

# A Smart Home Remote Control System Based on ARM and ZigBee

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**Abstract**—for making life more comfortable, safer and more intelligent, a system for remote monitoring of smart home is proposed based on ARM and ZigBee. This system not only can centralize and monitor family affairs by gathering computer technology, embedded technology, sensor technology, and network communication technology, but also can meet the pursuit of high quality life in the information age by collecting the security control, lighting control, multi-media entertainment, network connection and other functions. In this paper, we complete visualized operations using S3C2440 as the core control host computer. Internal network of smart home is constructed based on ZigBee technology. TCP/IP and GSM are adopted to be the external network of smart home finally. The experimental results show that this system is reliable and good mobility, can realize local and remote monitoring of smart home.

**Keywords**-smart home; ZigBee; s3c2440; remote control.

## I. INTRODUCTION

With the rapid development of economy and technology, people put forward higher requirements for their own life: high-tech, intelligent, human nature, etc. Smart home just meet the needs of people's life, it can improve the quality of people's life and change people's habits and customs gradually, bring new experience and feeling to the people's life at the same time which will become a trend in home life and the development direction of the future. But there are also some defects in the current smart home [1], the most important problem is the system of smart home is too complicated to operate and the capex is too high.

In order to realize the monitoring and control for the household equipment conveniently, we proposed a remote control system based on ARM and ZigBee. The system has the characteristics of high efficiency economy, easy operation and low power consumption. The ZigBee technology follow IEEE802, 15.4 specifications, which is suitable for the occasion at close range and low speed requirements, so it is very suitable for transmission control information between household equipment [2].

In section two, the paper will introduce the overall design of system. In section three, the paper will discuss the system hardware design. In section four, the paper will discuss the system software design. The conclusion is in the last section.

## II. THE OVERALL DESIGN OF SYSTEM

The system overall block diagram is shown in Fig. 1.

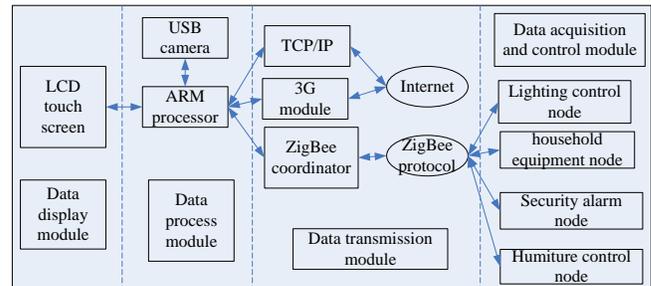


Figure 1. System overall block diagram

As Fig. 1 shown, the system consists of four modules.

### 1) Data acquisition and control module

This module mainly includes: the lighting control, home appliances control (television, air conditioners, refrigerators, washing machines, etc.), security alarm monitoring [3] (human body infrared monitoring, door magnetic detection, etc.), temperature and humidity detection, image monitoring, gas and smoke monitoring.

### 2) The data transmission module

Data transmission is mainly through three ways: ZigBee protocol, TCP/IP protocol and 3G protocol. The ZigBee protocol is used to set up the smart home internal network, all the home applications and monitoring node can connect with this ZigBee network. The latter two protocols is used to connect to the Internet, so the smart home can be watched by owner's smart phone through Internet in anytime and anywhere.

### 3) The data and image processing module

For image quality is not very high, and power consumption requirements for sensor must be very low, we choose the USB camera [4] for video surveillance. ARM processor need to process the received data and image, and also store some important data, so that the touch screen can display.

### 4) The data display module

LCD touch screen display the data that ARM has processed, and ZigBee terminal node can be controlled by touch screen, so touch screens are both output and input module.

The lighting control node need relay and ZigBee to connect from nodes (terminal nodes), and this node is in the accepted state, accepting instructions from higher level to control the light. Security alarm node detects combustible gas leaks and thieves invasion, it consists of the combustible gas detection module and pyroelectric infrared sensor. When thieves invade or combustible gas exceeds the set threshold, the security alarm module immediately transmit the information to the data processing module, then the system will inform the user through the WeChat or text message, and trigger the buzzer and camera , to record the scene when thieves invade. It's convenient to view later. Temperature and humidity nodes transfer data that has monitored to the master node continually; it will turn on the air conditioning when the temperature and humidity is more than the set point. We can adjust indoor light intensity through the touch screen to build a recreational atmosphere when we are watching TV. We can also set the work time of the kitchen appliances through LCD touch screen and see their work state, that it can get meals when we are not in the kitchen.

### III. THE SYSTEM HARDWARE DESIGN

#### A. ZigBee node hardware design

ZigBee terminal nodes are the most basic link in the whole system, including the function of data acquisition and control the household devices. Because this system is the only information acquisition and control of short distance and all terminal nodes do only need to communicate with the coordinator node, we selected star topology to deploy the ZigBee network. The system terminal node chooses half functional equipment (RFD), the coordinator chooses full functional equipment (FFD) [5]. In order to reduce cost, we selects CC2530 to implement ZigBee node, which includes RF transceiver, enhanced 8051 MCU, the programmable flash memory, 8kb RAM. CC2530 has different operating mode, making it adapt to the low power requirements system especially.

ZigBee master-slave node design is roughly same, the master node interacts with the ARM processor, and the slave node not only interacts with the master node, but also is responsible for data acquisition and equipment control. ZigBee node basic hardware block diagram is shown in Fig .2.

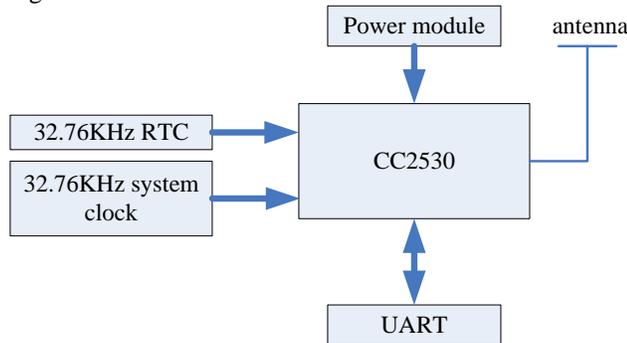


Figure 2. ZigBee node block diagram

#### B. The ARM controller hardware design

ARM controller is the core of this system, it need to process data come from ZigBee coordinator, USB camera and touch screen, and add some data to store. Considering the demand for processing power, we select S3C2440 to implement controller. This processor uses ARM920T kernel, its maximum working frequency is 400 MHZ, which supports Linux, WinCE operating system, external memory controller, three UARTs, camera interface, touch screen interface. The hardware structure is shown in Fig .3.

The LCD screen chooses 3.5 inch resistive touch screens. Touch screen not only display indoor temperature and humidity, light switch, security alarms, cameras and all home appliances, but also can control their working status.

In order to remote control smart home, the system needs access to the internet. We use DM9000 to implement Ethernet interface, and SIM5320 to implement 3G module. When the TCP/IP network is down, the system will automatically switch to the 3G network.

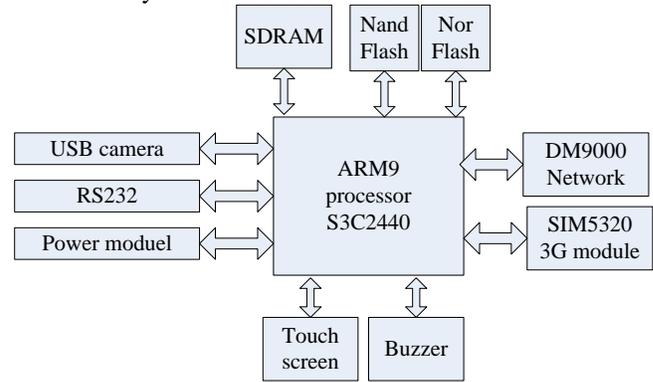


Figure 3. ARM processor block diagram

### IV. THE SYSTEM SOFTWARE DESIGN

The system software design includes two parts: ZigBee node software design and the S3C2440 software design, ZigBee software design uses Z-Stack software architecture, which is based on a polling system. The S3C2440 embedded software is an application based on Linux operating system and Qt human-computer interaction interface.

#### A. ZigBee node software design

ZigBee master node is responsible for establishing the network and accepting data from child node and sending the data to the ARM. ZigBee child node is responsible for the collection of data in time and the control of all indoor devices.

ZigBee protocol architecture is the physical layer(PHL), the media access control (MAC), network layer and application layer from bottom to top respectively. Z-Stack protocol Stack[6] defines how to work coordinate with different layer, ZigBee software flow diagram is shown in Fig .4.

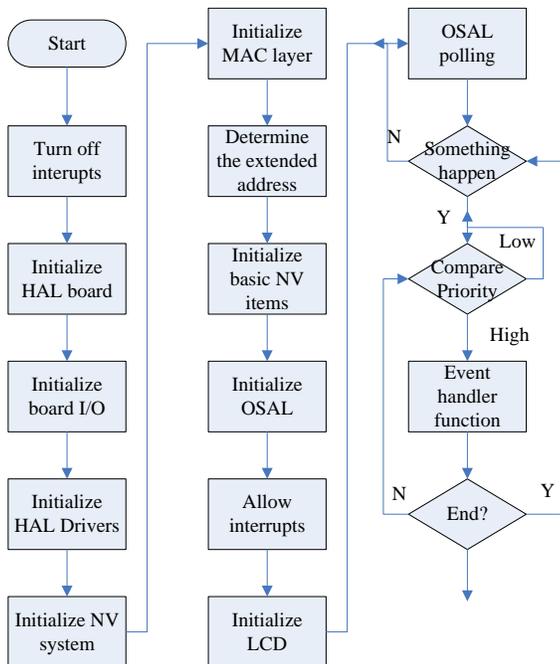


Figure 4. ZigBee software flow chart

### B. S3C2440 software design

Embedded system chooses the Linux kernel[7] of 2.6.36 version, it is used in the S3C2440 platform after the standard Linux operating system has cut and configured according to the corresponding need, which can provide operating system service for application software under embedded. The application will check the network when the Linux OS is startup. If the Ethernet is online, the application will move to the next step, otherwise the application will activate the 3G module to transmit the smart home information. The LCD touch screen that man-machine interface needed is compiled by Qt, and Qt is a cross-platform GUI system based on C++, which can realize the powerful function of the user interface design [8].

Using the Qt interface to display the states of lamp switch, household appliances, security alarm, temperature and humidity, cameras, and kitchen appliances, and their work states can be controlled, thus it is not only convenient to control, but also can reduce power consumption and save energy.

ARM software process is shown in Fig .5.

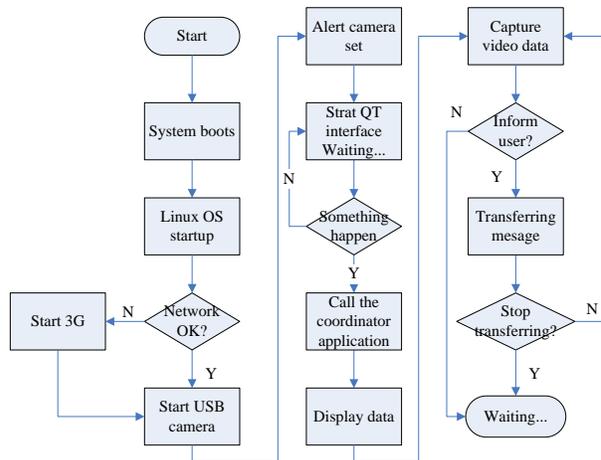


Figure 5. S3C2440 software flow chart

## V. THE EXPERIMENTAL RESULTS

The comprehensive experiment and debugging have done after the completion of the system hardware and software design under laboratory conditions. The system consists of a controller, a USB camera, a ZigBee msater node and three ZigBee slave node modules, which are made of star network ,the open of light is controlled by first slave node, the second slave node control temperature and humidity indoor, the third slave node is the alarm of the human body infrared alarm. First of all, the master node set up network, secondly, the slave node join the network, and then test. The first node to open the lights quickly, the temperature and humidity sensor of the second node selected integrated precision for 0.3 °C, which can meet the requirements. The third infrared alarm node respond within 3m, and the middle slave node test stability within the 20min. USB camera is 300000 pixels, which ask light when taking pictures, but you can see the pictures of human faces, which meet the requirements. Although the system overall debugging achieve the desired effect, there is still room for optimization.

The QT interface is shown in Fig .6 and the system picture is shown in Fig .7:

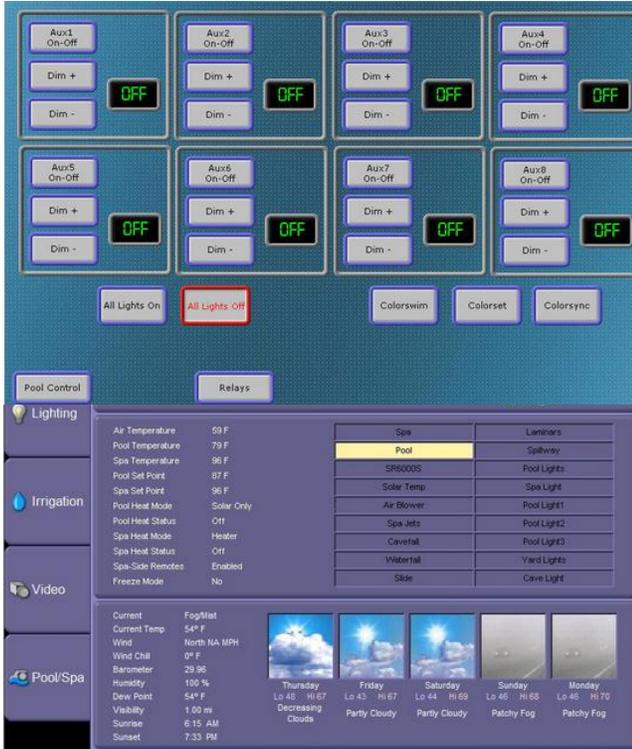


Figure 6. Qt interface figure



Figure 7. Practical system picture

## VI. CONCLUSION

The remote smart home control system is designed, mainly using the ARM and ZigBee technology to achieve the purpose of the smart home, safety, portable, and this system provides reference for the popularization of smart home later, it is believed that most of the families will use such convenient system in the near future, and this system will play a role under the intelligent household broad prospects.

## ACKNOWLEDGEMENTS

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