



Using ZigBee and RFID technology with GPRS to development of smart home system

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ABSTRACT

ZigBee technology is a kind of wireless technology with short distance, low complexity, low power consumption, low data rate, low cost and wireless network technology. Smart Home system consists of the system server, the family controller (modules), the composition of routers, switches, communication device, controller, wireless transceiver, all kinds of detectors, sensors, actuators and other major parts. The paper proposes using ZigBee and RFID technology with GPRS to development of smart home system. Smart home system uses RFID and ZigBee technology to complete the lighting control systems, gas leak, fingerprint identification system. Experiments show that this method has very good effect.

Keywords: ZigBee, RFID, Smart Home, GPRS.

INTRODUCTION

Large Smart Home Control System usually consists of system server, Family Controller (various modules), a variety of routers, switches, communications, controller, wireless transceiver, a variety of detectors, various sensors, actuators, printers and other major components. Generally smart home system functions include the following three aspects: lighting control traditional mechanical light switches from light to dark-mounted mounted, its development but the shape changes in the structure, which features a single inconvenient to use. So there is a dimmer switch, single and multi-channel infrared switch, wireless switch, but these various electronic switches has its own limitations, can not replace the traditional mechanical switches.

This article combines smart home networking and related technology, sensors, controllers and other devices through wireless technology to connect and collect data information processing, using a sensor to collect indoor temperature, light and other data in the embedded terminal for information read and processed, and make the appropriate action. The whole process involves ZigBee-based wireless sensor network and GPRS mobile communications modules of the application.

ZigBee technology is a kind of wireless technology with short distance, low complexity, low power consumption, low data rate, low cost and wireless network technology, mainly suitable for carrying less data traffic service, can be embedded in a variety of devices, and supports for the geographical location [1]. Compared with the various existing wireless communications technology, ZigBee technology is the lowest power consumption and cost is also a big hot spot in the embedded application at present.

RFID radio frequency identification is a kind of automatic recognition technology of non-contact, RF signal through its automatic target recognition and access to relevant data, identify the work without human intervention, it can work in various environments. RFID technology can identify the moving objects and can also identify multiple tags; the operation is fast and convenient.

GPRS is the general packet radio service (General Packet Radio Service) for short; it is a mobile data service available on the GSM mobile phone users. GPRS can be said to be a continuation of the GSM. GPRS and the past continuous in the channel transmission in different ways, is the packet (Packet) to the transmission, so the burden the cost is calculated based on the data transmission unit, not using its entire channel, theory relatively cheap. The transmission rate of GPRS can be increased to 56 or even 114Kbps. Smart Home is a system and a process. It is the use of advanced network communication technology, electrical automation technology, computer technology, wireless technology, and home life on a variety of devices together organically, through a network of integrated management, so that home life easier. Smart home not only has the traditional residential function, but are no longer passive, intelligent initiative is a tool that provides a full range of information exchange functions, optimizing our lifestyle and living environment. The paper proposes using ZigBee and RFID technology with GPRS to development of smart home system.

2. Development of smart home system based on ZigBee technology with GPRS

This paper describes the three basic functions of intelligent home furnishing system has: lighting control, home appliance control, security alarm function. This chapter is consistent with intelligent home furnishing system requirements for the intelligent home furnishing system based on GSM network has carried on the demand analysis the basic functions required to achieve the design to determine the. On the basis of the demand analysis, the overall design scheme of network home furnishing system based on GSM.

ZigBee technology is a new sensor network a network, security and application software, known as IEEE802.15.4 technology standardization in the standard, the IEEE802.15.4 working group is mainly responsible for the development of physical layer and MAC layer protocol, the protocol reference and use existing standard, high-level application, testing and marketing etc. the work will be responsible for the ZigBee alliance. Two-way wireless communication technology has the advantages of simple structure, low power consumption, low data rate, low cost and high reliability, which is suitable for the field of automatic control, can be embedded in various devices, and supports for the geographical location. The complete ZigBee protocol suite consists of high-level application layer, application convergence layer, network layer, data link layer and physical layer.

ZigBee technology has powerful networking equipment; it supports the star structure, network structure and tree structure of three kinds of self-organizing wireless network type [2]. Especially the network structure, it has the reliability of network robustness, strong. This design is the tree structure to expand the communication area, as is shown by equation 1.

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} d_1 \\ d_2 \end{pmatrix} \quad (1)$$

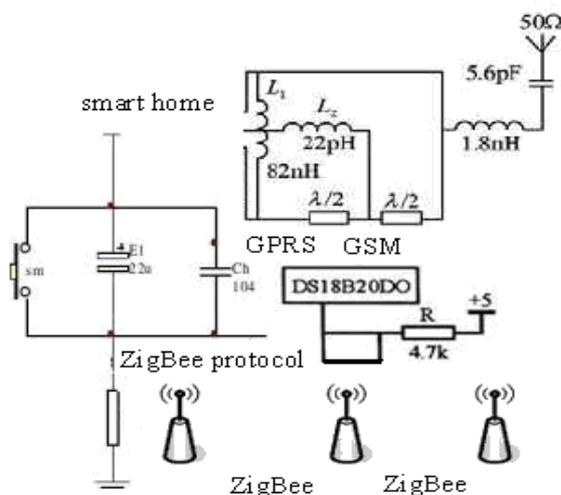


Fig. 1. Development of smart home system based on ZigBee technology with GPRS

The system through the sensor data collected by the ZigBee, wireless transmission module to the node controller, and then by the infrared emission chip IR6721C for household electrical appliance control signal, can be completed within the family control and GPRS remote control; the use of serial communication connect wireless data transmission chip ZigBee network module, ZigBee network module is the UART interface half-duplex wireless

transmission module.

The software design of each module of the intelligent home furnishing system based on GSM network, GSM communication module and MCU is mainly through the serial port to send AT commands to GSM module, short message or control of the GSM short message sending module reads the GSM module to accept. Communication of the single-chip microcomputer and the fingerprint identification module is an instruction set way of controlling the fingerprint identification module, fingerprint recognition input, search.

CC2431 is a system with hardware location engine on-chip (SoC) solutions, integrated positioning engine based on RSSI, can satisfy the need of application of low power ZigBee/IEEE802.15.4 wireless sensor network. According to the requirement of processing ability of the MCU protocol stack, network and application software execution, CC2431 includes an enhanced industry standard of 8 8051 microcontroller core, runs at a clock rate of 32MHz. The CC2431 also contains a DMA controller, it can be used to reduce the 8051 microcontroller core of data transferring, thus improves the performance of the whole chip.

The system uses wireless sensor network based on ZigBee technology to realize data acquisition and transmission [3]. Sensor nodes by artificial arrangement or plane points and mode distribution in the monitoring region, through the form of wireless multi-hop networks, in the collection of environmental data, can be directly or indirectly through the router will environment upload data to the central control node, the central control node of the environmental data to the monitoring center computer environmental data analysis, storage and early warning through the serial port.

$$\begin{aligned} \hat{X}(k|k-1) &= X(k) - \hat{X}(k|k-1) \\ \hat{X}(k|k) &= X(k) - \hat{X}(k|k) \end{aligned} \quad (2)$$

The embedded server terminal hardware module mainly has the center controller, GPRS module and ZigBee module. The central controller is a single-chip, single-chip microcomputer as the core components of the system, it besides the period with MCU minimum system, the serial communication circuit and the MC703 through the RS232 module, MCU P0 port and the P1 port is connected with the display, keyboard. The connection of various control and sensor with P2 interface. GPRS module MC703 module, this module has one serial port, baud rate is 115200bps, by the way of serial port, and this module can communicate with single chip microcomputer.

The nodes of wireless sensor network are composed of four main modules: sensor module (sensor, signal adjusting, A/D converter), the processor module (microprocessor, memory), wireless transceiver module (wireless network, MAC, transceiver) and power supply module (power supply, AD-DC). In addition, also can choose other additional functions, such as positioning module, device module. Wireless sensor network node is the realization mechanism of serial communication module based on ZigBee transmission module to replace the traditional, the information data collected by wireless mode accurately send out.

Zigbee message consists of 127 bytes, it mainly includes the following parts: MAC header: the header contains the current message is transmitted to the source address and destination address [4]. If the message is routed, the address may not be the actual address, produce and use the header for the application code is NWK header: the header transparent the message contains the actual source address and destination address, and the use of APS header is transparent to the application code: the header contains the configuration of ID, the destination terminal clusters of ID and the current message. Similarly, produce and use header is transparent. Payload: this field contains the application layer Zigbee protocol frame.

Meter reading to the residents of the area, the meter reading terminal usually with dense distribution, distance, the ZigBee technology can meet these requirements; centralized meter reading management center terminal data needs to be sent to the electric company, this can be achieved by using GPRS / CDMA network, and no distance limit, and no need of network planning, almost do not need maintenance. In addition, the construction of the ZigBee network can be a star topology, can also be a mesh network topology, however, no matter what kind of topological structure of the Zig-Bee network, can according to the actual network structure network need to design reasonable.

ZigBee work at a lower rate of 20 ~ 250kb/s, respectively 250kb/s (2.4GHz), 40kb/s (915MHz) and 20kb/s (868MHz) of the original data throughput rate, to meet the application requirement of low rate of data transmission. Between the transmission range is generally between 10 ~ 100m, the increased RF emission power, can be increased to 1 ~ 3km. This refers to the distance between neighboring nodes. If the routing and communication between the

nodes of the relay, and it is that transmission distance will be longer. The ZigBee response speed fast, generally from the sleep into the working state of only 15ms, nodes are connected into the network only needs 30ms, further saving electric energy. Compared to 3 ~ 10s, Bluetooth, WiFi need 3s.

$$w_b^B = J_M w_b = \begin{bmatrix} w_{b,M} \\ w_{b,M-1} \\ \vdots \\ w_{b,1} \end{bmatrix} \quad (3)$$

Digital home control system can make people can phone at any time, any place on the home of any electrical appliances (air conditioning, water heaters, rice cookers, lighting, sound, DVD recorders) for remote control; You can also commute advance to home air conditioning open, so that hot water heater burned in advance, cooked fragrant rice cooker; and all this is achieved are simply playing a simple phone call. Short Message Service is a GSM system provides GSM terminal (mobile phones) between the through service centers (service center) for text messaging application services, including service center complete information storage and forwarding.

Zigbee wireless network formation, first of all, the Zigbee coordinator is to establish a new Zigbee network [5]. A start, Zigbee coordinator will allow the channel to search other Zigbee Coordinator. And based on each channel to allow the passage of the detected energy and network number, select only 16 PAN ID, to build their own networks. Once a new network is created, Zigbee routers and terminal devices can be added to the network.

Wireless communication has the bidirectional data transmission function, using GSM short information system has stable performance, provides a powerful platform for communication of remote data transmission and monitoring equipment. Taking GSM as wireless data communication network, it can be applied in the bank, savings little room monitoring, telecommunication equipment room power and environment monitoring, communication industry remote unattended station computer monitoring and remote maintenance (such as mobile communication base station, microwave station, optical fiber relay station) and other unmanned point (such as warehouse, office buildings and so city public utilities) monitoring and real-time monitoring and maintenance system as the gas pressure regulating station, water supply, sewage pipes and heating system, power system in the city power grid situation.

The sensor node is the system data source, which is mainly composed of humidity, temperature, soot and other multi-channel sensor acquisition module, and it is signal conditioning module and wireless transceiver module model the transmission of the control command responsible for various environment parameters acquisition and uploads the monitoring region and the receiving environment monitoring center. In order to meet the needs of outdoor unattended, design can use battery power supply mode, the central control node is responsible for starting the whole network nodes and maintenance, collection of environmental parameters of the wireless sensor network to upload, and transmitted to the monitoring center computer through serial port, serial port interrupt reception at the same time to listen, to control instruction, to send mode sensor nodes so, can be extended using RS232 serial port in the central control node hardware platform.

Continue to use the CC2420 CC2430 chip architecture to achieve a system on chip (SoC) solutions. It can meet the ZigBee-based 2.4 GHz ISM band applications for low cost, low power requirements, integrated on a single chip ZigBee radio frequency (RF) front-end, memory and microcontroller. It uses an 8 MCU (8051), with 32/64/128 KB programmable flash memory and 8 KB of RAM, also includes analog / digital converter (ADC), several timers (Timer), AES128 coprocessor Watchdog timer (WatchDog Timer), 32 kHz crystal oscillator Sleep mode timer, power-on reset circuit (Power On Reset), brown-out detection circuit (Brown Out Detection) and 21 programmable I / O pin.

Using GSM short message system for wireless communication is two-way data transmission function, stable performance, provides a powerful platform for communication of remote data transmission and monitoring equipment. Taking GSM as wireless data communication network, it can be applied in the bank, savings little room monitoring, telecommunication equipment room power and environment monitoring, communication industry remote unattended station monitoring and remote maintenance (such as mobile communication base station, microwave station, optical fiber relay station) and other unmanned point (such as warehouse, office building city public utilities etc.) monitoring and real-time monitoring and maintenance system as power station, water supply, sewage pipes and heating system, power system in the city.

Taking ARM6410 as the control core, transmitting and processing of remote data by GPRS, using 6410 serial data communication with the GPRS, the internal data information is sent to the owner of the house home away from the mobile phone, and can be through the master mobile phone sends control information control room appliances, as is shown by equation4.

$$\begin{cases} w_{j,\min}^{\xi}(m,n) = \frac{1}{2} - \frac{1}{2} \left[\frac{1 - M_{j,AB}^{\xi}(m,n)}{1 - T} \right] \\ w_{j,\max}^{\xi}(m,n) = 1 - w_{j,\min}^{\xi}(m,n) \end{cases} \quad (4)$$

The hardware node design coordination of ZigBee, the composition of the node by wireless transceiver CC2430, RF antenna RF, power supply module, crystal oscillator circuit and the serial port circuit. Input / output RF is high impedance and differential, differential RF port for the appropriate load is $(115 + j180)$ [6]. When using the unbalanced antenna (such as the monopole antenna), in order to optimize the performance, should use not balance transformer. Doesn't balance transformer can be run in separate inductors and capacitors with low cost? Power module for power supply of CC2430 digital I / O and I / O simulation, the power supply voltage is 2 ~ 3.6 V.

3. Application of RFID Technology in Building Smart Home System

RFID electronic tag is a breakthrough technology: the first, very specific objects can identify individual, not like a bar code that can only identify a class object; second, which uses radio frequency, through the external material to read data, and bar code must rely on laser to read the information; third, at the same time to understand multiple objects, and can only be a bar code reading. In addition, the amount of information storage is also very large.

RFID technology is a non-contact automatic identification technology, it through space coupling (alternating magnetic or electromagnetic fields) automatic target recognition and access to relevant data, to identify work without human intervention. As a wireless version of the bar code, RFID technology has a barcode do not have waterproof, anti-magnetic, high temperature, reading distance, can simultaneously handle multiple labels, the label on the data can be encrypted, data storage capacity greater freedom to store information such as changes Features [7].

$$S_t = \frac{1}{M} \sum_{i=1}^M \tilde{x}_i \tilde{x}_i^T = \frac{1}{M} \Phi_t \Phi_t^T \quad (5)$$

Home automation is no longer a passive building, on the contrary, became to help the owner make the best use of time tools to make home more comfortable, safe, efficient and energy saving. Network smart home system can provide you with remote control, home appliances (air conditioning, water heaters, etc.) control, lighting control, indoor and outdoor remote control, curtain automation, burglar alarm, telephone remote control, programmable timing control and computer control and many other features and tools make life more comfortable, convenient and secure.

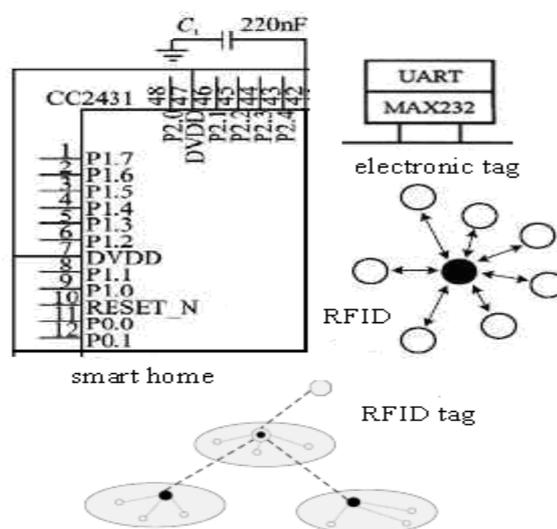


Fig. 2. The design of using FPGA in High-speed CMOS Color Recognition System

RFID systems based on sensor networks and context-aware RFID system that integrates the RFID tags and wireless sensor network technology for context-sensitive events [8]. Context-aware active RFID systems is the ability to automatically obtain an RFID tag integrated system events, context-aware RFID system is aimed at the identification information environment can identify and use of resources.

Phone module is mainly used to create a wireless GSM channel, receive and send short messages. SCM system is used to control the phone module, and the received short message information to interpret and execute short message format contains emitted from the Internet platform short message. The system uses the communication cable connection. IR learning remote vision for air conditioning, TV and other needs only infrared remote control infrared control home appliances category AC power alone can not make it into the working state. Therefore proposed to use the infrared remote control for the air conditioning and other electrical infrared control scheme, the system has the IR learning function can be realized on the effective control of these appliances.

Wireless transceiver module is built on the wireless transceiver chip SMARTI base transceiver consists of a differential receiver circuit, non-metastatic modulation loop transmitter, RF PLL, and IF synthesizers, external transceiver antenna. Power supply module is to power the system. TC35i GSM engine is required DC voltage 3.3-4.4V, the maximum current is 2A (standby current is very small, typically 3mA, but the transmission of voice, SMS modem driver when a large current, the power must be applied, the rated current of at least 2A). FLASH memory stores various operational instructions, data and control information, data is not lost down.

The system uses various means to achieve centralized control device. Concentration of each device is the first device on the infrared remote control signals to identify and store, and then restored when necessary to control the corresponding device operation. Constituted by the microcontroller centralized controller, it is self-learning and restores the core part of the infrared receiver demodulation circuit or in part by the CX20106 integrated infrared receiver components, infrared LED emission part has an extremely driven parts. Typically, the infrared remote controller in the remote control signal modulated on a carrier of 38KHz, amplified by a buffer to the infrared light-emitting diode, into the infrared signal emitted. Binary pulse code in many forms and it is of which the most common is the PWM code (pulse width modulation code) and PPM code (pulse position modulation code).

RFID frequency by application is divided into different frequency (LF), High Frequency (HF), Ultra High Frequency (UHF), microwave (MW), the representation of the corresponding frequencies were: LF 135KHz less high frequency 13.56MHz, ultra-HF 860M ~ 960MHz, microwave 2.4G, 5.8G RFID divided according to the way of supplying energy passive RFID, active RFID, and semi-active RFID. Passive RFID reader from the past, low prices; active RFID reader can provide further distance, but SRR110U UHF UHF Desktop Reader requires a battery-powered, cost is higher, suitable for remote reading and writing applications.

Mobile terminal includes an RFID tag; you can run JAVA mobile payment software for mobile phones and can read RFID, POS machines. Where RFID cards and RFID POS machine is RFID subsystem [9]. RFID POS machine through RFID technology to read the user information and the use of PSTN, GPRS, etc. and mobile payment platform linked. JAVA mobile phone users use mobile payment software via GPRS network and mobile payment platform for interactive information to complete the payment.

Smart Home is a house as a platform, the use of integrated wiring technology, network communication technology, security technology, and automatic control technology, audio and video technology to home life-related equipment to form an integrated smart home system living environment. Things smart home smart home management system through a device is to achieve home security, comfort, and information exchange and communication capabilities.

4. Using ZigBee and RFID technology with GPRS to development of smart home system

Smart home system mainly consists of three parts: a sensor node WSN networks, embedded server terminal, GPRS communication module and other devices. Wherein the sensor node network includes a plurality of wireless sensor nodes, each node is coupled by a sensor module of a ZigBee communication module. Sensors for real-time detection, the detected data transmitted via ZigBee communication module control node, the node control processing the collected information, and make the appropriate operation processing. Mobile terminal can be remotely via GPRS network connected to the embedded server terminal center console, center console handle connections, through ZigBee module sends information to the appropriate processing ZigBee module, the node consoles receive command with an appropriate treatment.

RFID tag stores a unique code, usually 64bits, 96bits or even higher, much higher than its address space bar can provide space, so you can achieve single-grade goods coding. When the RFID tag reader into the active region, can be based on inductive coupling principle (within range of the near field) or electromagnetic backscatter coupling

principle (within range of the far-field) induced in the tag antenna potential difference across and the label weak current path is formed in the chip, if the current intensity exceeds a threshold value, it will activate the RFID tag circuit chip, and thus the memory chip of the tag read / write operation, the microcontroller can be further added, such as a password or anti-collision algorithm and other complex functions..

The system also has good scalability and can be easily according to the specific requirements of the data acquisition module on the expansion of the corresponding sensor data collection in order to accomplish specific needs. Zigbee wireless sensor networks because of its flexible networking node low power consumption and other powerful features can be automatically restored, its application in the smart home will be more extensive.

Users need a remote control curtain switch, as long as the specified command using a mobile phone to send text messages via GPRS module receives and short message translated into commands can be identified to the family transmission controller, the controller has been treated by the ZigBee module wireless transmission sends commands to the motor and the curtains are connected to the controller, the controller controls the realization of the curtain..

$$REDUCE(I)[i, j] = \sum_{m=1}^5 \sum_{n=1}^5 w(m, n) I[2i + m, 2j + n] \quad (6)$$

We need to switch the TV remote control, as long as the specified command using a mobile phone to send text messages via GPRS module receives and short message translated into commands can be identified to the family transmission controller, the controller has been treated by the ZigBee module wireless transmission to send commands to the TV connected to the controller, the controller implements control of the TV. We need to switch the remote control air humidifier, as long as the specified command using a mobile phone to send text messages via GPRS module receives and short message translated into commands can be identified to the family transmission controller, the controller has been treated by the ZigBee wireless transmission module to send commands to the air humidifier connected controller, the controller implements the control of the air humidifier.

The power supply is integrated RFID AFE interior, away from the current analysis seems dangerous. Figure 3 shows the test RFID schematic contact method: by the RFID antenna and connected in series directly across the load resistor divider AC signal in accordance with the specifications, RFID load feedback signal may be a hundred times the signal strength of the wireless mode directly on top of the loaded AC signal. Changes due to the chip power and load modulation is essentially the same, so if the AFE improper power supply design, RFID micro processing execution state may be different from the internal processing at both ends of the series resistance of the AC signal is reflected.

Smart home system in a variety of family-related communication and information equipment, household appliances and home security devices, through the family bus technology to connect to a home intelligent system for centralized or remote monitoring, control and management of family affairs and maintain these facilities and residential environment of harmony and coordination. These features are intelligent home system via a home network controller is not achieved, the family has a home network controller bus system, through the family bus system offers a variety of services, and housing outside of all connected with the outside world. It can be said, smart home system is a smart residential core. Thus, it is the smart home system in the smart house in an important position. The system design chose the first platform, there are three main modules: the sensor node WSN ZigBee module, embedded server terminal module, GPRS communication module and RFID devices.

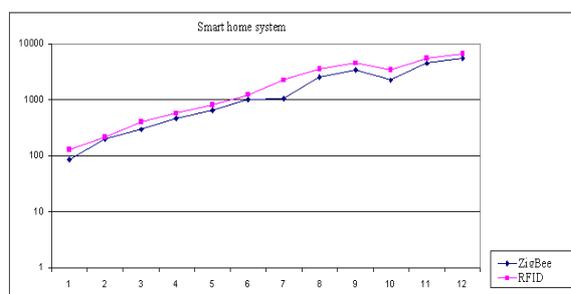


Fig. 3. Comparison results of development of smart home system with GPRS by ZigBee with RFID

This paper takes ZigBee as the wireless communication mainly, study on the technology development and application in home furnishing industry aspect is advanced and practical. Through the GSM network to realize

mobile phone terminal and intelligent home furnishing long-distance two-way communication system, breaks through the traditional wired distance constraints, to achieve remote receiving, sending messages, and has a modular program and high scalability, high degree of intelligence. Smart home furnishing system is embedded control terminal system, ZigBee wireless sensor network and GPRS communication. It is good to improve the home furnishing environment, it also contains audio and video entertainment functions, meet the entertainment needs of the family.

A complete RFID system, by the electronic tag reader and also is the three part of the transponder and the application software system called the composition, the working principle is radio wave energy to the Transponder Reader to launch a specific frequency, is used to drive the Transponder circuit will internal data is sent, the Reader will sequentially receive interpretation data for the application, and make corresponding treatment.

CONCLUSION

Smart home system uses RFID and ZigBee technology to complete the lighting control systems, gas leak, fingerprint identification system test, the successful completion of the system to be designed, made and demonstrated the design, detailed description of the smart home GSM short messaging implementation methods and related circuit design principles, the design takes full advantage of the system's hardware and software resources, to achieve a coordinated control of each module, to improve system reliability and versatility. The paper proposes using ZigBee and RFID technology with GPRS to development of smart home system. Principles are designed demonstration program, designed the corresponding hardware and system software, the results show that the design of the circuit to complete the basic test functions.

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