Design and Implementation of Low Cost Home Security System using GSM Network

Sadeque Reza Khan, Ahmed Al Mansur, Alvir Kabir, Shahid Jaman, Nahian Chowdhury

Abstract— Home security has been a major issue where crime is increasing and everybody wants to take proper measures to prevent intrusion. In addition there is a need to automate home so that user can take advantage of the technological advancement in such a way that a person getting off his home does not need to think of his home security again and again. It is therefore the purpose of this invention to provide a security device, which gives immediate notification to the owner and security services like police station or fire brigade at the moment the unauthorized event occurs. This purpose is accomplished via use of some modules and a controller which activates a GSM (Global System for Mobile) module to send one or more SMS (Short Message Service) to the owner and corresponding security services at the time of break in. This system is low cost as it does not contain expensive sensors to detect emergencies and it is also easy to implement as the security modules will take very low space for installation.

Index Terms—GSM, Heat sensor, Modem, Microcontroller, Max232, Obstacle sensor, RS232, SMS, Smoke sensor, Sound sensor, Touch sensor.

1 Introduction

Security systems are important features of a modern Home [1]. The earliest home security systems date back to the early 1900's. These systems were generally expensive and very hard to monitor. In the past 100 years as technology has changed, home security systems have also changed [2]. Early home security systems were very expensive and surprisingly ineffective. The requirement for an efficient and cost effective system to cater the disasterous situations and in order to fulfill the security concerns of home owners when the user is away from home, there was a strong need to develop a cost effective and reliable system to satisfy the security related needs of occupants [3]. Home security has changed a great deal over the last century and will continue to do so as long as technology continues to progress [4]. This paper mainly focuses on the controlling of home appliances remotely and providing security when the user is away from the place. The system is SMS based and uses wireless technology to revolutionize the standards of living. This system provides ideal solution to the problems faced by home owners in daily life [5]. The system is wireless therefore more adaptable and cost-effective. The project is aimed at developing the security of Home against Intruders and Fire. In any of the above cases if any one met while you are out of your home then the device sends SMS to the emergency number provided to it. The device is made up of three components: one or more sensors set up in a remote array depending on the application; a PIC micro-controller; and a GSM module.

- *Sadeque Reza Khan is with the dept. of electrical and electronic engineering (EEE) in Prime University, Bangladesh, E-mail: sadeque_008@yahoo.com*
- *Ahmed Al Mansur is currently pursuing PhD degree in EEE in Islamic University of Technology, Bangladesh, E-mail: mansur.iut@gmail.com*
- *Alvir Kabir is with the dept of electrical and telecommunication engineering in University of Liberal Arts Bangladesh, E-mail: alvirkabir@gmail.com*
- *Shahid Jaman is with the dept. of EEE in Ahsanullah University of Science and Technology (AUST), Bangladesh, E-mail: shahid_jaman_aust@yahoo.com*
- *Nahian Chowdhury is with the dept. of EEE in AUST, Bangladesh, E-mail: nahian.eee@live.com*

2 Proposed System

The system contains sensors to detect obstacle, touch, heat, smoke, sound. The whole system is controlled by a PIC microcontroller 16F76. It collects information from the sensors, makes a decision and sends SMS to a corresponding number by using a GSM modem. If it finds any interruption in its sensors like if the IR is interrupted then PIC will send a SMS to the home owner and another SMS to the Police Station. In the same way for fire interruption a SMS will be sent to the fire brigade and another to the home owner shown in Fig. 1.

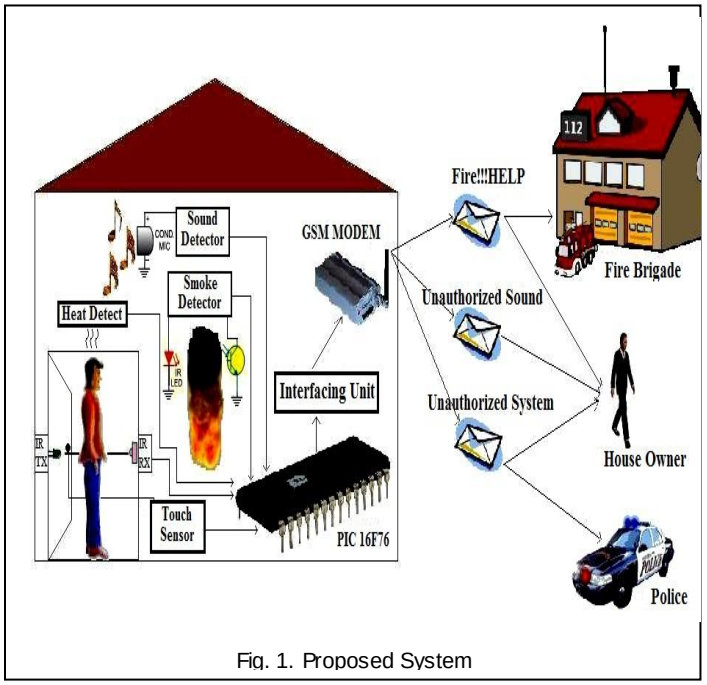


Fig. 1. Proposed System

3 System Design

The design steps and working principles of the system is or-

ganized into different units like controller unit, interfacing unit, GSM module and different sensors. It also requires compiler to build the assembly program used in PIC microchip.

4 HARDWARE DESIGN

4.1 Controller Unit

The control module is built with the microcontroller IC. The central controller is Microchip PIC16F76. It consists of a microprocessor, RAM, EEPROM or EPROM, I/O capacities, ADC, timer, interrupt controller and embedded controller. The microcontroller chip has the versatility to sense inputs and control outputs in the devices. F-family has been selected because it can be burned 1 million times without enabling code protection option. PIC 16F76 is a mid range and 16 series low cost 8 bit microcontroller [6]. It consists of 28 I/O (Bi directional lines) with 25mA current in per pin. It also has five channel built-in A/D converter and serial communication.

4.2 AT Command Supporting GSM MODEM

Modem stands for "modulator / demodulator" and it encodes and decodes signals sent to and from the network servers. A wireless modem shown in Fig. 2 is a network device which connects to a wireless network [7]. Modems are frequently associated with telephone systems, but wireless modems are used with computers and also with communication mediums. Wireless modem interfaces include PCMCIA, Compact Flash, USB and Serial Port. In this project we interface the modem through a Serial Port with a microcontroller IC. AT commands are used to automatically receive the call on system from the preconfigured number and system also sends the voice message to preconfigured number about the status of appliances and intrusion through AT commands [8].

Fig. 2. GSM MODEM

TABLE 1

THE FOLLOWING SECTION DESCRIBES THE AT-COMMAND SET. THE COMMANDS CAN BE TRIED OUT BY CONNECTING A GSM MODEM TO ONE OF THE PC'S COM PORTS.

Command	Description
AT	Check if serial interface and GSM modem is working.
AT$AREG=0	AT command to turn off the automated GSM registration feature.
AT+CFUN=1	Turn the radio on.
AT+COPS=0	Select network operator for registration.
AT+CGATT=1	AT command to start the ATTACH sequence.

TABLE 2

THE FOLLOWING SECTION DESCRIBES THE AT-COMMAND SET. THE COMMANDS CAN BE TRIED OUT BY CONNECTING A GSM MODEM TO ONE OF THE PC'S COM PORTS.

Command	Description
ATD<number>	Dial to a number
ATA	Answer
AT+CMGF=1	Set message format to TEXT mode.
AT+CMGS="number"	Send a message to the telephone number.

4.2.1 GSM Network Overview

Table 1, 2 shows the AT-command which can be tried out by connecting a GSM modem to one of the PC's COM ports [9]. The Mobile Station (MS) is the GSM module we use to communicate. In general however the term Mobile Station refers to a "mobile phone". The Base Transceiver Station (BTS) is the part of the network that receives and sends data from the Mobile Station. The coverage or reception of MS is dependent on proximity and transmission of the BTS it is attached to. The Base Station Controllers (BSC) is a digital switching platform that connects a mobile switching centre MSC and the BTS. The mobile service switching centre (MSC) is the core switching entity in the network [10]. The Gateway Mobile Switching Centre (GMSC) connects a mobile network to a Public Switched Telephone Network (PSTN) which is the backbone of non-cellular telecommunication. The Home Location Register (HLR) acts as a database storing information on all permanent subscribers. Fig. 3 shows the GSM overview.

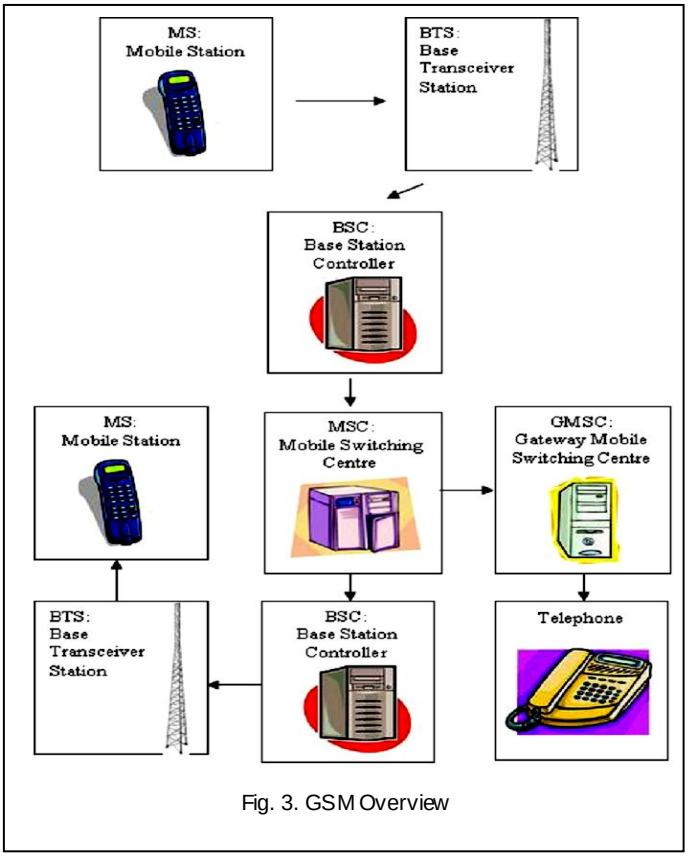


Fig. 3. GSM Overview

4.3 Interfacing Unit

Interfacing unit includes a MAX232 dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply and a RS232 which is the most known serial port used in transmitting the data in communication and interface [11]. This unit is used to interconnect the PIC with the MODEM.

4.4 Obstacle Detection

The circuit comprises a transmitter unit and a receiver unit, which are mounted face to face on the opposite pillars of the gate such that the IR beam gets interrupted when someone is standing at the gate or passing through it. The transmitter circuit (see Fig. 4) is built around timer NE555 (IC1), which is wired as an astable multivibrator producing a frequency of about 38 kHz. The infrared (IR) beam is transmitted through IR LED1. The receiver circuit is shown in Fig. 5. It comprises IR sensor TSOP1738 (IR RX1), NPN transistor BC548 (T1), timer NE555 and some resistors and capacitors. Timer NE555 is wired as a monostable multivibrator with a time period of around 30 seconds. The transmitter and receiver units are aligned such that the IR beam falls directly on the IR sensor. As long as IR beam falls on the sensor, its output remains low, transistor T1 does not conduct and trigger pin 2 of IC2 remains high. When anyone interrupts the IR beam falling on the sensor, its output goes high to drive transistor T1 into conduction and pin 2 of IC2 goes low momentarily. As a result, IC2 gets triggered and its pin 3 goes high to supply 4.2V to PIC 16F76.

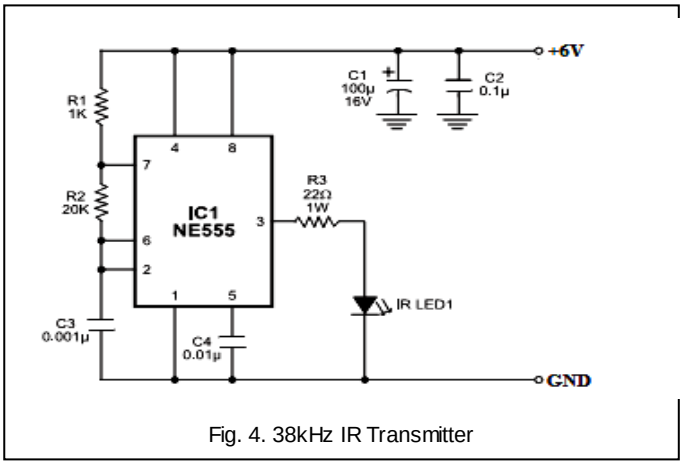


Fig. 4. 38kHz IR Transmitter

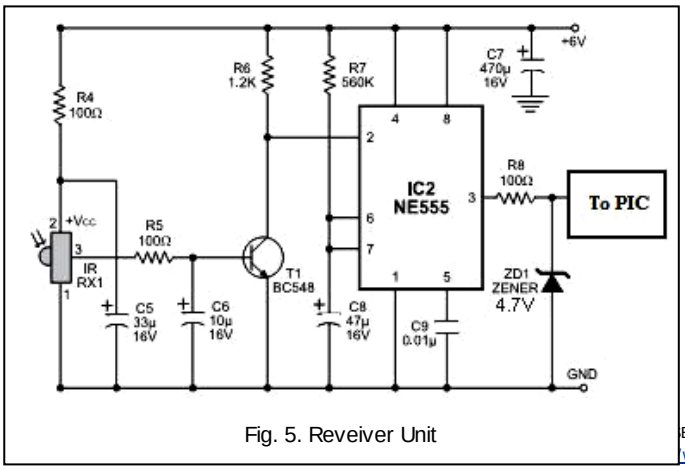


Fig. 5. Reveiver Unit

4.5 Smoke Detector

It also contains an IR transmitter and Receiver. If the smoke is present IR signal is attenuated due to presence of smoke.IR receiver conductivity is converted into voltage and compared with threshold voltage set by variable resisters. If smoke is present, conductivity of IR receiver is reduced and if it falls bellow threshold then it configures a certain pin of microcontroller high. Fig. 6 shows a smoke detector circuit.

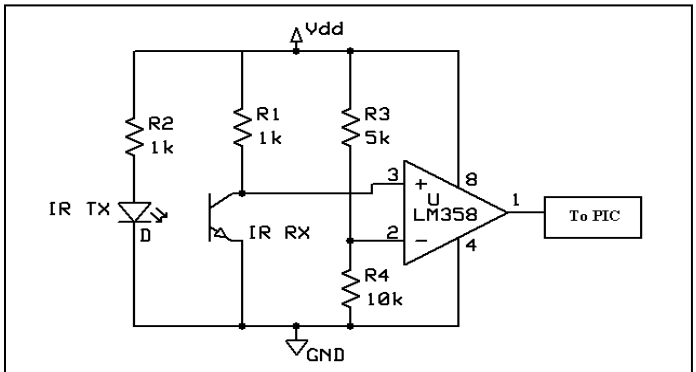


Fig. 6. Smoke Detector

4.6 Sound Detection

Sound signal is received from microphone. Amplified by OP AMP LM358 and then compared with fixed DC Voltage. If the amplitude of sound is more than threshold value defined by user is detected and a high signal is transferred to the PIC microcontroller. Here the sensitivity of the circuit can be varied changing R4 value. C4 value can be varied from 220 to 470nF in order to change the circuit speed-response. ICA amplifies about 100 times the audio signal picked-up by the microphone and drives ICB acting as peak-voltage detector. Fig. 7 shows a circuit diagram of the sound detector.

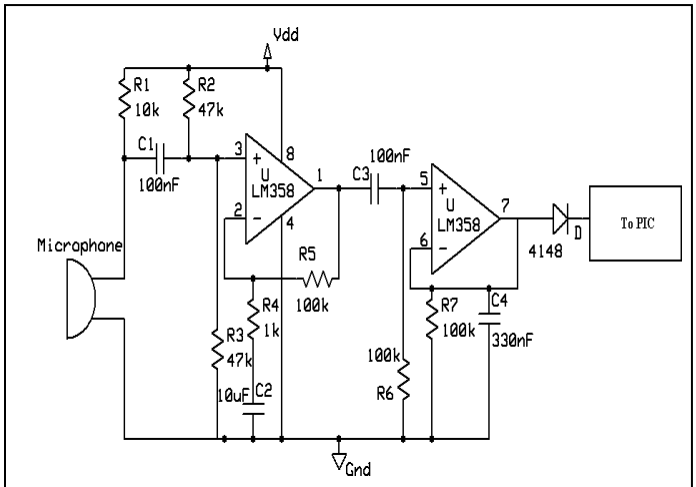


Fig. 7. Sound Detector

4.7 Heat Detection

The pyro-electric sensing is located in order to detect unautho-

rized intruders. It detects the heat generated from the human body and sends a signal to the PIC notifying a possible intruder existence. The electronic circuit uses the CMOS LS6511 integrated circuit for detecting motion from the PIR sensor and initiating appropriate response. The LS6511 includes two staging differential amplifier along with a window comparator. Fig. 8 shows the PIR sensor [12].

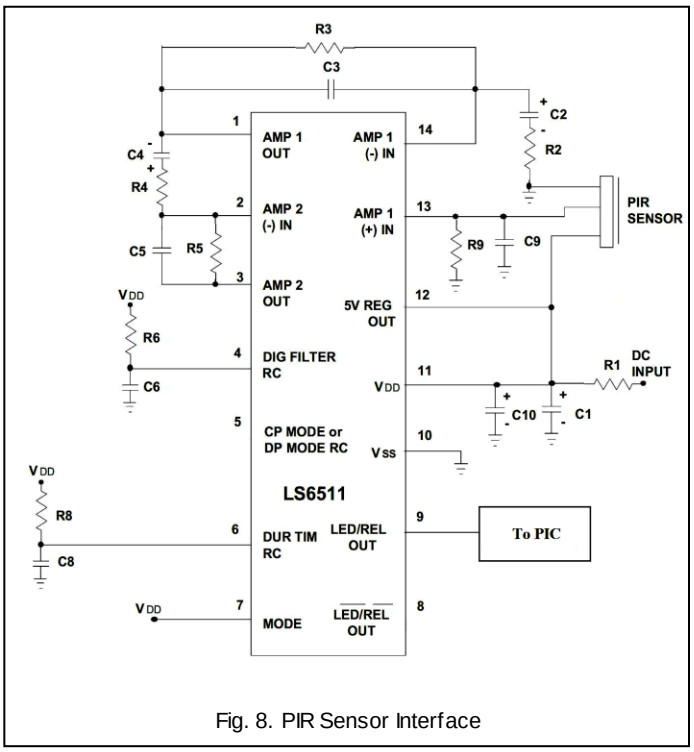


Fig. 8. PIR Sensor Interface

4.8 Touch Sensor

The touch sensor is located in the door knob. The touch wire is connected to pin 2 of the 555 timer. This wire uses the body resistance to activate a certain port of PIC. Fig. 9 shows the schematic diagram of the touch sensor circuit.

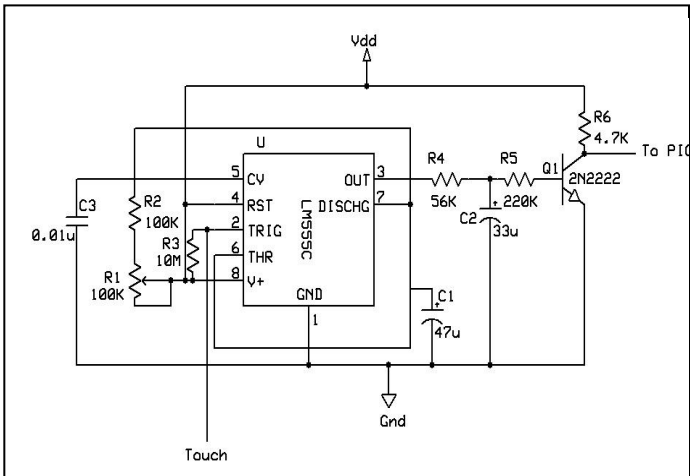


Fig. 9. Touch Sensor

5 Working Diagram

Fig. 10 shows the schametic working diagram of the system, where sound detector, smoke detector, PIR sensor, touch sensor and obstacle detection are connected with the PIC 16F76.

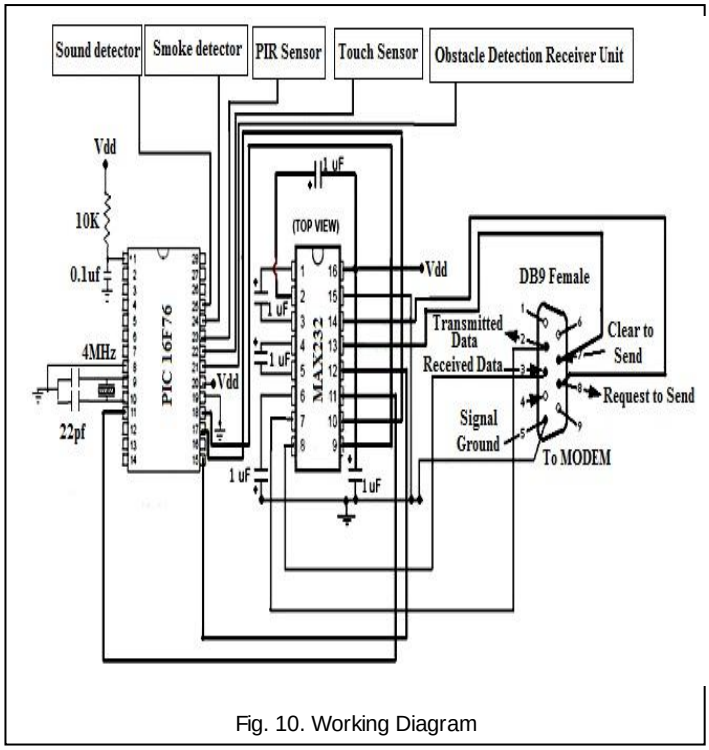


Fig. 10. Working Diagram

6 Software Design

6.1 MPLAB v 8.40

In this system MPLAB v8.40 is used to develop the program for PIC microchip. This compiler consists of Hitech C as well. So this compiler can be used to program in C language. Here the program is divided into six macros. The main macro controls the whole program. It calls the three sub macros 'Unauthorized', 'Fire' and 'Sound' whether there is any fault in the system. Inside these three sub macros two sub macro, 'Tx' and 'Rx' are developed. This two macros help to set communication with network and send the SMS properly. If there is any fault in RB0 or RB1 or RB2 pin of microcontroller then the system will send a preloaded SMS, 'Unauthorized System' to two certain number of home owner and police station. Again if there is any fault in RB3 the PIC will send a message 'Fire!!!' to two numbers of home owner and fire brigade. If the condition of RB4 is changed then the system will generate only one SMS 'Unauthorized sound' to home owner only.

7 FLOW CHART

Fig. 11 shows the flow chart of the total system, which is also clearly showing that if obstacle detector, touch detector, sound detector, heat detector and smoke detector can detect any required signal the system will take necessary action to inform the police, house owner and fire brigade respectively.

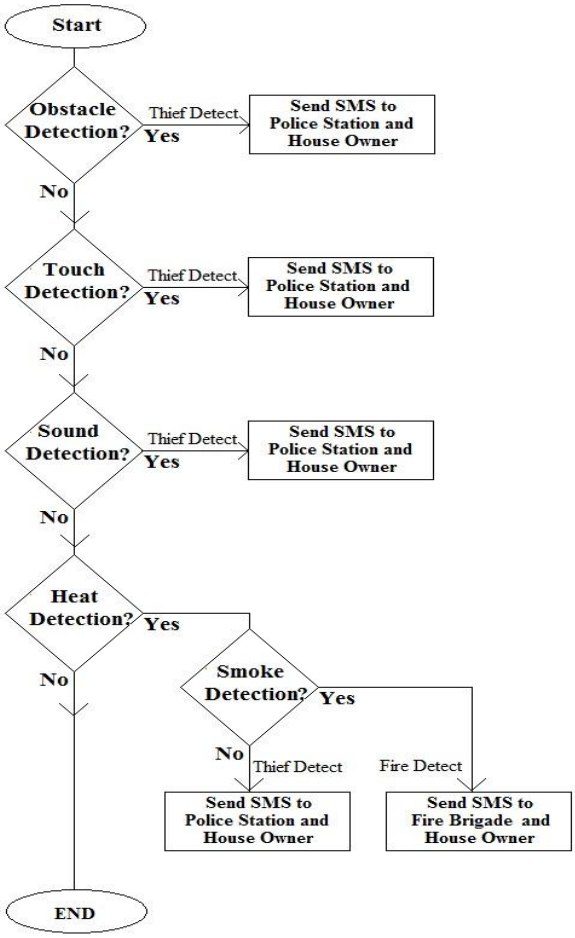
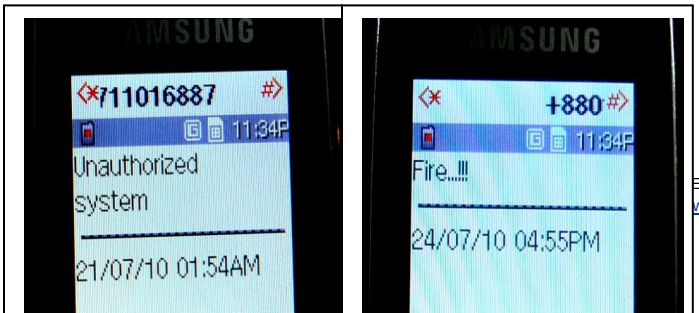


Fig. 11. Flow Chart of the system

8 RESULT

Fig. 12 shows the SMS for unauthorized system, Fig. 13 shows the SMS for the fire attack.



9 CONLUSION

This security home feature is expected to draw much attention in the next decades. People are getting more and more concerned about how to protect themselves and their houses from emergencies. These emergencies include not only thief intrusion, but also fire attack. This device provides a means for being able to securely monitor a house by use of sensors integrated with a microcontroller and a GSM unit. SMS provides an economical and convenient way to alert users of a possible intrusion into the property. The use of mobile handsets as a client device to receive warning messages on implies that the user will not have to carry an additional piece of equipment as most people already have a mobile phone with them most of the time. By using this system the security services like police and fire brigade of a near by region also be informed about the intrusion instantly and they can take steps rapidly. So this system is safe and cost effective as well.

REFERENCES

1. Vishy Karri, J.S. Daniel Lim, "Method and Device to Communicate via SMS After a Security Intrusion", *1st International Conference on Sensing Technology November 21-23, 2005* Palmerston North, New Zealand.
2. Ibrahim Geha, Kfoury Elie, and Ashraf Jaafar "SAFE HOME© An Advanced Home Security System", Department of Mechanical Engineering American University of Beirut Beirut, Lebanon, Volume 2, 2009 , pp 234-239.
3. Nadia Shaheen, Aihab Khan, Malik Sikander Hayat Khiyal and Qaiser Javed "Home Automation Disaster Management System via SMS and GSM" *JOURNAL OF COMPUTING*, VOLUME 3, ISSUE 7, JULY 2011, ISSN 2151-9617, pp 132-136.
4. The-History-of-Home-Security 4th July 2010 [Online]. Available: http://ezinearticles.com
5. Malik Sikandar Hayat Khiyal, Aihab Khan, and Erum Shehzadi "SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security", *Issues in Informing Science and Information Technology* Volume 6, 2009 , pp 887-894.
6. PIC 16F76 Microchip Data sheet [Online]. Available: http://ww1.microchip.com/downloads/en/devicedoc/30325b.pdf

7. Wireless Modem [Online], accessed on 6th June 2010. Available: Web page. http://en.wikipedia.org/wiki/Wireless modem
8. Marriam Butt, Mamoona Khanam, Aihab Khan, Malik Sikandar Hayat Khiyal, "Controlling Home Appliances Remotely Through Voice Command", (IJACSA) *International Journal of Advanced Computer Science and Applications*, Special Issue on Wireless & Mobile Networks, pp 35-39.
9. AT Commands, GSM AT Commands set [Online]. Available: http://www.engineersgarage.com/tutorials/atcommands?page=4
10. Introduction to GSM Network [Online]. Available: http://media.wiley.com/product_data/excerpt/49/04700169/0470016949.pdf
11. MAX232, DUAL EIA-232 DRIVERS/RECEIVERS Available: http://www.datasheetcatalog.org/datasheet/texasinstruments/max232.pdf
12. PIR SENSOR INTERFACE, 10th June 2010. [Online]. Available: http://www.lsicsi.com/pdfs/Data_Sheets/LS6511.pdf