Digital Innovations
& Contemporary Research in SCIENCE, ENGINEERING & TECHNOLOGY
Vol. 6. No. 3, September, 2018

Article Citation Format
Ogunrinola O.B., Olalere N.A., Nwosu E.U. & Babalola I.T.(2018). Enhancing Home Safety Using GSM Technology
Journal of Digital Innovations & Contemp Res. In Sc., Eng & Tech. Vol. 6, No. 3. Pp 37-48

Article Progress Time Stamps

Article Type: Research Article
Manuscript Received: 15rd August, 2018
Review Type: Blind
Final Acceptance:: 5th September, 2018
DOI Prefix: 10.22624

Enhancing Home Safety Using GSM Technology

Ogunrinola O.B.[1], Olalere N.A.[2], Nwosu E.U.[3] & Babalola I.T.[4]
[1,2,3] Dept. of Industrial Maintenance Engineering, Yaba College of Technology, Yaba-Lagos.
[4] Dept. of Electrical Engineering, Yaba College of Technology, Yaba-Lagos.
E-mail: naolalere@yahoo.com
Phone: +2348058484851

ABSTRACT

A burgled home is assumed to be better than a home erupted by fire because a thief only picks what he needs while fire engulfs everything including the building itself. However, be it robbery or fire, no individual would wish to lose his properties to either. This paper presents an automated safety technique that protects your home against fire outbreak and unauthorized access. It is essentially an electronic gadget in which various kinds of sensors were incorporated for detecting gas leakage, smoke, and human presence. When any of these is identified, the concerned sensor sends equivalent electrical signal to a microcontroller, and the microcontroller gives corresponding command to a GSM modem. Consequently, the modem sends a notification SMS message to designated SIM at the advent of the incident. The microcontroller was also interfaced with a buzzer and an LDR. The former serves as a local alarm measure for possible intervention of people within the vicinity, while the latter is for controlling the security lights without human intervention. The program for interfacing each of the hardware with the microcontroller was written in C language but the required hex file was created with the use of Keil µVision5 and loading of the machine language onto the microcontroller was done with the ProgISP software. Proteus software was used for the PBC design and simulation. Finally, effectiveness of each of the sensors as well as reliability of the GSM network was tested and the results corroborates the simulation outcomes.

Keywords: Buzzer, LPG Sensor, Robbery, Smoke. Home Safety & GSM Technology

---

CISDI Journal Reference Format
Ogunrinola O.B., Olalere N.A., Nwosu E.U. & Babalola I.T.(2018): Enhancing Home Safety Using GSM Technology. Computing, Information Systems, Development Informatics & Allied Research Journal. Vol 8 No 1. Pp 37-48. Available online at www.cisdijournal.org

---

1. INTRODUCTION

How safe is your home when you are away or asleep? For the purpose of this paper, a *safe home is a home protected against theft and fire outbreak. While we always blame the government or constituted authority for insecurity and break-ins, the guilt for fire outbreak, which is another aspect of home safety, is often placed on the occupants. According to* The Tide Newspaper (Dec. 24, 2010)*;* Fire outbreak has become a perennial societal issue. People die every day and some are seriously injured in addition to losing their properties as a result of fire *outbreaks.*

Adulterated fire-extinguishing chemicals, obstructing structures, lack of good access roads and sophisticated equipment are some of the hindrances to the job of the firefighters. Data obtained from the Lagos State fire service *shows that gas leakage and electricity are the major causes of home fire outbreaks. This fire eruption often originate from either the kitchen or electrical outlets. However, most of the fire incidents and cases of home robbery people encounter today would be averted with the implementation of the system developed in this paper.* Below is a brief review of some advancements in the area of home safety technology.

1.3 Home Safety Techniques (Burglary)

The struggle to protect life and properties is as old as man himself. In the early days, people had mainly relied on the sounds from animals like geese and dogs to detect unauthorized entry into their homes. This idea is quite crude and comes with a lot of limitations.

I) Burglar Alarm System

The first electro-magnetic alarm system was a battery-operated gadget that reacted to the closing of an electric circuit. Doors and windows were connected as independent units by a parallel circuit. If a door or window was opened and the electric circuit closed, the sudden flow of current caused one of the attached magnets in the system to vibrate. The electro-magnetic vibrations were transmitted to a hammer which then struck a brass bell. This system was effective only when there is someone within the neighborhood to take necessary action. A better result was later obtained by connecting many alarm systems to a central monitoring station such that in the event of break-in, the premises control unit communicates with the central station and operators at the station take appropriate action (Terrance, 2012). However, communication with the monitoring station can be terminated simply by cutting off the connecting cables. Other drawbacks famous with this invention are the high cost of installing long wires to reach remote places and the fee charged by security companies for providing monitoring services.

II) Video Surveillance System

This is the use of electronic means such as CCTV (closed-circuit television) to watch over an area. An earlier model of video surveillance system was a large motorized analog camera that moved down a track to view the exterior of a home through four peepholes mounted in the front door. The video camera transmitted grainy images of visitors to a stationary television monitor that also served as the control panel where the homeowner could remotely control the camera's movements. (*Kumar & Svensson, 2015).* A major weakness of this model was that there was no means of recording the images. With series of developments since 1942 to date, we now have IP cameras for remote monitoring via PC (Personal Computer) using standard network and PC server hardware for video recording and management. The use of video surveillance system is very effective in deterring crime but a large number of homes in developing countries cannot afford it considering its acquisition, installation and running costs. Video surveillance can be hacked if it uses the internet and it gives room for people to be spied upon unnecessarily. People are often not free to wander at will and behave as they wish wherever CCTV cameras are being installed.

1.4 Home Safety Techniques (Inferno)

Prevention of fire outbreak in the home is achievable through basic precautions on the side of the occupants. Human activities in the home that often lead to inferno include: Storage of flammable substances around the home. Refueling a generator while it is running. Smoking in bed and careless disposal of cigarette stubs. Falling asleep while cooking. Gas leakage. Faulty wiring and reckless use of electrical appliances. It requires a perfect being to be safe from all the potential causes of fire. Hence the need for mechanisms that could arrest the situation before it gets out of hand.

1.4.1 Fire Sprinkler System

This is typically a fire-fighting system commonly used in commercial buildings to put-out fire as quickly as possible. There is a small heat-sensitive plug right inside the sprinkler head, and when its surrounding air is up to 155 °C, the plug shatters and allows water to flow through the system to quench the fire underneath (Brett Staines, 2017). Since fire sprinkler systems are triggered by heat and not smoke, some amount of damage would have been done before the activating temperature is attained. Another flaw in this technique is the indiscriminate sprinkling of chemical.

1.2.2 Automatic Fire Alarm System

The automatic fire alarm system consists of smoke and heat sensors located throughout a building to detect a fire in its early stages. These sensors are connected to a fire alarm control panel by special cables, while the control panel itself is connected to **notification devices (**bells, horns, speakers, chimes, strobes and flashing lights**)** to give either an audible or a visual signal informing the occupants that there is a fire emergency so that they may evacuate the building. The control panel also reports the emergency to first responders via signal to a central monitoring station (Brett Staines, 2014). This system is *more effective in saving life than properties and it is expensive.*

2. MATERIALS AND METHODS

The home safety device presented in this paper combines both burglary and fire prevention in a single unit. The system consists of **four** sensors namely: smoke sensor, LPG sensor, PIR sensor and an LDR. The first two are for detecting potential fire outbreak, the third one is for sensing illegal entrance into a premises, and the last one is for automatic control of the security lights around a building. The first three sensors mentioned above were interfaced with a microcontroller such that whenever the presence smoke, gas, or human is detected, the concerned sensor sends equivalent electrical signal to the PIC microcontroller.

A number of outdoor lights are controlled by the microcontroller through electromagnetic relay based on status of the LDR. Also interfaced with the microcontroller was a GSM modem, an LCD panel, and a programmable buzzer.

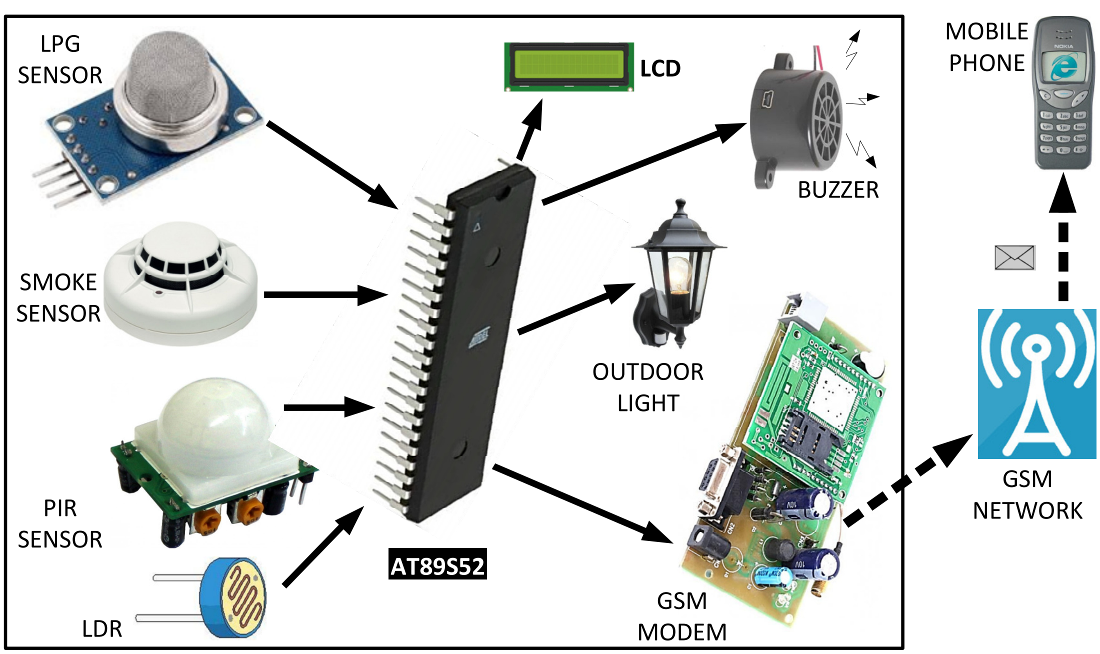

Figure 2.1: Layout of the System

As soon as the microcontroller receives a signal from any of the first three sensors mentioned, it gives corresponding AT command to the GSM modem and a notification SMS message would be sent to designated SIM or mobile phone number by the modem. In this manner, the responder (firefighters, police, or property owner) is aware of the impending fire outbreak or intrusion in a home and appropriate action to avert the incidence could be taken. Meanwhile, the LDR helps to switch on the security lights at dusk and put them out at dawn based on the darkness or light it senses. The LCD unit was integrated into the system to communicate on-going processes in the microcontroller, while the buzzer serves as a local awareness for possible rapid intervention of people within the vicinity.

2.6 System Design

The activities here involve hardware design, software design, and fabrication. The hardware is typically made up of **initiating devices (sensors), control device (PIC microcontroller), and notification devices (buzzer and GSM modem). Other integral parts of the entire system include** the GSM network, a cell phone, and the power supply section. The software aspect involves series of computer programs for interfacing each of the sensors and output devices with microcontroller.

A) The LPG Sensor

The LPG (Liquefied Petroleum Gas) sensor can detect the concentrations of propane and butane (constituents of LPG) from 200 to 10000ppm. MQ-6 was used in this design because it can serve as a digital or analog sensor. Its ability to produce digital output voltage: 0V or 5V (TTL Logic) eliminated the need for a comparator IC. The **sensor module has four pins (figure 2.1). Pin 1 (**Vcc**) was used to** power the module from a +5V dc supply, and pin 2 (GND) was used to connect the module to system ground. Digital output is obtained from pin 3 (D0) by setting a threshold value using the VR1 (figure 2.3), while pin 4 pin (A0) outputs 0-5V analog voltage. A0 gives out voltages corresponding to the levels of LPG sensed. When a certain threshold is reached, D0 goes high and a signal is sent to the microcontroller. The **MQ6 sensor has three pairs of pins labeled: H, A, & B.**

B) The Smoke Sensor

The optical type of smoke sensor was used because it can detect small particles of smoke produced by fast-flaming fires and also very sensitive to slow burning, smoldering fires. The sensor contains a photocell that receives infrared beam from an LED. The photocell generates and maintains a constant circuit current as long as the beam of light continues to fall on it. This circuit current is interrupted whenever smoke particles cloud the beam. A signal is sent to the microcontroller indicating the presence of hazardous smoke. Sensitivity calibration of the sensor is done based of the place where it will be installed to prevent false alarms during normal activities. In areas where smoke does not usually appear, the sensor would be calibrated to maximum sensitivity.

C) The PIR Sensor

This sensor is to be installed at the most likely places through which a burglar can gain access into a home. Passive Infrared (PIR) sensor contains a pair of pyroelectric detector that generates a temporary voltage when heated or cooled. The temperature changes is a result of infrared radiation from the body of an intruder. There are two preset resistor on the sensor module (figure 2.1). One is used for adjusting the delay time and the other for adjusting the sensitivity. The default delay time is 5 seconds which is also known as the sensor's response time. The sensor sends a signal to the microcontroller whenever value of the generated voltage lies outside the predetermined range.

D) The LDR

Light Dependent Resistor (LDR) is a component that offers higher resistance when its surroundings is dark, but lower resistance when light falls on it. Therefore, the amount of daylight sensed by the LDR is translated to resistance value and the microcontroller generates a control signal after analyzing the amount of resistance available on the LDR in terms of voltage. The control signal turns on/off an NPN transistor which energizes/de-energizes a relay coil to either put ON the security lights or switch them OFF. Although a photodiode or phototransistor possesses better sensitivity, our choice of LDR in this design is based on the facts that it is cheap in price, easily available in market, sufficient for the task, and can be easily interfaced with microcontroller.

E) The LCD Module

A 16 x 2 Liquid Crystal Display (LCD) unit was used because of its ability to display numbers /character/graphics, the ease of programming it, and its low power consumption. The module has an in-built HD44780 controller which must be initialized before sending any data to the LCD otherwise nothing will be displayed. To power the LCD unit, its VCC and GND pins were connected to the +5V dc and the ground respectively (figure 2.3). The backlight pins (A and K) were connected across a 5kΩ potentiometer through a 330Ω current limiting resistor and the output of the potentiometer was then connected to the VEE pin so that the LCD contrast can be adjusted simply by rotating the potentiometer knob forward and backward.

F) The Programmable Buzzer

This is a transducer that converts electronic signal from the microcontroller into sound whenever any of the sensor's output is high. In order to give voice notification to the inhabitants and neighbourhood, MP3 file was programmed in this buzzer via USB from a computer. Indicating the actual approaching hazard will aid decision making aimed at rescuing the situation. The buzzer can continuously repeat a speech, and its volume can be controlled by file programming.

G) The GSM Modem

SIM300 GSM modem was used. This modem accepts any GSM network SIM card and acts just like a mobile phone with its own unique phone number. It has both TTL and RS232 interfacings, although it can only connect with a PC that has a serial port (DB9), but it is cheaper than a modem which provides USB interface. The TTL interface was used to directly connect the modem with the microcontroller, while the RS232 interface was used for setting-up the modem and develop embedded applications such as the one for SMS control. The RXD of the GSM modem was connected to TXD (pin 11) of the microcontroller, while TXD of the modem was connected to RXD (pin 10) of the microcontroller such that the RXD and TXD were used for the receiving and transmitting data continuously (figure 2.3).

H) The AT89S52 Microcontroller

This is a variant of 8051 microcontroller manufactured by Atmel™. It is a 40 Pin PDIP (Plastic Dual Inline Package) with each pin having an input/output line. This means that each pin can be used for both input (read data form devices) and output (send instruction to devices) because they are bi-directional. AT89S52 has four ports with eight pins each; making a total of thirty-two input/output lines. P3.7 is interpreted as pin 8 of port 3 and pin 17 of the microcontroller. Utilization of the four ports for interfacing each of the hardware components was done as follows.

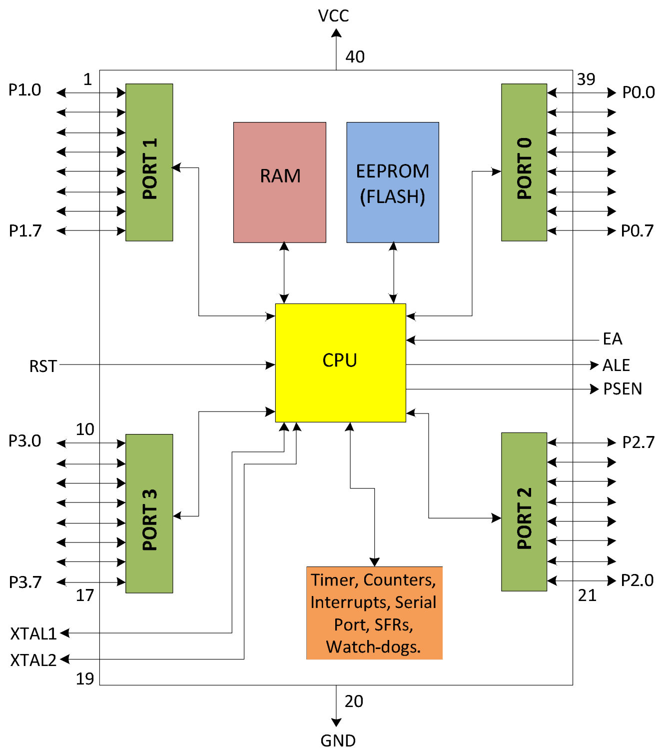

Figure 2.2: Architecture of AT89S52 Microcontroller

The data pins (DB0 to DB7) of the LCD module were connected to port 0 (P0.0 to P0.7) of the microcontroller, while we used P1.0 to connect an LED to the microcontroller for signal transmission/power indication purposes. The remaining pins of port 1 were reserved for additional sensors or interface devices except P1.7 which was connected to the programmable buzzer through its control circuitry which included a transistor, diodes, and resistors. P2.5, P2.6 and P2.7 were connected to the control pins (E, R/W and RS) of the LCD module, while the remaining pins of port 2 (except P2.0) were connected to the sensors as follows: P2.4 for the LPG sensor, P2.3 for the LDR sensor, P2.2 for the smoke sensor, and P2.1 for the PIR sensor. These sensors were not connected directly to the microcontroller but through LM324 op-amp to amplify the sensor signals.

The GSM modem was connected to port 3 (P3.0 and P3.1). Aside these thirty-two pins of the four ports, RST (pin 9) is the reset pin used when there is need for the microcontroller or program to start from the beginning. Pin 18 and 19 were connected to a 20MHz crystal oscillator, while pin 20 was connected to the ground. Pin 29 (PSEN) and pin 30(ALE) are used for connecting the microcontroller to external memory but they were left unused in this design. Pin 31 (EA) tells the microcontroller to use external memory when connected to Ground. This pin was connected to Vcc because no external memory was involved. Finally, pin 40 was connected to the +5V dc supply (figure 2.3). AT89S52 has two different memory types namely: RAM (Random Access Memory) and EEPROM (Electronically Erasable and Programmable Read Only Memory) also known as the FLASH memory. RAM which has 256 bytes of memory is used to store the data (variable) during execution of a program, while the EEPROM which has 8k bytes of memory is used to store the program itself. The CPU reads the program from the FLASH memory and execute it by interacting with the various peripherals such as the GSM modem, buzzer, sensors, display unit, etc.

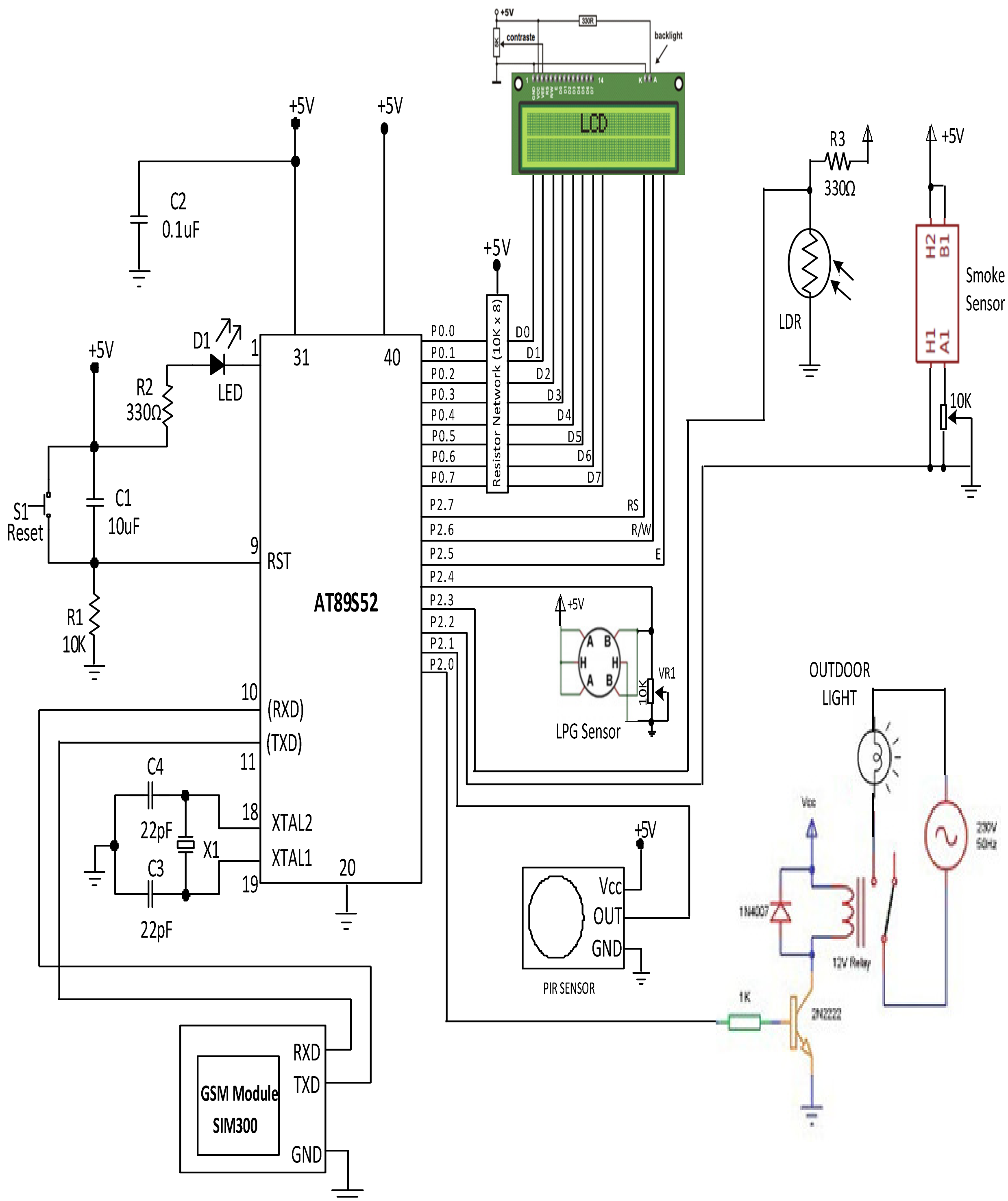

Figure 2.3: Implemented Circuit Diagram

3. RESULTS AND DISCUSSIONS

Performance evaluation for each of the sensors was carried out through a number of trials by generating various disturbances as their respective inputs. The result was helpful in further sensitivity calibration of the sensors for their suitability in our design. The sensitivity adjustment for the PIR sensor affected the amount of infra-red radiation required to trigger the sensor. This applies to all other sensors in accordance with what they sense. Appropriate delay time for each of the sensors was decided by observing the response time of the GSM modem and the buzzer. Also, SIM cards of different network providers were inserted in both the transmitter (GSM modem) and the receiver (mobile phone) to evaluate reliability of the network.

3.1 Testing the PIR Sensor

With deliberate movements across the sensor at different distances and angles, the view field of the sensor was observed to be 5×5 meters at vertical angle from -11°C to 11°C and horizontal angle from -19°C to 19°C. **An** oscilloscope was connected to the comparator output circuits of sensor to measures the output currents and record the alarms generated when intrusion was detected. The intrusion process was repeated for 8 trials and the timing diagram for each case was plotted and displayed on the oscilloscope.

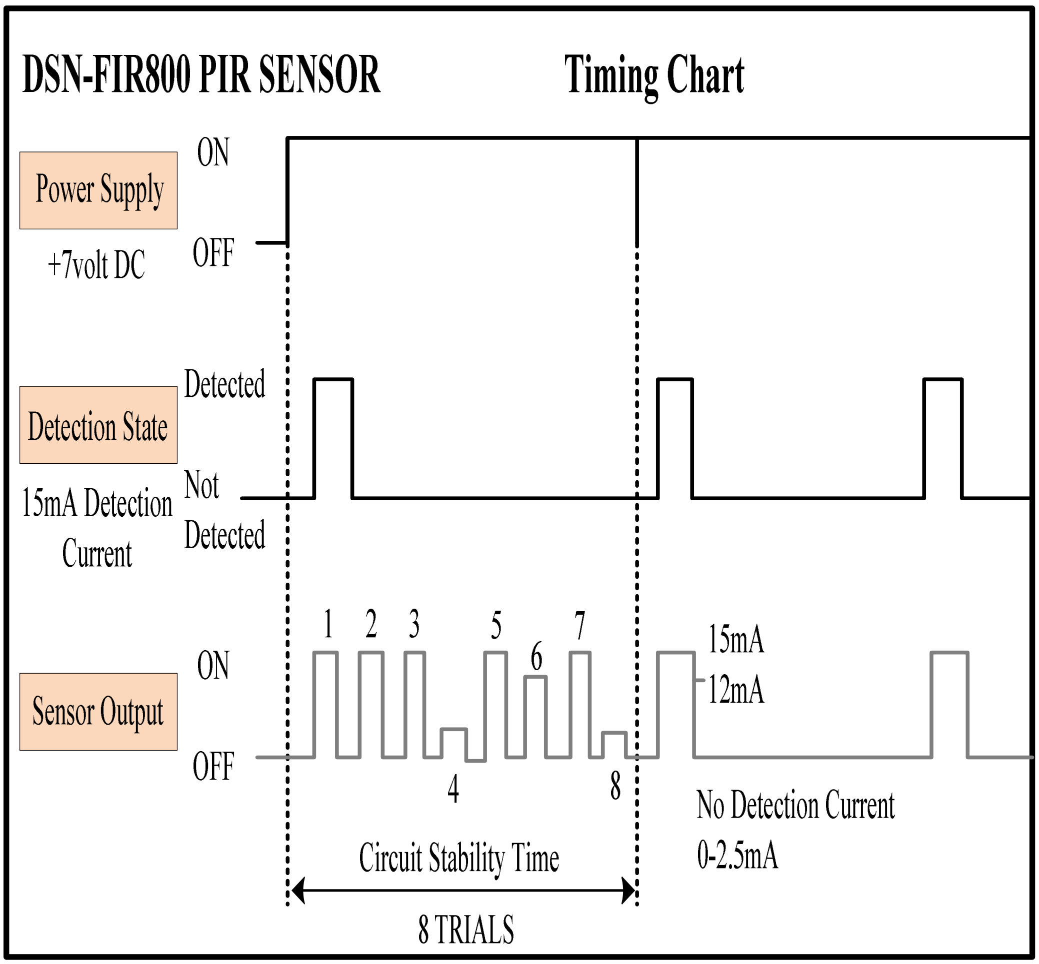

Figure 3.1: Sensor Timer Output Results

The PIR sensor failed in detecting intrusion for two trials (trial 4 = 2mA, and trial 8 = 1.5mA) where the output current lies between zero and 2.5mA. These values are considered as not alarm values. Trial no 6 recorded 12mA and it is considered as a partial alarm value. For the remaining five trials, the PIR sensor recorded alarms and the output current was 15mA (detection current).

3.2 Testing the LPG Sensor

The LPG sensor was place near a gas stove burner at a distance of one metre. The burner was turned ON for a few seconds without igniting it, and then turned OFF. The preset VR1 (figure 2.3) was varied to adjust sensitivity of the sensor until the buzzer was triggered and SMS message was received. Since resistance of the sensor varies with the concentration of LPG in the air, for more accuracy and to distinguish one gas from another measuring of the ppm was carried out. The sensor was calibrated by finding the value of resistance it produces in fresh air (Ro) and the output voltage was recorded. Resistance of the sensor in gas concentration (Rs) was then calculated using the formulae:

$$R_s = \frac{V_C \, x \, R_L}{V_{out}} - R_L$$

Where: V_C is the reference voltage (5V dc supply), R_L is the load resistance, and V_{OUT} is the recorded MQ-6 gas sensor output voltage. The equivalent value of ppm for any particular gas can then be obtained using the graph given in the **MQ-6 datasheet.** The values are plotted on a semi-log paper. They will represent a curve like an exponential one when plotted on a normal graph.

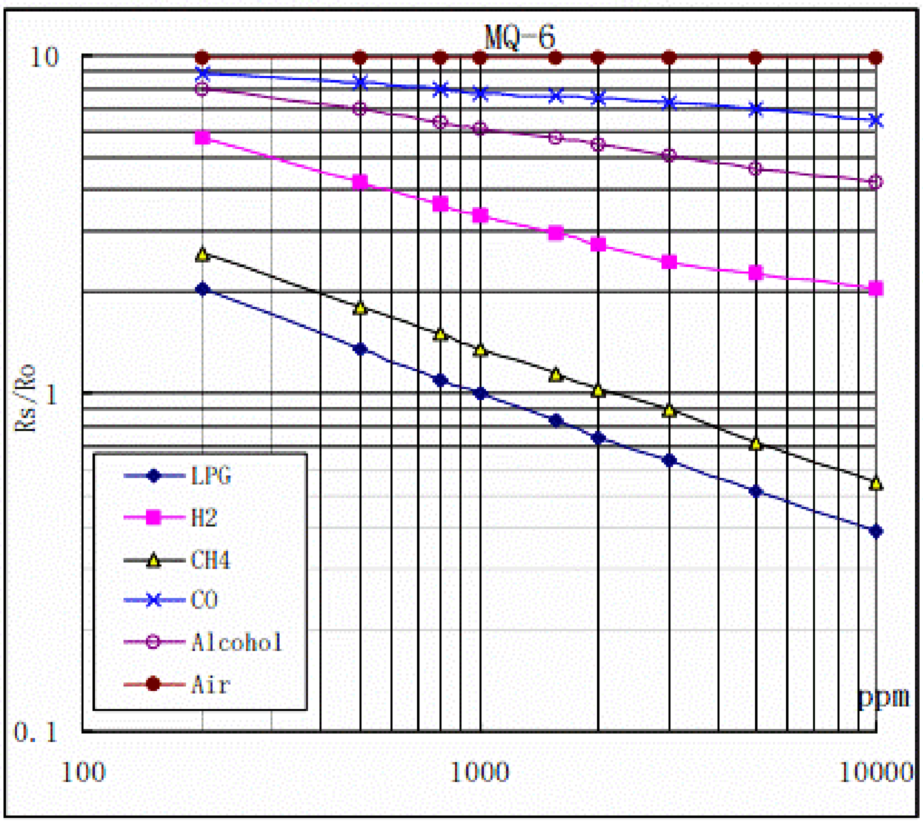

Figure 3.2: Sensitivity Characteristics of MQ-6 for Several Gases

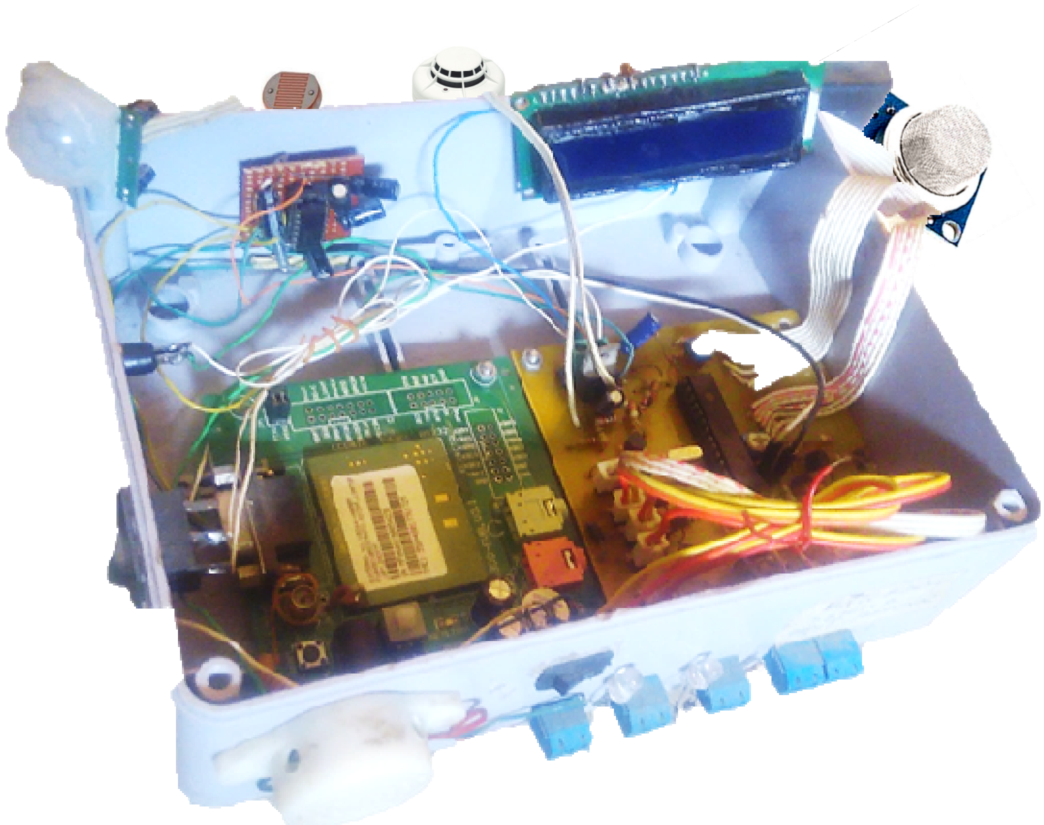

Figure 3.3: Image of the Model

4. CONCLUSION

Safety is desired in almost every aspect of human endeavours and not in the home alone. Therefore, application of the safety system presented in this paper cuts across residential, commercial, and industrial purposes. The resultant impact of safety at home and workplace is felt on the socio-economic development of a nation as it promotes business activities and encourages both local and foreign investors. When a home or workplace is protected against fire and theft, the owner would be entitled to reduced rates on insurance policy. Seeing your outdoor (security) lights always ON, even in the daytime, can give a clue to criminals that the occupant is likely to be away. This is regardless of the fact that the energy waste would be accompanied by higher electricity bill. This danger and wastage are eliminated through one of the features of this project. With the idea of using GSM network provider infrastructure, the need of setting-up a personal transceiver rig to cover a long distance is excluded. This translates to a low initial cost in the usage of the system. Other benefits associated with deployment of GSM network include wide coverage, reliability and accessibility. All the components used in our design were easily acquired in local markets at very pocket friendly prices which makes the project relatively cheap. Finally, the system needs periodic maintenance to ensure all the sensors are working properly, and forestall false alarm or alert failure.

REFERENCES

2. Bukowski, R.W., and Mulhol-land, G.W. (1978.) "Smoke Detector Design and Smoke Properties". National Bureau of Standards, National Engineering Laboratory, Center for Fire Research.
3. Hong, S.G. et al., "Window Energy Detection for Unmanned Surveillance with PIR Sensor," *Proceeding of IEEE International Conference. Trust, Security Privacy Computer and Communication,* June 2012, pp. 1543-1547.
4. Horowitz P. and Hill W. (1989), "The Art of Electronics". 2nd Edition, Cambridge University Press.
5. Iyapo Kamoru Olarewaju *et al*, "Design and Construction of an Automatic Home Security System Based on GSM Technology and Embedded Microcontroller Unit" *American Journal of Electrical and Computer Engineering* (June 2017), Vol. 1, Issue 1, pp, 25-32.
6. Jun Zhang, Hui Wang, Tianhua Meng and Guangming Song, "Design of a Wireless Sensor Network Based Monitoring System for Home Automation", *International Conference on Future Computer Sciences and Application (ICFCSA)*, Nanjing (June 2011), pp. 57-60.
7. Karri V., and Daniel Lim J. S., "Method and Device to Communicate via SMS after a Security Intrusion". *1st International Conference on Sensing Technology* (November 2005), Palmerston North, New Zealand, pp. 21-23.
8. Mahmud S.A, and Mohameed G.A, "Development of a Simple Sound Activated Burglar Alarm System" *Leonardo journal of sciences.* Issue 9, July-Dec 2006.
9. Meyer M., Hotter M., and Ohmacht T., "A New System for Video-Based Detection of Moving Objects and its Integration into Digital Networks". *30th Annual International Carnahan Conference* (1996), pp. 105-110.
10. Ogunrinola O.B., Olalere N.A., Nwosu E.U., and Alao W.A., "Smart Phone Based Intrusion Detection System". *Proceedings of SMART-iSTEAMS International Multidisciplinary Conference* (February 2018), Ogwuashi-uku, Delta State, Nigeria, pp. 201-210.
11. Osman E.A., et al, "An estimation of a Passive Infra-red Sensor's Probability of Detection" *Proceedings of the 7th Conference on Nuclear and Particle Physics* (11-15 Nov. 2009), Sharm El-Sheikh, Egypt.
12. Sadeque Reza Khan, et al, "Design and Implementation of Low Cost Home Security System using GSM Network". *International Journal of Scientific & Engineering Research* (March 2012), Volume 3, Issue 3, pp.194-199.
13. Sheikh Izzal Azid, and SushilKumar. "Analysis and Performance of a Low Cost SMS Based Home Security System", *International Journal of Smart Home,* (2011) July. Vol. 5, no. 3.
14. Theraja B. L. and Theraja A. K. (2003), "A Text of Electrical Technology". 23th Edition, Schand and Company Ltd. New Delhi.
15. Visa M. Ibrahim, and Asogwa A. Victor, "Microcontroller Based Anti-theft Security System Using GSM Networks with Text Message as Feedback". *International Journal of Engineering Research and Development* (August 2012), Volume 2, Issue 10, pp. 18-22.