The Design of SmartHome System Based on the Internet of Things

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Abstract. This paper proposes a solution based on the Internet of things and Android technology for the design of the SmartHome system based on the rapid development of the Internet of things technology and the popularization of RFID and ZigBee technology. The system hardware consists of the A10 platform, the ZigBee module, the RFID modules, the server, the web and so on. The ZigBee sensors within the rooms can accomplish multiple point environment data acquisition (including temperature, humidity, smog etc) and control, the RFID module control system can identify the information of the family member. ZigBee coordinator and RFID reader module collected data and transferred to the A10 platform real-time processing. The actual operation shows that this system can realize the real-time monitoring the environment information of the room, and can control the lighting of a plenty of rooms in various ways. The system design scheme is practical and effective, and it has high practical value.

Introduction

The concept of SmartHome System originated in the United States, then has been very good development in Europe, Japan and other countries. The concept of SmartHome System entered to our country about in the late 90s of last century. The SmartHome System is a combined product of modern electronic technology, automation technology and communication technology, it can automatically control and manage the household appliances, monitor and alarm the safety of the house environment, and can provide safe and comfortable, efficient and convenient learning and living environment for the residents.

Based on the research of RFID technology and ZigBee technology, this paper designs a SmartHome system based on the Internet of things. The system adopts wireless network consisting of ZigBee module can real-time monitor the environment information and safety information of the house; can also be used to control the lighting of a plenty of rooms in the house by a variety of ways. At the same time, the system uses RFID technology to identify the identity of the family members, and realizes the access control system.

The Hardware Design of the System

System Overall Framework. The SmartHome system based on the Internet of thing architecture diagram shown in Fig 1, the system consists of the A10 platform(Andriod-based) , the ZigBee modules, the RFID modules, the servers, the web, etc. The ZigBee sensors within the rooms can realize multiple point environment (including temperature, humidity, smog etc), RFID module control system can identify the identity information of the family member. ZigBee coordinator and RFID reader module collected data and transferred to the A10 platform real-time processing. Then the data uploaded to the web server through the Internet, users can obtain relevant information through the web or the mobile terminal.

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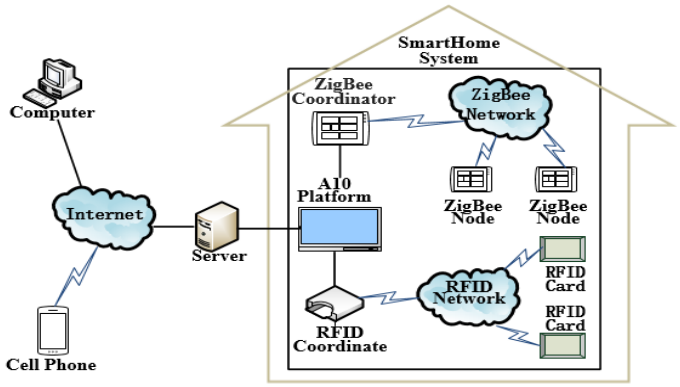

Figure 1. Architecture of the SmartHome system

ZigBee Module. The ZigBee module includes a ZigBee coordinator and some ZigBee nodes, the ZigBee nodes are equipped with a plurality of data acquisition sensors (including temperature sensor, humidity sensor, smog sensor, infrared sensor etc). The ZigBee nodes are placed in different rooms of the house, collect multi-points environmental information of the house. After the success of the networking, the coordinator uses the polling mode to receive sensor data, and transfers the data to the A10 hardware platform.

RFID Module. The RFID module is consists of RFID reader, the identity tag and the RFID Antenna. The Antenna can transmit the RF signal between the tag and the RFID reader. The module can realize the identity information of the family members, to achieve the effect of access control. The user issuing identity tags for each family member through the tag issuing module, the identity tag includes corresponding information (name, sex, age, etc.). The Reader module is installed in the entrance of the house, can receive the data of the identity tag when the family members want to enter or leave, in the case of permission to enter the family, and transfers the real-time data to the A10 hardware platform and server.

The A10 Platform based on Andriod. The hardware platform of the system uses the A10 processor of the Allwinner company, and the software system based on Andriod. The platform extended circuit is very rich, display output can through LCD display, LVDS interface, HDMI, VGA and so on. The communication between the platform and the PC can be carried out through the serial port and RJ45, and the communication data interface of the peripheral equipment includes USB, Mini USB, WiFi and so on.

The platform is a hub for the transfer of data, is a collection of all data points, mainly responsible for data collection and upload. The system platform uses Andriod system, obtains the environmental information of each room, equipment security information, family members real-time access information through the USB interface. The A10 platform analyzes the collected data, and then splices into JSON mode, and uploads to the server through the RJ45 interface.

The Server. The work of the server in the system is mainly to complete the following aspects:

1) Receiving the environment monitoring data from the A10 platform.

2) Sending the information to the Web client or web browser via the Internet.

The Web Browser. After the user successfully logged in, the browser will send data requests to the Web server continue. The server will return the corresponding data, the browser receives the data and display on the web page for users to browse, query, control, and ultimately achieve real-time monitoring of the environment within the house and lights control operation of a plurality of rooms.

The Software Design of the System

The Server Configuration and Implementation. The system using the SpringMVC architecture to write the web code. HTTP protocol uses JSP technology to define an extensible message processing framework, which provides a message structure that can be exchanged through a variety of underlying protocols. The system administrators can view the information including temperature,

humidity, family members access information of the house they managed, the temperature and humidity can be displayed in a broken line graph or a digital form. At the same time, the user can control the lighting of the room manually through the switch in the browser page, or set into an automatic mode in the Setting page, the system will automatically control the light according to the indoor light intensity.

The data transfer between the server and the browser is JSON mode, the browser sends the request to the server, the server receives the request and inserts the data of the temperature and humidity inside the room collected by A10 through Web service into the database

The Design of the A10 Platform. The A10 platform is a bridge between the bottom and web servers. It can receive the data from the ZigBee coordinator, and then decodes the data after processing. Requesting server, and store the data into the database.

The work of A10 platform can be divided into three parts: first of all, the JNI read and write the serial port; secondly, the Activity set the serial port baud rate of the ZigBee coordinator; Lastly, the service always Service running in the background, can complete the data reception, decoding, packaging and sending.

1) Implementation of the Serial Port Operation. In the JNI, here use the C language to open and close the serial port. Use Ndk to compile in the Ubuntu. The libserial_port.so library file Generated is what we want to use, The Android.mk configuration when compiling is as follows:

```
LOCAL_PATH := $(call my-dir)
include $(CLEAR_VARS)
TARGET_PLATFORM := android-3
LOCAL_MODULE := serial_port
LOCAL_SRC_FILES := SerialPort.c
LOCAL_LDLIBS := -llog
include $(BUILD_SHARED_LIBRARY)
```

After opening the serial port uses FileDescriptor as return, the user can read and write to the serial port as the file.

2) Open the ZigBee Coordinator. Call the .So to open the serial port to find out the COM and set the baud rate. Open a thread to wait for data as file input and output streams, the OnDataReceived is defined that provides listeners for data arrival as an abstract method.

3) Data decoding, packing and sending. After receive the 11 bits hex data, decode the data out of data type, numerical information, and then add the information and time of current house, package for the JSON object, open the sending thread, request the server to send data to the server.

The Software Design of ZigBee Module. The ZigBee Node will search and request to join the network according to the ZigBee protocol when the devices are initialized. If it has being determined, the ZigBee node will sent the current node address to the coordinator and automatically set up the binding. After receiving the data transfer instructions, the ZigBee node will collect data and then transmit to the coordinator periodically.

The ZigBee module network uses the star network in the system. The coordinator starts the network when it’s connected with the A10 platform through the serial port, and with the addition of the ZigBee node the data acquisition and transmission are started.

The ZigBee coordinator and the ZigBee node cooperation mode:

(1) Firstly, the coordinator starts to set up the network, and establishes the network according to the specified channel and ID; then each ZigBee node is added to the network.

(2) Then, the ZigBee node sends the address information and the network information to the coordinator periodically. After receiving the information of the ZigBee node, the coordinator sends the collected data to the A10 hardware platform.

The Web Brower Design. The system is the JSP page running on the Web apache-tomcat-7.0.59 server, includes two modules: environment monitoring and lighting control of the house. The system uses Java EE classic MVC architecture, can effective separate of the interface and background logic. The use of Http protocol, JSON objects, Java tunnel

communication, and interaction with the network database, asynchronous request, data will be displayed to the user.

1) Program starting, preparing data. When loading the home page, will first determine whether the user is login or not, if not logged in, the interceptor will intercept part of the function, users can not view the current state of the whole house, and also gives information to remind the user login.

2) User login(login.jsp). The initialization page, the page includes two parts, login and about us, the page uses the JavaScript and jQuery technology, make the page more beautiful.

3）Homepage(index.jsp). Initialization the data, show the temperature, humidity, smoke and infrared information of the rooms according to the Ajax asynchronous request, when there is data beyond, it will give the corresponding alarm, the user can detect the alarm information and make processing seasonable.

4) Temperature/humidity query (temperature.jsp/humidity.jsp). Initialize the relevant controls, open a thread to connect the server data request. Select the appropriate controls, sends a request to the background, the data was returned to the foreground after the background deal with. Then the data will be converted into the form of a line chart in the page to display to the user, or give a prompt, access to data failure.

5）Lighting control(lamplight.jsp). Initialize the relevant controls, open a thread to connect the server data request. Select the appropriate controls, sends a request to the background, the data was returned to the foreground after the background deal with. Then the data will be converted into the form of a line chart in the page to display to the user, or give a prompt, access to data failure.

6）Setting page(setting.jsp). The settings page must be login first, divided into user settings and equipment settings, user settings can change your password, add the user and view the user information; device settings can set room information, serial port information, baud rate and so on.

System Test

Data Reception Test Results. The data can be seen sent from the A10 platform, the data stored in Hash Map, A10 platform as a transit station contains all the data sent by the sensor, as well as time.

As can be seen from the diagram, after a short period of testing, the database has a number of temperature/humidity, smoke and other records, indicating that the real-time record is good.

External Request Test. The control of the server postback the data correspond with after receive a request from the web browser to send data, at. The data will be sent in the form of JSON, including temperature, humidity, smog, lights status information snd so on. The data is sent back to the web browser program and is used to display to the user.

Test of the Web Page. Enter the account and password in the login page after successful login, the user can see the latest temperature and humidity, smoke concentration information on the right of the three rooms, on the left side of the page is the entrance of other operation.

Summary

Based on the research of the ZigBee technology and the RFID technology, this paper designed a SmartHome System Based on Internet of Things, the system mainly achieve the following functions:

1) Can monitor the environment information through temperature and humidity sensors, and can obtain relevant safety information through infrared sensors and smoke sensors of the house real-time, play a certain role of house security, when a emergency situations can be alarm real-time.

2) Can control the lights of a plurality of rooms in various ways in the remote, in the Lighting control page can control the lights by the switch manual; or set to automatic mode in the Setting page, this time will automatically control lighting according to indoor light intensity.

3) After the success of the networking, the ZigBee coordinator can uses the polling mode to receive data from the ZigBee nodes, and transfers the data to the A10 hardware platform.

4) The software design of the Reader module, can write the name, sex, and age information of the family members into the computer, then generate a serial number, and write the serial number into the RFID tags, So that can identify the identity of the family members when they want to access.

The actual operation shows that the system design scheme is practical and effective, and it has high practical value.

Acknowledgments

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