DESIGN AND CONSTRUCTION OF A GSM-BASED GAS LEAKAGE DETECTOR FOR USE IN RESIDENTIAL AREA

BY

OMEGA PRINCE NWAEZE
EEE/13/1118

A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING, FEDERAL UNIVERSITY OYE-EKITI

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE

(B.ENG ELECTRICAL AND ELECTRONICS ENGINEERING)

FEBRUARY, 2019

DECLARATION OF ORIGINALITY

I; OMEGA PRINCE NWAEZE hereby declare that this project is all my own work and has not been copied in part or in whole from any other source except where duly acknowledged. As such, all use of previously published work (from books, journals, magazines, internet, etc.) has been acknowledged within the main report to an entry in the References list.

I agree that an electronic copy or hardcopy of this report may be stored and used for the purposes of plagiarism prevention and detection.

I understand that cheating and plagiarism constitute a breach of University Regulations and will be dealt with accordingly.

Copyright

Signed:..... Date: 4/03/2019

Office Stamp

CERTIFICATION

This is to certify that this project titled "DESIGN AND CONSTRUCTION OF A GSM-BASED GAS LEAKAGE DETECTOR" by OMEGA PRINCE NWAEZE (EEE/13/1118), submitted in partial fulfilment of the requirements for the degree of Bachelor of Engineering (B.ENG.) in ELECTRICAL and ELECTRONIC ENGINEERING of Federal University Oye-Ekiti, in the 2017/2018 academic year, is a bona fide record of work carried out under my guidance and supervision.

DR. ENGR. J. Y. ORICHA _____

(PROJECT SUPERVISOR) SIGN & DATE

ENGR. G.K. IJEMARU _____

(DEPARTMENTAL PROJECT COORDINATOR) SIGN & DATE

DR. ENGR. J.Y ORICHA _____

(H.O.D ELECTRICAL AND ELECTRONICS) SIGN & DATE

EXTERNAL SUPERVISOR _____

SIGN & DATE

DEDICATION

This report is hereby dedicated to the Almighty God, the Alpha and the Omega and then to my parents Pastor and Mrs Omega for their guidance, support and love.

ACKNOWLEDGEMENTS

First of all, I will like to give thanks to God who kept me in his mercies.

Special thanks to my supervisors Dr. J. Y. Oricha and Engr. R. K. Soremekun for their valuable insights into my project and their commitment in helping me finish my project. Thank you so much Sirs and God bless you.

I will also like to thank the Head of Department, Dr. J. Y. Oricha, the Dean of the Faculty of Engineering, Prof. B. A. Alabadan, Prof. Y. A. Adediran, Engr. G. K. Ijemaru, Engr. H. U. Ezea, Engr. Olusuyi, Engr. A. K. Babarinde, Engr. Ofusori, Engr. Sanni, Mr Omoleye and a host of other lecturers and staffs for their supports throughout my degree program.

I will also like to appreciate the members of the Chapel of Transformation such as Engr. J. Abioye, Mr. S. Bayeri, Dr. Mrs F. Ndububa and so many more.

for their support, guidance and love, I thank my fellow hostel mates and friends, *Ericayo, Joshua, Lawrence, Philip ventures, Emmalana, Bukumi, Benzene, Eneji, Ancestor-Tunji, Temi, Segun,* my departmental mates, my wonderful close companions *Bodunde Grace "Omalicha" (my Best Friend), Ella, Tope, Tofumi, the Silicon Sisters (Tosin and Victoria), Olaide, Bolu, Honour, Baderinwa Blessing, Edewho Esther, Mobolaji Hannah, Blessing Titilope, Olaoluwa, Lizzy, Emmanuel Oluwaloni, Olaiya Oluwakorede (one of the brains behind this project work)* and so many others.

Finally, my acknowledgement would not be complete without the mention of the contribution of my Parents, Pastor. and Mrs. Ikechukwu Omega and my siblings, *Princess, Faith, Samuel,* and *Lovwyna* for the motivation, support and encouragement. I am really grateful.
God bless you all.

ABSTRACT

In urban areas, Liquefied Petroleum Gas (LPG) is a leading source of fuel because it is clean compared to kerosene, charcoal and firewood. Due to increase in its use, there is always danger of gas leakage which pose great danger to lives and property due to highly flammable nature of the gas. Cases of gas explosions has been on the rise and thus the need for development of a fast response and high accurate GSM based gas detection system. The developed device is a gas detector using an MQ-6 gas sensor (with gas detection range of 300-10000ppm), ATMEGA328 microcontroller as the control unit, Liquid Crystal Display (LCD) for displaying gas status, a Buzzer as an alarm, two Light Emitting Diodes (LEDs) with colour green (to indicate no gas leakage) and colour red (to indicate detection of gas leakage).

The overall architecture of the design suits its purpose with incorporated special feature which is the GSM module. This on detection of leakage send an SMS to the users coded phone number. The microcontroller senses the presence of a gas when the voltage signal from the MQ-6 sensor goes beyond a certain level and gives an audio-visual alarm. The microcontroller is programed using C++ / C programing language and all the peripherals connected to it through its pins. The device has a two-way powering system which is connected to the Alternating Current (AC) mains and a Direct Current power supply keeping it powered during power failure. When the system is powered the sensor calibrates while the LCD displays a welcome note for a 10 to 15 seconds period. The microcontroller lit the green LED to show the absence of a gas leakage. In the presence of LPG gas, the sensor conductivity increases and the characteristic of the sensor is that at 2.0V output from the sensor, the gas concentration is 300ppm, thus the trigger level is 2.0V. Therefore, the GSM microcontroller based gas leakage detector and MQ-6 sensor is able to detect gas leakage concentration from 300ppm and give an audio-visual signal.

Table of Contents

List of Figures

CHAPTER ONE

1.0 INTRODUCTION

Fire outbreak leading to loss of lives and property has being one of the rising menace in Nigerian society. The major cause of this is due to the increase use of hydrocarbons and Gases as a source of energy. Some of these Gases (propane and butane) have been found good and suitable for cooking. Home fire accidents are majorly caused by leakage of this cooking gas (LPG). The Gas detector is a new invention to help keep the source of these menace in check.

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and can interface with a control system so a process can be automatically shut down. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This device is important because there are many gases that can be harmful to organic life, such as humans or animals.

Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. This type of device is used widely in industry and can be found in locations, such as on oil rigs, to monitor manufacture processes and emerging technologies such as photovoltaic. They may be used in firefighting.

Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, etc. Common sensors include combustible gas sensors, photoionization detectors, infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and semiconductor sensors. More recently, infrared imaging sensors have come into use. All of these sensors are used for a wide range of applications and can be found in industrial plants, refineries, pharmaceutical manufacturing, fumigation facilities, paper pulp mills, aircraft and ship-building facilities, hazmat operations, waste-water treatment facilities, vehicles, indoor air quality testing and homes. However, in this work an MQ-6 sensor module was used for the design.

1.1 GENERAL BACKGROUND

Liquefied Petroleum Gas (LPG) is a leading source of energy used for cooking in Nigerian homes today. Its use is on a high side in developing countries like Nigeria, India, Bangladesh, Nepal, South Africa etc. It provides an economical and clean source of energy compared to other sources of energy like Firewood and Kerosene**Invalid source specified.**. LPG gas is a mixture of butane and propane gas or purely butane or propane gas.**Invalid source specified.** It is a by-product of Natural Gas and crude oil processing. These gases have a characteristic of being highly flammable and can cause suffocation in high concentration. Because of this, the usage of gases should be done with great care and safety standards should be put in place to ensure everyone using the gas is safe. Gas used for cooking is supplied in gas cylinders which have a regulating valve. After using the gas, the User is supposed to turn off the gas. The supplier of the gas should make sure the valve is working well and not leaking the gas because any leakage is dangerous to human health and can cause damage to human lives and property if explosion occurs.**Invalid source specified.**

Observation of the safety standards would avoid the dangers posed by the gas. However, systems made by human being are bound to fail at one point due to wearing out, accident or by intention. Also by accident, we might forget to turn off the gas. This poses an immediate danger to life and property due to the flammable and intoxicating nature of the gas. As an engineer, it is a lifesaving task to design a LPG detector used to detect the leakage of gas and if the gas leak occurs, an alarm is raised by a Buzzer, an equivalent message is conveyed by the means of an LCD screen and with the help of the GSM module it is capable to broadcast messages to the stakeholders about the LPG leak anywhere they are. Thus we are going to design an Arduino microcontroller based cooking gas detector and alarm system. The Gas leak detector device can find application not only at residential homes but also it is applicable to hotels, restaurants and even in industries where LPG gas is used for some or the other purposes.

1.2 PROBLEM STATEMENT

With the increasing rate of fire outbreaks due to presence of LPGs in homes and the fact that there will always be a risk of gas leakage whenever we are using the gas, it is paramount to design and implement a microcontroller based cooking gas leakage

detector capable of giving an audio-visual alarm in conjunction with an SMS alert system to inform you right wherever you are.

LPG gas is odourless therefore a little amount of a pungent gas such as ethanethial is added to help people smell a gas leakage. However, this is not reliable as you may not smell the gas hence the need for a gas leakage detector. One such kind of a sensor is an Arduino microcontroller based gas leakage detector. The detector is capable of raising an alarm, displaying the status of the detection system and sending an SMS to the user during gas leak. To design such a detector, a gas sensor (MQ-6 LPG gas sensor), a microcontroller (ATMEGA 328), a LCD display, a Buzzer, a GSM module and a number of other components are required. The success of designing the LPG gas leakage detector will help to efficiently detect the leakage of LPG gas and avoid risk of fire and pollution, saving lives and property.

1.3 MOTIVATION

Gas cylinders are taking over as the main source of cooking in Nigeria and with this increase there has been a lot of fire incidence as a result of gas leakage. Lives and property has been destroyed because of Gas explosions and fire due to accidents and mismanagement of Gas cylinders. What happens to the gas then depends on the nature of the gas and the immediate environment, but can pose a threat to life in three ways:

- Combustible gas can gather and reach a density at which it can ignite and cause a fireball.
- Toxic gas can cause illness, paralysis or death if inhaled.
- Any gas in sufficient quantities will displace oxygen and therefore pose a serious risk to life.

This has created phobia for Gas usage. However, this prompted the design and construction of a Gas leakage detector device which will aid the detection of LPG (in the atmosphere in a confined room or what have you) when there is a leakage and alert its User for precaution measures making Gas usage as a source of cooking safer and enjoying.

1.4 SIGNIFICANCE OF STUDY

Gas leakage is always a risk whenever we use gas for one purpose or the other therefore posing a great danger to both lives and property. This design presents an effective

power saving gas detection system at a cheap price making it possible for all who use gas in homes to buy and install.

1.5 AIM AND OBJECTIVES

The aim of this project is to design, construct and implement a LPG gas leakage detection system in residential homes. The objectives of this project are:

1. Detect Gas leakage (LPG leak, Butane leak, Propane leak) using MQ-6 sensor.
2. Sound an alarm upon gas leak and stop the alarm once gas leak is under control (gas concentration in atmosphere is in normal level).
3. Display status in an LCD using 16×2 LCD module.
4. Send an SMS alert to the specified user using a GSM module.
5. To make recommendations based on findings from this project.

1.6 SCOPE OF STUDY

LPG gas is the gas mainly used for cooking. The gas leakage detector being designed is limited to detecting LPG only. It can be used at LPG gas sales point, homes, restaurant and any other place where a LPG gas is being used for heating or cooking. Since the device uses a MQ-6 sensor it cannot be used to detect Natural gas or any other Methane based gas. Also it cannot be used as smoke detector in case of fire. One of its main purposes is to monitor an area. Gas detectors measure and indicate the concentration of certain gases in an air via different technologies. Typically employed to prevent toxic exposure and fire, gas detectors are often battery operated devices used for safety purposes. This device designed as portable or stationary (fixed) units and work by signifying high levels of gases through a series of audible and visible indicators, such as alarms and lights.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND OF THE STUDY

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and can interface with a control system so a process can be automatically shut down. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals.

Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. This type of device is used widely in industry and can be found in locations, such as on oil rigs, to monitor manufacture processes and emerging technologies such as photovoltaic. They may be used in firefighting.

Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, etc. Common sensors include combustible gas sensors, photoionization detectors, infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and semiconductor sensors. More recently, infrared imaging sensors have come into use. All of these sensors are used for a wide range of applications and can be found in industrial plants, refineries, pharmaceutical manufacturing, fumigation facilities, paper pulp mills, aircraft and ship-building facilities, hazmat operations, waste-water treatment facilities, vehicles, indoor air quality testing and homes.

2.2 REVIEW OF PAST RELATED WORKS

LPG is a stable, high energy content, relatively low Sulphur, clean burning fuel which can be transported economically as a liquid therefore making it the main source of fuel used for cooking and in heating appliances.**Invalid source specified.** It is a by-product of crude oil and Natural Gas processing.**Invalid source specified.**

LPG gas is a highly inflammable gas with lower Explosive Limits of about 1.4% that is about 14,000PPM.**Invalid source specified.**

In the year 2014, Apeh S.T *et al* designed and developed a Gas Leakage Detection and automatic shut off system. The system was designed to detect gas leakage and alert the user through alarm and status display besides turning off the gas supply valve as a primary safety measure. The system uses a closed solenoid valve for the shutting off of the Gas valve before visual display and audible alarm to those in the environment. Also the system is an intelligent one in the sense the alarm stops beeping once the gas concentration in the atmosphere goes below the default value set. It was observed that when the LPG device was tested by placing it at different distances from the gas source, the response time of the LPG system increased as the distance from the gas source increased and vice versa. The gas sensor's sensitivity varied with temperature/Humidity while the reference voltage remained constant over time with error of ±1V. At constant gas concentration, the sensed voltage will always be constant. The gas sensor has a very fast response to gas since the time difference between test results with same concentration is very small. They came to a conclusion that the device could be deployed anywhere cooking involving kitchen gas is used affirming that the device will detect and avert the leakage of LPG.**Invalid source specified.**

In the year 2016, Gurusamy P *et al* designed and constructed an LPG detection system that uses GSM module. The system detects the leakage of the LPG using a gas sensor and *uses the GSM* to alert the person about the gas leakage via SMS. When the concentration of LPG in air exceeds a certain level, the sensor senses the gas leakage and the output of the sensor goes LOW. The detection is done by the gas sensor, through the microcontroller the LED and buzzer are turned ON simultaneously. An alert is provided to the user, sending an SMS to the programmed mobile number.
The input module consists of a gas sensor (MQ7) and a temperature sensor (LM35). The gas sensor detects the any change in concentration of gases in the air. If there occurs a change in concentration, the voltage of the gas sensor goes LOW. Similarly, if there is any fire or any abnormal temperature activity at the place, its voltage gets LOW. The increase of gas concentration in the air may also lead to a rise in temperature. Hence the LOW voltage is detected by the microcontroller.
The output is proportional to the temperature. The sensor has three pins. The first one is a supply voltage VCC and possess voltage value of 5V. The second pin is an output

voltage pin; it generates a voltage of around -1V to 6V. The third pin is used as a ground here.**Invalid source specified.**

In the year 2013, Hamdzani designed a gas leakage and fire alert warning system via GSM. This project used microcontroller system, sensors, GSM modem and several other devices. The detector is based on the commercial gas sensor from Hanwei Electronics Co. Ltd, Temperature Sensor by National Semiconductor and LCD alphanumeric display. This system uses Microchip microcontroller as a tool to collect input data, process and release output data. The significant of this project is to briefly show how to connect a microcontroller system with input and output devices consists of LCD display and GSM modem. The project focuses more on the study case and the project development based on the gas and temperature sensor. The microcontroller continuously receives the data from both of the sensor in analogue packet of data. It processes the data and convert it to ppm and degree Celsius respectively. The converted data will be displayed by the LCD. Whenever the reading of the sensors exceeding the limit set, it will automatically send an SMS alert wirelessly by using GSM Network to the numbers as being set on the source code.**Invalid source specified.**

In the year 2017, the work by Geeta *et al* aimed at designing a system that detects gas leakage and alerts the subscriber through alarm and status display besides turning off the gas supply valve as a primary safety measure. The shutting off of the supply valve stops further gas flow to the cooker to prevent. The system more like a first Aid, automatically uses a normally closed solenoid valve for the shutting off of the gas valve before calling for help via visual display and audible alarm to those within the environment. The system is an intelligent system, as it does not create nuisance by continuously sounding alarm but the alarm stops beeping once the concentration of the gas in the atmosphere after leakage goes below the set point and opens the valve again for operations. It was observed that when the LPG device was tested by placing it at different distances from the gas source, the response time of the LPG system decreased as the distance from the gas source increased and vice versa. The gas sensor's sensitivity varied with temperature while the reference voltage remained constant over time. This brought the project to a conclusion that the device could be deployed any cooking place or in kitchen involving use of cooking gas. The system ensures that

explosions resulting from leakages of cooking gas from the cylinders are averted.**Invalid source specified.**

In the year 2012, Ramya & Palaniappan,"Embedded System for Hazardous Gas Detection and Alerting" This work modified the existing safety model installed in industries. The main objective of the work was designing microcontroller based toxic gas detecting and alerting system. The hazardous gases like LPG and propane were sensed and displayed each and every second in the LCD display. If these gases exceed the normal level, then an alarm is generated immediately and also an alert message (SMS) is sent to the authorized person through the GSM. The advantage of this automated detection and alerting system over the manual method is that it offers quick response time and accurate detection of an emergency and in turn leading faster diffusion of the critical situation. The gas sensors and the critical level of the respective gas should be known, and then this system can be implemented for detecting various gases either in domestic area such as places of educational institutions, residential and industrial areas which avoids endangering of human lives. This system provides quick response rate and the diffusion of the critical situation can be made faster than the manual methods.**Invalid source specified.**

In the year 2008, LIU zhen-ya, WANG Zhen-dong and CHEN Rong, "Intelligent Residential Security Alarm and Remote Control System Based On Single Chip Computer", the paper focused on, Intelligent residential burglar alarm, emergency alarm, fire alarm, toxic gas leakage remote automatic sound alarm and remote control system, which is based on 89c51 single chip computer. The system can perform an automatic alarm, which calls the police hotline number automatically. It can also be a voice alarm and shows alarm occurred address. This intelligent security system can be used control the electrical power remotely through telephone. (Tsow *et al,* 2009)

In the year 2008, Chen Peijiang and Jiang Xuehhua, "Design and implementation of Remote Monitoring System Based on GSM", this paper focused on the wireless monitoring system, because the wireless remote monitoring system has more and more application, a remote monitoring system based on SMS through GSM. Based on the overall architecture of the system, the hardware and software architecture of the system is designed. In this system, the remote signal is transmitted through GSM network. The

system includes two parts which are the monitoring centre and the remote monitoring station. The monitoring centre consists of a computer and a TC35 communication module for GSM. The computer and the TC35 are connected by RS232. The remote monitoring station consist of a TC35 communication module for GSM, a MSP430F149 MCU, a display unit, sensors and a data gathering and processing unit. The software for the monitoring centre and the remote monitoring station were designed using VB. (Geng Juntato *et al*,2017)

In the year 2016, Ioan Lita, Ion Bogdan Cioc and Daniel Alexandru Visan, "A New Approach of Automatic Localization System Using GPS and GSM/GPRS Transmission", this paper focused on, a low cost automotive localization system using GPS and GSM-SMS services, which provides the position of the vehicle on the driver's or owner's mobile phone as a short message (SMS) on his request. The system can be interconnected with the car alarm system which alerts the owner, on his mobile phone, about the events that occurs with his car when it is parked. The system is composed by a GPS receiver, a microcontroller and a GSM phone. In additional the system can be settled for acquiring and transmitting the information, whenever requested about automobile status and alerts the user about the vehicle started engine. The system can be used as a low cost solution for automobile position localizing as well as in car tracking system application. (Ioan Lita *et al*,2016)

In the year 2012, K. Galatsis, W. Wlodarsla, K. Kalantar-Zadeh and A. Trinchi, "Investigation of gas sensors for vehicle cabin air quality monitoring", this paper focused on, car cabin air quality monitoring can be effectively analyzed using metal oxide semiconducting (MOS) gas sensors. In this paper, commercially available gas sensors are compared with fabricated Moo3 based sensors possessed comparable gas sensing properties. The sensor has response 74% higher relative to the hest commercial sensor tested. In the year 2000, K. Galatsis, W. Woldarsla, Y.X. Li and K. Kalantar-zadeh, "A Vehicle air quality monitor using gas sensors for improved safety", this paper focuses on A vehicle cabin air quality monitor using carbon monoxide (CO) and oxygen (02) gas sensors has been designed, developed and on-road tested. The continuous monitoring of oxygen and carbon monoxide provides added vehicle safety as alarms could be set off when dangerous gas concentrations are reached, preventing

driver fatigue, drowsiness, and exhaust gas suicides. CO concentrations of 30ppm and oxygen levels lower than 19.5% were experienced whilst driving. (Jung *et al,* 2008)

In the year 2012, S. Rajitha and T. Swapna designed a security alert system that uses GSM for gas leakage detection. The system detects the leakage of the LPG using gas sensor and alerts the consumer about the gas leakage by sending SMS. The alert system uses the GSM to alert the person about the gas leakage via SMS. When the system detects the LPG concentration in the air to have exceeded a certain set level then it immediately alerts the consumer by sending SMS to specified mobile phone and alert the people at home by activating the alarm which includes the LED, Buzzer simultaneously and display the message on LCD display to take the necessary action and switch on the exhaust fan to decrease the gas concentration in the air. The author applied a protective circuit in form of an exhaust fan which was interfaced to the LPC2148 microcontroller used. Also a driver circuit was designed to activate the exhaust fan using a relay. This showed that using an LPC2148 microcontroller in place of some other microcontrollers may require a more robust circuit which needs a lot of protection.**Invalid source specified.**

In the year 2014, Wickramasinghe & Abhayasinghe,"LP Gas Leakage Alarm" In this paper, M. G. D. D. Wickramasinghe and N. Abhavasinghe presented a low cost, power efficient centralized LP gal leakage alarm system. The system has two main devices: the gas detector and the centralized alarm unit. The gas detector that is located close to the gas usage point (gas cylinder) is a battery operated device that is designed to operate up to 6 months with two AA size alkaline batteries. Provision was made for more than one detector in the system, which can be separately identified in the system. The centralized alarm unit detects the alerts sent by the detectors and releases the alarm. It has an indication of which detector has released the alert. The alarm unit is ac mains powered and has a battery backup to cater power failures. The components of the device were chosen considering the power consumption and the time intervals were also calculated concerning the current consumption of each component.**Invalid source specified.**

In the year 2016, Naresh Naik, Siva Nagendra Reddy, Nanda Kishore and Tharunkumar Reddy in their publication "Arduino Based LPG Gas Monitoring &

Automatic Cylinder Booking with Alert System" proposed a system that will make entire LPG cylinder booking procedure automated without human intervention. This system continuously measures the weight of the cylinder and once it reaches minimum threshold it will automatically sends message to the authorized LPG Agent so that they can deliver the LPG cylinder in time. Along with the automated cylinder booking, they also designed feature related to the safety of the user in which it continuously monitors the leakage of LPG gas and alerts the user regarding leakage to avoid major accidents which costs human lives mostly. When the system identifies that LPG concentration in the air reaches the specified level then it alerts the consumer by sending SMS to registered mobile phone and alert the people at home by activating the alarm which includes Buzzer simultaneously and also display the same message on LCD to take the necessary action and switch on the exhaust fan or opening windows to decrease the gas concentration in the air.**Invalid source specified.**

In the year 2011, A. MAHALINGAM, R. T. NAAYAGI,1, N. E. MASTORAKIS, "Design and Implementation of an Economic Gas Leakage Detector", This project developed system to detect the gas leakage and providing immediate alarm or intimation to the user.

Later in 2013, few people developed the design proposed for home safety. This system detects the leakage of the LPG and alerts the consumer about the leak by buzzer. This project was developed using microcontroller ARM version 7 processor and simulated using Keil software.

In the year 2014, Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare, designed a system, they provided security issues against thieves, leakage and fire accidents. In those cases, their system sends SMS to the emergency number provided to it. In the proposed system, they designed "LPG gas monitoring and automatic cylinder booking with alert system". The report focused on detection of economic fuels like petroleum, liquid petroleum gas, alcohol. etc., and alert the surrounding people about the leakage through SMS. It also senses surrounding temperature, so that no fire accidents occur. The one more important feature is automatic cylinder booking by noticing the current expenditure of LPG gas in our daily life. These projects alert the user by sending message to mobile through SMS in three conditions. They are, when LPG gas weight reaches to maximum threshold value, when

the LPG gas exceed its peak value and when the temperature exceeds more than room temperature.

In the year 2017, Akshay & Ashwin, developed a Gas Leak Detector Using Arduino Uno Microcontroller. The main advantage of this simple gas leak detector is its simplicity and its ability to warn its stakeholders about the leakage of the LPG gas. The future aspects of the detector include the gsm module and a tripper circuit which increases the efficiency of the system and provides more safety to the users. The other advantage of this system includes its audio – visual warning systems. This detector was implemented successfully and is easy to use and also a low cost product. Another advantage of the device is that even though if no one is there in the house and then gas leaks occurs, GSM module is there to send immediate messages to the stakeholders regarding the gas leak and thus it lowers the intensity of accidents. GSM module in this device ensures better safety regarding the gas leaks.**Invalid source specified.**
In the year 2016, Njue George designed a Microcontroller based cooking Gas leakage detector. The objective of the project was to design and implement a cooking gas detector capable of giving an audio-visual warning when there is a gas leakage. The detector was designed to use a PIC16F690 microcontroller and a MQ-6 gas sensor. The detector shows a green LED for no gas leakage and red LED when there is a gas leakage. The detector used a LCD to show the concentration of the gas leakage.
However, he observed that the use of an alarm, LED and LCD as the alarm system was not enough. This require a person presence in the vicinity to be notified when there is gas leakage. He further recommended that the detection system can be improved by including a GSM module for sending SMS alert to a mobile phone. This way, wherever someone is, he can be notified when there a gas leakage. To improve the safety of people and property, the SMS alert can be sent to the relevant authority like the fire brigade department to deal with the gas leakage issue if the gas leakage has reached a very high concentration.**Invalid source specified.**

In the year 2015, Ashish developed a microcontroller based LPG gas detector using GSM module. This unit can be easily incorporated into an alarm unit, to sound an alarm or give a visual indication of the LPG concentration. The sensor has excellent sensitivity combined with a quick response time. The sensor can also sense iso-butane, propane, LNG and cigarette smoke.

If the LPG sensor senses any gas leakage from storage the output of this sensor goes low. This low signal is monitored by the microcontroller and it will identify the gas leakage. Now the microcontroller is turn on LED and Buzzer. After few milliseconds delay, it also turns on exhaust fan for throwing gas out and continue send messages as „GAS LEAKAGE" to a mobile no., written in c-code.
However, the exhaust fan incorporated in the device meant to blow off the LPG in space cannot be efficient enough to work in a sized room. This brings the whole system mechanism to a big limitation.**Invalid source specified.**

Mahalingam, Naayagi and Mastorakis developed, designed and successfully implemented a cost-effective gas leakage detection system as a laboratory prototype, which was presented in their written work. The practical testing of the system was done using butane based lighter, which forms an ingredient of LPG. The test results confirm the efficient operation of the prototype by detecting low and high gas leakage levels and alerts the users by issuing appropriate audio-visual warning signals. The proposed system is designed to meet UK occupational health and safety standards with respect to gas leakage detection in residential and commercial premises. The cost involved in developing the system is significantly low and is much less than the cost of gas detectors commercially available in the market. (Mahalingam, T, & E, 2016)

In the year 2017, Enalume and Obianke developed an efficient LPG Leakage Detector. This system was developed so that gas leakage can be quickly detected and notification of the user is immediately carried out. A GSM module is used to send SMS to the user if gas leakage is detected and the status is displayed on an LCD. The PIC18F2520 microcontroller carries out all the processing of the signal received from the MQ6 gas sensor and activate the GSM module and LCD to inform the user. To make the system very efficient it was configured to detect gas leakage at 250ppm which is far less than the standard 1000ppm and it was designed to be powered by the mains and from rechargeable battery. Test result carried out on the system were satisfactory indicating that it can be successfully deployed for domestic use. (Enalume & Obianke, 2017)

In the year 2017, Jebamalar *et al* in their work "LPG Gas Leakage Detection and Alert System" presented LPG leakage detection and alert system. This system triggers LED and buzzer to alert people when LPG leakage is detected. The system is battery

operated hence making it portable. It was designed in such a way that it can also be operated with ac power supply. To support the latter case, it has a bridge rectifier with a capacitor filter. This system is very simple yet reliable as they affirmed. (Jebamalar, Asir Singh, Abinaya, & Deepika, 2017)

In the year 2013, Daudi Simbeye developed a Gas Leakage Detection System (GLDS). The paper mainly focuses on the detection of gas leakage and providing security when the user is around or away from home. The system is Short Message Service (SMS) based and uses wireless technology for providing security against gas leakage to users hence cost effective and more adaptable. The system comprises of sensors for detecting gas leak interfaced to microcontroller that will give an alert to user whenever there is a gas leakage, display warning information by using Liquid Crystal Display (LCD), sending SMS to the user for notification wherever he/she might be and turning off electric power with the help of magnetic relay. This will enable the user to take precaution of explosion disaster which may result on Liquefied Petroleum Gas (LPG) cookers like loss of properties, injury or even death. GLDS provides ideal solution to gas leakage problems faced by home owners in daily life. (Daudi, 2013)

2.3 REVIEW OF TYPES OF GAS ALARM SYSTEM

Gas detectors can be classified according to the operation mechanism (semiconductors, oxidation, catalytic, photoionization, infrared, etc.). Gas detectors come packaged into two main form factors: portable devices and fixed gas detectors.

Portable detectors are used to monitor the atmosphere around personnel and are either hand-held or worn on clothing or on a belt/harness. These gas detectors are usually battery operated. They transmit warnings via audible and visible signals, such as alarms and flashing lights, when dangerous levels of gas vapours are detected.

Fixed type gas detectors may be used for detection of one or more gas types. Fixed type detectors are generally mounted near the process area of a plant or control room, or an area to be protected, such as a residential bedroom. Generally, industrial sensors are installed on fixed type mild steel structures and a cable connects the detectors to a SCADA system for continuous monitoring. A tripping interlock can be activated for an emergency situation.

Electrochemical

Electrochemical gas detectors work by allowing gases to diffuse through a porous membrane to an electrode where it is either chemically oxidized or reduced. The amount of current produced is determined by how much of the gas is oxidized at the electrode, indicating the concentration of the gas. Manufactures can customize electrochemical gas detectors by changing the porous barrier to allow for the detection of a certain gas concentration range. Also, since the diffusion barrier is a physical/mechanical barrier, the detector tended to be more stable and reliable over the sensor's duration and thus required less maintenance than other early detector technologies.

However, the sensors are subject to corrosive elements or chemical contamination and may last only 1–2 years before a replacement is required. (Zhijie, 2011) Electrochemical gas detectors are used in a wide variety of environments such as refineries, gas turbines, chemical plants, underground gas storage facilities, and more.

Catalytic Bead (Pellistor)

Catalytic bead sensors are commonly used to measure combustible gases that present an explosion hazard when concentrations are between the lower explosion limit (LEL) and upper explosion limit (UEL). Active and reference beads containing platinum wire coils are situated on opposite arms of a Wheatstone bridge circuit and electrically heated, up to a few hundred degrees C. The active bead contains a catalyst that allows combustible compounds to oxidize, thereby heating the bead even further and changing its electrical resistance. The resulting voltage difference between the active and passive beads is proportional to the concentration of all combustible gases and vapours present. The sampled gas enters the sensor through a sintered metal frit, which provides a barrier to prevent an explosion when the instrument is carried into an atmosphere containing combustible gases. Pellistors measure essentially all combustible gases, but they are more sensitive to smaller molecules that diffuse through the sinter more quickly. The measureable concentration ranges are typically from a few hundred ppm to a few volume percent. Such sensors are inexpensive and robust, but require a minimum of a few percent oxygen in the atmosphere to be tested and they can be poisoned or inhibited by compounds such as silicones, mineral acids, chlorinated organic compounds, and sulphur compounds.

Photoionization

Photoionization Detectors (PIDs) use a high-photon-energy UV lamp to ionize chemicals in the sampled gas. If the compound has an ionization energy below that of

the lamp photons, an electron will be ejected, and the resulting current is proportional to the concentration of the compound. Common lamp photon energies include 10.0 eV, 10.6 eV and 11.7 eV; the standard 10.6 eV lamp lasts for years, while the 11.7 eV lamp typically last only a few months and is used only when no other option is available. A broad range of compounds can be detected at levels ranging from a few ppb to several thousand ppm. Detectable compound classes in order of decreasing sensitivity include: aromatics and alkyl iodides; olefins, sulphur compounds, amines, ketones, ethers, alkyl bromides and silicate esters; organic esters, alcohols, aldehydes and alkanes; H2S, NH3, PH3 and organic acids. There is no response to standard components of air or to mineral acids. Major advantages of PIDs are their excellent sensitivity and simplicity of use; the main limitation is that measurements are not compound-specific. Recently PIDs with pre-filter tubes have been introduced that enhance the specificity for such compounds as benzene or butadiene. Fixed, hand-held and miniature clothing-clipped PIDs are widely used for industrial hygiene, hazmat, and environmental monitoring.

Infrared point

Infrared (IR) point sensors use radiation passing through a known volume of gas; energy from the sensor beam is absorbed at certain wavelengths, depending on the properties of the specific gas. For example, carbon monoxide absorbs wavelengths of about 4.2-4.5 μm. (Edward,2010) The energy in this wavelength is compared to a wavelength outside of the absorption range; the difference in energy between these two wavelengths is proportional to the concentration of gas present. (Edward,2010)

This type of sensor is advantageous because it does not have to be placed into the gas to detect it and can be used for remote sensing. Infrared point sensors can be used to detect hydrocarbons (Figaro Sensor, 2017) and other infrared active gases such as water vapour and carbon dioxide. IR sensors are commonly found in waste-water treatment facilities, refineries, gas turbines, chemical plants, and other facilities where flammable gases are present and the possibility of an explosion exists. The remote sensing capability allows large volumes of space to be monitored.

Engine emissions are another area where IR sensors are being researched. The sensor would detect high levels of carbon monoxide or other abnormal gases in vehicle exhaust and even be integrated with vehicle electronic systems to notify drivers. (Edward,2010)

Infrared imaging

Infrared image sensors include active and passive systems. For active sensing, IR imaging sensors typically scan a laser across the field of view of a scene and look for backscattered light at the absorption line wavelength of a specific target gas. Passive IR imaging sensors measure spectral changes at each pixel in an image and look for specific spectral signatures that indicate the presence of target gases. (General Monitors,2018) The types of compounds that can be imaged are the same as those that can be detected with infrared point detectors, but the images may be helpful in identifying the source of a gas.

Semiconductor

Semiconductor sensors detect gases by a chemical reaction that takes place when the gas comes in direct contact with the sensor. Tin dioxide is the most common material used in semiconductor sensors, (Naranjo, 2007) and the electrical resistance in the sensor is decreased when it comes in contact with the monitored gas. The resistance of the tin dioxide is typically around 50kΩ in air but can drop to around 3.5kΩ in the presence of 1% methane. (Martínez-Hurtado, 2018) This change in resistance is used to calculate the gas concentration. Semiconductor sensors are commonly used to detect hydrogen, oxygen, alcohol vapour, and harmful gases such as carbon monoxide. (Moore, 2011) One of the most common uses for semiconductor sensors is in carbon monoxide sensors. They are also used in breathalysers. (Martínez-Hurtado, 2018) Because the sensor must come in contact with the gas to detect it, semiconductor sensors work over a smaller distance than infrared point or ultrasonic detectors.

Ultrasonic

Ultrasonic gas detectors use acoustic sensors to detect changes in the background noise of its environment. Since most high-pressure gas leaks generate sound in the ultrasonic range of 25 kHz to 10 MHz, the sensors are able to easily distinguish these frequencies from background acoustic noise which occurs in the audible range of 20 Hz to 20 kHz. The ultrasonic gas leak detector then produces an alarm when there is an ultrasonic deviation from the normal condition of background noise. Ultrasonic gas leak detectors cannot measure gas concentration, but the device is able to determine the leak rate of an escaping gas because the ultrasonic sound level depends on the gas pressure and size of the leak. (Colhoun, 2015)

Ultrasonic gas detectors are mainly used for remote sensing in outdoor environments where weather conditions can easily dissipate escaping gas before allowing it to reach leak detectors that require contact with the gas to detect it and sound an alarm. These

detectors are commonly found on offshore and onshore oil/gas platforms, gas compressor and metering stations, gas turbine power plants, and other facilities that house a lot of outdoor pipeline.

Holographic

Holographic gas sensors use light reflection to detect changes in a polymer film matrix containing a hologram. Since holograms reflect light at certain wavelengths, a change in their composition can generate a colourful reflection indicating the presence of a gas molecule. (Martinez Hurtado, 2014) However, holographic sensors require illumination sources such as white light or lasers, and an observer or CCD detector.

2.4 THEORY OF COMPONENTS

2.4.1 Operating Principle of MQ-6 Sensor

The Figure 2.1 shows a photo of MQ-6 sensor. In clean air, the sensor has a high resistance and in presence of a gas the sensor conductivity increases. The sensor has a simple drive circuit shown in Figure 2.2. The sensor is driven from a 5V supply. A voltage (heating voltage) is applied between Pin 2 and 5 with a resistance of 26 ± 3Ω to heat the sensor to the working temperature. When Tin Oxide is pre-heat in presence of oxygen, oxygen is adsorbed on the crystal surface with negative charges. The donor electrons on the crystal are transferred to the adsorbed oxygen thus leaving positive charges in a space charge layer. This create a surface potential which acts as potential barrier against electrons flow hence the high resistance of the sensor in clean air. In presence of reducing gas such as LPG, the gas molecules are adsorbed on the material surface reducing the surface density of the negatively charged Oxygen ions thus increasing concentrations of electrons and the conductivity of the sensor.

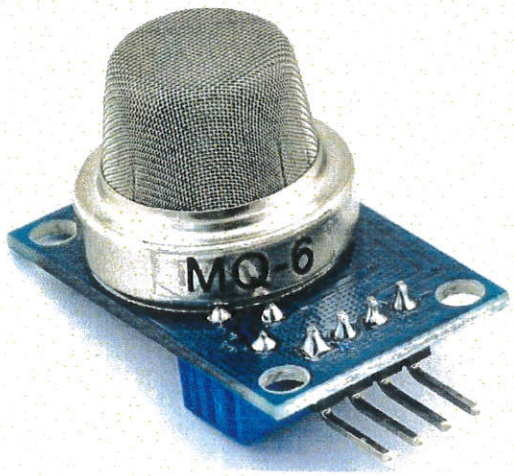

Figure 2.1 MQ-6 Gas Sensor

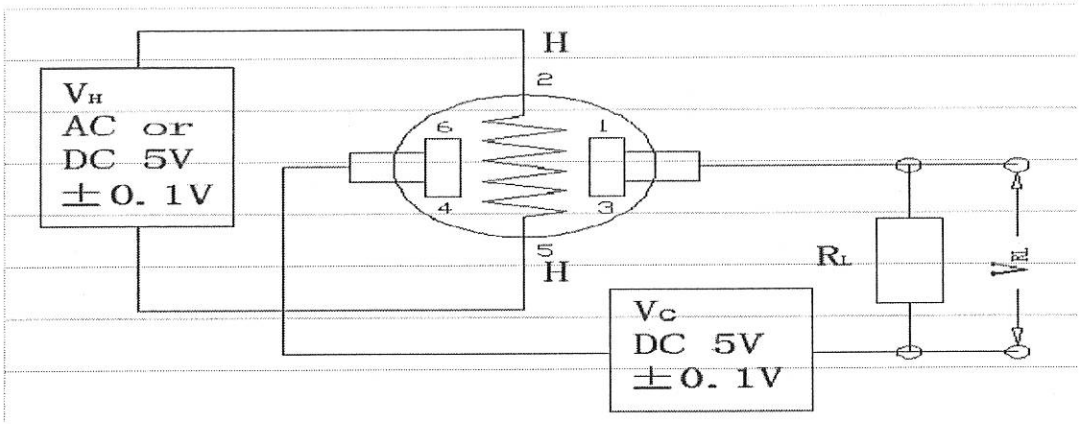

Figure 2.2 MQ-6 sensor Drive Circuit

Therefore, as the gas concentration increase the conductivity of the sensor will increase and so does the sensor output voltage. However, this relationship is not linear and Figure 2.3 describe this relationship. This sensor resistance is between pins 6&4 and 1&3 and a loop voltage is applied between the series of the sensor resistance and the load resistance. The sensor output voltage is the voltage across the load resistance. The load resistance is used to change the sensitivity of the sensor. A very high resistance, reduce the sensor sensitivity and small changes in the concentration of the gas would not be noticed. MQ-6 sensor has a load resistance of 4.7K.

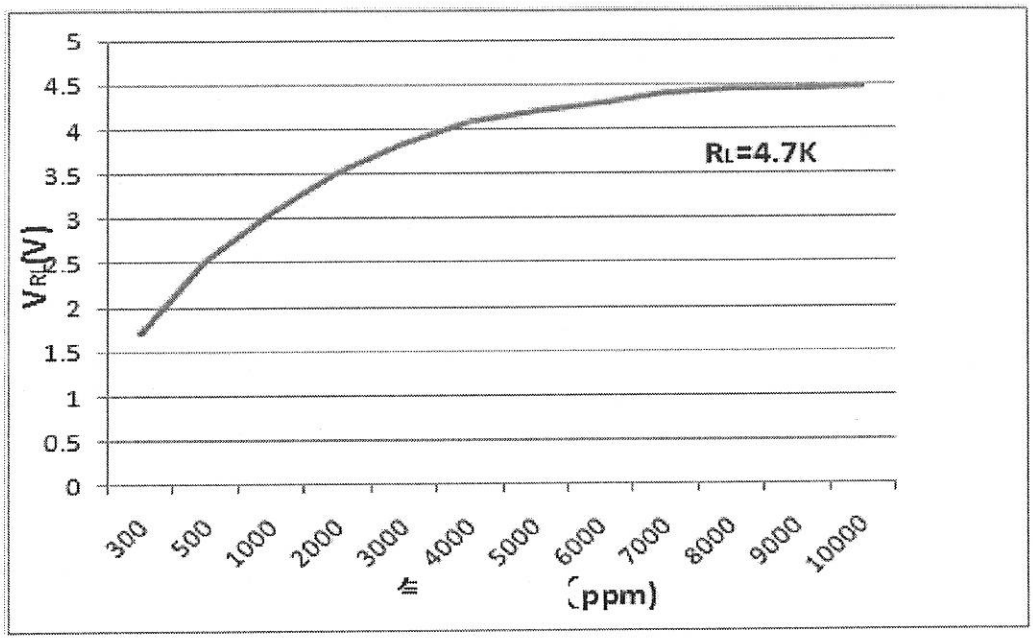

Figure 2.3 MQ-6 Sensor Sensitivity Curve

The sensor detects the gas concentration from a range of 300-10,000PPM. The sensitivity curve of the sensor forms the basis for setting the alarm trigger level and the amount of gas concentration for a given voltage. From the curve, the sensor has an output voltage of 2.0V at 300 PPM and thus the trigger level is 2.0V. When the input voltage to the MCU is equal to or more than 2.0V, the MCU starts the audio-visual alarm. Although the relation between gas concentration and sensor voltage is not linear, there are ranges of sensor output voltage with constant gradient i.e. between 2.0V and 2.5V, for every increase of 20 PPM in gas concentration there is an increase of 0.1V. Thus gas concentration for any other voltage is through extrapolation from the known values of sensor voltage and gas concentration from Figure 2.3.

NB: MQ-6 sensor technical specifications are outline in the Appendix A, Table A.1

2.4.2 The ATmega328 Microcontroller

A microcontroller (MCU) is a microprocessor with memory, input and output (I/O) pins and other additional peripheral features such as Timers/Counters on one chip depending on the type of the microcontroller.

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core.**Invalid source specified.**

Specifications

The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz **Invalid source specified.**

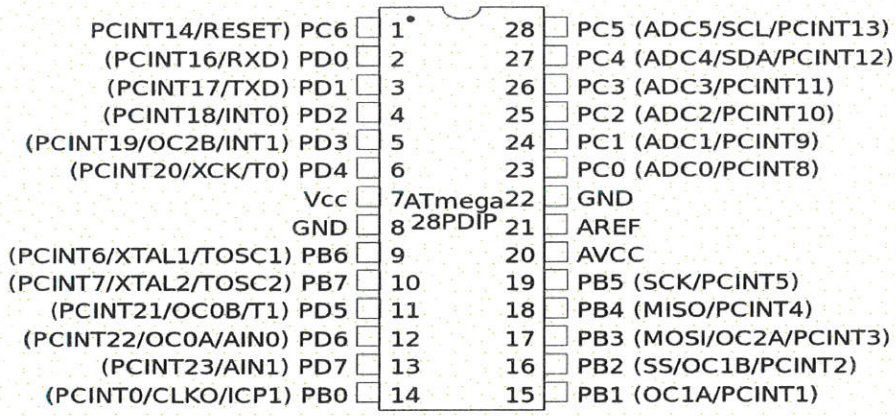

Figure 2.4: ATmega328 Pin Diagram

The pin functionality as a General purpose I/O depends on whether a peripheral feature on that pin has been enabled. A pin configured as input for the comparator module cannot be used a digital input pin. The complete description of the functionalities of each pin is in Table B.1 in Appendix B.

2.4.3 Gsm Module (SIM800L)

Global System for Mobile Communication (GSM) in Figure 2.4 is an open, digital cellular technology used for transmitting mobile voice and data services. A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator. A GSM modem connected to a computer, allows the computer to use the GSM modem to communicate over the mobile network. GSM modems can also be used for sending and receiving Short Messaging Service (SMS) and Multimedia Message Service (MMS) messages. Attention (AT) commands are used to control GSM module while ATD commands are used for calling.

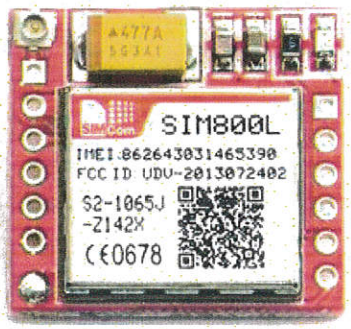

Figure 2.5: SIM800L GSM Module

2.4.4 LCD 2×16 Module

The LCD 2×16 Module will be used for display of the gas concentration. This LCD displays alphanumeric characters (letters, numbers and symbols) which can be used to convey adequate information concerning the gas concentration status. The fact that it is built around the Hitachi HD44780 controller makes the LCD a smart device. The LCD has controls lines and data lines which makes it possible to send information for displaying on the LCD by putting the controls lines and data lines high or low. Therefore, the LCD can be interfaced to the microcontroller pins and information be sent to the LCD by controlling the microcontroller. Figure 2.5 shows the LCD pin out and Table 2.1 the description of the function of each pin.

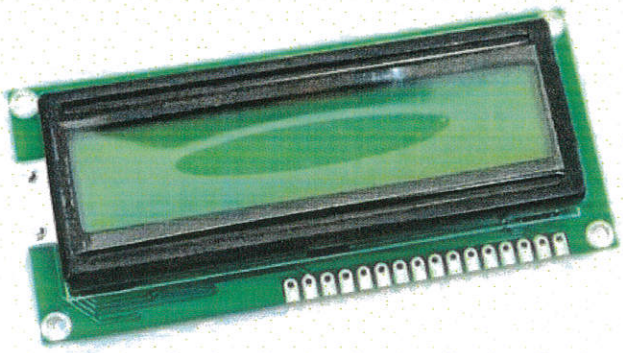

Figure 2.6: LCD 2×16 Module

The control lines are RS, R/W and EN and data lines (D0-D7) whose functions are described in Table 2.1

The 16*2 display means that only 2 lines of 16 characters can fit on the LCD display screen.

The LCD is used in 8-bit mode and all the 8 data lines (D0-D7) are connected to PORTC pins. The LCD can be used in 4-bit mode where only D4-D7 pins are used to transfer data and commands. Although this saves the MCU pins for other peripherals, data can only be sent in nibbles thus requiring more lines of code and takes more time to executes compared to the 8-bit mode where data is sent in bytes.

NB: Table C.1 shows the list of commonly used commands with the LCD.

2.4.5 Buzzer

The buzzer used is Piezoelectric Active Buzzer. It uses the inverse relationship of piezoelectricity. When an alternating current is applied to piezoelectric material such as Piezo ceramic, they stretch and compress depending on the frequency of the signal

producing a sound. The active Buzzer has a built in oscillator circuit and when applied with DC voltage will produce a consistent sound.

2.4.6 Power Supply Unit

The sensor, Buzzer and the MCU are require a 5V D.C voltage for powering up. Such a power supply is design using a 5V voltage regulator. The 5V power supply can be achieved using the circuit shown in Figure 2.6

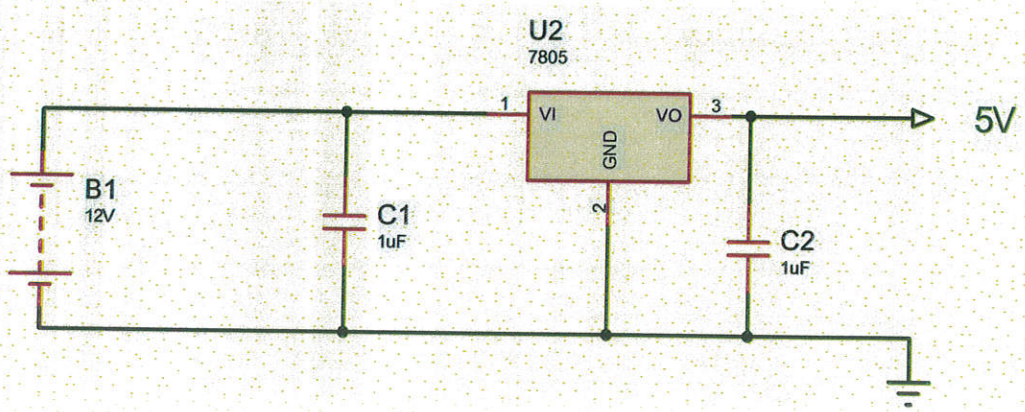

Figure 2.7: 5V Power Supply using 7805 Voltage Regulator

The circuit uses a 7805 voltage regulator which output 5V. Capacitor C1 filters out the noise from source voltage which is 9V battery by shorting the AC signal in the source voltage into the ground and allowing the DC signal only to pass. Capacitor C2 is used to filters out any AC signal in the output DC voltage.

CHAPTER THREE

METHODOLOGY

3.1. OVERALL BLOCK DIAGRAM

At the beginning of the project, the background of the related field has been studied to collect data and generate the ideas needed. Based on the survey on the current Gas detector in market today, there are still some limitations in gas detector system that need to be addressed. The idea of this project is to design and implement gas leakage detector for residential home security system using GSM. The next step is designing the overall system including the system functionality and specification. The components hardware that will be used for this project is studied and chosen according to the specification, flexibility, cost and user -friendliness, which comply with engineering economic management.

Figure 3.1 shows that the circuit is powered by a direct current (DC) supply of 5V which powers all the components in the circuitry. The MQ-6 sensor is connected to the microcontroller; the ATMEGA 328, The GSM module, Buzzer, LCD, and the light emitting diodes (LED) are connected to the micro-controller. The ATMEGA 328 is the central processing unit of the system, being the brain. On detection of LPG gas by the sensor, it sends the signal or issues the command to the GSM module to send an SMS.

Figure 3.2 describes the GSM module interaction. The micro-controller issues the command to the module to send an SMS to the user (the programmed cell phone number), the module executes its programmed function and the alert is received by the individual.

In this proposed system, the gas leakage is detected using the MQ-6 sensor. At this time, the system triggers an alarm detecting the presence of LPG in the room in a specific interval of time and simultaneously send an SMS to the programmed number through the GSM Module.

The aim of this project is to implement a simple and affordable, but efficient home gas leakage alarm system. The project is designed for detecting leakage of gas and informing the owner by making sending an SMS.

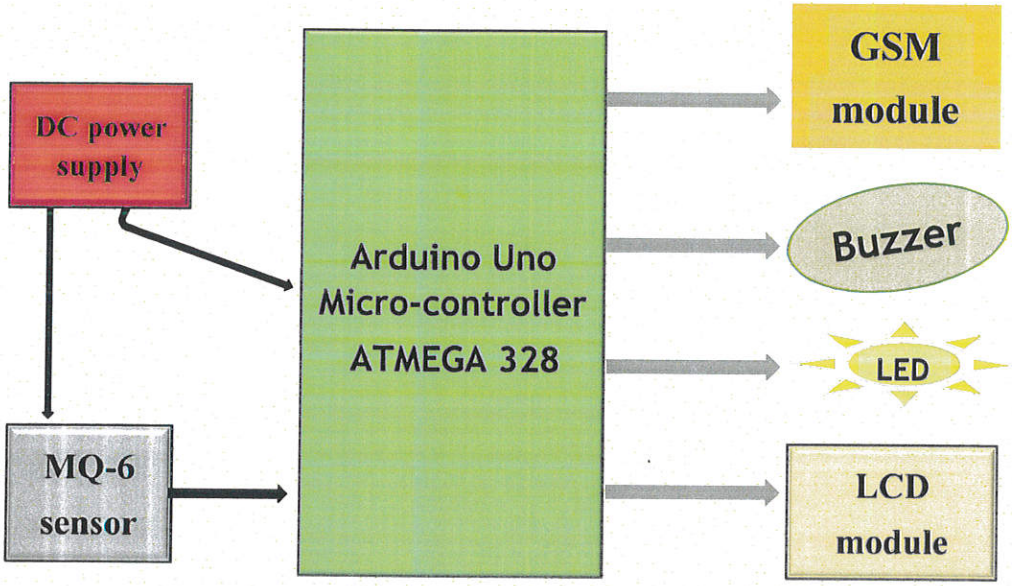

Figure 3.1: Block Diagram of the Gas Detector

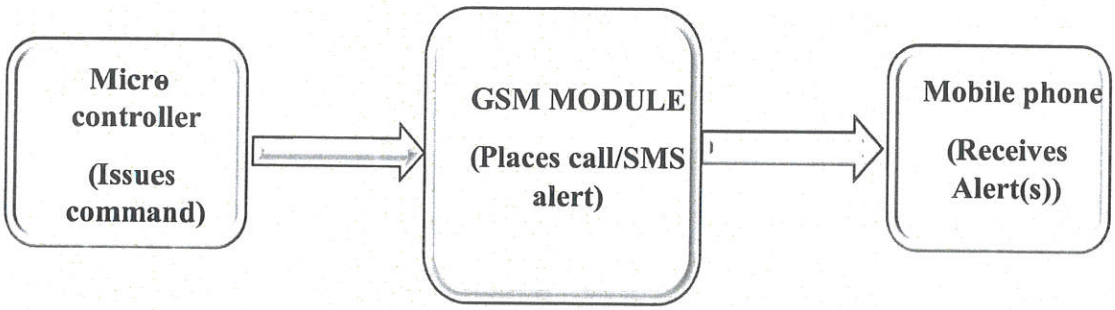

Figure 3.2: GSM Module Interaction

3.2. PRINCIPLE OF OPERATION OF THE GSM-BASED GAS DETECTOR

In this project the use of an ATMEGA 328 micro-controller is implemented to control the overall gas detector system. An MQ-6 sensor is used for sensing the presence of Gas relative to air in the atmosphere. And when the MQ-6 sensor senses any LPG in the room, it gives a HIGH logic to the micro-controller and then sends an SMS via GSM module to a predefined mobile.

MQ-6 sensor detects gas by sensing the difference in atmospheric gas concentration in the room. The output of the sensor goes high when it detects any abnormal proportion. The measurement range of a typical MQ-6 sensor is around 100ppm to about10000ppm.

For proper operation of MQ-6 sensor, it requires a warm up time of 10 to 30 seconds. This is required because, the MQ-6 sensor has a heating element inside it which becomes hot at 5 volts and remains stand by.

To set the calibration, the unit is fixed 1-2 meters away from the burner or gas cylinder. VR1 is adjusted for maximum sensitivity of gas. The sensor is placed near the burner and the burner is opened for few seconds and close without igniting. VR1 is adjusted immediately to set the sensitivity.

During this time, there should be no obstacle between the gas burner and the sensor. If the sensor is not given enough calibrating time, the output of the MQ-6 sensor may not work as expected. When the MQ-6 sensor detects any motion, the output of the sensor is high. This is detected by the ATMEGA 328 micro-controller. The micro-controller then communicates with the GSM module via serial communication to send an SMS to the pre-programmed mobile number.

An important point to be noted about MQ-6 sensors is that the output will be high when it detects LPG. The output of the sensor remains high for some time, even when there is no leakage from the gas source any longer which may mislead the microcontroller into considering that the cylinder is still leaking. This just shows that the sensor is sensitive to the presence of the particular gas in the atmosphere and will only go low when the gas concentration is below 100ppm.

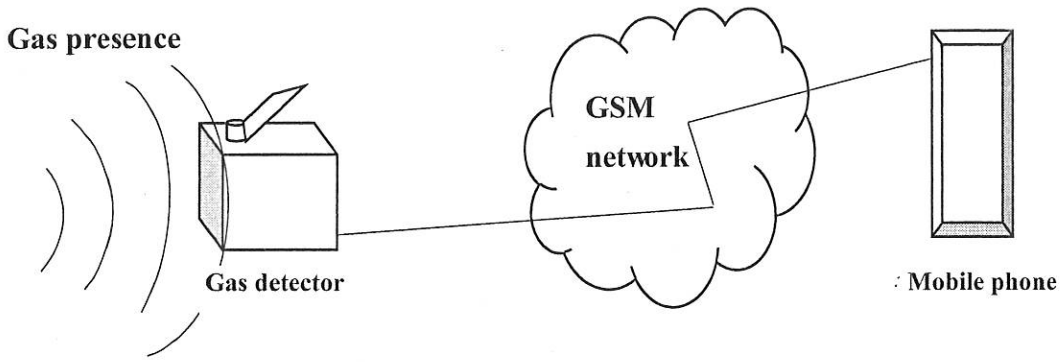

Figure 3.3: Overall Gas Detector Architecture

3.3. DESIGN PRINCIPLES

The system design is in three main phases: the sensitivity phase, the central processing phase and the action phase. The sensitivity phase is the perception section that is done through MQ-6 sensor mounted at the watch-area. It detects the gas which triggers the HIGH signal to the microcontroller.

The central processing stage is performed by a programmed microcontroller, the ATMEGA 328. The micro-controller controls the action to be executed, it issues the necessary commands for the desired result to be achieved.

And the action (task) is done through an interaction of an attached on-board GSM module to the processor (the microcontroller), which then sends an SMS to the user or owner mobile phone number. This system is designed to detect only LP gas (Butane and Propane). The overall system architecture is shown in Figure 3.3.

The resistor is not connected in series or parallel because only a single resistor is required to step the current for the light emitting diode (LED) and thus, there is no effect on how resistor is connected. For the reception and transmission of signals, the receiver (Rx) and transmitter (Tx) of the GSM module is connected to the transmitter (Tx) and receiver (Rx) of the ATmega328 micro-controller respectively. The GSM is connected directly to the power source and the ground of the module is also connected to the ground (GND) of the power source.

In the complete circuit diagram in the Appendix I, the GSM module is connected to the Tx and Rx pins of the micro-controller for transmission and reception of signals. The circuitry is centred on the ATMEGA 328 micro-controller, being the processor of the entire circuit.

3.3.1. Design Specification

Circuit voltage: 5V ± 0.1

Heating voltage: 5V ± 0.1

Heating Consumption: less than 750mW

TTL output: 5V, 0V

Lock time: 0.2 sec

Trigger methods: L – disable repeat trigger, H enable repeat trigger

Sensing range: from zero to 4 meters from the source

Temperature: 0c ~ +60c

Dimension: 32×24 mm, distance between screw 28mm, M2, Lens dimension in diameter: 23mm

High output level 5V / Low 0V

Maximum 110 ° angle sensor

Sensing distance: less than Six (6) meters (< 6m)

Calibration: The MQ-6 sensor requires a warm up time of about 10 to 30 seconds. This is required because, the MQ-6 sensor has a heating element inside it which becomes hot at 5 volts and remains stand by. During this time, the whole device is set to boot for half a minute.

The module dimensions of the MQ-6 sensor is shown in Figure 3.4.

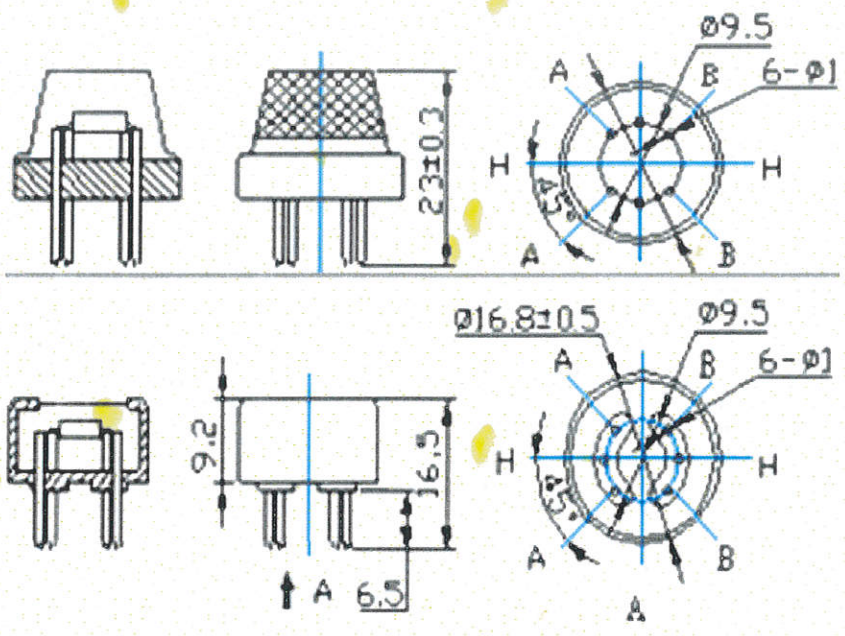

Figure 3.4: MQ-6 Sensor Dimension

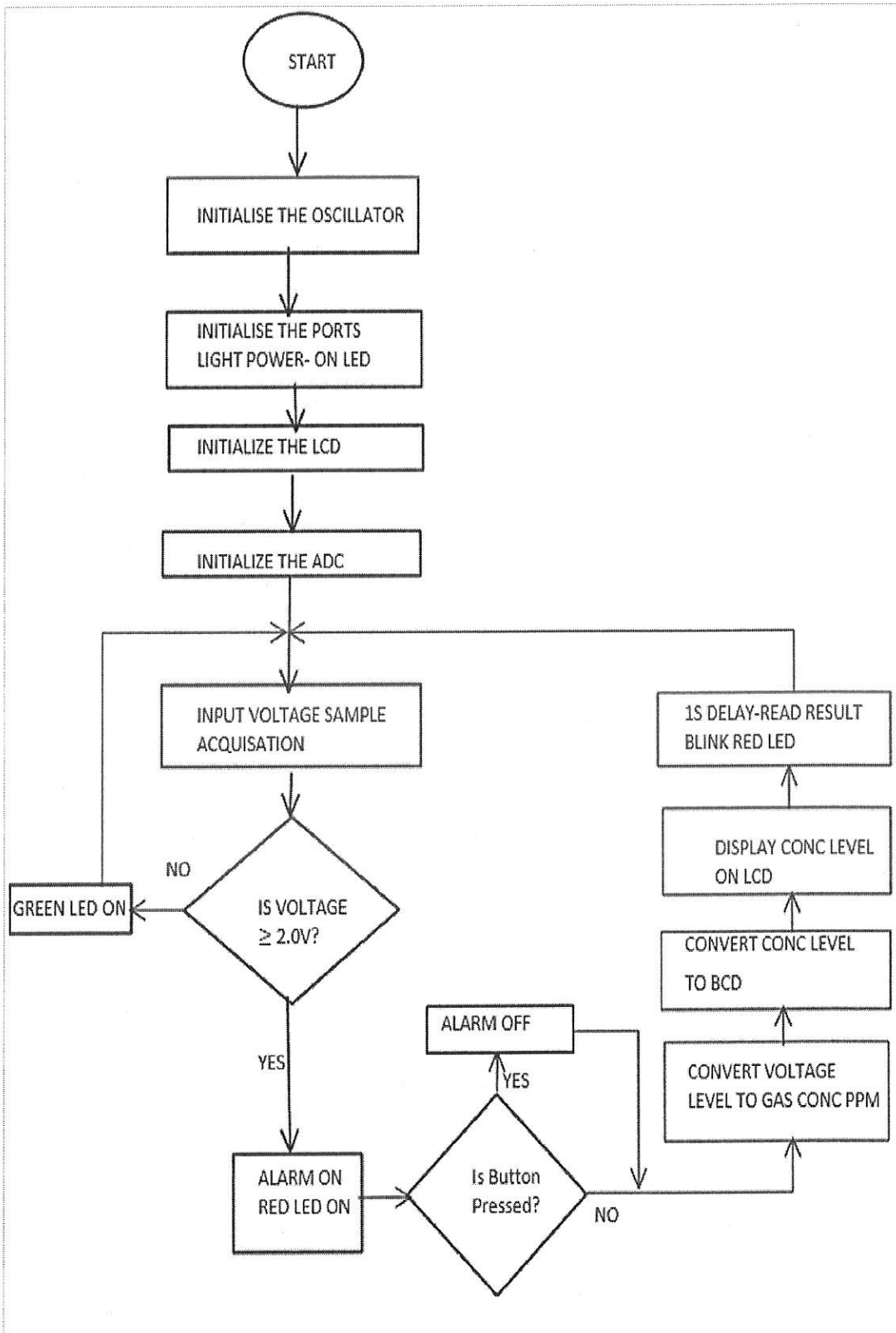

Figure 3.5: Flow chart of the device

The flow chart in Figure 3.5 depicts the operational flow of the system. The "start" section in the diagram indicates that the gas detector device is powered on and the circuit calibration commences immediately after the circuit is powered on. After calibration of the circuit, the MQ-6 sensor is ready to detect gas in the atmosphere. In the event of failure of detection by the MQ-6, the circuit would recalibrate. After detection of gas by the sensor, the MQ-6 signals to the micro-controller (sends a HIGH logic) which will issue the necessary command to buzzer, LCD, LED (red) and the GSM module to place a direct call to the programmed mobile phone number. This process will go on continuously until the system is reset.

CHAPTER FOUR

CONSTRUCTION, RESULTS AND DISCUSSION

4.1. CONSTRUCTION

The project is a prototype designed to handle the detection of gas (or LPG) and convey the necessary information to appropriate party. A prefabricated approach was employed in the design of this project, by implementing and creating the design on a breadboard, in order to ensure that the hardware works properly before permanently executed on a Vero board. The microcontroller used in the project is the Arduino Uno, which is suitable for such applications.

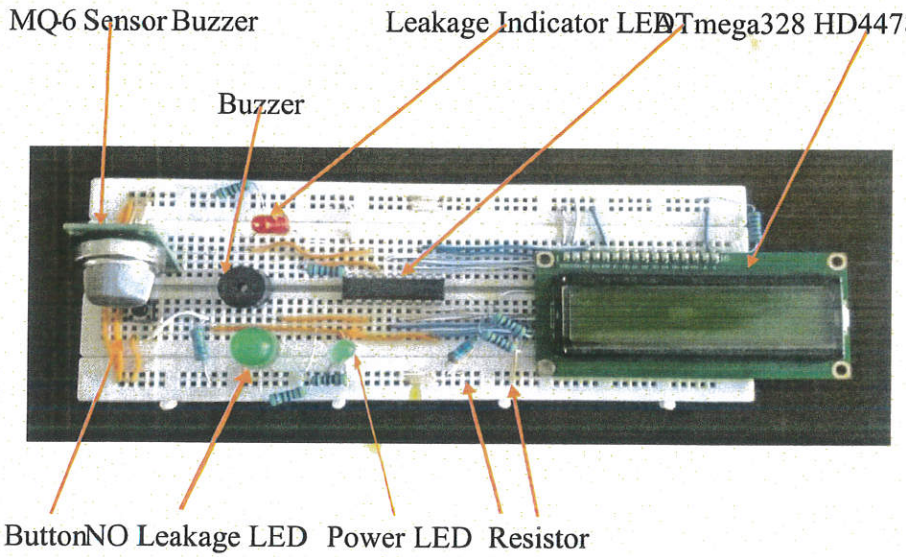

Figure 4.1 Connection of various components on a breadboard.

The project was constructed on the Vero board with the circuit diagram in Appendix I acting as a guide. All the necessary components were made available and connected properly to ensure the desired results.

A different circuit was designed and implemented for the Arduino micro controller. This is because the Arduino micro-controller uses a regulated voltage of 5V and needs special attention to avoid frying the micro-controller. A 12V Adaptor which serves as our DC power supply was connected to a 5V voltage regulator which steps down the 12V to 5V and then connected to the circuit to power up the circuit. The circuit was

tested and it functioned properly as expected, the Gas sensor senses the gas in the air and signalling the microcontroller gave the necessary instructions to the GSM module, which sends an SMS to the desired party.

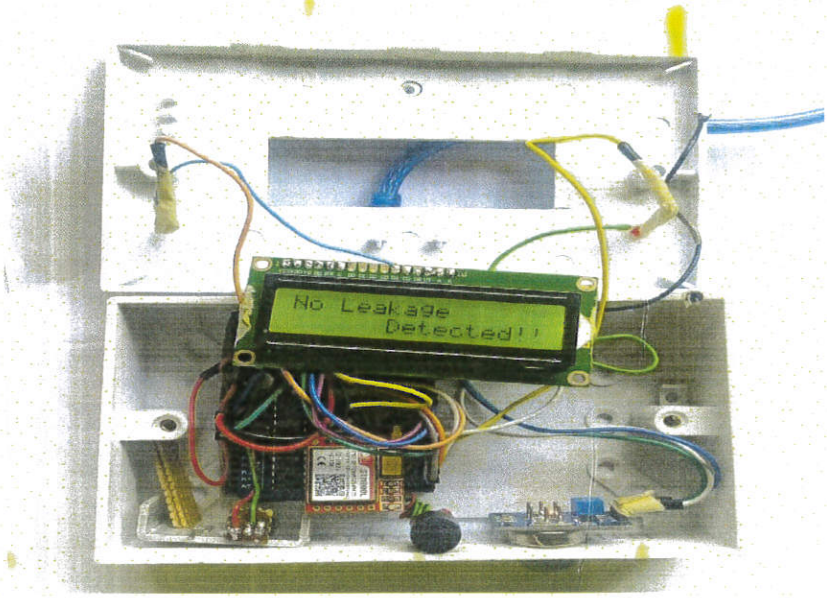

Figure 4.2: Internal Construction

Figure 4.3: External Construction

The casing of the project as shown in figure 4.2 and 4.3 is made from of a grade of plastic material known as "Phenol formaldehyde" used for constructing fuse boxes, switches, knobs and so on. The dimension of the project casing is 16cm by 8cm, in order to ensure portability.

4.2. TESTING

Each of the components was first tested using a multimeter in order to check for their state of performance and accurate values. After the connecting all the components together, each of these components on the Vero-board was then tested. This was done in other to carry out the continuity test, which is meant for proper connection of the circuit and to detect any wrong connection.

The circuit was tested multiple times and the results were precise and correct. The Gas sensor shown in Figure 4.5 detected gas leakage and signalled the microcontroller to activate the module to send this message "Gas Leaking! Please check!" to the programmed mobile phone number as shown as Figure 4.4.

After proper testing was conducted, the packaging of the design into a model and casing was done. The connecting wires were properly connected and well insulated. Also, these wires were well packaged inside the casing.

4.3. RESULTS AND OBSERVATION

On switching on the circuit, there was a 30 second waiting time for the circuit (mainly the MQ-6 and GSM Module) to calibrate. During this period, the LCD is programed to display a welcome message. After which the light emitting diode (LED) blinked twice in rapid successions indicating that the calibration is over and detection could now occur with accurate precision and yield the accurate result.

When the sensor detected gas (opening the valve of a litter or gas cylinder) the LED was flashing continuously and the microcontroller signalled to the GSM module which immediately sends an SMS to the programmed phone number.

The developed GSM based gas detection system gives good response to the sensor and places a call when it detects intrusion in the room. 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 25-30 seconds.

4.4. PROBLEM ENCOUNTERED

- Programming the Micro-controller: The micro-controller was programmed via the Arduino programming language (C language) platform after which the programmed is compiled into the microcontroller. Understanding this programming language and know-hows proved tricky but after consultations and studying, the desired results were achieved.

- In-depth Practical Knowledge: Due to insufficient knowledge of the components, their properties and the connections to be carried, there was difficulty in carrying out the connections effectively and accurately and thus, there was delay in the construction of the project. This was eventually solved by the means of seeking the required knowledge and resources from individuals with the practical know-how, video tutorials and online discussions necessary for the successful construction and implementation of the project.

- Design of the Circuit: During the design phase of the project, there were hiccups in design because some the software platforms used did not have all of the components needed to implement the design such as multisim. The circuit diagram was eventually designed using the Proteus application software. This proved difficult in the early stages of design because of its complexity but eventually, the necessary knowledge required to operate and manoeuvre the software was acquired and implemented.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION AND CONTRIBUTION TO KNOWLEDGE

The challenge of inadequate security and protection has plagued homes and is still plaguing the Nigerian homes. Inability to monitor properties, lives and other valuables has caused an increased worry in the minds of individuals across the globe. The implementation of this project in homes and other places like hospitals, malls, organizations and so on has minimized the inability to monitor valuables and has given a boost in increasing the level of security in the society in a very cheap, effective and efficient way.

The project involved the use of components such as the ATmega328 micro-controller, MQ-6 sensor, GSM module and so on. The entire decision making is done with the help of a ATmega328 microcontroller. After the MQ-6 sensor has detected gas within its range, it gives a signal to the micro-controller which issues command to the module to execute the programmed function (i.e. to send and SMS to the desired party).

The test result shows that both the gas sensor (MQ-6) and the GSM module perform adequately as expected. The developed GSM based gas detector system gives good response to the sensor and sends an SMS when it detects gas leakage. This result will give Users in homes an edge by being able to monitor and have certain knowledge about what happens in their homes and so on irrespective of where they are. The time taken by the system to deliver the SMS is dependent on the coverage area or range of the specified mobile network. A flexible way to control and explore the services of the mobile, AT commands is used in the system. In addition, the application of this design is in area of security usage, industrial use, commercial use, automation usage and protection.

5.2. LIMITATIONS

Despite how this project might look good it is still wanting. The following are the limitations based on the functionality and observations:

- The use of a buzzer, LED, and LCD for the alarm system is not enough. This require a person's presence in the vicinity to be notified when there is gas leakage. (although the GSM module has addressed the issue to some extent)
- The system has no provision for automatically stopping the gas leakage when gas leakage has been detected in the area of installation.
- The GSM module in the device sends SMS to a programed cell number only. This is a limitation since the User may not be conscious of receiving SMS.
- GSM network may fail at any point in time. This hinders the functionality of the GSM module in sending SMS to the User wherever he is.
- The constructed device cannot tell if the gas leakage has caused a fire or not. This keeps the user that is not at home out of the loop and just worried.

5.3. RECOMMENDATION AND FUTURE IMPLEMENTATION

The following are the recommendations based on my findings from this project:

- The use of *SOLENOID VALVE* for automatic shut down when gas leakage is detected should be employed. This will aid in quick preventive actions to avoid or avert fire accident in the home.
- Since calls involve the immediate action of the user than SMS (which may be attended to later), the programing of the GSM module to place a call to the programed User cell phone number should be considered instead of the SMS application used in this case.
- Since there are places where GSM network are not available, future research should look into the possibility of establishing connectivity via satellite network in case of GSM failure in order to ensure constant and effective communication between the motion detector and the user.
- Other important sensors especially the Temperature sensor and Smoke detector should be incorporated in the whole detector system to aid in fire detection. This will help the user know the degree of urgency and situation of the home.