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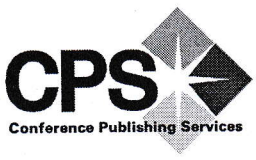

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Design and Implementation of Intelligent Kitchen System based on Internet of Things

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Abstract—**This paper proposes a kind of intelligent kitchen management system which integrates various technologies such as sensor, ZigBee, embedded, database, Web application, Android mobile development and so on. The paper introduces the system structure, system function, design plan and system implementation of the system. The system provides many ways to check, manage, control and monitor the kitchen information for users intelligently. It has good practicability and extensibility, and improves the intelligentized level of people's life.**

Keywords- Internet of things; Intelligent Kitchen, ZigBee, Remote Control

I. INTRODUCTION

With the development of the Internet of things technology, one of the most important features of the development of the information society is intellectualization. With the continuous improvement of people's living standards, the demand for the quality of life is gradually diversified. The kitchen is essential for every family. Therefore, the appearance of an intelligent kitchen will bring a new experience to people.

People gradually need a kitchen environment that can be closely connected with modern technology. With this demand, new concepts such as kitchen environment monitoring, intelligent kitchen control have come into our life.

Therefore, this paper proposes an intelligent kitchen system based on Internet of things technology. The intelligent kitchen system is based on digitalized information and network, combined with smart phones and various sensors to realize intelligent management of kitchens.

II. SYSTEM OVERALL DESIGN

The intelligent kitchen system is an intelligent management system of IOT based on the operation functions of information collection, processing, transmission and application. The intelligent kitchen system consists of four parts, The first is the information perception subsystem of the kitchen; the second is the network gateway system of the kitchen, which receives the information from the perception subsystem and transmits data to the server; the third is Web server which is used to store and process the kitchen information and to provide communication with the perception and mobile terminals. The last one is the mobile terminal subsystem, which realizes the remote control and check the information of the kitchen. The architecture of the system is shown in Figure 1.

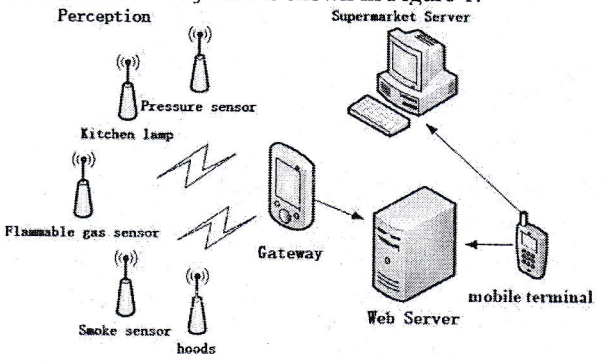

Figure 1. System Architecture Diagram

The information perception subsystem is composed of sensors and devices deployed in the kitchen, including smoke sensors, flammable gas sensors, pressure sensors to detect the state of the dressing, human detection sensors, light sensors, kitchen lamps, refrigerators, hoods and so on. Each sensor and device is a node of the ZigBee network. The ZigBee network is composed with these ZigBee nodes and ZigBee coordinator. The perception subsystem communicates with kitchen gateway through ZigBee coordinator at last.

The kitchen gateway is an embedded system, its hardware is based on the embedded microprocessor and communicates with the ZigBee coordinator through the serial port. It can receive the information of various sensors and devices in the kitchen in real time. At the same time, it communicates with the Web server through the WiFi.

The Web server can obtain all kinds of sensor information and execution state of the kitchen from the gateway, and store the information in the network database, and provide the interface to the gateway and mobile terminal, such as the interface of remote login verification, remote check and control and so on; and also can realize the information management of the user information, sensor and device information and so on.

The mobile terminal can communicate with the Web server as a client, and can check the kitchen status and remote control device in the kitchen remotely. The functions of each subsystem of the intelligent kitchen system are shown in Figure 2.

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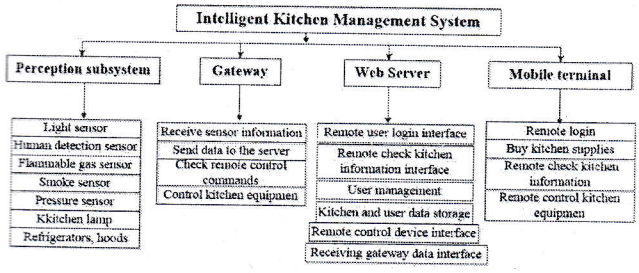

Figure 2. Functions of the System

III. TECHNICAL SCHEME

A. *Business Process*

The functional modules of the intelligent kitchen system based on the Internet of things are described as follows:

1) Intelligent management of kitchen supplies module

Solve the problem of lacking of dressing and forgetting to purchase. When the oil, sugar and some supplies is lack by detected by sensors in the kitchen, the information is sent to the host's mobile terminal, prompting the current status of the supplies, and giving hints for purchasing. After the user confirms, it will send the information to the supermarket to purchase the goods, so as to save the host's time and improve the efficient management of kitchen. The business process of this module is shown in Figure 3.

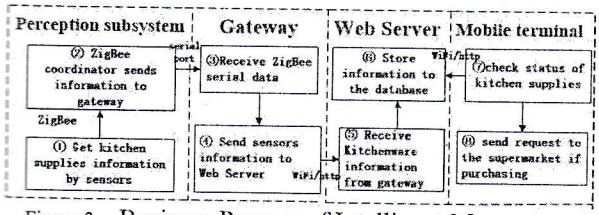

Figure 3. Business Process of Intelligent Management of Kitchenware

2) Saving energy for kitchen lighting module

Solve the problem of forgetting to turn off the lights and wasting electricity. If anyone enters the kitchen, it can be detected by sensors installed at the entrance of the kitchen, so that it will turn on or turn off the kitchen light switch intelligently.

3) Sensing gas module

Solve the problem of forgetting to turn off the gas valve. It can cut off the switch of gas valve intelligently by detecting the flammable gas by the sensors.

4) Remote control module

Users can monitor the state of various devices in the kitchen by mobile terminals. The kitchen devices can be operated regularly or manually. The business process of this module is shown in Figure 4.

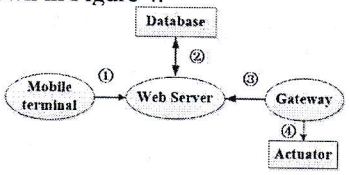

Figure 4. Business Process of Remote Control

(1)The mobile terminal sends remote control command requests to the Web server.

(2)The Web server changes the state of actuator stored in the database in response to the request of mobile terminal.

(3)The gateway sends the request of querying actuator state in real time.

(4)The gateway sends the control commands to the actuator.

B. *Hardware Design of Perception Subsystem*

In the perception subsystem, we gather all kinds of sensor information in the kitchen through the ZigBee network, and communicate with gateway through the ZigBee coordinator. The core chip of ZigBee coordinator and node is CC2530, the hardware circuits of ZigBee include power module, reset circuit, JTAG Unit, crystal circuit and so on. In the module of ZigBee end device, the CC2530 receives the sensor information through AD circuit and sends command to the actuator in order to control the devices of kitchen. The hardware design of perception subsystem is shown in Figure 5.

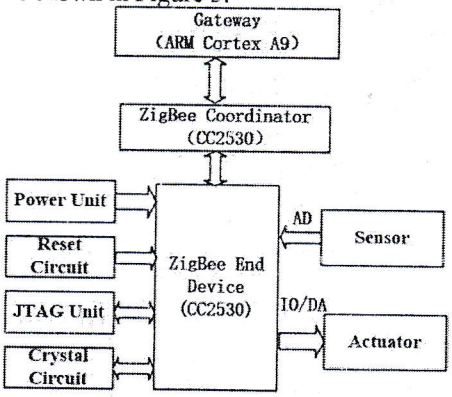

Figure 5. Hardware Structure of Perception Subsystem

C. *Software Design of ZigBee Coordinator*

In the perception subsystem, ZigBee network includes nodes and coordinator.

ZigBee coordinator is connected to the gateway through the serial port. The main functions of it are: initialing hardware chip and protocol stack; building the ZigBee network with sensors nodes and kitchen devices nodes; monitoring the ZigBee wireless signal and so on. If some routers or terminal nodes join the network, the coordinator distributes network address to them; receives data from end device nodes, and sends data to the gateway through the serial port; receives the control command from the gateway, analyses and recombines the control command, sends it to ZigBee end device control nodes, such as controlling the kitchen devices. The coordinator software flow chart is shown in figure 6.

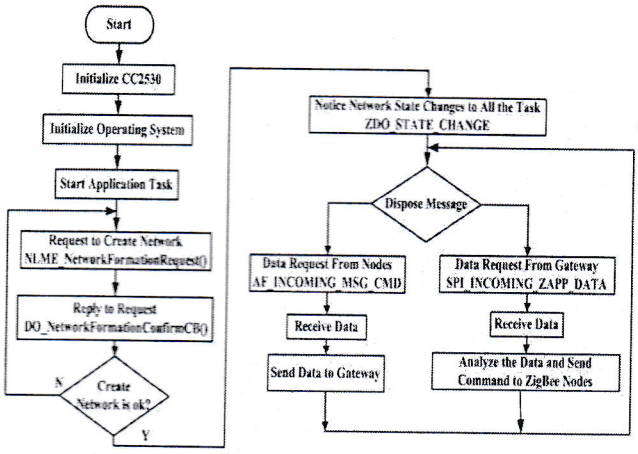

Figure 6. Coordinator Software Flow Chart

D. *Software Design of ZigBee End Device*

The main work of ZigBee end device node in th system is:

(1) Apply for adding to ZigBee network

(2) Communication with the ZigBee coordinator.

(3) Send kitchen sensors information to coordinator.

(4) Kitchen devices nodes receive the control commar sent by the coordinator.

The end device node software workflow is shown Figure 7.

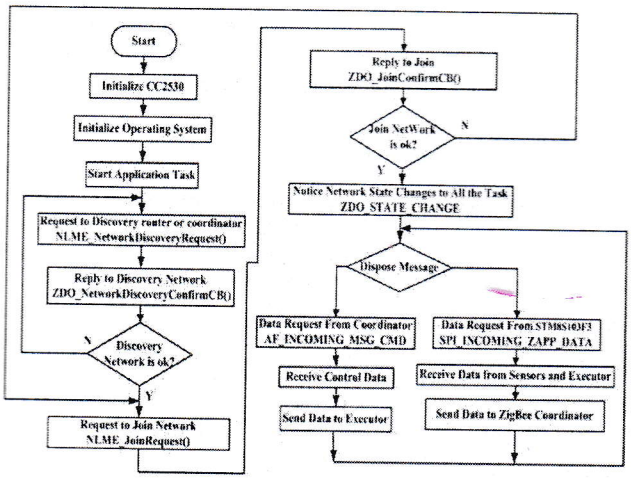

Figure 7. End Device Software Flow Chart

E. *Interface Design of Web Server*

The gateway subsystem of the intelligent kitchen syste should push the information obtained from the sensors the Web server, and the mobile terminal also needs request the Web server to obtain or transmit the informatic Gateways and mobile terminals send HTTP requests to tl interfaces set up by the Web server to the clients are shown in Table I.

Table I Web Server Interfaces

function	url	input	output
Login Validation	http://ServerIP:8080/Smartkitchen/ServSer/UserLoginVerificationServlet	user password	Administrator General user
Send data to Web Server	http://ServerIP:8080/Smartkitchen/Servlet/SetSensorInfoServlet	flammable gas smoke body detection ……	
Query data	http://ServerIP:8080/Smartkitchen/Servlet/GetSensorInfoServlet		flammable gas smoke body detection… …
Remote control	http:/ServerIP:8080/Smartkitchen/Servlet/SetExecuteServlet	device name device state	Success fail
Query device status	http://ServerIP:8080/Smartkitchen/Servlet/GetExecuteStatusServlet		device name device state

Note: the ServerIP in URL in Table I should be the specific IP address according to the actual deployment of the system.

IV. System Deployment

The system prototype is implemented according to the system design plan, and the software and hardware environment of each subsystem is configured as follows.

Perception subsystem: It uses CC2530 chips to acquire sensor information, each chip as ZigBee node and ZigBee coordinator forms a ZigBee network, it also integrates ZigBee protocol stack.

Gateway: ARM Cortex A9 microprocessor is the core of the hardware, and it is integrated with serial ports, WiFi and other communication interfaces. Android4.2 version operation system.

Web server: Intel core i5 is the CPU, the main frequency of the CPU is 2.3GHz, memory is 8GB; operating system is Win10, Web server is Tomcat9.0, JDK version is 1.8, database is MySQL5.7.

Mobile terminal: HUAWEI nova mobile, Android 7.0, memory is 3GB.

Gateway, Web server and mobile terminal are implemented using software. The operation interface is shown in Figure 8.

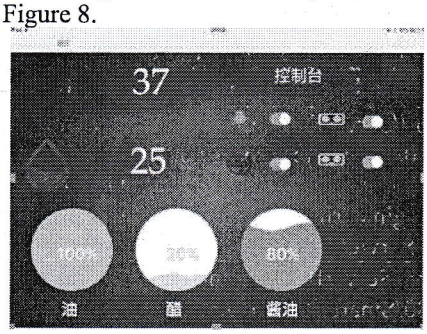

Figure 8. Interface of Mobile Terminal

By verification, the design of the intelligent kitchen system is basically reasonable, it can realize the basic intelligent management of the kitchen, and can be referred to be productized.

V. CONCLUSION

The intelligent kitchen system is based on the Internet of things technology, and combined with modern means for management. Using sensors, ZigBee, Web applications, mobile development and other technologies to manage and monitor the kitchen information, providing an effective intelligent management platform for people's home life. Through practice, it has proved that the system also needs to be improved, but the design scheme is basically reasonable. Based on the advantages of low cost, high reliability and good stability, the system has certain feasibility, and it can be predicted that its application will be have a certain development prospect.

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