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The Design and Implementation of Smart Baby Monitor System Based on ZigBee and GoAhead

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Abstract. This paper takes CC2530 chip as the core, presents the design and implementation process of wisdom baby monitor system based on ZigBee and GoAhead technology, the wireless sensor and control nodes takes CC2530F256 as core in this system, collected and controlled the baby environment data (temperature and humidity, light etc), to do some intelligent processing. At the same time takes GoAhead as the embedded Web technology, The system realized the remote controlling for the equipment in the baby room with relatively low cost, it can constantly adjust relevant parameters for a baby living environment, this also will be the future direction of the development of the Internet of things.

Introduction

The Internet of things (IOT) has been focused on by the whole society, since IBM corporation presents the concept of "Smart Earth"[1]. The rapid development of IOT has a profound and lasting influence on the field of the Health care. This raises a series of innovative design ideas for baby care, can monitor the surrounding environment using a variety of sensor[2], For example, the baby's body temperature, humidity, as well as the noise intensity changes, and through a feedback mechanism to provide real-time protection for the baby.

This paper introduces a kind of smart baby monitor system which is low cost, low power consumption and constructed based on the short distance wireless communication technology -ZigBee and embedded Web server technology-GoAhead.

Structure and Function of Smart Baby Room System

The aim of the system is to realize the intelligent management of the baby room, the system can improve the efficiency of baby room management and reduce the human resources investment and save energy. It is a typical IOT system based on B/S structure; it includes perception layer, network layer and application layer. In this system, CC2530 is used as the processing chip of the wireless sensor nodes and the coordinator, ZigBee technology is adopted in wireless communication, the gateway uses the Coretex-A8 processor and Linux operating system as the core, and uses GoAhead to build an embedded Web server [3].

Wireless information nodes installed in the baby room includes temperature and humidity, illumination; wireless implementation nodes includes light switch, air switch, curtain switch and projection switch and so on. The room lamps, air conditioner, curtains, projection can receive control command from control center. The brightness of the baby room lamps can be adjusted automatically according to light intensity, time, when the light is dark, lamps automatically light, when the light is strong, lamps and curtains are shut off automatically. If you find no one in the room, the switch can be remote control. All kinds of information and equipment status in the room can be watched through the mobile phones or other terminal equipments whenever and wherever possible in the network environment, and the management person has a certain authority can manage the room whenever and wherever. At the same time the parents can monitor the surrounding environment through the website, and the late information and so on will be transmitting to the attendance system real-time.

The structure of this system is shown in Figure 1. In this system, the network topology model of ZigBee is satellite. The ZigBee coordinator is the organizer of Zigbee network; it receives the wireless sensor nodes information and sends the information to the room gateway through the serial port. The GoAhead server transplanted in the gateway receives the user's request and disposes the information by the CGI program, and feeds back the processing information to control and display terminal.

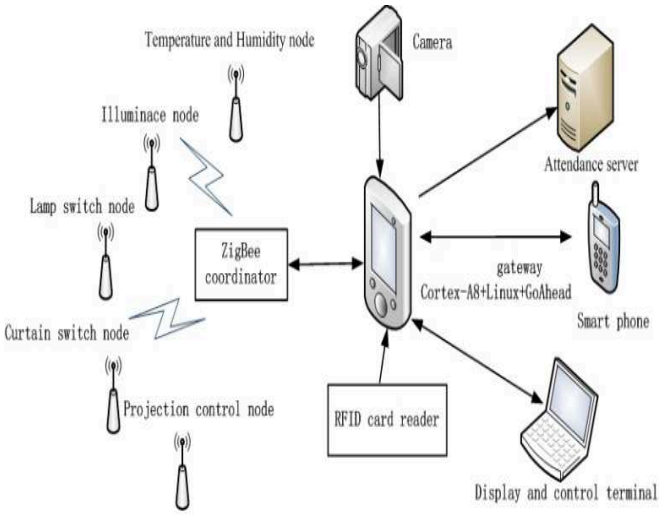

Fig 1. Structure of the System

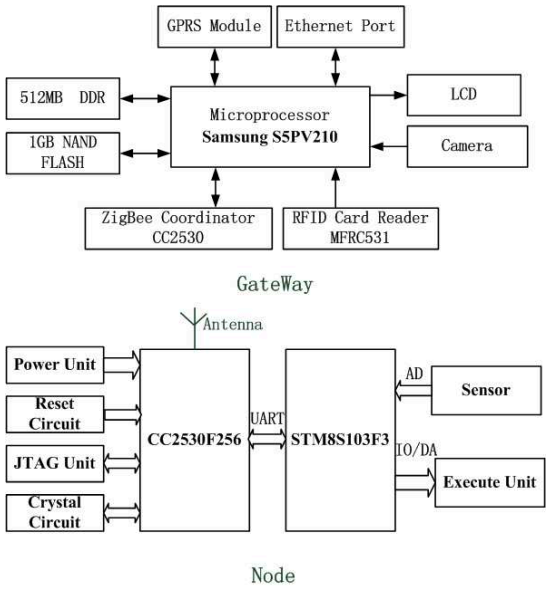

Fig 2.Hardware Structure of Gateway and Sensor Nodes

Hardware Design

The hardware design of the system includes room gateway design and ZigBee wireless sensor node design. The gateway is an exchange station. It is responsible for exchanging the information between wireless sensor nodes and attendance server, display and control terminals. All wireless nodes data, RFID data and camera data must be transmitted to the room gateway. The gateway receives the data, transforms the data, and sends the data to the display and control terminal by Internet or sends to smart phone by GPRS. At the same time, the display and control terminal sends the controlling command to the wireless nodes by Internet or GPRS [3].

The microprocessor of room gateway is Samsung S5PV210, the chip bases on the kernel of ARMCortexTM-A8, frequency is 1GHZ; peripheral resources include: 512MB memory, 1GB NAND Flash, 7 inch LCD touch screen, ZigBee transceiver; RFID card reader, the camera module and so on.

The system adopts CC2530 produced by TI corporation as the main chip in the ZigBee communication module. A 2.4GHz DSSS (Direct Sequence Spread Spectrum) RF transceiver based on IEEE802.15.4 and an industrial level low power, enhanced 8051 microprocessor core is integrated into a CC2530 single chip mainly[4]. CC2530 chip is power-saving, low-cost. Using CC2530 as ZigBee wireless communication module has a certain economic benefits in the smart room system.

CC2530 provides a complete ZigBee solution with combination of the Z-Stack. Wireless sensing and control nodes of the system uses the CC2530F256 as the core, includes wireless transceiver circuit, power module, debugging module, crystal oscillator circuit, reset circuit, information collection or control module. The information collection module sensor uses the STM8S103F3 chip as the micro processor. The sensing information converted by the AD is sent to CC2530 through the serial port. Hardware Structure of Gateway and Sensor Nodes is shown in figure 2.

Gateway Software Design

The development process of the gateway is: firstly loading boot program; secondly transplanting the embedded operating system; thirdly transplanting the root file system; fourthly transplanting the embedded Web server; and running CGI program; finally running the local GUI control application[5].

Loading the boot program. BootLoader is the first section of the program when the hardware is power on, it initializes the hardware devices, sets up the memory space images and prepares the environment for invoking the operating system kernel and user program.

Transplanting the root file system. The first file system loading by operating system kernel at startup is the root file system. Use the busybox software to generate the file system commands and tools, generate bin, sbin and user directories, and then create dev, etc, lib, proc, tmp, var, mnt, home subdirectories, prepare inittab, rcS, fstab, profile files in the etc directory. Then transmute all the files to rootfs.img with mkyaffs2image tool, finally download rootfs.img to the flash.

Transplanting the embedded Web server-GoAhead. The source package of GoAhead contains various operating system directories. They are CE, ECOS, LINUX, LYNX, MACOSX, NW, QNX4, VXWORKS, WIN respectively. The HTML files are stored in the Web directory. The CGI executable programs are stored in cgi-bin directory.

Transplanting the application of the gateway. The system gateway not only acts as a Web server but also is responsible for displaying variety of room information and controlling the executed devices in the LCD of the gateway. The GUI controlling program is implemented with Qt.

Coordinator Software Design

The ZigBee coordinator is connected to the room gateway through the serial port. It's tasks are: initialing CC2530F256 and protocol stack; building the ZigBee network with the temperature nodes and light intensity 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 terminal nodes, and transmits data to the room gateway through the serial port; receives the control information from the gateway, analyses and recombines the control data, sends it to ZigBee terminal control nodes, such as controlling the room lamps and curtains [6]. The coordinator software flow chart is shown in figure 3.

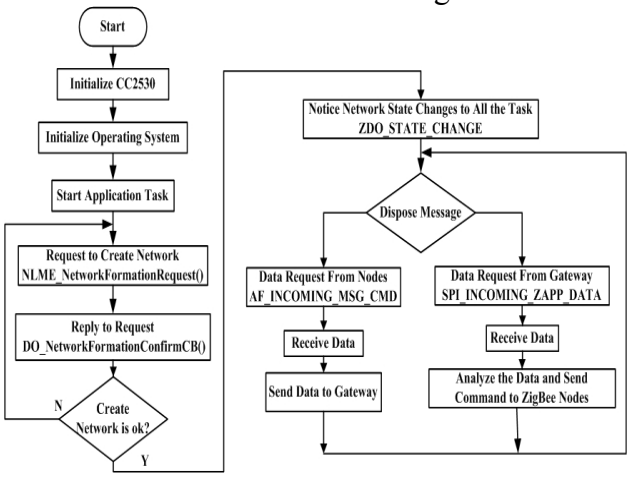

Fig 3. Coordinator Software Flow Chart

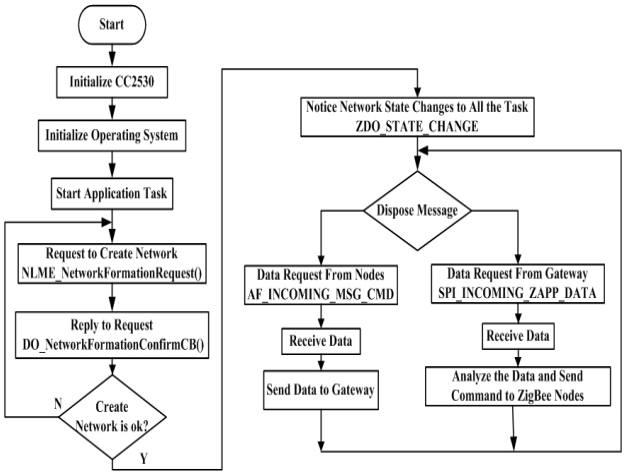

Fig 4. End Device Software Flow Chart

End Device Software Design

The ZigBee end devices main work is applying to join ZigBee network and communicating with ZigBee coordinator. Temperature and humidity, light intensity end devices are responsible for sending information to the coordinator. Lamps and curtains, projection switch controlling end devices are responsible for receiving the control command from the coordinator and feeding back switch state to the coordinator. The end devices software flow chart is shown in figure 4.

The Remote Control Interface Design

In the network environment, any display and control terminal can access gateway through the browser, the managers with relevant permissions can watch variety of information parameters of the class and control the equipment of room according to the actual condition. The display and control interface is shown in figure 5.

Fig 5. Display and Control Interface

Conclusion

In this paper, the low cost, low power wireless ZigBee technology and embedded Web server GoAhead are combined and apply in the smart room system. The system realizes the remote intelligent control to the room equipment through Internet. It improves the operational efficiency and system application flexibility by using the wireless sensor network instead of the traditional wired network, and at the same time reduces the manpower cost. It is proved that application of ZigBee wireless technology and GoAhead embedded Web server technology in the smart system has a certain feasibility through practice; it has high reliability and good stability. Based on the advantages of the low power consumption, high reliability, good stability[8], energy saving, It can be verified that the ZigBee and GoAhead technology will have broad prospects for development in the smart campus field.

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