RESEARCH ARTICLE   OPEN ACCESS

Global System for Mobile Communication Based Smart Home Security System

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ABSTRACT
Home security system is needed for occupants' convenience and safety. In this paper, we present the design and implementation of an affordable, low power consumption, and GSM (Global System for Mobile Communication) based wireless home security system. In existing system, the home network is engaged with non-wireless technology, where the installation and maintenance is difficult. So the system cost is very high. In our proposed system, these difficulties are overcome by introducing a wireless home network which contains a GPRS Gateway and three kinds of security nodes namely door security node, anti intrusion node and SMS node to inform the user. The nodes are easy installing. All the three nodes are connected to the microcontroller.
Keywords – Affordable, GSM, Microcontroller, Security, SMS, Wireless.

I. Introduction

In this project we are implementing the interfacing of the RFID tag along with the door lock to give easy access to the one possessing the RFID tag into the house. Further, we have introduced a pair of RF transmitter and receiver sensors to detect the intrusion. In order to aware the owner about the intrusion we have used a GSM module which helps the user to do further preventive actions in order to drive out the thieves. As a further security we have introduced an alarm system and a Camera capable of capturing the images of the intruder and storing them inside its memory.

II. Implementation

The hardware and the software used for this project are as follows:

2.1 Hardware:

The hardware used consists of following basic components:

2.1.1 P89V51RD2 Microcontroller

The P89V51RD2 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Philips's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Philips P89V51RD2 is a powerful microcontroller which provides a highly-flexible and cost-effective solution

to many embedded control applications. Working wise it is similar to the AT89S52 microcontroller, but additional features like flashing infinite times & some power saving features are present in P89V51RD2.
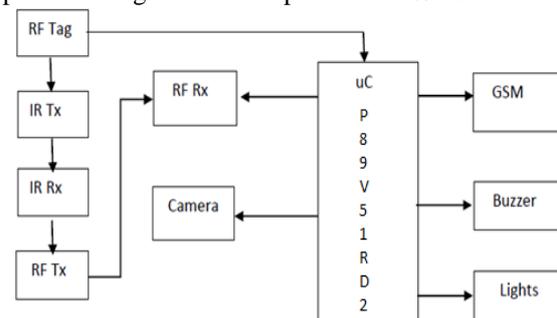

Fig. 1: Block Diagram of GSM based Home Security System.

2.1.2 MAX232A

Converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V. MAX232A is backwards compatible with the original MAX232 but may operate at higher baud rates and can use smaller external capacitors — 0.1

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µF in place of the 1.0 µF capacitors used with the original device.
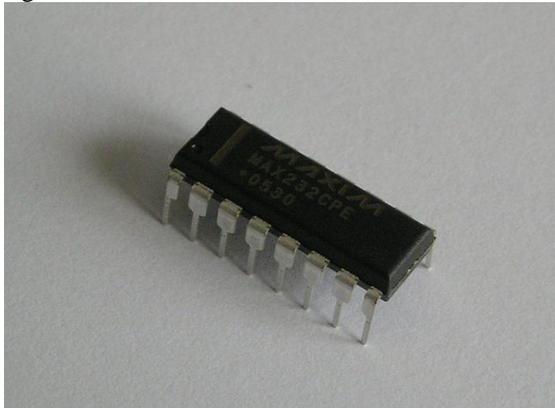

Fig. 2: MAX 232A IC

2.1.3 RS232

An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies, and other peripheral devices. However, the low transmission speed, large voltage swing, and large standard connectors motivated development of the Universal Serial Bus, which has displaced RS-232 from most of its peripheral interface roles.[citation needed] Many modern personal computers have no RS-232 ports and must use either an external USB-to-RS-232 converter or an internal expansion card with one or more serial ports to connect to RS-232 peripherals. RS-232 devices are still found, especially in industrial machines, networking equipment, and scientific instruments.


Fig. 3: RS232 ports

2.1.4 Subscriber Identity Module

Subscriber Identity Module- A subscriber identity module or subscriber identification module (SIM) is an integrated circuit that securely stores the international mobile subscriber identity (IMSI) and the related key used to identify and authenticate subscribers on mobile telephony devices (such as mobile phones and computers).

A SIM circuit is embedded into a removable plastic card. This plastic card is called a "SIM card" and can be transferred between different mobile devices. A SIM card follows certain smart card standards.SIM cards were first made the same size as a credit card (85.60 mm × 53.98 mm × 0.76 mm). The development of physically smaller mobile devices prompted the development of smaller SIM cards where the quantity of card surrounding the integrated circuit is reduced. A SIM card contains its unique serial number (ICCID), international mobile subscriber identity (IMSI), security authentication and ciphering information, temporary information related to the local network, a list of the services the user has access to and two passwords: a personal identification number(PIN) for ordinary use and a personal unblocking code (PUK) for PIN unlocking.
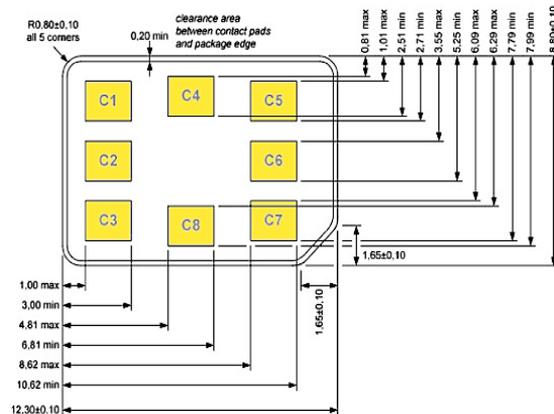

Fig. 4: SIM Module

2.1.5 GSM Modem

GSM/GPRS RS232 Modem is built with SIMCOM Make SIM900 Quad-band GSM/GPRS engine, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with RS232 Level converter circuitry, which allows you to directly interface PC Serial port .The baud rate can be configurable from 9600-115200 through AT command. Initially Modem is in Autobaud mode. This GSM/GPRS RS232 Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS as well as DATA transfer application in M2M interface. The modem needed only 3 wires (Tx, Rx, GND) except Power supply to interface with microcontroller/host PC. The built in Low Dropout Linear voltage regulator allows you to connect wide range of unregulated power supply (4.2V - 13V).Using this modem, you will be able to send & Read SMS, connect to internet via GPRS through simple AT commands.

Amrit Zoad Int. Journal of Engineering Research and Applications
www.ijera.com
ISSN : 2248-9622, Vol. 4, Issue 7(Version 4), July 2014, pp.50-55

Fig. 5: SIM 900 GSM Module

2.1.6 RF Module

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK). Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.
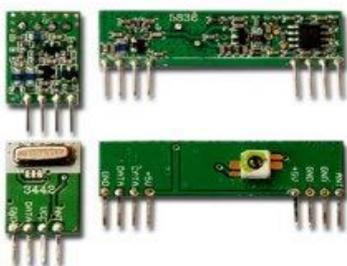

Fig. 6: RF Transmitter & Receiver Pair.

2.1.7 CCTV Dome Camera

Closed-circuit television (CCTV) cameras can produce images or recordings for surveillance purposes, and can be either video cameras, or digital stills cameras. Marie Van Brittan Brown was the inventor of the CCTV camera. Video cameras are either analogue or digital, which means that they work on the basis of sending analogue or digital signals to a storage device such as a video tape recorder or desktop computer or laptop computer. We can record straight to a video tape recorder which are able to record analogue signals as pictures. Analogue signals can also be converted into a digital signal to enable the recordings to be stored on a PC as digital recordings. In that case the analogue video camera must be plugged directly into a video capture card in the computer, and the card then converts the analogue signal to digital. These cards are relatively cheap, but inevitably the resulting digital signals are compressed 5:1 (MPEG compression) in order for the video recordings to be saved on a continuous basis.
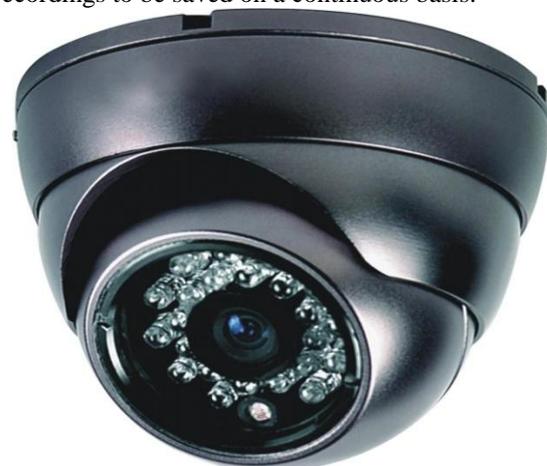
Fig. 7: CCTV Dome Camera

2.1.8 IR Sensors

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation.

2.1.8.1 IR Transmitter

IR Transmitter and Receiver pair can be easily made using 555 Timer, IR LED and TSOP1738 IR Receiver. This can be used for remote controls, burglar alarms etc. TSOP1738 is a very commonly used IR receiver for PCM remote control systems. It has only 3 pins, Vcc, GND and Output. It can be powered using a 5V power supply and its active low output can be directly connected to a microcontroller or microprocessor. It has high immunity against ambient light and other electrical disturbances. It is able to transfer data up to 2400 bits per second. The PCM carrier frequency of TSOP1738 is 38KHz, so we want to design a astable multivibrator of 38KHz. This can be done by using 555 Timer.
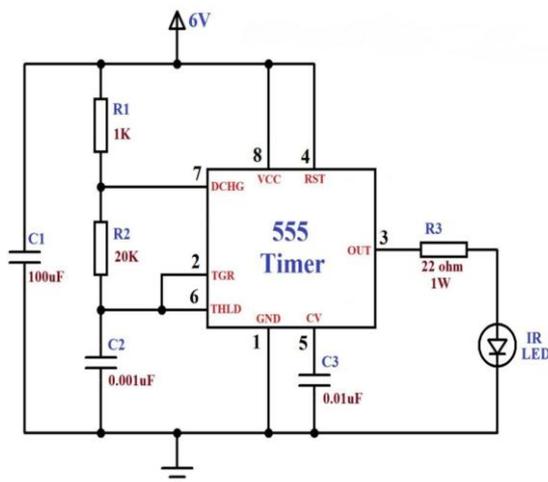
Fig. 8: IR Transmitter for TSOP1738

2.1.8.2 TSOP1738 IR Receiver

For receiving signals send by the transmitter you need only TSOP1738. Connect 5V to Vs and Ground to GND pin of TSOP1738. The output will be active low. Output of TSOP1738 will be HIGH when no signals fall on it and the output will be LOW when 38KHz infrared rays fall on it.
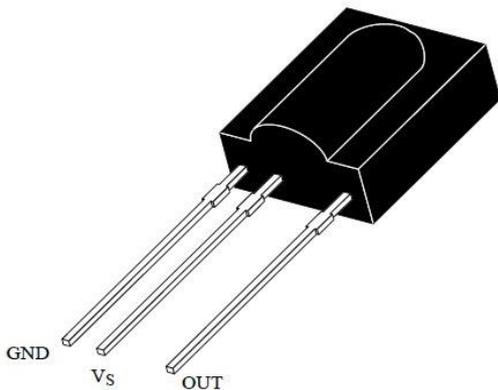

Fig. 9: TSOP1738 Pin Out

2.2 Software:
2.2.1 Keil µVision 3

In order to achieve proper functioning of the project accurate codes and programming was the important requirement. The programming was divided in various logical modules and done in C language. Programming in small modules proved to be more efficient and accurate as the task was simplified and debugging was easier.

2.2.2 Flash Magic

A GUI Software for programming AT89S52 Microcontrollers. Flash Magic is a PC tool for programming flash based microcontrollers from NXP using a serial or Ethernet protocol while in the target hardware.

2.2.3 Express PCB

A Standard PCB Designing software in which we first draw the Schematic of the Circuit Diagram & then the Software automatically creates a PCB Layout for the Schematic.

III. Inspiration and Working
3.1 Shortcomings of current home security systems

A conventional home security system consists of a Closed Circuit Television and burglar alarm. But the power consumption is considered as a concern of installing a security system [3]. The other security systems involve use of alpha numeric key pads and other security devices for guarding the area. But there is no provision of offering a smart solution if this security is transgressed [2] [1].

By using Global System for Mobile Communication based Smart Home Security System we are intending to make a smart anti-theft security system which would be capable of determining any intrusion in an intended area of the house and take remedial measures.

3.2 Working

First of all the door lock has a lock mechanism consisting of a stepper motor connected to a RFID system. The house owner has a RFID Tag with him/her. The system locks and unlocks depending upon its present condition when the tag is touched to the system. As the door locks the security system activates, and when the door unlocks the security system de activates.

The free standing intrusion detector consists of an Infrared Transmitter and Receiver pair. The area under surveillance is monitored by an infrared detector which activates the transmitter upon the detection of intrusion. As long as the receiver receives the infrared signal its output is high. This output is passed through the inverter. The output at inverter is hence low.

As soon as there is a break in the infrared signal its output at receiver becomes low. This low input gives High output when it passes through the inverter. This high output is transmitted by the Radio Frequency transmitter a radio signal is emitted by the transmitter which is received by the RF Receiver. This RF receiver is connected to the microcontroller. The microcontroller instructs the GSM module to send the message to the owner that a break in has occurred. Also it sends a message to the police station with the house's address. Also if the owner is out of coverage or the message is not delivered till stipulated time then the buzzers starts, and lights blinks.

After this the microcontroller will turn on the lights which will facilitate two purposes. First it will scare the intruder and the second it will improve

Amrit Zoad Int. Journal of Engineering Research and Applications
ISSN : 2248-9622, Vol. 4, Issue 7(Version 4), July 2014, pp.50-55

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lighting conditions for the camera to function more effectively. After the lights are on the microcontroller will instruct the camera to take 2-3 images in burst mode. These images will be stored in the removable memory of the camera which can be used in case of identification if the theft still takes place.
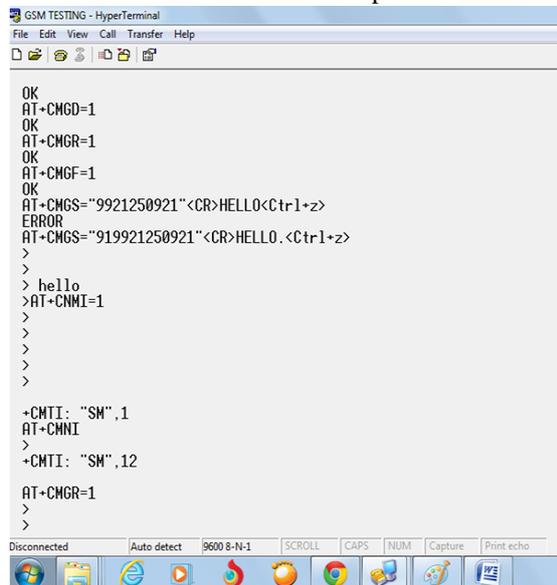
Fig. 10: Snapshot of response by GSM using Hyperterminal.
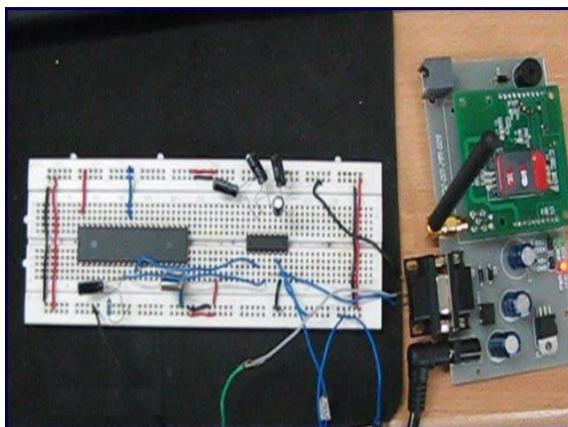
Fig. 11: GSM Interfacing with 8051

IV. Results

4.1 Speed of Range

All components are working within optimal time frames.

As soon as the IR sensor detects intrusion it triggers the camera with the help of RF module within 1 second. Then the microcontroller sends the command to GSM module i.e. SIM900, to send SMS to the user to inform them about the intrusion. The speed of this segment depends on the GSM network of the user as well as the GSM module. In our testing it was found to be around 8 to 9 seconds however it rarely takes more than 10 seconds in worst network conditions.

After the complete transmission of AT commands to the GSM module the microcontroller turns on the buzzer within 1 second. Next it turns on the lights in a pattern that is on for 2 seconds and off for 1 sec. For testing and demonstration we have limited this pattern for 15 seconds.

4.2 Accuracy

4.2.1 IR Sensors

The sensors were very accurate within their specified range. Even with integer calculations, it has a ±1cm accuracy. For our project the maximum range is found to be 5 to 6 meters at its best which is sufficient.

4.2.2 RF Module

RF transmitter and receiver has range 10 to 12 meters which is ideal for our project.

4.2.3 SIM 900

The GSM module works on GSM technology hence it can be used from anywhere in the world. However it still depends on the network strength.

Fig. 12: The Final Project

4.3 Future Scope

The "Global System for Mobile Communication based Smart Home Security System" project that we implemented will incur a fairly simple production process as it incorporates cheap components which perform at par with their commercial counterparts. Our security system has tremendous scalability in design as well as a concept. Gas sensor can be added to the system to alert the user about gas leakage at home via SMS. Fire sensor can be added to the system to alert the user about fire via SMS also sprinklers can connected to quench the fire. LCD touch-screen can be connected to set and reset the phone numbers to call on. GPRS capability of SIM900 can be used to access internet. RFID with NFC can be used instead of normal RFID thus making use of unique NFC code of the user's mobile making the system more user oriented.

V. Conclusion

As we were able to build a home security system with inclusion of GSM and RF technologies thus applying our knowledge of communication engineering to our project, we were able to meet all the project objectives we set which were,

1.   To provide security to the restricted area from remote place.
2.   To make the system much more user friendly.
3.   To ensure highest security in minimal hardware.
4.   To ensure cost efficiency.

In this project low cost, secure, ubiquitously accessible, auto-configurable, remotely controlled solution for security of homes has been introduced. This approach is novel and can be expanded further to achieve the target to control home appliances remotely using the SMS-based system satisfying user needs and requirements.

Advantages:

1. Improved security: From this system we can try to save our house from theft being anywhere in the globe. So this system is more advanced and useful than the simple home security system which available in today's Indian market at same price.

2. Cost Effective: The cost each component is less hence the overall cost of the system is very less compared to conventional security system.

3. Less Power Consumption: The complete system turns on only when the intrusion takes place hence power consumption is minimal.

Limitations:

1. Network Coverage: The system won't work at its full potential if there is no network coverage.

VI. Acknowledgement

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