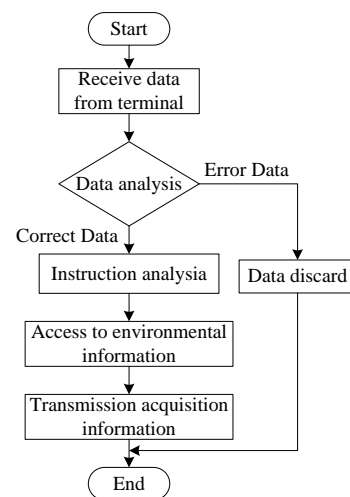


Figure 4. Acquisition node flow chart

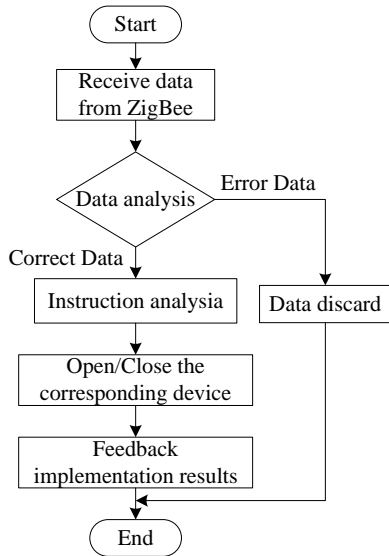


Figure 5. Control node flow chart

First, acquisition node reads the information from the terminal, data transfer to the coordinator node according to the fixed format after the analysis. Control nodes determined the node receiving or sending through the short address and send information to the nodes, thus observed or controlled the corresponding equipment. At the same time, it can control the corresponding equipment by setting the limit value automatic.

4. EXPERIMENTAL RESULTS

After the completion of the system software and hardware designed, debugging and comprehensive experiments were carried out under laboratory conditions. The system is consisted of ARM controllers, ZigBee master node and ZigBee star network topology from the node module. The distance between smart home controller and ZigBee monitoring module is 10m, the distance between adjacent ZigBee monitoring modules is 15m.



Figure 6. ZigBee node physical map

The coordinator node is powered on and networked, and no delay is detected, the communication distance is about 100m in open without obstacles by using an external antenna, the communication distance is about 20m in the office environment without obstacles, the distance is less than 10m for the two room doors and windows closed, which may exist communication interrupt and packet loss. The terminal node can re-join the network after power-down; network speed is relater with distance. PC is connected with controller for a few seconds of delay in LAN. After a successful connection, command control is response timely, equipment state and

sensor data can be displayed on the PC and the LCD screen; it can control LED lights, motor reversing, and alarm switch through the button remote terminal. The test results show that the system is stable, information collection is timely and accurate, and achieved the purpose of family information network, and has the advantages of wiring arrangement and mobility.

5. CONCLUSION

According to the characteristics of ZigBee technology and modern smart home system, thI paper puts forward an overall framework of the smart home system based on ARM microprocessor and ZigBee technology, and the hardware and software of system is designed and implemented. ARM9 chip is used as the main controller; the communication within the home is realized through the ZigBee network, which makes all kinds of devices in the home network as a smart home overall control system, it can realize the remote control and alarm functions through the GPRS module to access. The test results show that the system can meet the requirements of modern smart home, and has the advantages of low cost, low power consumption, strong versatility, so it is an effective solution.

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