Intelligent ARM7 Based Wireless Security System Using Sensor Nodes and GSM Gateway

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Abstract: This paper presents the design and implementation of a low cost, low power consumption GSM (Global System for Mobile Communication) based wireless home security system. The system is a wireless home network which contains three kinds of wireless security sensor nodes, GSM gateway, GSM module and a Remote User. The three kinds of wireless security sensor nodes are door security nodes, infrared security nodes and fire alarm nodes. Every sensor node has a wireless transceiver module and an 8 bit microcontroller. The communication between the GSM gateway and the sensor nodes is through wireless transceiver. When an alarm incident occurs, the nodes will send alarm information to the GSM gateway immediately. The alarm state will be displayed in the gateway and also sent to the Remote User through GSM module. In order to ensure the security of the system information, some security methods are taken, such as password for gateway to prevent unauthorized person to access the system and a pseudo security key for data encryption and decryption to ensure security wireless communication.

Keywords: ARM7,GSM, Sensor, Wireless, Bluetooth.

I. INTRODUCTION

In order to enhance the occupants convenience and safety, home security system is indispensable in the field of intelligent home network. The requirements of a home security system include low cost, low power consumption, easy installation and rapid response to alarm incidents.

According to connecting mode, home network can be divided into two kinds: wireless network and non-wireless network [2]. The wireless technology has some remarkable benefits comparing with non-wireless technology. For example, it makes the installation and maintenance easier and reduces the system cost. Bluetooth [3], ZigBee [4], [5], 802.11 [6] and wireless USB [7] are the most popular technologies in the field of home wireless network. [3] Introduces a method to form a home network which provides flexible and dynamic services via Bluetooth. However, the system mentioned in [3] is high power consumption and high cost so that it is not convenient to use in security system. [4] and [5] present how to apply ZigBee/IEEE802.15.4 to establish a home network that is cost effective and low power consumption.

How to inform user in real time when alarm incidents occur has become a crucial feature of home security system. This can be done via internet or GSM. GSM is more convenient than internet. The main reason is that the GSM network has wide spread coverage making the whole system available for almost all the time. Furthermore, GSM network has high security infrastructure which makes sure that the information sent or received cannot be monitored [8]. The network examples mentioned in [3], [5], [6] and [7] send the information to remote users via internet. [8] and [9] are examples of home systems using GSM network for remote controlling. However, [8] only illustrates that GSM is communication method between remote user and home network server but doesn't apply it to home security system. The system in [9] only applies GSM technology to intrusion detecting and its communication is non-wireless.

This paper has the following features:
Low cost. All the microcontrollers used in the sensor nodes and the gateway are cheap and all other devices are inexpensive.
Low power consumption. All security sensor nodes are powered by batteries.
Easy installing. Because the nodes communicate with the gateway by wireless, they can be installed anywhere inside the home.
Rapid response. The GSM gateway will send SMS (Short Message Service) messages to inform remote PMP (Property Management Person) and users when alarm incidents occur.
Friendly user interface. The system has a friendly user interface including keypad and a LCD. Users can view the states of security sensor nodes, modify password of the

gateway and change the mobile phone number for receiving the alarm messages.

Emergency alarm function. There is an emergency alarm key (SOS key) in the GSM gateway which makes users at home to alarm in emergency situations.

Information security method. In order to ensure the security of system information, some security methods are taken, such as a password for gateway to prevent unauthorized person to access the system, and a pseudo security key for data encryption and decryption to ensure security wireless communication.

II. THE HOME SECURITY SYSTEM

The general structure of the home security system is shown in Fig. 1. The system includes two parts: wireless security sensor nodes and a GSM gateway. There are three kinds of sensor nodes in this system: door security nodes, infrared security nodes and fire alarm nodes. The GSM module is the interface between the gateway and the GSM network.
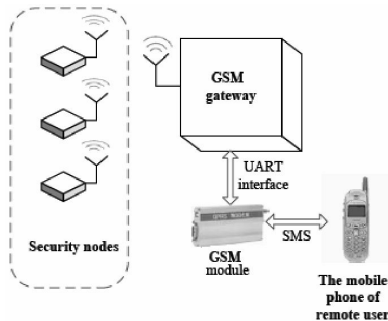

Figure. 1 Block Diagram of Wireless Home Security System

Every security sensor nodes consists of an Atmel AT89C51 microcontroller and a wireless 433 MHz transceiver. The GSM gateway consists of an ARM LPC2148 microcontroller, wireless 433 MHz transceiver, Keypad and an LCD.

III. THE GSM GATEWAY

The diagram of the hardware of GSM gateway is shown in Fig. 2. The GSM gateway consists of six major components:

ARM LPC2148 Microcontroller,
Wireless transceiver,
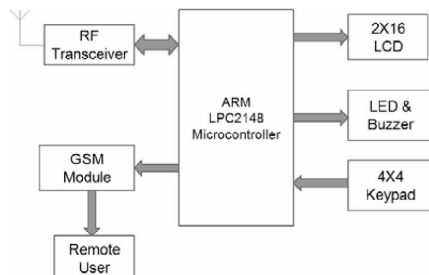LCD,
LEDs and buzzer,
Keypad, and
GSM module.

Figure. 2 The Diagram of GSM Gateway

LPC2148 is the central device of the gateway. It receives the information coming from the nodes and sends out alarm messages to remote users via GSM module. The received information not only sent to remote user, it is also displayed in LCD and buzzer and LED will be turned ON. The communication between the GSM module and ARM LPC2148 are implemented in the form of AT (Attention) commands. The keypad is used to modify password and mobile number for receiving the alarm messages.

IV. THE WIRELESS SECURITY SENSOR NODES

The general diagram of wireless security sensor nodes is shown in Fig. 3. Every sensor node has a wireless transceiver module and a microcontroller.
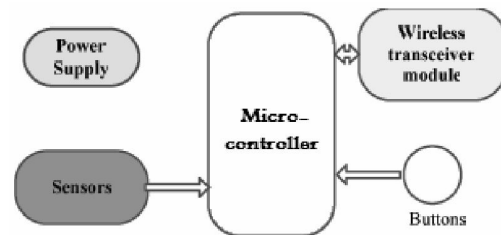

Figure. 3 The Wireless Security Sensor Node

The three kinds of sensor nodes are door security node, PIR security node and fire alarm node. The door sensor node adopts a magnetic sensor. PIR sensor responds to the infrared radiation of human body. The sensor can be placed in the entrances of rooms or other areas. When an intruder enters these areas, the sensor will detect the infrared radiation generated by the intruder. The temperature sensor monitors environment temperature. If the temperature of environment exceed defined thresholds, the node sends out alarm signal. If any of these nodes are activated, the microcontroller sends alarm information to the Gateway through wireless transceiver.

V. THE WIRELESS COMMUNICATION

When alarm incidents occur, the nodes will send alarm information to the GSM gateway immediately. When a node is queried, it returns its state to the gateway. The communication packet format between the gateway and node is given in Fig. 4. The packet consists of Preamble (P), Start of Packet (SOP), Packet Length (PL), Payload Data (PD) and the CRC16 bits.

Payload data have two bytes. The first byte represents the identity of security node, the second byte represents the state of node (0x00000001: "Open" State; 0x00000010: "Close" State; 0x00000100: "Alarm" State) or query command (0x00001111) from gateway. Before the payload data is transferred, it is encrypted with a pseudo security key. The payload data is decrypted with the same pseudo security key after received. The security key is generated by GSM gateway and is sent to each node when installing.
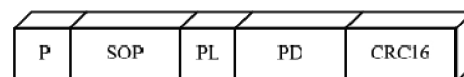

Figure .4:The Communication Packet Format

VI. CONCLUSION

This paper presents the design and the implementation of a wireless home security system. The gateway is protected with a login password and the information are encrypted and decrypted to ensure secured wireless communication.

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