

## RESIDENTIAL AREA SECURITY NETWORK AND REMOTE HOME SECURITY SYSTEM

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**Abstract:** *The spate and frequency of home intrusion is exponentially increasing especially in developing nations. Although there are several smart security devices that allow for enhanced features to prevent home invasion, however, their current cost has made overall cost of implementing home security systems unavoidable for average house owners in the developing countries. Community policing is another means through which home invasion can be combated, but the implementation has suffer setback in developing countries because of fear of being hijacked by high profile people. In this paper, a community policing security framework, which helps to monitor and send information about the security and safety of a residential area to a remote location, is developed. In the framework, each house security system in the area can communicate with the Area Security Network (ASN) as well as with the authorized owner of the house and nearby neighbours to increase the probability of Short Message Service (SMS) delivery. The system incorporates multiple sensors to detect gas leakage and smoke presence, as well as an infrared transceiver to detect intrusion. The prototype when tested, allowed an authorized occupant upon entering the house to enter the password within 30seconds to deactivate the alarm, otherwise it will be considered as intrusion and the alarm will be triggered on and SMS will be sent. In the event that the occupant is at home while some other forms of security breach occurs, the pressing of the panic button ensure that SMS alert is sent to the ASN.*

**Keywords:** *Gas Detection, Intrusion Detection, Panic Situation, Safety, Security.*

### 1. INTRODUCTION

Cases of intrusion and burglary are on the increase due to economic hardship and fallen moral standards. Therefore, the importance of good security in a home environment can never be over-emphasized as it gives the house owner peace of mind. However, it has been observed that in estate areas with security personnel, there are still incidences of crime and burglary, this is because there is little or no security situational awareness of the area by the security persons. Therefore it becomes necessary to have individual house supervision, but the cost of hiring security operatives to fill such gap, may not be affordable to the owners. An alternative of having the supervisory role and reporting conducted by electronic devices deployed in the area premises is thus very desirable in this situation. It is also becoming more desirable for people to be able to remotely control their homes and appliance when they are not around; there is therefore a need to automate the home so that the authorized owner can take advantage of technological advancement. The availability of this kind of home systems will make security and safety breaches to be detected easily, and notification sent to appropriate authority, in order for necessary action to be carried out. Furthermore, this system enables home owners to collaborate with security authority in ensuring the security and safety of the area, since notification is sent to the owner whose house security was compromised as well as neighbours. Therefore, the idea of community policing is inherent in the system. This makes the system especially useful for the developing world, where community policing has not been implemented, because of fear of being hijacked by few high profile people.

### 2. RELATED WORKS IN SECURE SMART HOME SYSTEMS

A movable intrusion detection system that utilize vibration and magnetic sensors, which sends SMS to home owner was presented in Elfasakhany et al. (2011). However, the system is useful only when direct attack is made on the door or window. A means of granting access to authorized people in highly secured area based on face recognition was presented in Kartik, Kumar and Srimadhavan (2013), the system sounds alarm and streams captured video when unauthorized entry is attempted. The system has been found to be expensive; require security operatives to be nearby and it is susceptible to false acceptance and rejection. Budijono, Andrianto and Noor (2014) implemented an intrusion detection system such that if PIR sensors detect any obstacle in covered area then the controller capture image through serial camera and save it to SD card; activate the alarm and send SMS to the home owner. However, this design is only limited to break-ins. In Potnis et al. (2015), Parab and Joglekar (2015), intruder detection systems for home security were implemented. These sent SMS to home owners in the event of intrusion. Although they are inexpensive, they are not sufficient for modern home needs. Shawki et al. in 2015, proposed a combination of home automation and home security system. It has provision to control some devices via GSM, while the security aspect only deals with Passive Infra-Red (PIR) based intrusion detection and designed smoke detector circuit. An intrusion detection

system based on pressure sensor, which sends SMS to house owner was presented in Hasan et al., (2015). It allows manual reset of the system through keypad and password from Bluetooth connected mobile phone; door control is provided by servo motor controlled magnetic switch. The system in Rahman et al. (2015) provides means of controlling five electrical loads via SMS. It also carries out motion detection through potential difference of door lock metal plates, temperature sensing, and flame sensing; this information is conveyed to the home owner via SMS. All the previously discussed home security system provided limited security; since only the home owner is aware of the security situation, which can lead to action being delayed. The security architecture being proposed in this work incorporates the idea of community policing into home security system. In (García et al., 2017), the use of Computer Vision in the Internet of Things, making use of pictures as sensors was explored. Currently, IP cameras is used in order to create safety areas, cities, or homes. This system needs people who watch the camera images, watch the recording after something occurred, or watch when the camera notifies them of any movement. These disadvantages do not suit Smart Cities and Smart Homes, which are proliferating around the world. In the design, a possible architecture (MIDgar) was used to integrate Computer Vision in an IoT platform. This Computer Vision module, analyses picture sequences, and returns to the IoT platform a Boolean result, as if it was a button sensor. However, if model is weak, the Computer Vision module could have a low accuracy. The module was tested using three different models for detecting upper bodies, heads and shoulders, and frontal faces. After evaluating the module with the three models, the model for detecting head and shoulders was found to be the best in the first phase, in which isolated pictures was analysed, with an accuracy of 100.00% for True Negatives but a 34.38% of accuracy for True Positives. However, much better results was obtained by analysing whole sequences of pictures. The model for detecting upper bodies achieved an accuracy of 100% for True Positives and 100.00% for True Negatives. In spite of the merit of the design, the solution is complex and expensive, and it can only address break-ins issue. In (Mahler, 2018) this paper, the feasibility of using old smartphones and their on-board sensors to build a home security system was explored. The unique vibration signatures of door-related events, such as opening and closing were compared to many types of environmental vibrational noise. These door events were captured by the accelerometer of a smartphone when the phone is mounted on a wall near a door. The rotation of the door was also captured by the magnetometer of the smartphone when the phone is mounted on the door. A machine learning algorithm was designed for the accelerometer and magnetometer data, to detect door opening events in accordance with a given threshold. To further augment the security system, the smartphone's built-in microphone was incorporated to detect door and window openings across multiple doors and windows simultaneously. The built prototype home security system can detect door openings and notify the homeowner via email, SMS and phone calls upon break-in detection. Experiments in a residential home show that the accelerometer-based detection can detect door open events with accuracy higher than 98%, and magnetometer-based detection has 100% accuracy. By using the magnetometer method to automate the training phase of a neural network, the sound-based detection of door openings has an accuracy of 90% across multiple doors. The limitations of the design are that the cost of smart phones is still very high in developing countries and the security is limited to break-ins.

### 3. RASN AND RHSS

The Remote Area Security Network (RASN) is comprised of the area security control room and Remote Home Security System (RHSS) enabled houses in the area. The control room has capability to receive SMS from all RHSS in the area and initiate appropriate response. To avoid missed SMS, an alarm signal is generated upon event signal reception. The RHSS system is controlled by an ATmega8L microcontroller chip which receives input signals from the sensors and performs a specified function based on the signal received. The output section includes the LCD, SMS module, LED and buzzer. The SMS module used is the SIM800L, which is a quad-band GSM/GPRS module. The general block diagram for the RHSS system is shown in Figure 1 and the schematic diagram is shown in Figure 2. This system hardware can be divided into three modules; the sensing network, the notification system and the alerting system. The sensors, which are active infrared (IR) sensor and MQ-2 gas detector monitors the condition of the house and send signal to the microcontroller.

The notification system consists of the LCD and the SMS Module. The microcontroller receives signals from the sensors and synchronizes with SMS Module in real time. When there is input signal from any sensor, data will be processed and a command will be issued to SMS module to send notification SMS to the user, the neighbour, as well as to the RASN. The LCD is especially useful in the event of inputting the password to deactivate alarm or change of password by the house owner. The audible alarm sounds buzzer when condition necessitates it.

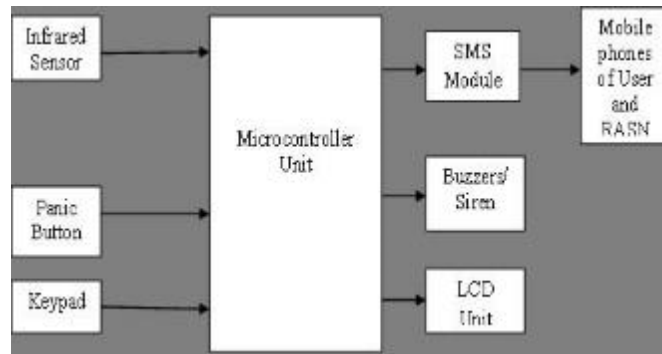


Figure 1 Block diagram of the system

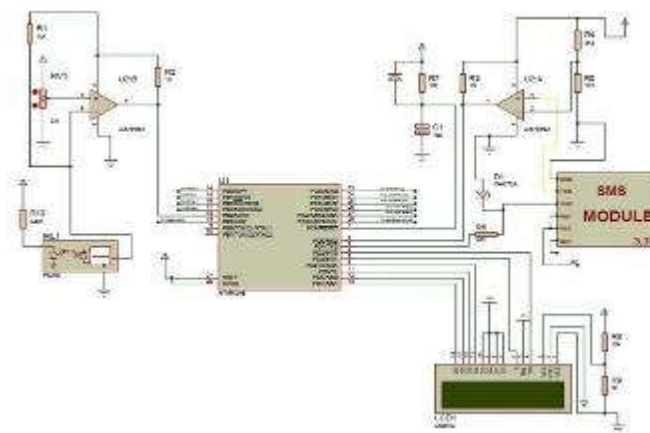


Figure 2 Circuit diagram for the RHSS

### 3.1. Intrusion Detection

To detect intrusion, an infrared transceiver is mounted at the door to detect opening of the door. It detects the opening and closing of the door by measuring change in resistance. The value of resistance when the door is closed is  $4.5M\Omega$  and when the door opens is  $0.9M\Omega$ . The keypad is used by authorized persons to input password upon entry into the house to prevent the alarm from false triggering. A 4x4 keypad is used in the design of the system. Figure 3 shows the flow chart for the operation.

### 3.2. Smoke Detection

The smoke sensor used in the implementation of the system is a MQ-2 sensor. This sensor has the ability to detect smoke as well as combustible gas, which made it functional for the purpose of monitoring safety in the house. Figure 4 shows the flow chart for smoke detection.

### 3.3. Emergency Events

The panic button as shown in Figure 5 is an inaudible alarm, used to alert nearby neighbours and the RASN in the case of an emergency or distress condition when the house owner is at home. The inaudible alarm is activated when the panic button is pressed by the house owner and it automatically sends a message to the RASN without sounding the buzzer.

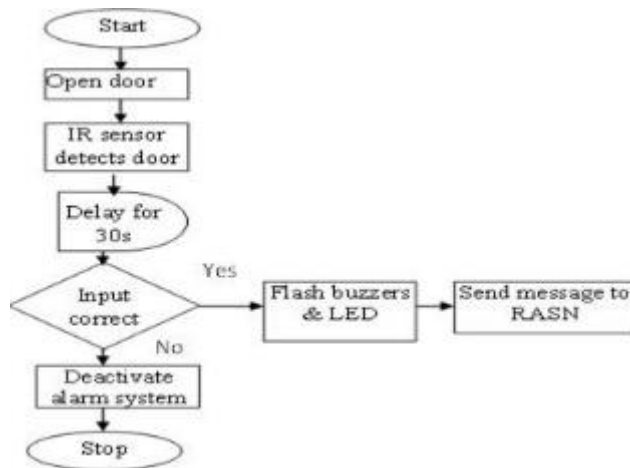


Figure 3 Flowchart for intrusion detection

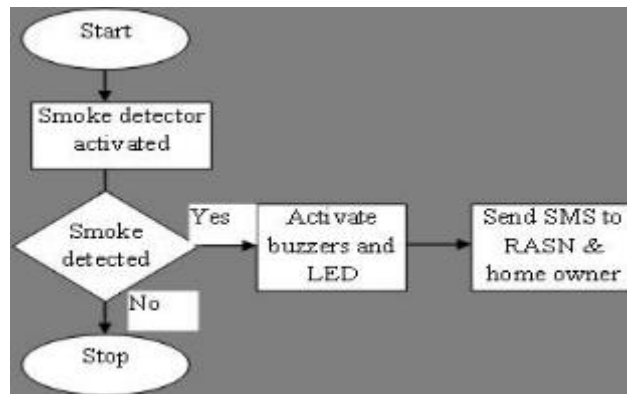


Figure 4 Flowchart for smoke detection

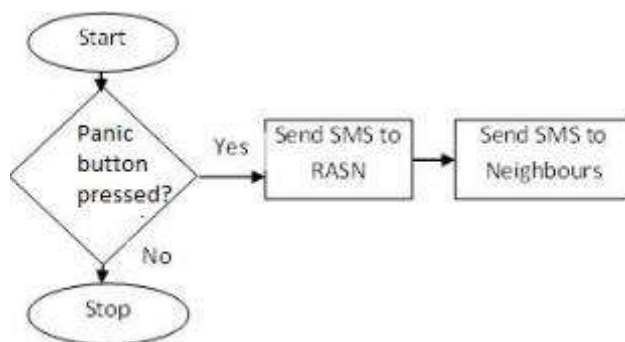


Figure 5 Flowchart for panic detection

#### 4. RASN and RHSS Implementation Model

A home fitted with RHSS is represented by the dog house in the RASN of Figure 6. Other houses in the residential area are represented using 3-gang switches. Each switch is used to represent a condition which could be intrusion detection, smoke detection or panic. The switches are connected to the microcontroller using a decoder array which consists of three 16-pin 74LS138 ICs. The zener diodes are used to protect the decoders from backward flow of current. The connection of the decoder array used to manage the switches is shown in figure 7.



Figure 6 Physical implementation of the system

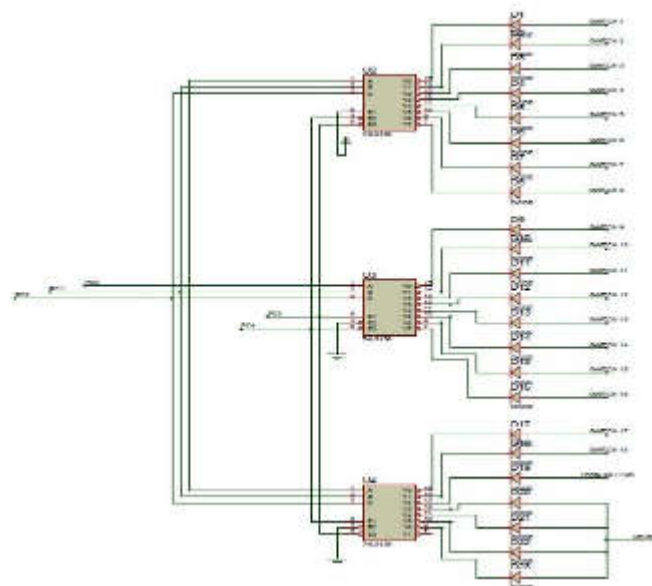


Figure 7 Decoder array for managing switches

## 5. RESULTS

When the door is opened, and correct password is entered within 30 seconds, the LCD displays “OKAY”. However, if a wrong password is entered, the system allows two more trials before it sends an “INTRUDER DETECTED” message to the house owner, the neighbour and the RASN. Same message is sent if the password is not entered within 30seconds. The gas sensor can detect combustibile gas and smoke in the range of 300-10,000 ppm, for an analog output voltage of between 0V to 24V. An output voltage of 3.5V was recorded during the testing of the smoke sensor which translates to about 1,458.333 ppm of gas concentration. Whenever gas leakages are detected, SMS messages will be sent to the mobile phones of the house owner, the neighbour and the RASN. The buzzer will also come on for about 30 seconds. When the house owner is present in the house and there is a case of emergency, it might be impossible for the house owner to make a phone call or call for help. The panic button provides silent means to alert the neighbour and the RASN of an emergency in such house by sending SMS messages to their phones. The operation and result summary is presented in Table 1. The actual time the message gets delivered to the mobile phones is dependent on the network coverage in such areas and the order in which they are sent by the microcontroller. The system also enables the password to be changed at any time. The password reset is done by pressing the # key. When

the key is pressed, the LCD displays “ENTER OLD PASSWORD”. The old password is entered and it then displays “ENTER NEW PASSWORD”, the new password is entered and then it displays “CONFIRM NEW PASSWORD”. The new password is re-entered and the system registers this password as the new password for the security system. The password is displayed in the form “\*\*\*\*\*” on the LCD screen, to protect the password against snooping. This should be brief stating the major findings of the research.

*Table 1 Summary of Security System Operation*

Action Performed	Display on LCD	Buzzer	Display on Mobile Phone
Password input	DOOR OPEN *****	NO	-
Correct password is entered	OKAY	NO	-
Incorrect password is entered	INCORRECT PASSWORD	NO	-
No action is taken after opening door/ wrong password is entered after 3 trials/ switch 1 is activated	SENDING MESSAGE	YES	HOUSE NO: INTRUDER
Smoke sensor is activated/ switch 2 is activated	SENDING MESSAGE	YES	HOUSE NO: SMOKE
Panic button is pressed/ switch 3 is activated	SENDING MESSAGE	NO	HOUSE NO: INTRUSION

## 6. CONCLUSION

The GSM based residential area security network and remote home security system had been constructed and tested with mobile network. The user can get SMS alerts anywhere, thus making the system location independent. The system can be incorporated as part of a smart house design. Additional features such as child safety, medical emergencies, security cameras, video surveillance, etc. can be incorporated into the system. The result of this project is a unified, fast and efficient system which will ensure shorter time to alert the authorized owner of the house, the neighbour as well as the security personnel in a residential area by sending SMS to their mobile phones.

## ACKNOWLEDGEMENTS

The author thanks Babalola Olufisayo for carrying out the laboratory aspect of the work.

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