

Home Security System Using Gsm Modem

Mehek Potnis¹, Ayesha Chimnani¹, Vishal Chawla¹ Mr. Amit Hatekar²

1. Undergraduate Students, Department of EXTC, Thadomal Shahani Engineering College, Mumbai, India

2. Assistant Professor, Department of EXTC, Thadomal Shahani Engineering College, Mumbai, India

Abstract

This paper mainly focuses on using wireless technology effectively for security. The system is SMS-based and uses wireless technology to revolutionize the standards of living. It uses a GSM Modem to send an SMS to the home owner in case of an intrusion. The project is realized by interfacing an infrared trans-receiver with an ATMEGA16 microcontroller and a GSM Module. As the system uses GSM technology, it provides ubiquitous access to the system for security.

Index Terms: GSM, ATMEGA16, Home automation, GSM SIM 300.

I. INTRODUCTION

We have come across various equipments in the market used to prevent an intrusion. These equipments use reinforced steel, digitized codes, double bolted locks etc. The purpose of such products is to prevent intrusion or robbery from the very beginning. These commercial products are isolated objects i.e. if you want to protect a room you have to buy the entire door. Also, if in any case an intrusion is made, these products can't do anything after. Due to the commercialization and isolation of products, they are heavy and expensive.

We have tried to overcome these drawbacks by implementing a home security system which includes an IR sensor, ATMEGA16 board, GSM Modem and a Relay circuit. When a person cuts through the infrared beam, an interrupt is sent to the microcontroller which is further interfaced with a GSM module. It sends an SMS to the home owner to alert him/her. The basic flow of this system is shown in Figure:1. Thus, this project takes some action after the intrusion has already taken place, unlike the systems usually seen in the market.

The home automation system gives the user the flexibility to activate or deactivate the system simple by using an SMS which includes a pre-decided code. The system also allows the home owner to dynamically transfer the authority to control the entire device. This system is portable, easy to install, reasonably priced and can be used in any environment.

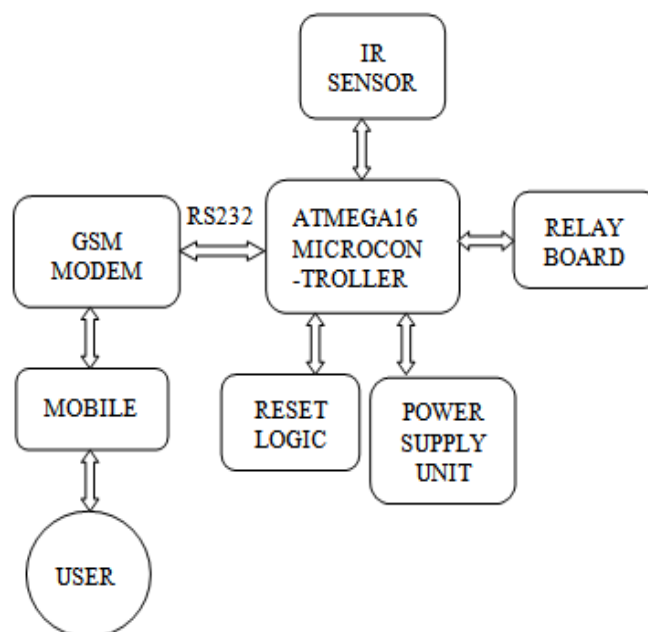


Figure 1: Block Diagram of Entire System

II. INFRARED TRANSRECEIVER

An infrared (IR) transceiver, sends and receives infrared data. The device may either have a focused beam, thus requiring it to be in a precise position in order to function properly, or it may be a broader beam, depending on the applications that it is designed for.

The IR transceiver board used in this system includes IC 555, IR LED and TSOP1738 IR Receiver. The IR LED transmits an infrared beam, which does not get reflected back unless there is an object, or in this case, an intruder cutting the beam. The range of the IR LED in this project is 15cm. If the beam is reflected back, then it is received by TSOP1738, which is an active low device i.e. it sends a high signal to the microcontroller unless it receives a reflected beam. A 5V supply is given to power up

this board. Data is transferred at a rate of up to 2400bps. The PCM carrier frequency of TSOP1738 is 38KHz.[8][9] This board and the IR Receiver is shown in Figure 2.

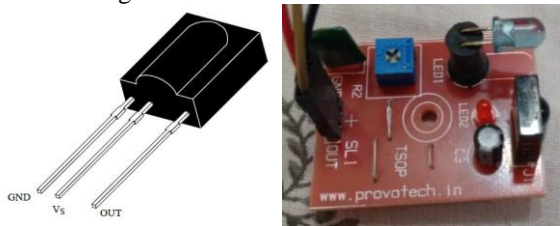


Figure 2: TSOP1738 IR Receiver and IR Transceiver Board

III. ATMEGA16 MICROCONTROLLER

ATmega16 is an 8-bit microcontroller which delivers high performance at a low power consumption rate. It has an advanced RISC (Reduced Instruction Set Computing) architecture with 131 instructions that mostly execute in one machine cycle. The maximum frequency of operation is 16MHz at 4.5V.

It has 16KB of in-system self-programmable flash program memory, 1KB of internal static RAM and 512 bytes of internal EEPROM. It has a data retention capacity of 20 years at 85°C and 100 years at 25 °C.

The microcontroller is a 40 pin IC out of which 32 pins are programmable I/O ports. These ports are divided into four groups of 8 pins each called PORTA, PORTB, PORTC and PORTD. The IC and its pin configuration are shown in Figure 2.

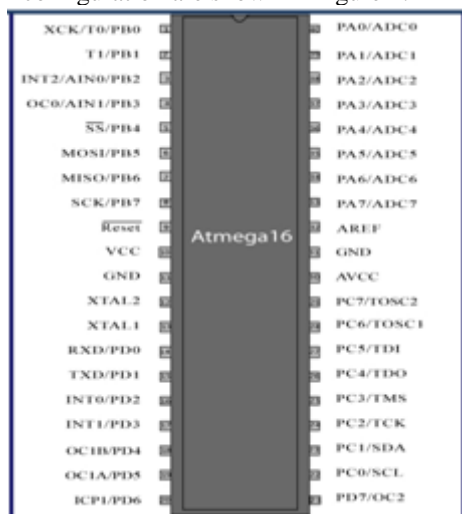


Figure 2: Pin Configuration of ATmega16

The operating voltage range for the ATmega16 microcontroller is 2.7V - 5.5V. [1][2] In this system a 12V adaptor is used to supply power. This input power is fed to a Voltage regulator - LM7805 which gives an output of 5V. This is then supplied to the rest

of the circuit. The microcontroller board also includes a reset pin, a power LED, serial port using MAX232. MAX232 is an IC which converts signals from RS232 serial port to signals suitable for TTL compatible digital logic circuits.[3] This circuit is shown in Figure 3.

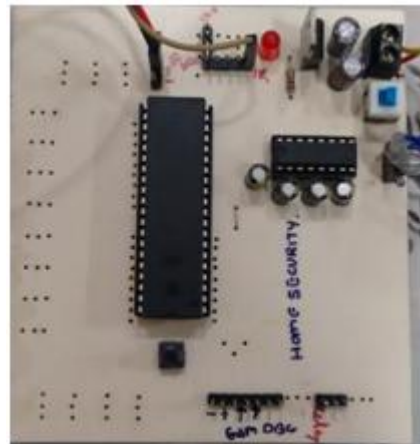


Figure 3: ATmega16 Board

The microcontroller is programmed by using the TopWin6 software. A hex file, generated using ATMEL Studio 6.2 is loaded into the driver and then fed into the IC. Embedded C is the language used to program the IC.

IV. GSM MODEM

GSM (Global System for Mobile Communication) is a wireless network system that uses a mobile operator and functions just like a mobile phone. The GSM modem has a SIM card slot, thus giving the modem a mobile number of its own and enabling it to activate communication over the network. The user can send or receive an SMS as well as make or receive voice calls over the modem interface.

The GSM modem may be connected to a computer directly through the serial port or to a microcontroller using RS232. Thus the modem can be used to develop embedded applications. [4] There are a set of AT commands that are used to establish communication between the microcontroller and the GSM modem.

The GSM modem used in this home security system uses SIM300 module. It has a power and network LED making it convenient to debug. There is also a wire antenna on the modem to provide better reception. SIM300 has an adjustable baud rate of 1200-115200bps. However, in this system it is set to 9600bps. The GSM modem consumes only 0.25A during normal operation and about 1A during transmission. Thus, it has very low power consumption. The operating voltage range is 7-15V.[5]

The ubiquity and low cost of implementation of the GSM standard makes it the ideal communication medium for a low budget home automation system. The GSM modem used in this device is shown in Figure 4.



Figure 4: GSM Modem using SIM300 module

V. RELAY BOARD FOR DEVICE

The type of relay used in this Home Security system is a Solid-State Relay (SSR). An SSR is basically an electronic switching device. Whenever an external voltage, over a certain threshold, is applied across its control terminals, a magnetic field is generated which attracts a movable lever, thus establishing a flow of current and switching it ON. It then switches this power to a load circuitry. Thus, it performs the function of an electromechanical switch without any mechanical parts.

The relay board includes ULN2803 IC which is an 8 channel Darlington driver, a relay, 3 pin PBT connector, IN4002 diode, 1K resistor and an indicator LED. The relay used in this system is JQC-3FC/T73 working at 12V DC which is shown in Figure 5. The maximum switching current for the relay is 7A-10A and the maximum switching voltage is 28V DC or 250V AC.[6][7]



Figure 5: Relay JQC-3FC/T73

The relay board used in the system is used to drive a camera. The camera is placed at such an angle, that when it is triggered by the relay, it takes a snapshot of the intruder and sends the same to the microcontroller. The implementation of a camera in the circuitry is a future prospect of the project. The relay board is shown in Figure 6.

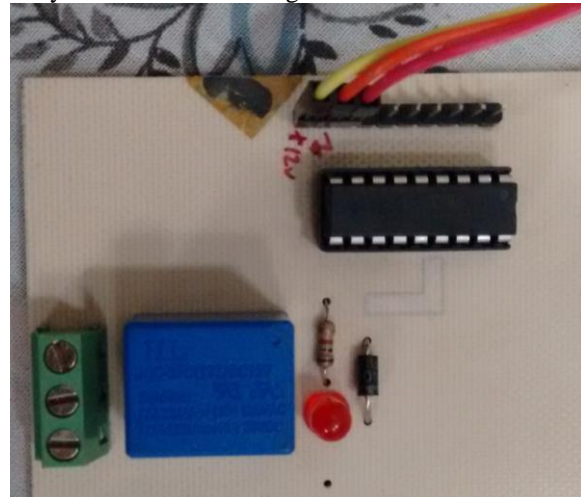


Figure 6: Relay Board

VI. PROBLEM FORMULATION

During the course of the project, we came across several problems that were a hindrance to the appropriate functioning of the system. There were hardware as well as software issues. Of the many problems encountered, some of them are listed below.

A. Complication with the GSM Modem:

A 12V/1A adaptor is needed to power up a GSM modem. After inserting a valid SIM card in the SIM card slot, the GSM catches network which is indicated by a network LED on the GSM Modem. It is also connected to a tested microcontroller via a serial communication port.

However, inspite of having network, the GSM Modem was unable to send an SMS to the pre-coded user.

B. Conflict in the ATmega16 Memory:

On programming the microcontroller, the numbers to which the SMS needs to be sent to are stored in the stack and the SMS' are stored in the GSM message storage area. On powering up the system, the GSM modem sends a message to the user - 'Home Security Powered Up' which is an indication that the system is active.

On sending an SMS to the GSM modem to carry out any specific function, the GSM wasn't responding to the same.

C. Soldering:

After testing the circuit on a bread board and obtaining the desired results, we made the PCB layout and soldered the components.

The final circuit board however was not working.

VII. PROPOSED PROBLEM SOLUTION

So as to ensure proper functioning of the system, the problems mentioned above were overcome as follows.

A. Solution for GSM Modem:

The GSM Modem can be connected to the microcontroller as well as to the computer directly through a serial port. We connected the Modem to the computer for debugging. The working of the GSM Modem can be tested using the software Terminal v1.9b. On typing the command 'AT' in the command window, the terminal replies 'OK' which indicates the proper functioning of the GSM Modem. However, the terminal was not responding to this command.

In order to overcome this problem, we used a 12V/2A adaptor. This extra current, gave the Modem the boost necessary for proper functioning. After this, we switched back to the initial adaptor i.e. 12V/1A adaptor and the GSM Modem started functioning normally. The terminal responded with 'OK' and then showed all the AT commands being exchanged between the microcontroller and the Modem thereafter.

B. Solution for ATmega16 Memory:

The messages previously sent to the number in the modem occupied the memory. Thus, the new messages were getting discarded as the memory was full.

In order to overcome this problem, a few changes had to be made in the program code. Every time the Home Security System is powered up, the first task carried out is deleting all the previous messages from the memory. This makes space for new messages thus enabling the microcontroller and the GSM Modem to respond to the same.

C. Solution to the Soldering Issue:

On testing the connectivity and the current flow in the soldered circuit with the help of a multimeter, we observed that a certain capacitor wasn't soldered properly. Opposite polarity had been soldered due to which the current reaching the IC exceeded the necessary level thus, spoiling the IC.

Therefore, we had to resolder the capacitor and replace the IC for the proper functioning of the circuit.

VIII. SYSTEM WORKING

When the system is powered up, the GSM Modem memory is cleared using the command 'AT+CMGD' so as to make space for the new messages. The command 'AT+CMGF' is used to set the GSM Modem to text mode in order to send and receive the messages.

The GSM Modem sends a message 'Home Security Powered Up' to the home owner. This is done by first reading the message from the GSM message storage area using the command 'AT+CMGR' and then sending the same using the AT command 'AT+CMGS'. This acts as a confirmation to the home owner, that the system is functional.

Every time a certain entity cuts the IR beam, The reflected signal is received by the TSOP1708 IR Receiver. This being an active low component, sends a low signal to the microcontroller on PortD-2 (i.e. PD2). When the microcontroller receives this interrupt from the IR Transceiver Module, it uses the command 'AT+CMGS' and commands the GSM Modem to send the message 'Intrusion Detected' to the home owner.

The home owner can dynamically control the working of the system by sending an SMS to the GSM Modem. When the Modem receives an SMS from the user, it gets stored in the message storage area and uses the same command mentioned above to read it.

The microcontroller enables or disables the IR Transceiver depending on the command sent by the user. Whenever an intrusion is detected, along with sending an SMS to the home owner, the microcontroller also triggers the relay which can be used to switch on the camera to take a picture of the intruder.

IX. RESULTS AND ANALYSIS

The Home Security System using GSM modem was successfully implemented.

| Digit | Message | Function |
|---------|--------------------------|--|
| 1 | IR Sensor Disabled | When this digit is sent by the user to the GSM Modem, the microcontroller disables the IR Transceiver Module |
| 2 | IR Sensor Enabled | When this digit is sent by the user to the GSM Modem, the microcontroller enables the IR Transceiver Module |
| Default | Home Security Powered Up | When power supply is switched ON, the modem sends this message to the user |

| | | |
|-----------------|--------------------|--|
| 9 | 9***** ** | When this digit is sent by any number to the GSM modem, it replies by sending the mobile number of the currently active user |
| *9**** ***** | - | active user is dynamically changed by sending this code |
| Default output | Intrusion Detected | Sent to the user when an intruder cuts the IR beam |

Different parameters are taken into consideration for the operation of the system. They are as follows:

1. Speed - We have specifically given a delay of 50ms so that an interrupt is not sent multiple times for the same intruder.
2. Range - The range of the IR sensor in our project is 15cm, which can be easily improved by replacing the IR sensor
3. Height - The device needs to be placed at an appropriate height so that an intruder cannot avoid the beam by going above or below it.

X. CONCLUSION

In this project, a low cost, user-friendly, simple, secure and universally acceptable solution for home security has been introduced. This approach has achieved the target to control the device remotely using an SMS-based system satisfying user needs and requirements. The system is cost-effective as compared to the previously existing systems in the market and can be easily implemented with high reliability and security. The basic level of home security control and remote monitoring has been implemented. The system is extendible and more levels can be further developed. Hence, we can conclude that the required goals and objectives have been achieved.

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