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Analysis and Performance of a Low Cost Multiple Alarm Security System for Smart Home Based on GSM Technology and Controlling Based on Android Smartphone

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Abstract

This paper demonstrates and explains the design and implementation of multiple alarm security system for smart home based on GSM technology and controlling based on android smartphone. Security is an important subject that could be added to a smart home system. Gathering all different security systems such as alarm, the fire alarm, access control, Intrusion Detection System (IDS), etc. makes our life safer. All the security systems mentioned above could be integrated into a smart home system. In addition, there are new available features that let users control objects remotely. Nowadays, most people have their smartphone nearby them; therefore, adding an interface on the smartphone to control an automated system is a big plus. Energy saving is another benefit of the smart home system. It enables us to save energy and cost with having a smart control of the heating and air conditioning system, lighting system, water sprinkler system, solar system, etc. this paper concerns integration of technologies to increase customer satisfaction. It focuses mainly on two parts: The first part is alarm based on Global System for Mobile technology (GSM) to send Short Message Service (SMS) to the owner, the proposed system is aimed at the security of home against theft, Fire, CO and gas. In case of risk the device sends SMS to the emergency number which is provided to the system. The system is made up of basic components: sensors, GSM Module, Arduino, relays to control the device and buzzers to give security alert signals in terms of sound. The second is the controlling part; it uses android application mobile to control the gas valve, the door lock of the main entrance and the PIR sensor. We propose and analyze home automation system that possess high design flexibility, greatly reduced delay time, and high expandability. The result of using the proposed system is improving the efficiency of operation, reducing delay time and cheaper as compared to existing systems.

Keywords: Android Application, Arduino Mega2560, Internet of Things, GSM Technology, Smart Technology

1. Introduction

The new idea of Internet of Things (IoT) is growing fast and people are doing more and more work over the Internet. In this area of development and technology age, smart home has become one of the fastest developing application based technologies in the world. The idea of smart home has changed for the past decade as digital and wireless technologies, are integrated into it. Not only integrated intervention is required to detract the effects but smart and innovative solutions should be adopted to increase the responsive actions quality in both time and level; and since [Sarwant Singh., 2015] has identified eight key aspects that define a smart city as shown in Figure 1 which depicts the smart city concepts: smart governance; smart building; smart infrastructure; smart energy; smart technology; smart citizen; smart mobility; and smart healthcare. In this paper we propose a system architecture for smart home based on GSM technologies.

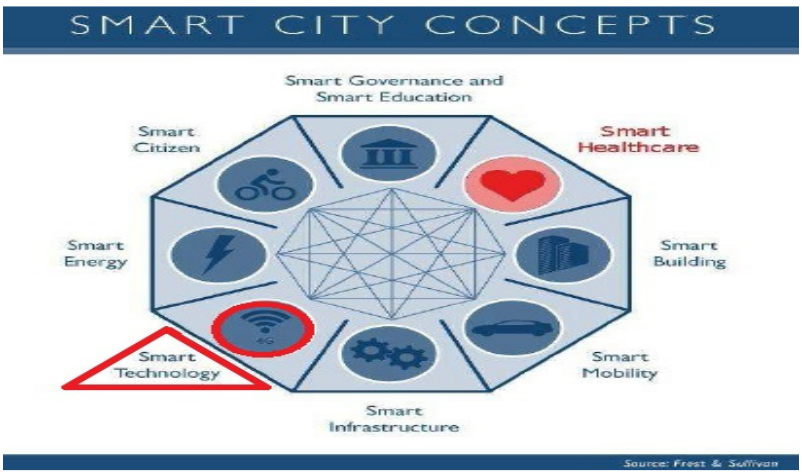
A smart home is an integrated system to gather security systems and appliances. Gathering all different security systems such as alarm, the fire alarm, access control (door lock), TVs, etc. makes our life safer.

The objective of this paper is to use Arduino Mega2560 microcontroller to design and build a smart home system which provides the user with new features such as door access control, fire alarm system plus remote access to control home appliance and objects wirelessly over smartphone [Daadoo, M. & Daraghmi, Y., 2016, Intelligent]. The purpose of the paper is to bring comfort, security and energy saving to our lives.

Energy saving is another benefit of the smart home system. It enables us to save energy and cost with having a smart control of the heating and air conditioning system, lighting system, water sprinkler system, solar system, etc.

A remotely accessible environment is an environment in which each appliance can be remotely accessed and controlled using software as interface, which include an android application [Daadoo, M. & Daraghmi, Y., 2016, Design].

Figure 1: Smart City Concepts



This paper presents an android application which can be interfaced with two different systems, home security system and home automation system. It mainly focuses on providing security when the user is away from home. SMS is a GSM mobile technology that can perform remote communication wherever they are[Khan et al., 2012]. The aim of paper is to use Arduino Mega2560 microcontroller to design and build a smart home automation system which provide home security device, that give us

send fast information to user GSM mobile device using SMS and also activate - deactivate system by SMS. The design of this home security system makes expandable their capability by add more sensors on that system.

2. GSM Technology

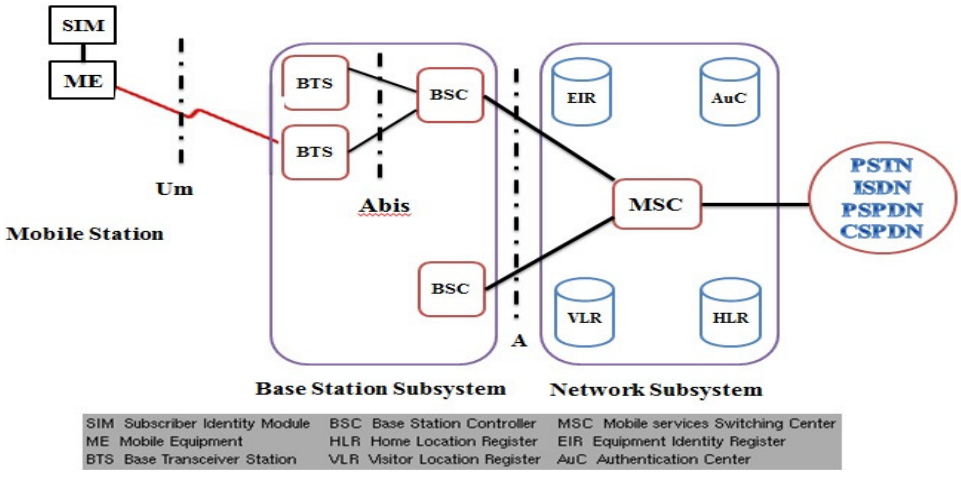
GSM is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900MHz. It is estimated that many countries outside of Europe will join the GSM partnership.

The need for people and businesses to be accessible at all times and outside the offices prompted the idea of manufacturing mobile telephones, which use radio waves as the communication medium. The idea was to provide the user with those facilities normally attributed to 'wire-line' networks, i.e. place and receive calls to/from other users connected either to fixed or mobile networks. Several cellular systems have existed, the very first ones using analogue technology[Tarapiah et al., 2016].

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. GSM uses a process called circuit switching.

A GSM network is composed of several functional entities, whose functions and interfaces are specified. Figure 2 shows the layout of a generic GSM network. The GSM network can be divided into three broad parts. The Mobile Station (MS) is carried by the subscriber. The Base Station Subsystem (BSS) controls the radio link with the MS. The network Subsystem, the main part of which is the Mobile services Switching Center (MSC), performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. The MS and the BSS communicate across the Um interface, also known as the air interface or radio link. The BSS communicates with the MSC across the A interface.

Figure 2: General Architecture of a GSM Network



2.1 Mobile Station

The MS consists of the mobile equipment (the terminal) and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services.

The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI) used to identify the subscriber to the system, a secret key for authentication, and other information. The IMEI and the IMSI are independent, thereby allowing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

2.2 Base Station Subsystem

The BSS is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). These communicate across the standardized Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers.

The BTS houses the radio transceivers that define a cell and handles the radio-link protocols with the MS. In a large urban area, there will potentially be a large number of BTSs deployed, thus the requirements for a BTS are ruggedness, reliability, portability, and minimum cost.

The BSC manages the radio resources for one or more BTSs. It handles radio-channel setup, frequency hopping, and handovers. The BSC is the connection between the mobile station and the MSC.

2.3 Network Subsystem

The central component of the Network Subsystem (NS) is the MSC. It acts like a normal switching node of the PSTN or ISDN, and additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. The MSC provides the connection to the fixed networks (such as the PSTN or ISDN). Signaling between functional entities in the NS uses Signaling System Number 7 (SS7), used for trunk signaling in ISDN and widely used in current public networks.

The Home Location Register (HLR) and Visitor Location Register (VLR), together with the MSC, provide the call-routing and roaming capabilities of GSM. The HLR contains all the administrative information of each subscriber registered in the corresponding GSM network, along with the current location of the mobile. The location of the mobile is typically in the form of the signaling address of the VLR associated with the MS. There is logically one HLR per GSM network, although it may be implemented as a distributed database. The VLR contains selected administrative information from the HLR, necessary for call control and provision of the subscribed services, for each mobile currently located in the geographical area controlled by the VLR. The geographical area controlled by the MSC corresponds to that controlled by the VLR. Note that the MSC contains no information about particular MS this information is stored in the location registers.

The other two registers are used for authentication and security purposes. The Equipment Identity Register (EIR) is a database that contains a list of all valid mobile equipment on the network, where each mobile station is identified by its IMEI. An IMEI is marked as invalid if it has been reported stolen or is not type approved. The Authentication Center (AuC) is a protected database that stores a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and encryption over the radio channel.

3. Proposed System

A proposed system model of smart home is prepared using low cost materials like acrylic, plywood etc., having sufficient strength as shown in Figure 3 and Figure 4 to test the prototype of developed system.

Figure 3: Model of Safety Home from Outside

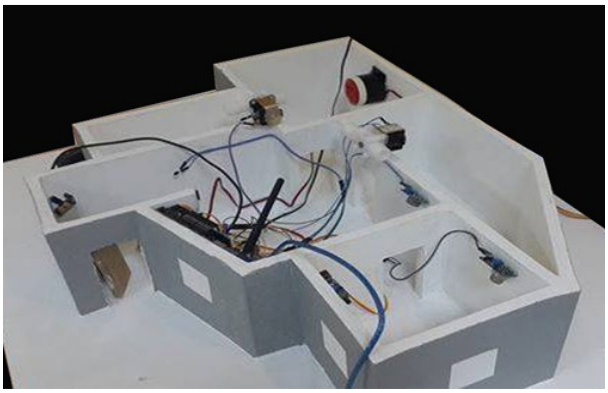
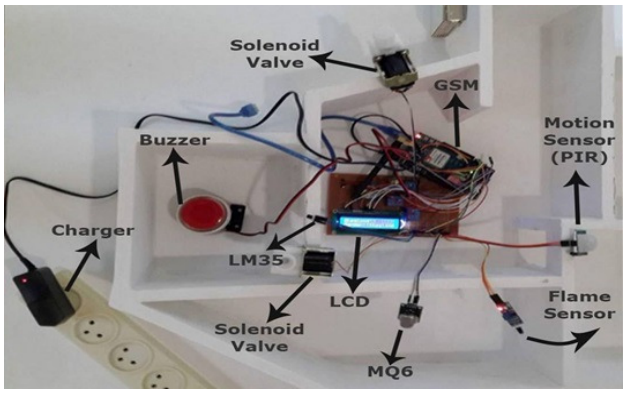


Figure 4: Model of Safety Home from Inside

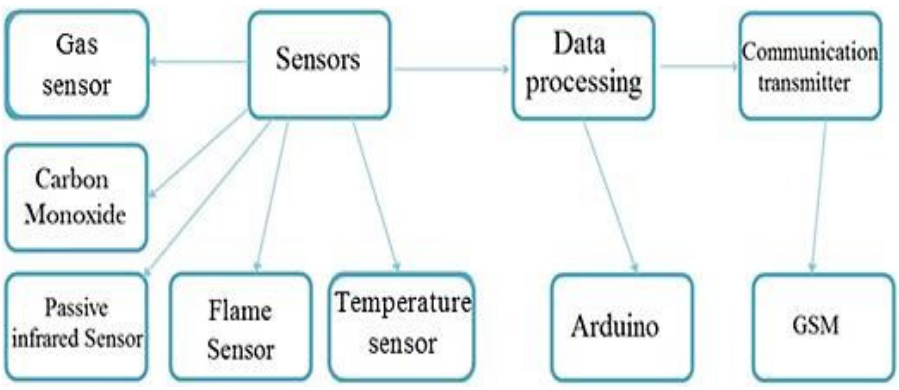


The proposed system is controlled by an Arduino MEGA2560 microcontroller. It collects all information from the sensors, process that information makes a decision and sends SMS to a corresponding GSM mobile phone number by using a GSM modem.

4. Methodology

Based on the design requirements and specifications, the system block diagram shown on Figure 5 is developed. This block diagram defines all the function to be performed by the system. A modular approach to project design was taken. The system is designed based on an Arduino Mega2560 microcontroller which is based on an Atmel2560 microprocessor.

Figure 5: Functional Block Diagram of the Smart Home System



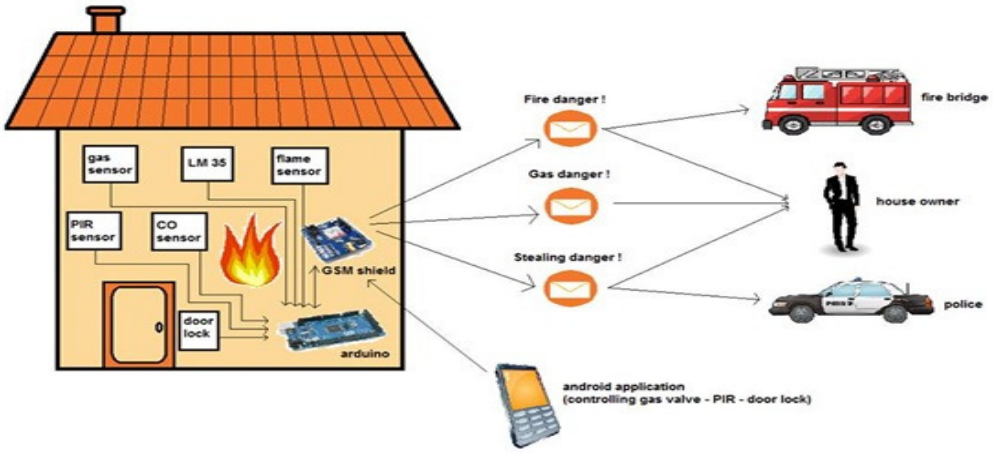
The following functions are performed by the system circuit: convert analog inputs, process the input data, communicate with the GSM module to send and receive data, convert to the data output, send output signal to output modules, acquire sensor data. Also, the android mobile application allows users to control by sending a message to Arduino over the network, and then commands will be issued by the microcontroller towards relays as shown in Figure 6. The android mobile application could operate three controls on/off switches simultaneously, such as opening/closing door, turning on/off PIR, turning on/off Solenoid. The system is designed based on an Adriano Mega2560 microcontroller which based on ATmega2560 microprocessor.

The system contains sensors to detect motion, flame, temperature, CO and gas. The sensor collects information and the system is controlled by the mega Arduino, the controller decides the danger and sends SMS to the owner using a GSM module, according to the sensors information. And another SMS is sent to the police if there is a stealing danger, to the fire bridge if there is a fire danger.

The system also consists of two parts: the first is the alarm, if there is one of the dangers the system turns on the buzzer and sends SMS using GSM; it also decreases the danger by opening the water solenoid in case of fire, and closing gas solenoid in case of gas danger or fire in the house. The second part is controlling using android application. The application controls the door lock and turns on the PIR sensor if the owner is away from house, then turns it off when he is in house. The application also controls the gas solenoid for more safety, all this is done by sending SMS.

This application helps the owner and makes controlling the house easier. The basic concepts of circuits that are used in the system design are explained.

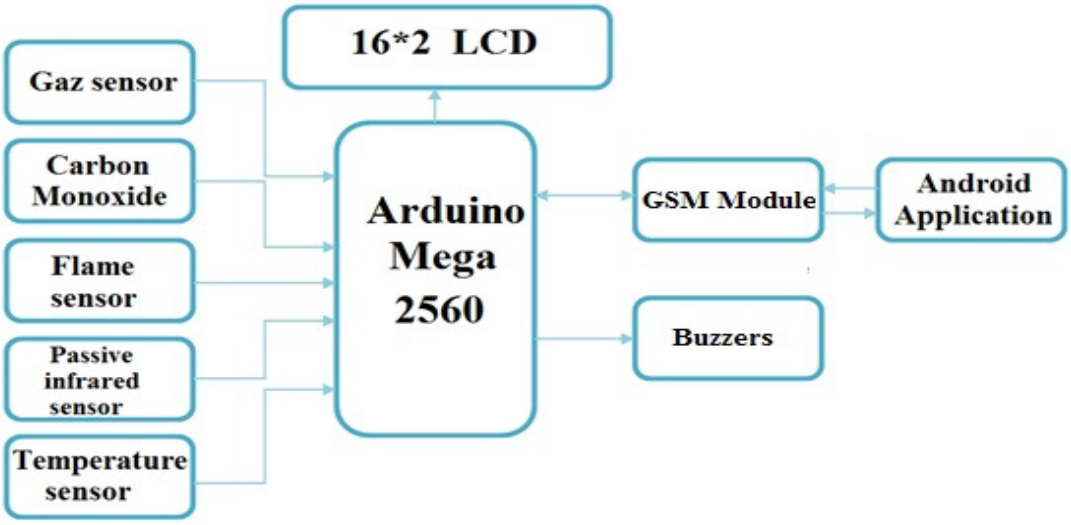
Figure 6: General Scheme of a Smart Home System



5. Hardware Design

Hardware of the system contains sensors, Arduino MEGA2560 microcontroller, SIMCOM SIM900 (GSM module), Buzzer, as shown in Figure 5 the outputs of all the sensors are connected to data processing unit which controlled by an Arduino MEGA2560 microcontroller. One Passive Infrared Sensor(PIR) is connected at window and other is at door.

Figure 7: Home Security System Block Diagram



The entry from the window is treated as unauthorized entry and entry from door is treated as authorized entry. If there is authorized entry inside the home, lights will be turn ON after checking the light intensity in a room and for unauthorized entry buzzer will be turned ON then the Arduino controller activate Buzzer alarm and send a SMS to the home owner mobile phone using the GSM Module as shown in Figure 7. Temperature is continuously monitored, if it is high greater than 45 degree in case of fire, a SMS is sent "There is a Flame" to the home owner. If gas sensor is ON indicating the gas leakage then SMS will be send to the owner "There is a Gas Danger". If CO sensor is ON indicating the Carbon Monoxide in home then SMS will be send to the owner "There is a CO".

5.1 Arduino MEGA2560 Microcontroller

This paper is uses an Arduino MEGA2560 as shown in Figure 8, which is based on an ATmega2560 microprocessor. An Arduino MEGA2560 Microcontroller has been designed based on an ATmega2560 microprocessor that runs at the speed of 16MHz. As Table 1shows, it contains 54 digital input/output pins, 15 of them could be used as PWM (Pulse Width Modulation is a method for getting analog results with digital means) outputs. Furthermore, it contains 16 analog inputs and 4 hardware serial ports.

Figure 8: ArduinoMega2560

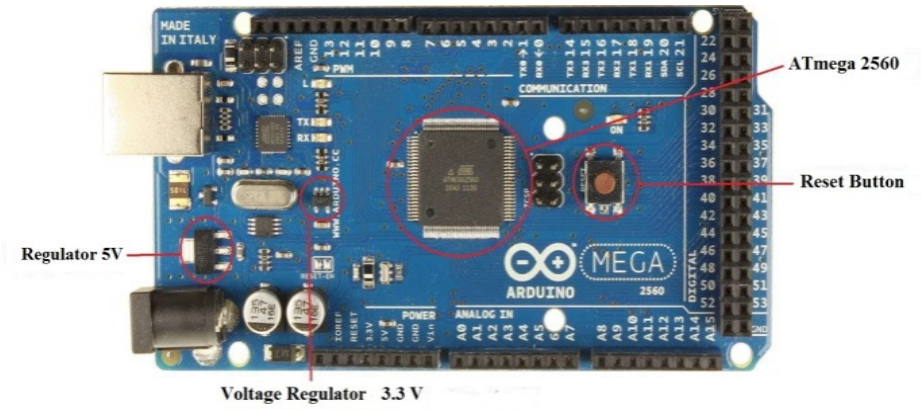


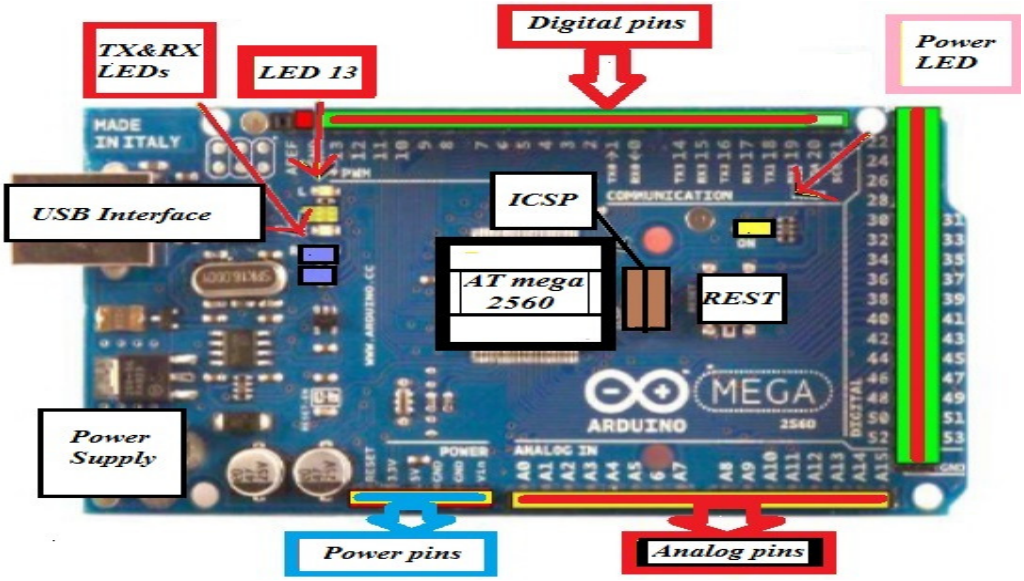
Table 1: Specifications of Arduino MEGA2560 Microprocessor

Specifications	Arduino MEGA2560
Processor	ATmega2560
Flash Memory	256 KB
Data Memory	8 KB
EEPROM	4 KB
Digital I/O Pins	54
PWM outputs	15
Analog outputs	16
Clock Speed	16 MHz
Serial Ports	4

5.2 Arduino MEGA2560 Components

The Arduino controller is a computer-based tool that can considerably sense and control the physical world more than a desktop computer can. Arduino is an open source physical computing platform based on a simple microcontroller board and a development environment for writing software for the board. Arduino Mega2560 is a microcontroller board based on the ATmega2560. It has 54 digital I/O pins and 16 analog inputs, any of which could be used either for input or output as shown in Figure 9. They all work at 5 volts and each of them is able to provide/receive a maximum 40_{mA}. Moreover, they have an inner pull-up resistor 20 to $50_{k\Omega}$. This microcontroller has 16 analog inputs. There is a reset button on the board to reset the microprocessor. Also, it has a test LED, a USB compatible connection port, a 9_V power jack including an ICSP header which is In-Circuit Serial Programming header. MEGA2560 supports I²C (Inter-Integrated Circuit) communication.

Figure 9: Components of an Arduino MEGA2560



5.3 GSM Module Unit

The GSM modem unit is built using SIMCOM SIM900 modem that specialized for arduino controller and support GPS technology as shown in Figure 10. This unit can send SMS to user mobile phone and also can receive SMS from user.

Figure 10: SIM900 for Arduino Controller

The working of GSM modem is based on commands, the commands always start with AT (which means ATtention) and finish with a <CR>character. The AT commands are given to the GSM modem with the help of PC or controller. The GSM modem is serially interfaced with the controller with the help of MAX232. Here MAX232 acts as driver which converts TTL levels to the RS-232levels. For serial interface GSM modem requires the signal based on RS-232 levels. The T1_OUT and R1_IN pin of MAX232 is connected to the TX and RX pin of GSM modem.

The AT commands for GSM-GPRS support is as follows in Table 2:

Table 2: AT Commands for GSM-GPRS

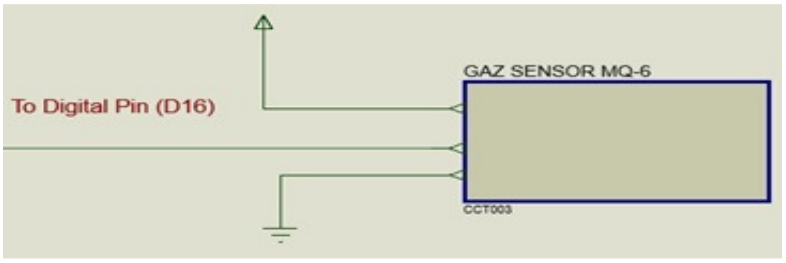
•+CMTI: SMS has been received
•+CREG: Network registration indication
•+CMGS: To send the message
•+CMSS: To Send Message from Storage
•+CMGW: command writes an SMS to the first location available
•+CPMS:command allows the message storage area to be selected (for reading, writing, etc.)
•+CMGR: Read Message
•+CCLK: Clock Management
•+CUSD: Unstructured Supplementary Service Data

5.4 Gas Sensor

This sensor module utilizes an MQ-6as the sensitive component and has a protection resistor and an adjustable resistor on board. The resistance of the sensitive component changes as the concentration of the target gas changes. They are used in gas leakage detecting equipment in family and industry, are suitable for detecting of LPG, iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke.

The main function of Gas Leak detection module is to detect the changes in concentration of LPG gas, thenARM-7controller immediately activates Buzzer.MQ-6 gas sensor, a simple circuit as shown in Figure 11 is used to sense the poisonous gas and has high sensitivity to LPG and also response to Natural Gas. It is portable gas detector which has long life with low cost.

Figure 11: Measuring Circuit for Gas Sensor

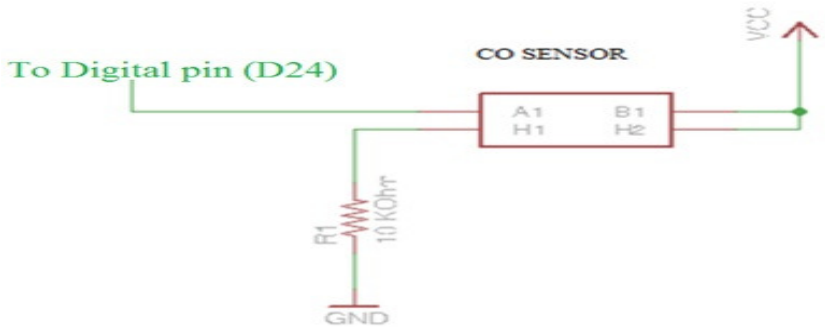


55 CO Sensor

The CO gas sensor is used in gas detection equipment for detecting Carbon Monoxide in home, automotive or industrial settings. MQ-7 gas sensor has high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases contains CO.

A simple circuit as shown in Figure 12 is used to map the changes in conductivity to the corresponding output signal of the gas concentration. The main advantage of the MQ-7 gas sensor is that it has high sensitivity to Carbon Monoxide. Additionally, it has a very long life time and is available at a low cost. Also it can be used for a wide range of applications.

Figure 12: Measuring Circuit for CO Sensor

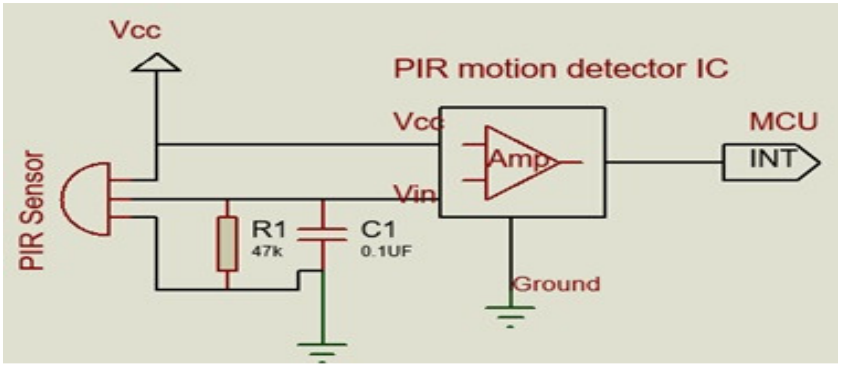


5.6 PIR Sensor

This PIR has a potentiometer to calibrate distance and delay time. Sensor unit is easy to use, affordable price. This sensor requires 100_{uA} - 150_{uA} and voltage conditions 3_{Volt} – 5_{Volt} to operate, has accuracy from 0.1 to 6 meters with the ability to work at a temperature of-200_C to700_C. Other than that, this sensor module also has a working wave length 7_{um} - 14_{um} and angle of coverage in 1200.

A simple circuit as shown in Figure 13 we use a digital output PIR, that is, AMN44121, made by Panasonic, it includes 80 sensing cells and is able to support a 110° horizontal and 93° vertical detection range. We collect the sensing data of a human passing by the front of the sensors under hot (31ºC) and clear (windless) conditions. We can estimate that two types of sensors have a similar detectable distance. Generally, an analog sensor requires extra circuits or signal processing techniques to create a detection signal, but it can improve the detection performance by using additional embedded circuits, such as filters and amplifiers. On the other hand, the digital PIR sensor has a comparator circuit inside of the sensor and thus does not require additional circuits to process sensor signals for detection. As a result, the digital PIR sensor is more appropriate for a resource-constrained processor requiring lightweight processing. For this reason, we select a digital PIR sensor to employ in our study.

Figure 13: Equivalent Circuit for PIR Sensor

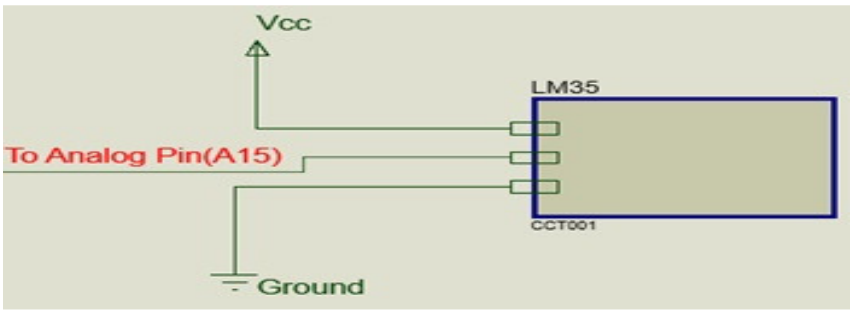


5.7 LM35 Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the Celsius (Centigrade) temperature. Temperature is directly measured by the PK7 pin of ArduinoMEGA2560.

A simple circuit as shown in Figure 14, The LM35 is a temperature sensor, whose output voltage is linearly proportional to the Celsius temperature. This sensor has linear output and low output impedance make it easy for connecting it to the readout circuitry. Three pins, $+V_s$, GND, and V_{out} are defined for the sensor.

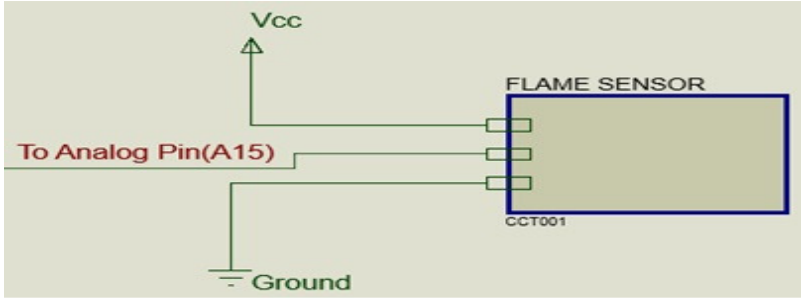
Figure 14: Measuring Circuit for LM35 Sensor



5.8 Flame Sensor

This module is sensitive to the flame and radiation. It also can detect ordinary light source in the range of a wavelength 760_{nm}-1100_{nm}. The detection distance is up to 100cm. The flame sensor can output digital or analog signal. It can be used as a flame alarm or in firefighting robots a simple circuit in Figure 15.

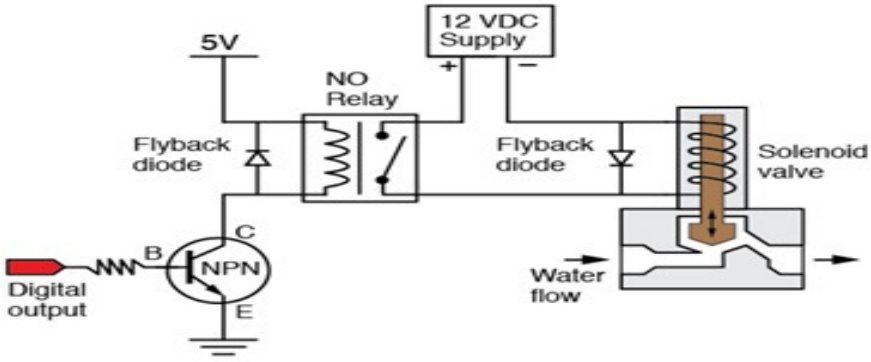
Figure 15: Measuring Circuit for Flame Sensor



5.9 Solenoid Valve

A solenoid is a simple electromagnetic device that converts electrical energy directly into linear mechanical motion, but it has a very short stroke (length of movement), which limits its applications. There are many valve design variations. Ordinary valves can have many ports and fluid paths. A 2-way valve, for example, has 2 ports; if the valve is open, then the two ports are connected and fluid may flow between the ports; if the valve is closed, then ports are isolated. If the valve is open when the solenoid is not energized, then the valve is termed normally open (N.O.). Similarly, if the valve is closed when the solenoid is not energized, then the valve is termed normally closed. There are also 3-way and more complicated designs. A 3-way valve has 3 ports; it connects one port to either of the two other ports (typically a supply port and an exhaust port) and simple circuit in Figure 16.

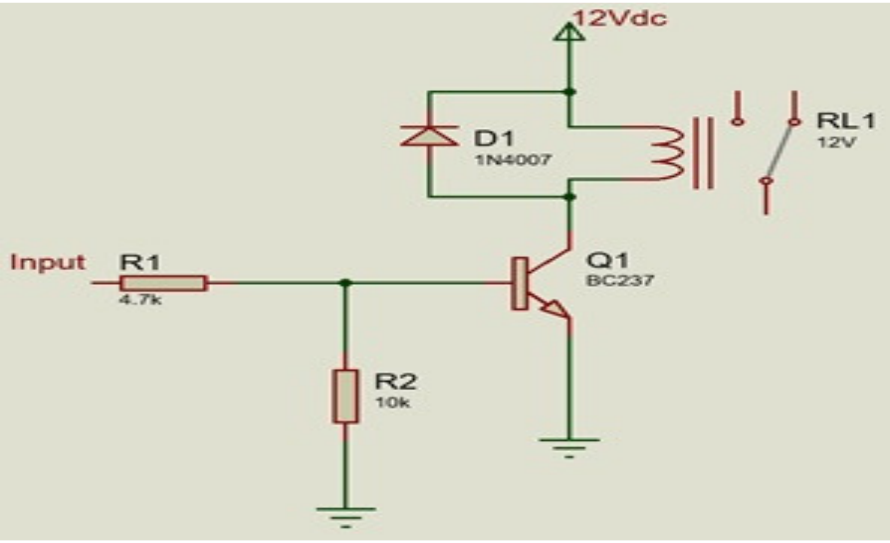
Figure 16: Equivalent Circuit for Solenoid Valve



5.10 Relay 5v

Relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts and simple circuit as in Figure 17.

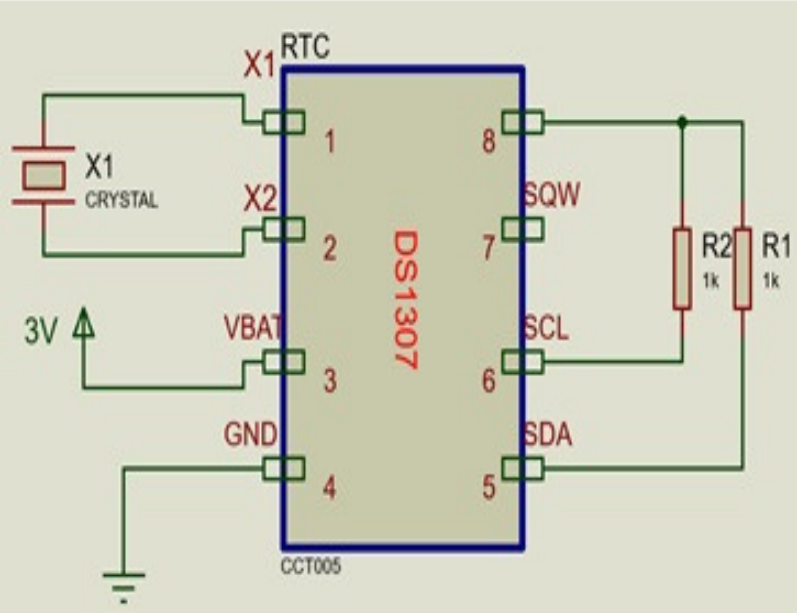
Figure 17: Equivalent Circuit for Relay



5.11 RTC (Real Time Clock)

Is a computer clock as shows in Figure 18 (most often in the form of an integrated circuit) that keeps track of the current time, although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time.

Figure 18: Equivalent Circuit for RTC

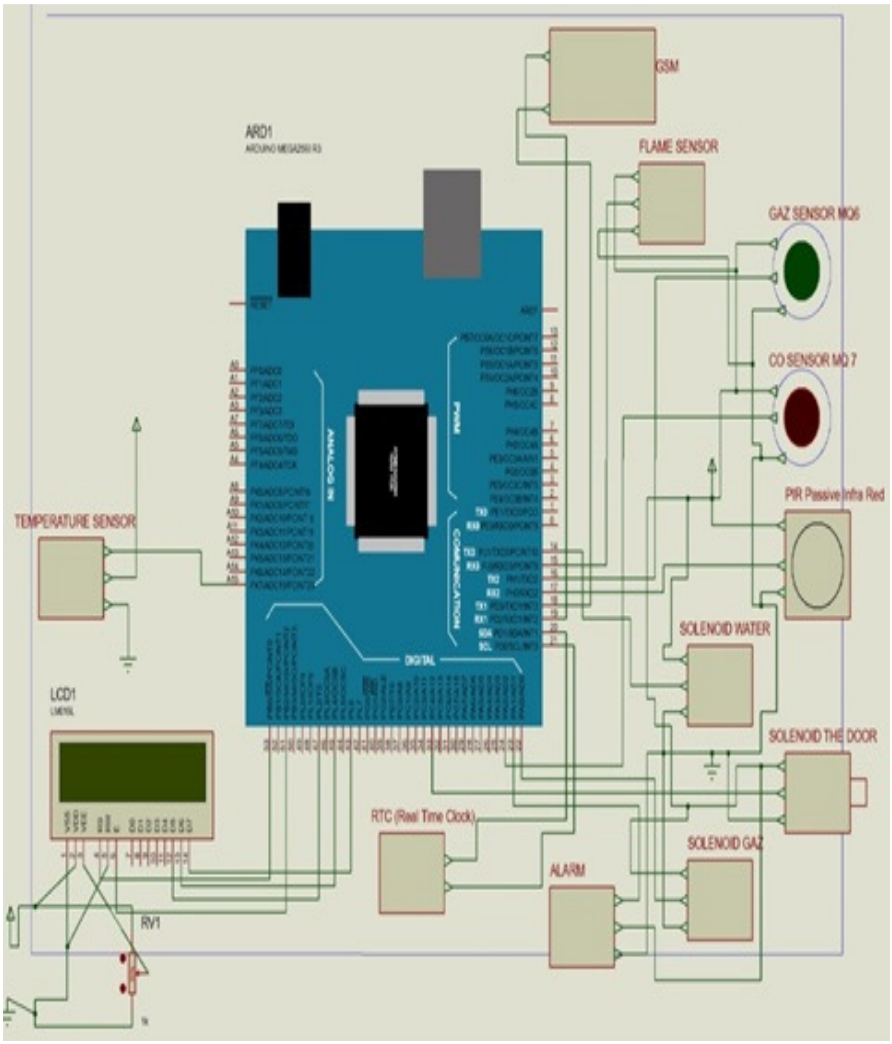


6. Driving Circuitry

We have designed and developed a driving circuit given in the Figure 19 in order to operate the smart home system. The driving circuitry is developed using an Arduino MEGA2560 microcontroller. It controls and runs specific functions of the smart home system such as opening/closing door, turning on/off PIR, turning on/off Solenoid. The system is designed based on an Adriano Mega2560 microcontroller which based on ATmega2560 microprocessor.

The figure shows the driving circuit of the system, where flame sensor, temperature sensor, PIR sensor, CO sensor and gas sensor are connected with the Arduino MEGA2560 microcontroller.

Figure 19: The Schematic of the Driving Circuitry



7. Software Design and Implementation

In this paper we describe the software system design, program techniques, and system approaches used in the development of programming the microprocessor in the smart home system. The software program is responsible for accepting data and commands, executing different commands, controlling operational terminals, and supporting data Input/output ports. This paper discusses the software in terms of routines and subroutines. The software mainly consists of two parts, one is control part, and the other is alarm part. It is intended to give a general idea of program flow and implementation.

7.1 Arduino

In this system arduino software from arduino developer is used to develop program for arduino controller. ArduinoIDE is an integrated development environment (IDE) used in computer programming. It contains a base workspace and an extensible plug-in system for customizing the environment. ArduinoIDE is written mostly in Java, but it may also be used to develop applications in other programming languages through the use of plug-in, including: Ada, ABAP, C, C++, etc., the environment is written in C++ and based on processing and other open-source software. This software can be used with any ARDUINO board.

7.2 Android Application Development

This is an open source android application which has a graphical interface. An android application is a software application that runs on the android platform. An android application is designed for a smartphone or a tablet running on the android OS. android application are written in Java programming language and use Java core libraries.

Users can extend its abilities by installing plug-in written for the eclipse platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules.

7.3 Control Part

7.3.1 Security Door Locks

Figure 20 shows a flowchart for security door locks. The home owner can log in to the system with the user interface window shown in Figure 21.The home owner enters a user name and password to securely enter the system. The system can be used successfully only if the correct login information is entered. To maintain safety and security, the system cannot be used if incorrect information is entered. The main façade contains three main parts: control messages, notifications and about device as shown in Figure 22, when home owner choose control messages he will see three sub parts: open the door, solenoid, PIR, if he choose open the door, the message is sent to the Arduino which controls all the system, Arduino sends a message to the door lock then the door open.

Figure 20: Flow Chart for security Door Locks

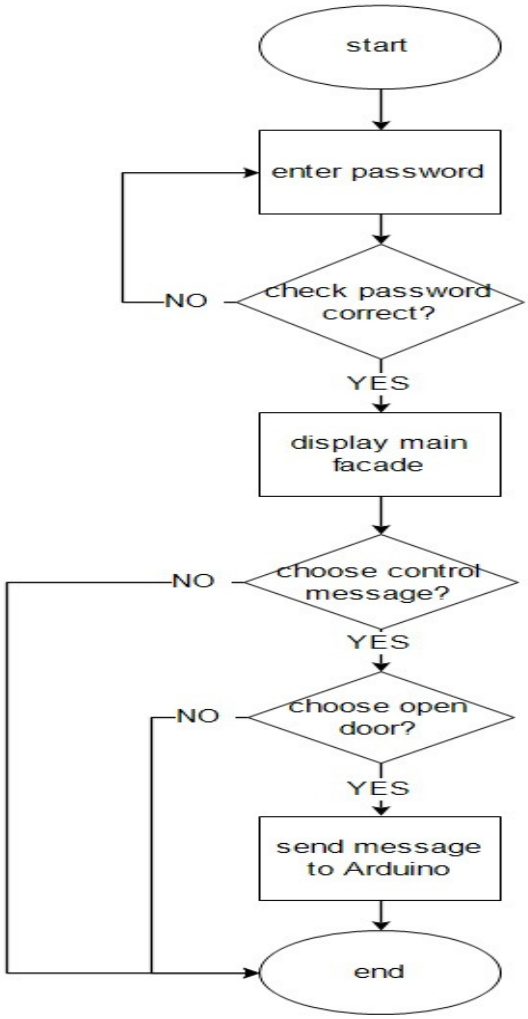


Figure 21: Interface for Enter Password

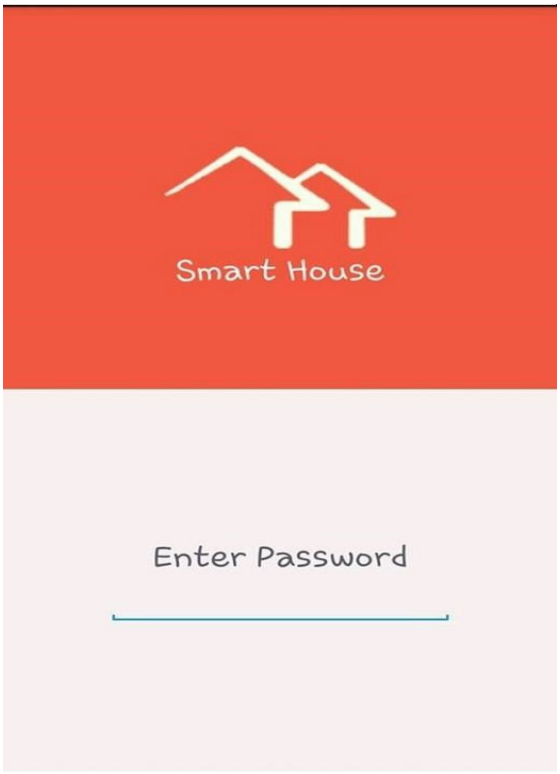
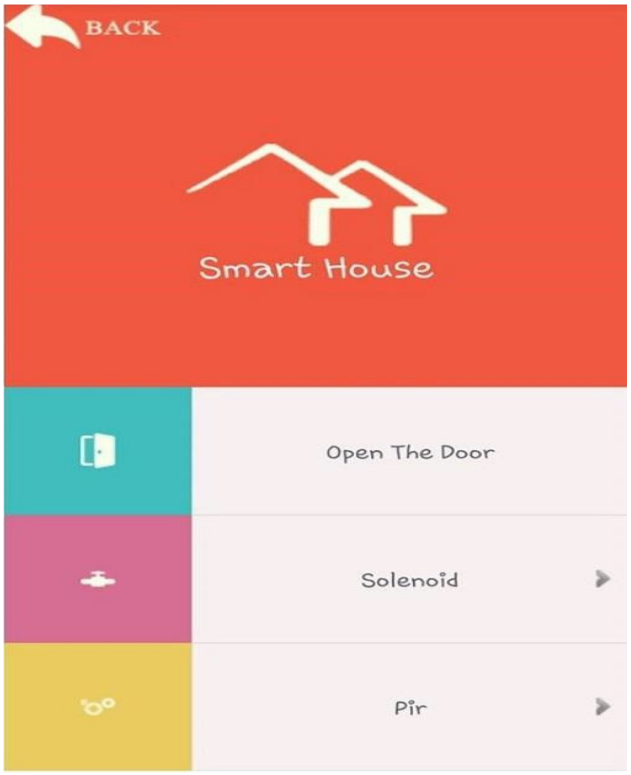


Figure 22: Main Interface



7.3.2 Solenoid

Figure 23 shows a flowchart for opening/closing solenoid. The homeowner enters a user name and password to securely enter the system. The system can be used successfully only if the correct login information is entered. The main façade contains three main parts: control messages, notifications and about device, when homeowner choose control messages he will see three sub parts: open the door, solenoid, PIR, if he choose solenoid he will see the choice: open solenoid, close solenoid as shown in Figure 24, when he chooses one of them the message will be sent to the Arduino which is controlling all of the system, Arduino sends a message to the solenoid then the solenoid is open or off.

Figure 23: Flow Chart for Opening/Closing Solenoid

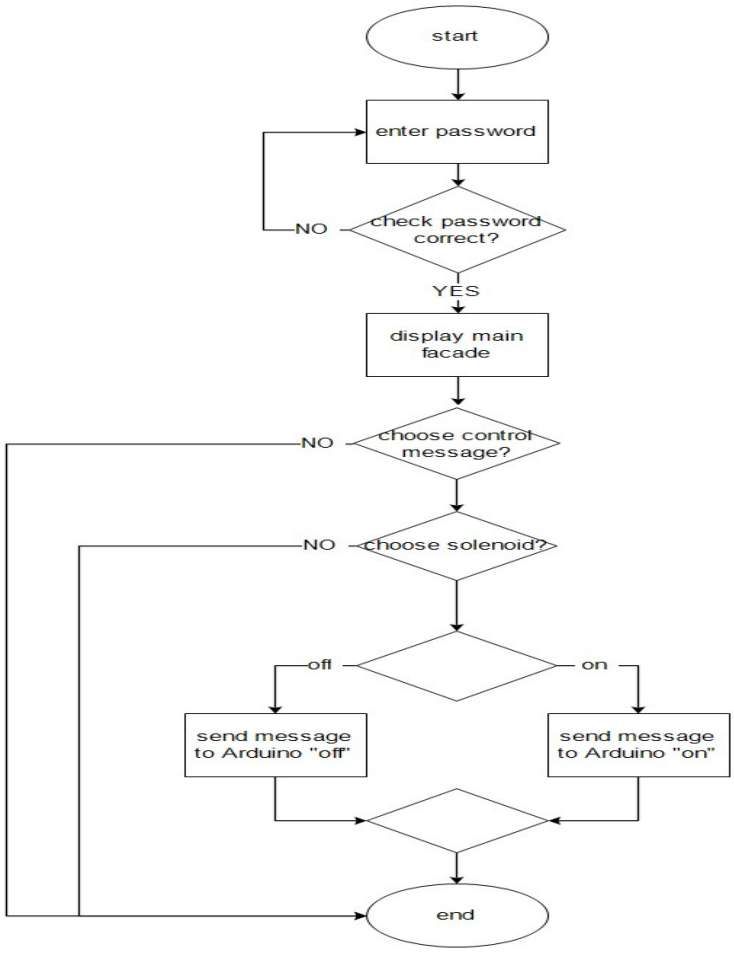
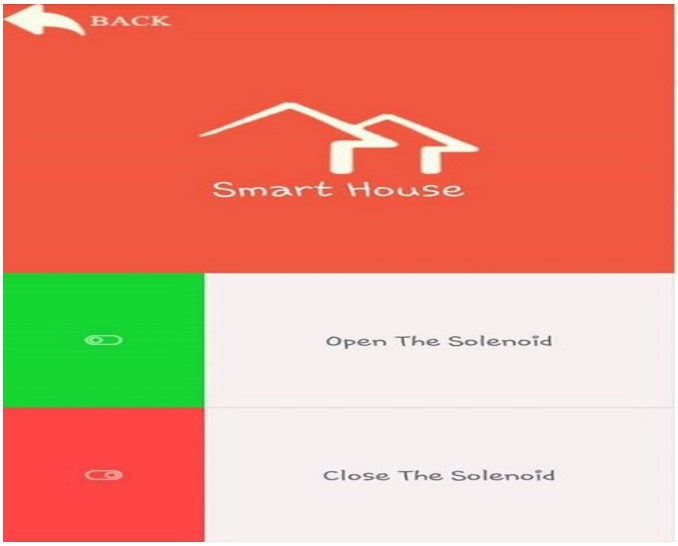


Figure 24: Interface when user chooses Solenoid



7.3.3 RIP

Figure 25 shows a flowchart for turning on/off PIR. The homeowner enters a user name and password to securely enter the system. The system can be used successfully only if the correct login information is entered. The main façade contains three main parts: control messages, notifications and about device, when homeowner choose control messages he will see three sub parts: open the door, solenoid, PIR, if he choose PIR he will see the choice: turn on PIR, turn off PIR as shown in Figure 26, when he chooses one of them the message will be sent to the Arduino which is controlling all of the system, Arduino sends a message to the PIR then the PIR turn on or off as the condition.

Figure 25: Flowchart for Turning on/off PIR

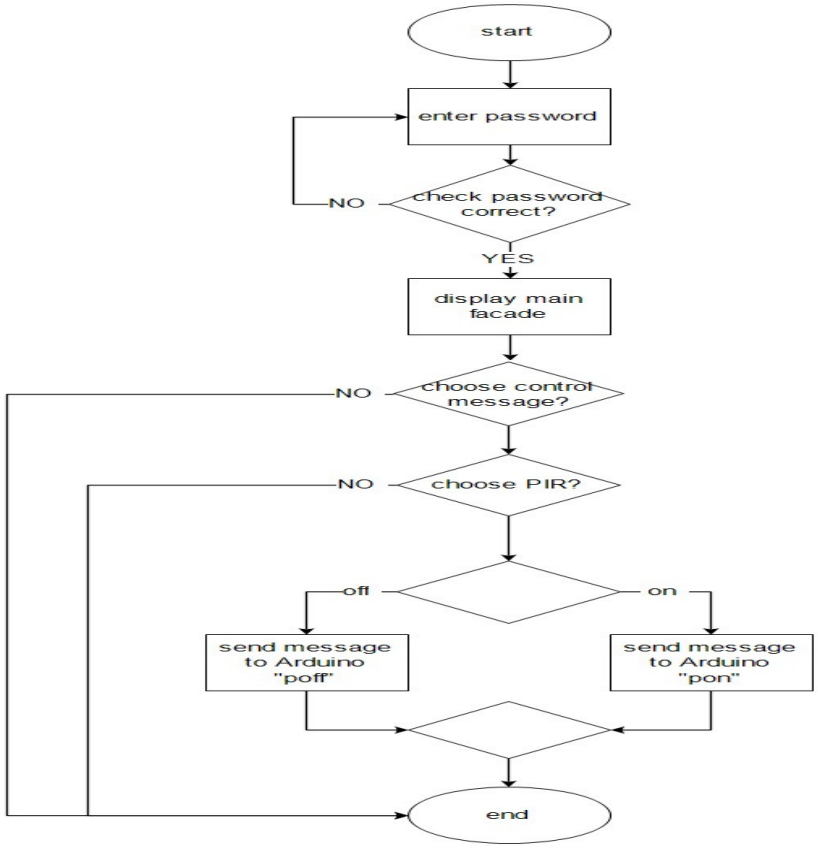
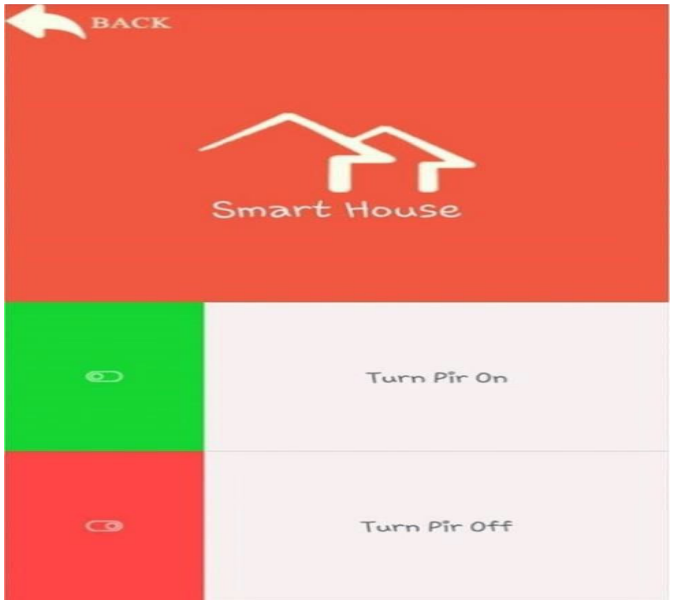


Figure 26: Interface when Home Owner chooses PIR

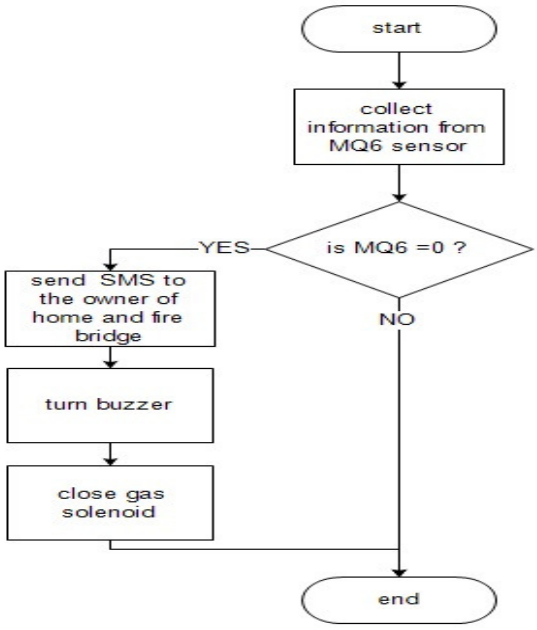


7.4 Alarm Part

7.4.1 MQ6

Flowchart for MQ6 sensor, shown in Figure 27, when the Gas leaking happen, MO6 sensor detect this risk and send the reading to ardiuno, arduino alarm the user that there is a risk in his/her home.

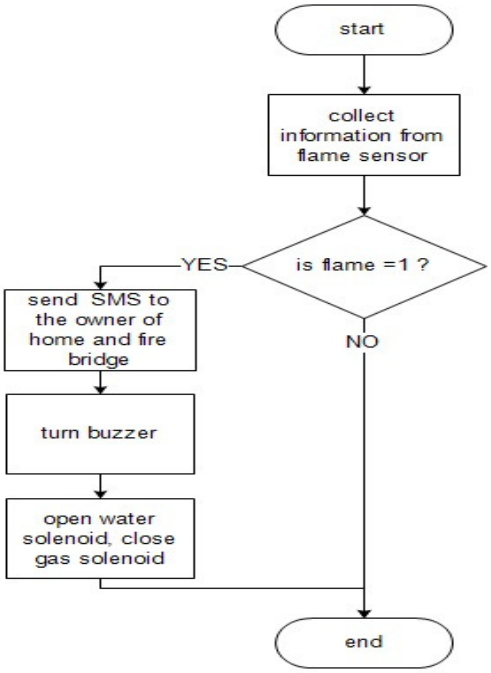
Figure 27: Flowchart for MQ6 Sensor



7.4.2 Flame Sensor

Flowchart for flame sensor, shown in Figure 28, when the fire happens, flame sensor detects this risk and sends the reading to ardiuno, arduino alarm the user that there is a risk in his/her home.

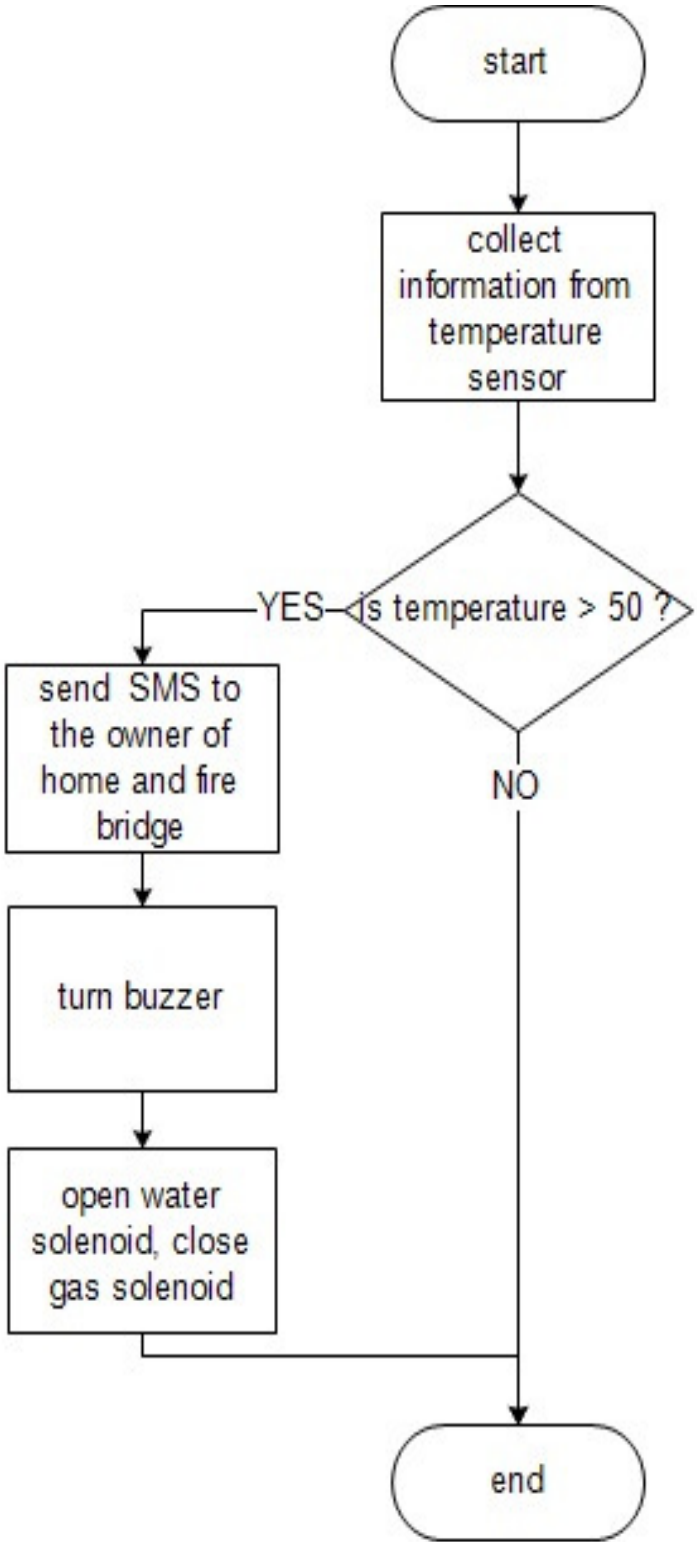
Figure 28: Flowchart for Flame Sensor



7.4.3 Temperature Sensor

Flowchart for temperature sensor, shown in Figure 29, when the temperature increase more than 45^{C}, LM35 sensor detect this risk and send the reading to ardiuno, arduino alarm the user that there is a risk in his/her home.

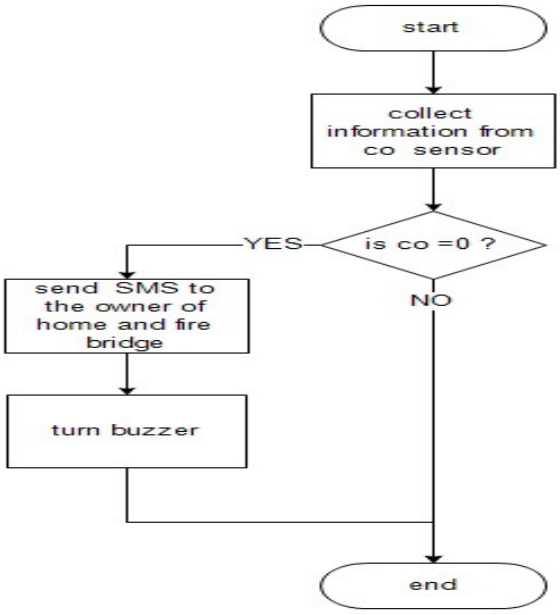
Figure 29: Flowchart for Temperature Sensor



7.4.4 Co Sensor

Flowchart for CO detection sensor, shown in Figure 30, when the CO leaking happen ,CO sensor detect this risk and send the reading to ardiuno, arduino alarm the user that there is a risk in his/her home.

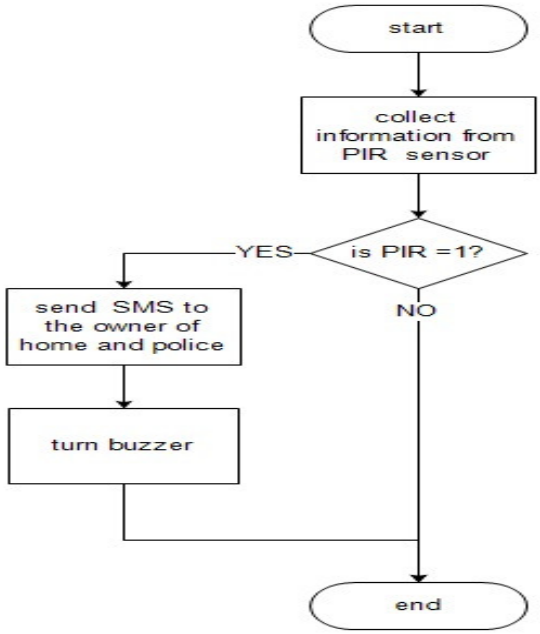
Figure 30: Flowchart for CO Detection Sensor



7.4.5 PIR Sensor

Flowchart for PIR sensor, shown in Figure 31, when unusual motion happen ,PIR sensor detect this risk and send the reading to ardiuno, arduino alarm the user that there is a risk in his/her home.

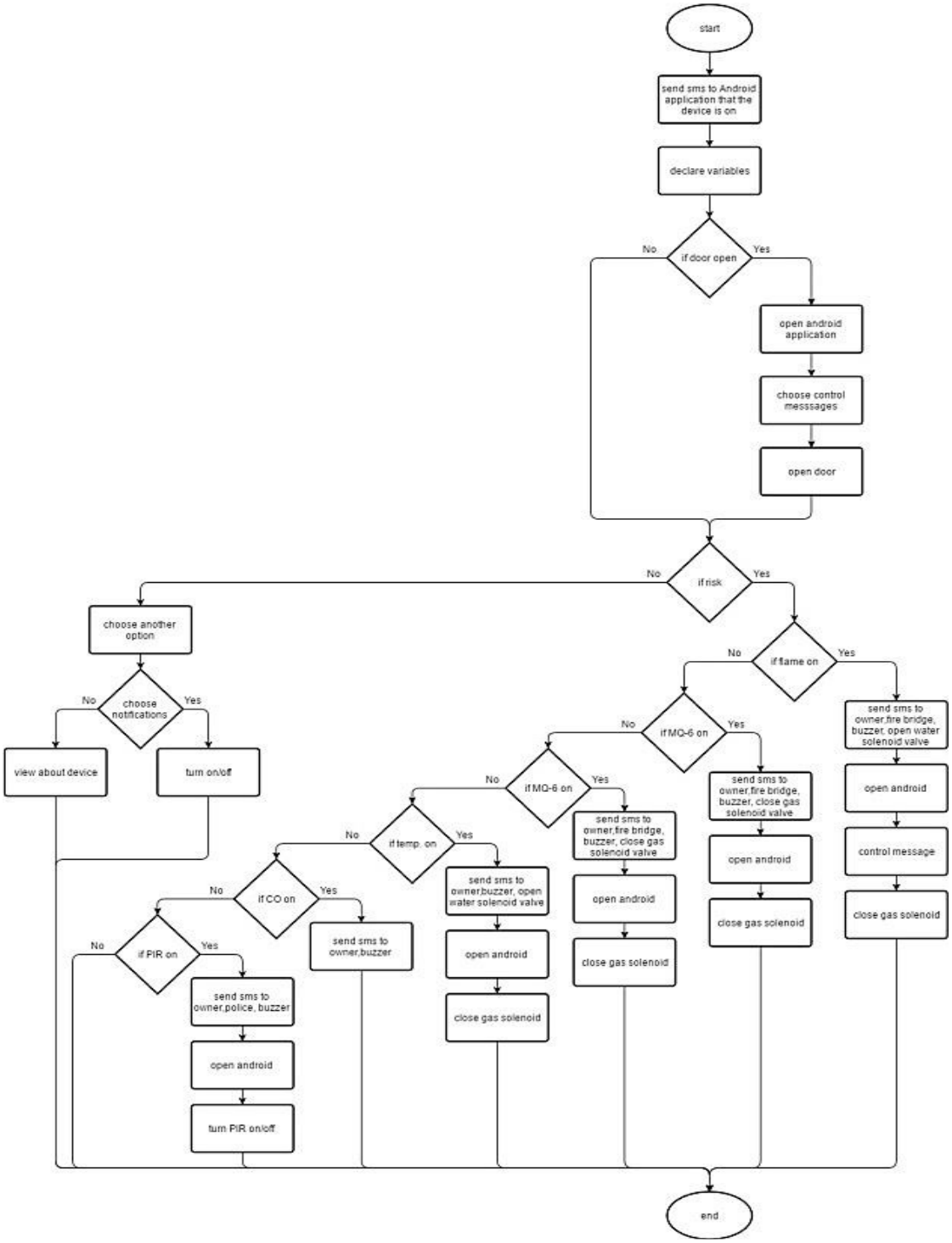
Figure 31: Flowchart for PIR Sensor



7.5 Flowchart of the Total System

Figure 32 shows the flowchart of the total system, which is also clearly showing how to turn on or turn off the home security system by sending SMS from user mobile phone. After the home security system on, the system will check the area capture by PIR sensor, if there are obstacles detected the system will take necessary action to inform the police, house owner and fire brigade respectively.

Figure 32: Flowchart of the Total System

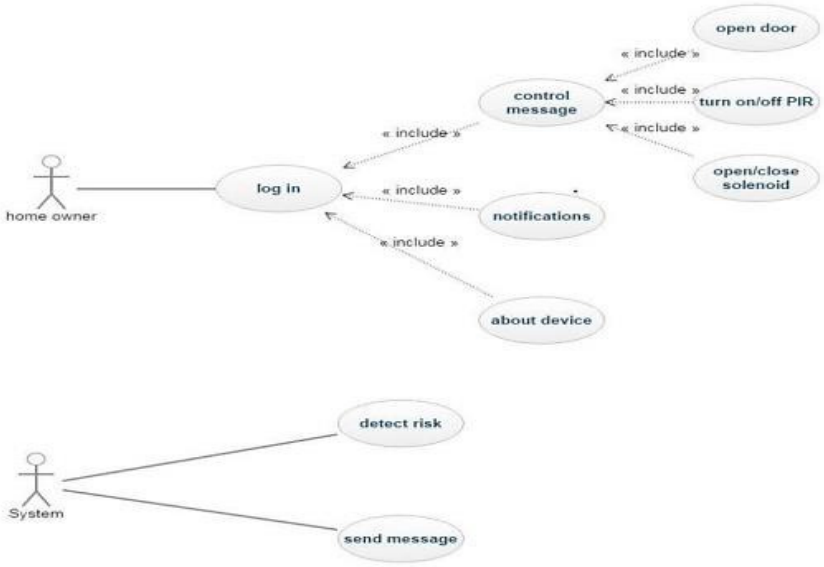


7.6 UML Diagrams

7.6.1 Use Case Diagram

Figure 33show home owner must be login at first, he/she can choose any of the choice which appear in main display of application (control message, notification, about the project) when he/she choose the first choice it include three part (open door, solenoid ,PIR) and our system do two thing detect risk and send SMS.

Figure 33: Use Case Diagram

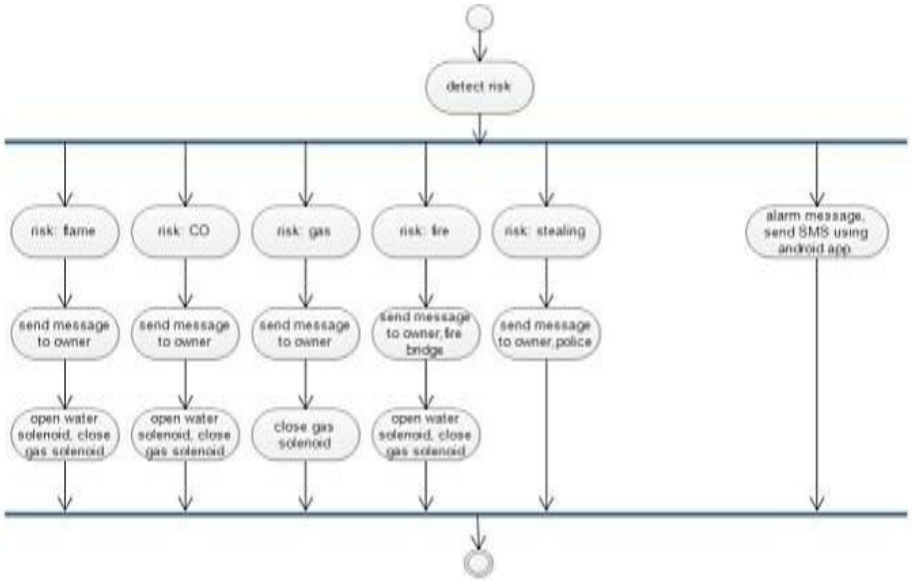


7.6.2 Activity Diagram

Figure 34 show activity diagrams for our system. At the first, sensor detect risk, if there any risk the device gives alarm to the owner by sending SMS to owner and fire bridge, police office ,turn on buzzer.

In control part, owner receives SMS from device in his/her home then the owner can control solenoid also in control part user can open the door turn on /off PIR.

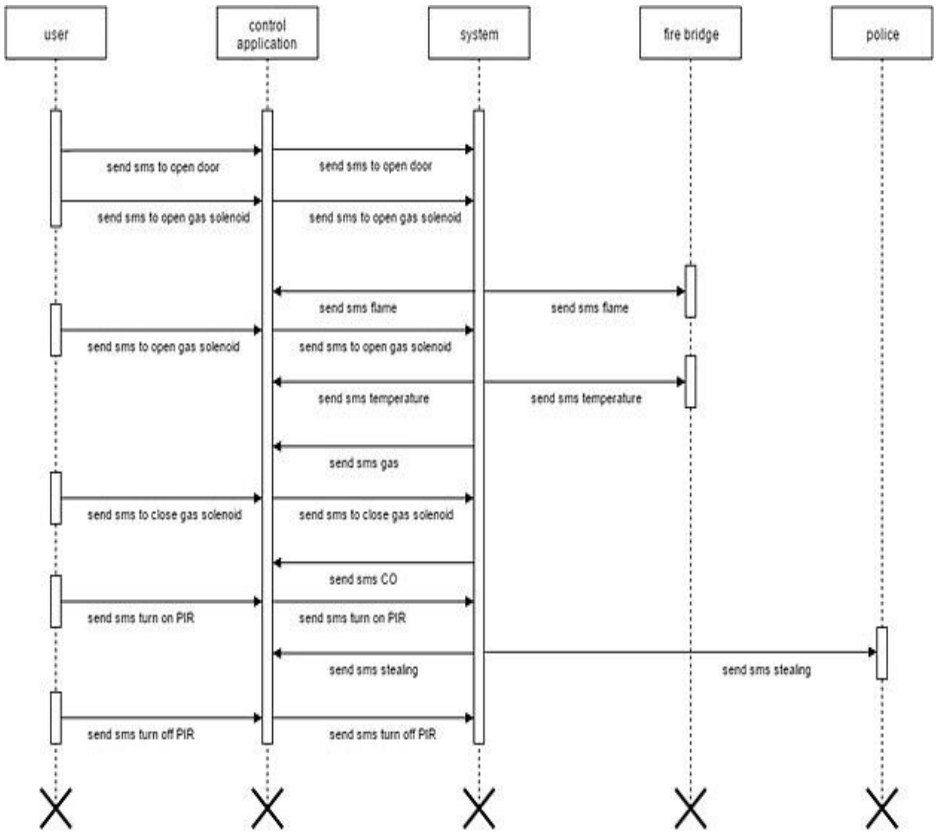
Figure 34: Activity Diagram



7.6.3 Sequence Diagram

Figure 35 show activity diagrams for our system. User sends a control message to open the door, open or close gas solenoid, and turn on or off the PIR sensor. The control application sends the message to the system. The system sends SMS to control application in case of flame, temperature, gas, CO or stealing danger. It also sends SMS to fire bridge in case flame or temperature, and to police if the danger is stealing.

Figure 35: Sequence Diagram



8. Experimental Result

After finishing all of the smart home system connections and programming, we've carried out a multiple experiments; the developed GSM based security system gives good response to the sensor and sends SMS when it detects intrusion and vibration on the door and window where the vibration sensor was fixed. The time taken by the system to deliver the SMS is dependent on the coverage area or range of the specified mobile network. If the mobile is in the range of the system then the SMS is delivered in 20-25 seconds.

We recorded the reaction of the device when one of the risks was occurring and the results were as follows:

Test Case 1:

Title: Temp

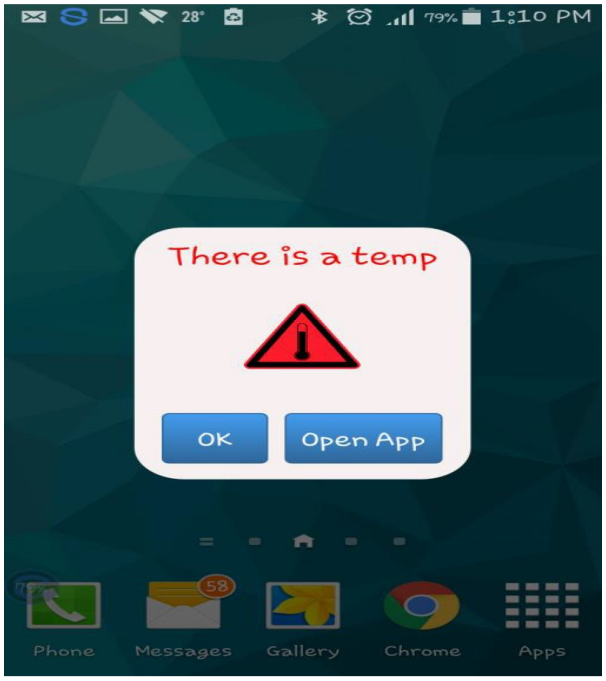
System: Smart home

Input Instructions: Acquire the LM35 sensor reading which is shown on the LCD while there was no leakage.

Output: alarming the user on his mobile by sending an SMS to the android mobile application

Result: Test Succeeded.

Figure 36: Test Temperature



Test Case 2:

Title: Gas Leakage

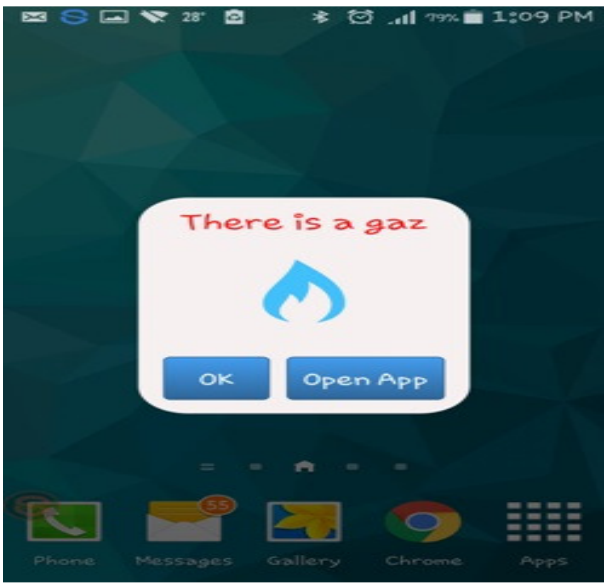
System: Smart home

Input Instructions: Acquire MO6 sensor reading which is shown on the LCD when a gas leakage is happening.

Output: alarming the user on his mobile by using the mobile application and opening the solenoid valve in home, send an SMS to the house owner and he can control the gas leakage through the mobile application by sending an SMS to the Arduino to close the gas cylinder.

Result: Test Succeeded

Figure 37: Result when Gas Leaking



Test Case 3:

Title: CO leakage.

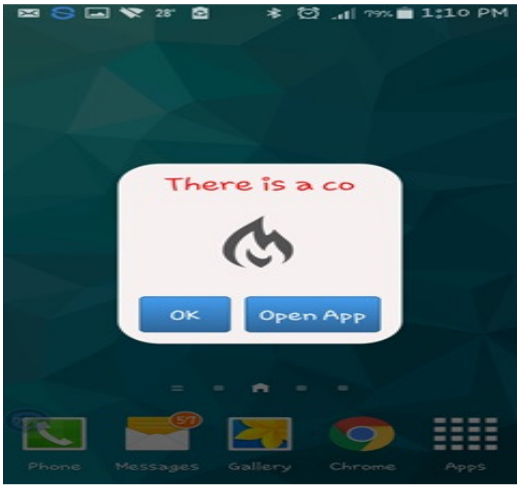
System: Smart home

Input Instructions: Acquire CO sensor reading which is shown on the LCD while CO leakage is happening

Output: alarming the user on his mobile by sending an SMS to the android mobile application

Result: Test Succeeded.

Figure 38: Result when CO Leaking



Test Case 4:

Title: Flame

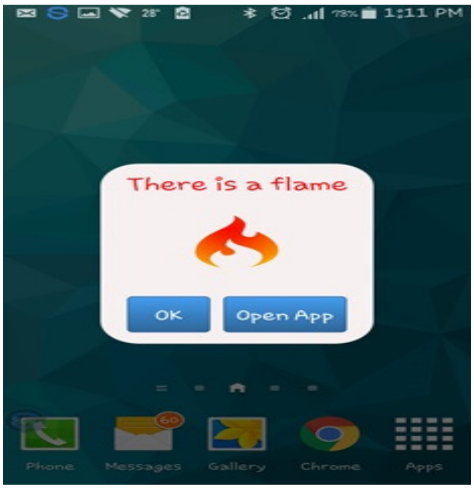
System: Smart home

Input Instructions: Acquire the flame sensor reading which is shown on the LCD while there's a house fire (flame).

Output: alarming the user on his mobile by sending an SM to the android mobile application, sending an SMS to the fire station, open the solenoid valve to reduce fire until the firefighters arrive.

Result: Test Succeeded

Figure 39: Result when Flame Happen



Test Case 5:

Title: Robbery (steal)

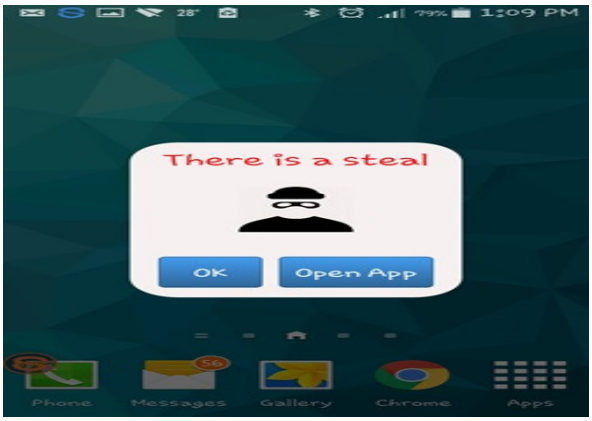
System: Smart home

Input Instructions: Acquire the PIR sensor reading which is shown on the LCD while a robbery is happening.

Output: alarming the user on his mobile by sending an SMS to the android mobile application, sending an SMS to the owner of the home and to the police station.

Result: Test Succeeded.

Figure 40: Result when Stealing



Test Case 6:

Title: No risks

System: Smart home

Input Instructions: Acquire the co sensor reading which is shown on the LCD while no risks are occurring.

Output: on the LCD we show that all is good.

Result: Test Succeeded.

Test Case 7:

Title: Turn on the device

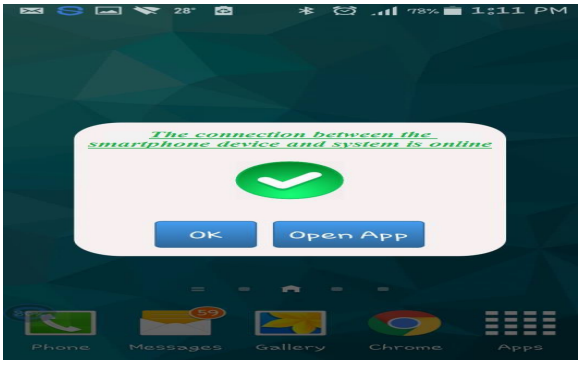
System: Smart home

Input Instructions: ----------

Output: the mobile application appears that the system is on.

Result: Test Succeeded.

Figure 41: Result when the Device with System is Online



9. Directions for Future Research

The developments of GSM based security system have been done. In its development, the cost incurred is very competitive and relatively cheap compared with the systems available on the market. Several tests must be conducted to adjust the appropriate parameter such as time delay or the time which taken by the system to deliver the SMS for the optimal work. In our future works, we will continue to enhance different aspect of the GSM based security system. The system is developed for educational purpose and is currently in use at microprocessor control lab at An-Najah National University-Palestine.

10. Conclusion

The proposed systems are tested on the model of smart home which is shown in Figure 3.This safety house feature is expected to draw much attention in the next decades. People getting more concerned to protect their house from unauthorized people. This system can monitor a house by use of sensors that integrated with a microcontroller and a GSM unit. SMS use to alert users via mobile phone. This system is design using modularity to become a flexible system that can be add more sensors without change the whole system, only add some sensors to increase systems functionality. This paper has successfully presented a functional, low cost and low complexity microcontroller based GSM security system. We solved in this system the problems faced by home owner in daily life and made his life easy, flexible and comfortable by proposing cost effective and reliable solution.

Acknowledgment

The authors would like to thank Palestine Technical University – Kadoorie (PTUK) and An-Najah National University for supporting this research and allowing us to conduct this work in the university labs. The system is developed for educational purpose and is currently in use at microprocessor control lab at An-Najah National University-Palestine.

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