Design of Intelligent Home Alarm System Based on ARM

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Abstract

With the rapid development of the national economy and the improvement of living standards, people are increasingly pursuing the safety and reliability of home life. At present, there are many hidden dangers and deficiencies in the home burglar alarm system on the market, which is far from people's expectations. Therefore, this design proposes an ARM-based smart home alarm system, which has the advantages of low cost, high practical performance, and easy operation. The smart home burglar alarm system designed in this paper is mainly composed of a core control board, a dangerous detection part, a police alarm part and a monitoring part, which can well meet people's needs for home security protection.

Keywords

ARM, alarm system, dangerous detection, security protection.

1. Introduction

The smart home alarm system designed in this paper mainly includes the core control board, dangerous detection part, police alarm part and monitoring part. The core control board used in this design is the 16/32-bit RISC microprocessor mini2440 introduced by Samsung, and its central processor is the embedded processor S3C2440A. The danger detection part uses a digital temperature sensor to detect the temperature in the room in real time. When the temperature is higher than 40°, an alarm device is triggered to make an alarm; a human body infrared pyroelectric sensor is used to detect whether a thief enters the home. The function of the police alarm part is to generate an alarm when there is a dangerous situation. There are two ways: one is to send a short message to the user's mobile phone to make an alarm, and the other is to send an alarm by a buzzer[1]. The monitoring part uses the camera to record the thief committing the crime and transmits the captured video image to the user's browser via Ethernet, which not only realizes the user's remote monitoring, but also provides powerful video evidence for the case detection. The block diagram of the system is shown in Fig. 1.

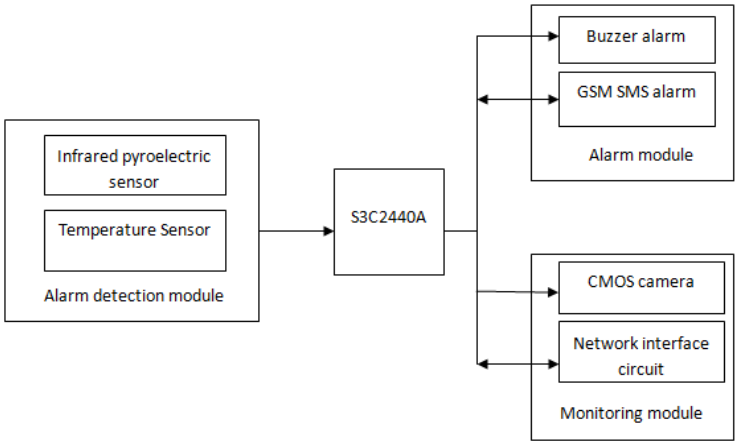

Fig 1. The block diagram of the system

2. Hardware Design of Intelligent Home Alarm System

2.1 Core Control Board

The embedded processor is the core component of the hardware platform in the embedded system and is the main hardware platform for the control and auxiliary system operation. The ARM processor occupies a dominant position in 32-bit embedded processors due to its low power consumption and high performance, and is particularly suitable for the design of mobile devices, handheld devices, and small systems. The ARM9 processor uses a Harvard system architecture, has an independent data cache and instruction cache, greatly reduces the chip area and system complexity, so the system uses ARM9 processor. The core control board selected by this security alarm system is the mini2440 embedded development board, which is a 32-bit ARM9 processor with a relatively high cost performance. It is suitable for a variety of applications such as civil and industrial applications.

2.2 Alarm Detection Section

The police detection part of this system includes human body infrared pyroelectric sensors and temperature sensors. The detection module is responsible for the real-time status detection of the home in the system. When it is detected that the home is in a dangerous situation, the alarm information is transmitted to the microprocessor, triggering the alert response module and the monitoring module.

(1) Human body infrared pyroelectric sensor

The human body infrared pyroelectric sensor includes a pyroelectric element, a field effect tube, and the like. The pyroelectric element converts the sensed infrared signal into a weak electrical signal, and then outputs the amplified signal through a field effect tube. In this system, we use the RE200 human infrared sensor module. Two detection elements are installed in the sensor, and they are connected in reverse polarity, which can suppress the rise of their own temperature and generate false alarms and improve the stability. At the same time, the sensor is also equipped with a Fresnel lens that collects infrared radiation from the human body to the pyroelectric element, dividing the detection into alternating "blind zones" and "high-sensitivity zones" when someone passes the sensor. Alternating electrical signals are generated, increasing the sensitivity of the sensor.

(2) Temperature sensor

Among the wide variety of temperature sensors, we chose the commonly used temperature sensor DS18B20. It is developed by DALLAS, USA, and the measurement temperature range is -55°C~+125°C. The main advantage of choosing the DS18B20 is that it adopts the “one-wire bus” interface and does not require complicated signal debugging circuits and A/D conversion circuits. The direct connection with the microprocessor can complete the temperature acquisition and processing. This "one-line bus" approach reduces the connection of external hardware circuits, reduces cost and ease of operation, and greatly improves the system's interference performance [2].

2.3 Alarm Alarm Section

In this system, when the police detection part finds suspicious personnel entering the home, an alarm will occur: one is to send a message to the owner through the GSM module to inform the police; the other is that the alarm device at home will send out an alarm sound to Scare the thieves.

(1) GSM module

In this system, if a dangerous situation occurs in the home, it will be sent to the user's original mobile phone via the GSM module as a short message. The GSM module we use is the TC35i module. It is developed by Siemens and is a GSM module that supports Chinese short messages. The operating power is 3.3V~4.8V.

(2) Buzzer alarm

In this system, the home alarm device uses an inexpensive active buzzer to trigger the buzzer when it comes to strangers.

2.4 Monitoring section

In this design, the monitoring part realizes the function of real-time remote monitoring of home conditions. Therefore, it is necessary to connect the camera to the microprocessor to achieve this function. Based on considerations such as sufficient availability, integration, power consumption, and cost budget, CMOS cameras have excellent performance, low power consumption, and low cost. In addition, S3C2440 has already provided the interface of CMOS camera, so this system adopts CMOS camera [3]. The system uses the camera to complete the collection of images in various home conditions. The captured images are stored in the control board and finally displayed on the PC after the microprocessor's compression, decoding, and other processing. This can provide powerful evidence for the police to solve the case.

3. Design of the Hardware Circuit

3.1 Alarm Module Circuit Design

In this design, the alarm module circuit includes two alarm circuits: one is a buzzer alarm, and the other is a short message alarm sent to the owner through the GSM module.

3.1.1 GSM Module Circuit

In the alarm circuit, the GSM module we use is the TC53i module developed by Siemens. The TC35i module is compact in structure and easy to operate. It can securely and reliably implement data transmission, voice transmission and short message service. The TC53i module integrates the baseband circuitry and radio frequency internally to support the instruction set of the AT command. The TC53i module has a total of 40 pins, which are pulled out through the ZIF connector. The 40 pins can be divided into five types: power supply, SIM card interface, data output or input, control switch, and audio port. The TC53i module provides a standard UART serial communication interface, so the S3C2440 can be easily connected to the GSM module by serial communication. The interface circuit diagram of the TC53i module is shown in Fig. 2.

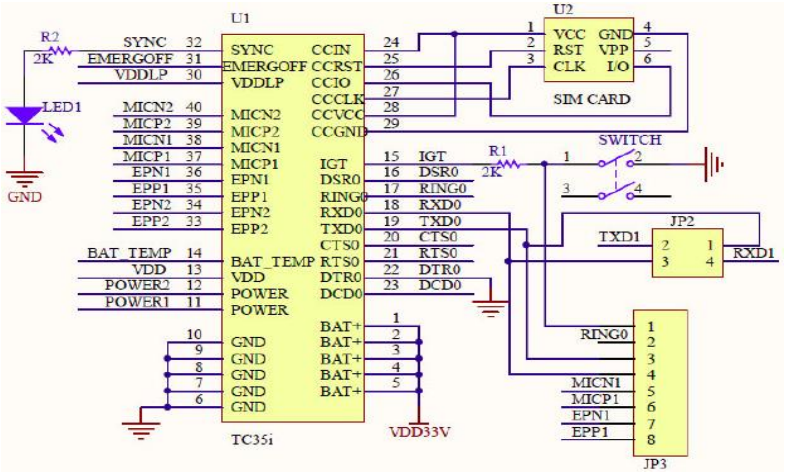

Fig 2. The interface circuit of the TC35i module

The TC53i module has 6 pins CCIN, CCRST, CCIO, CCCLK, CCVCC and CCGND connected to the SIM card on the ZIF connector.

The SYNC pin of the TC53i module controls R1 and LED1 to indicate the operating status of the TC53i module. When LED1 is off, the TC53i module is in the off or sleep state; when LED1 is on and off 600ms alternately, it indicates that the TC53i module is performing network login or the SIM card is not inserted; when LED1 is in 3s off/ when the 75ms is on, the TC53i module has successfully logged in to the network and is in the standby state.

The RXD0 pin and TXD0 pin of the TC53i module are connected to the S3C2440 chip for serial communication.

The BAT+ pin of the TC53i module provides the 3.3V operating voltage for the SIM card.

The 15 pin of TC53i module is the start pin IGT. After the system is powered on, the module enters the working state.

3.1.2 Alarm circuit for Buzzerorce Analysis

In the circuit where the buzzer alarms, if an unexpected situation occurs in the home, the I/O port GPB0 of the S3C2440 processor outputs a low level and the buzzer alarm is triggered after amplification by the triode. Fig. 3 shows the circuit diagram of the buzzer alarm.

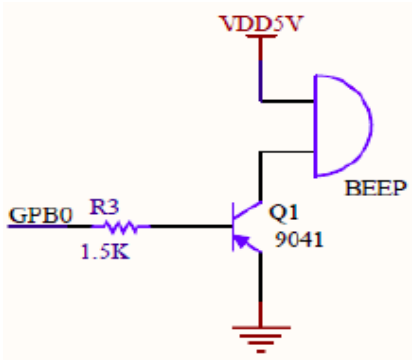

Fig 3. Alarm circuit for 3.1.2 buzzer

3.2 Circuit Design of Danger Detection Module

The danger detection module includes two parts: the human body infrared pyroelectric sensor and the temperature sensor, which are responsible for real-time collection and simple processing of the home environment state.

3.2.1 Human Body Infrared Pyroelectricity Detection Circuit

Human body infrared pyroelectric sensors are used to detect whether someone has sneaked into their home. This sensor detects the infrared radiation emitted by the body in a non-contact manner and converts it into an electrical signal. In the system design, the RE200 human body infrared sensing module produced by Shanghai Nisera Sensor Co., Ltd. was used. The sensor mainly includes a shell, a pyroelectric element PZT, a filter, a field effect transistor, and the like. Among them, the shell plays a protective role; the role of the filter is to filter out infrared rays at other wavelengths, and is specifically used to detect infrared radiation emitted by the human body; pyroelectric element PZT converts infrared rays collected from the human body into weak electrical signals. The role of the FET is to amplify the weak electrical signal. The human pyroelectric sensor circuit consists of a pyroelectric sensor and a BISS0001 chip. BISS0001 is a sensor signal processor with higher performance. It integrates an operational amplifier, a voltage comparator, a state controller, and a delay time timer. The working principle of the infrared sensor circuit is shown in Fig. 4.

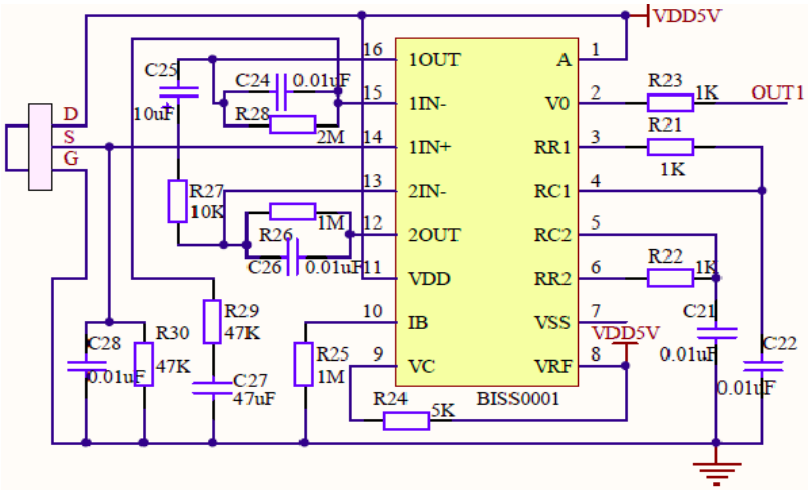

Fig 4. Working principle circuit diagram of infrared sensor

In Fig. 4, we can see that when the module senses someone passing by, the sensor's output voltage rises to 4.2V. This voltage is divided into two paths. One is the input pin that connects the BISS0001 pyroelectric chip. Through the 2 pin output low; the other way is through the first stage of the amplifier circuit, and then through the coupling capacitor C25 for secondary amplification, and finally through the two-way discriminator processing, get the Vs signal used to trigger the internal delay The timer operates so that the low level of the output pin is retained for a period of time determined by the parameters of R21 and C22.

3.2.2 Temperature Detection Circuit

Among the wide variety of temperature sensors, the DS18B20 digital temperature sensor is used. It can be connected to the microprocessor S3C2440 with just a single wire, which is easy to operate and cost-efficient. The connection between DS18B20 and S3C2440 is shown in Fig. 5. It can be seen that the connection between the DS18B20 and the S3C2440 requires only one data line, which can transmit data and transmit clocks[4].

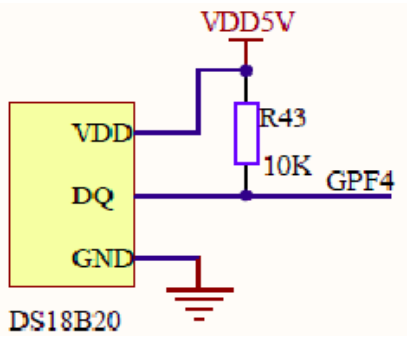

Fig 5. Circuit Diagram of DS18B20 Temperature Sensor

3.2.3 Camera Interface Circuit

In the monitoring system, the CMOS camera we used was an OV9650 image sensor developed by Omni Vision, and the OV9650 had 1.3 million pixels. The interface circuit diagram of the OV9650 sensor is shown in Fig. 6.

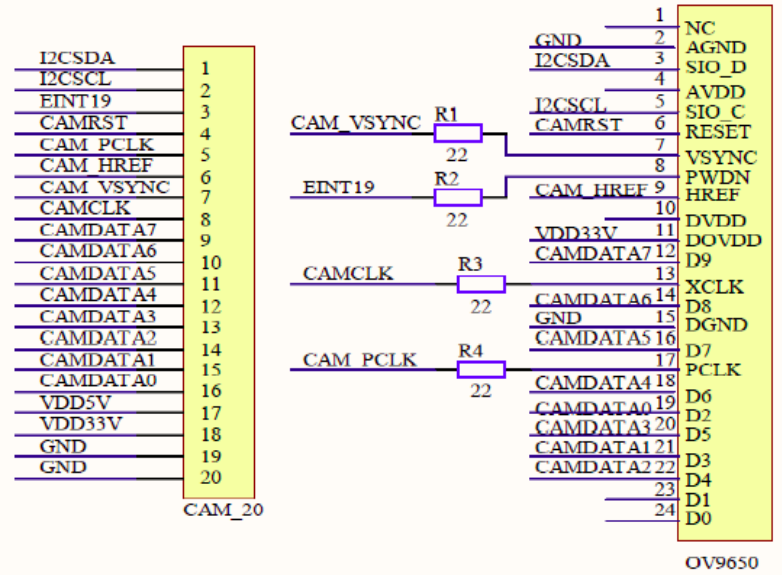

Fig 6. Camera interface circuit

In Fig. 6, we can see that the camera interface includes 8 input and output signals CAMDATA0~ CAMDATA7 from the camera, 1 output master clock signal CAMCLK, and 3 input synchronization clock signals CAM- PCLK, CAM_ HREF, CAM_VSYNC from the camera, 1 Output reset signal CAMRST, 2 power supply signals VDD33V, Signal lines I2CSDA, I2CSCL for VDD5V and 2 I2C buses.

4. Conclusion

This article has completed the design of the smart home alarm system, the main includes the core control board, dangerous detection part, police alarm part and monitoring part. The danger detection part uses a digital temperature sensor to detect the temperature in the room in real time. When the temperature is higher than 40°, an alarm device is triggered to make an alarm; a human body infrared pyroelectric sensor is used to detect whether a thief enters the home. The function of the police alarm part is to generate an alarm when there is a dangerous situation. There are two ways: one is to send a short message to the user's mobile phone to make an alarm, and the other is to send an alarm by a buzzer. The monitoring part uses the camera to record the thief committing the crime and transmits the captured video image to the user's browser via Ethernet, which not only realizes the user's remote monitoring, but also provides powerful video evidence for the case detection.

References

[1] Samsung Electronics Co.Ltd. S3C2440A 2-Bit CMOS Microprocessor user's manual[R]. Samsung Electronics Co.Ltd ,2004.

[2] Yan Zhe.The Design and Implementation of Smart Home Control System[J]. Techniques of Automation and Application, 2010,29(3):93-96.

[3] Wheeler A. Commercial Applications of Wireless Sensor Networks Using Zig Bee[J]. IEEE Communications Magazine, 2007, 45(4):70-77.

[4] Chan M. and Esteve D. A review of smart homes - Present state and future challenges[J]. Computer Methods and Programs in Biomedicine, 2008, 91(1):55-81.