SALEM MOHAMED YOUNES A MICROPROCESSOR BASED GAS LEAKAGE DETECTION SYSTEM IN THE OIL AND GAS INDUSTRY NEU 2019

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A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
SALEM MOHAMED YOUNES

In Partial Fulfilment of the Requirements for the Degree of Master of Science in Computer Information Systems

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Approval of Director of Graduate School of Applied Sciences

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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Date:

ACKNOWLEDGEMENTS

My utmost gratitude goes to my thesis supervisor Assist. Prof. Dr Elbrus İmanov for his relentless effort in guiding and helping me through all the processes of this study.

I also want to appreciate the contributions of every staff of the Department of Computer Information Systems, Near East University especially Prof.Dr. Nadire Çavuş, Prof. Dr Dogan Ibrahim and Assist. Prof. Dr Seren Basaran for helping me through my academic courses.

My gratitude also goes to my parents Mr., Mrs Mohamed Younes and my wife who have given me spiritual support to get through my educational pursuit thus far and also to my brothers and sisters.

To my parents and wife…

ABSTRACT

Industrial and technological development aim at offering the stakeholders a better living with the oil and gas sector is one of the most prominent. Daily, workers in Oil and Gas companies are exposed to several dangers amongst which that of toxic gas exposure. The presence of measurable quantities of such gases can be detrimental to the health of the workers even lethal. This project focuses on an automated responses mechanism in case of detection of values beyond the threshold of toxic gas. This study aimed at designing an alarm mechanism in case of detection of this impurity. Initial hypothesis stipulates H2S is always present in variable quantities in Natural Gas. Exposures may be lethal when prompt emergency action is not taken. Automated response mechanisms could keep the safety officers alert as well as the whole personnel. A microprocessor is designed to control and activate an emergency response system. A system of MQ2 sensors is are connected in a circuit. These sensors relate the information on a screen display revealing the concentration of the gas at a given time. Beyond the threshold level, an SMS message is sent with concordant alarm to activate a response. The overall process is programmed in Python and control through a Raspberry microprocessor. Expected efficiency of the system is 90% with 97% response due to the double SMS text message and alarm system.

***Keyword*:** H2S; microprocessor; MQ2; raspberry pi; safety; sensors

ÖZET

Endüstriyel ve teknolojik gelişme, paydaşlara petrol ve gaz sektörüyle daha iyi bir yaşam alanı sunmayı hedefleyen en önemli sektörlerden biridir. Günlük olarak, Petrol ve Gaz şirketi işçileri, arasında toksik gazın maruz kalındığı, bazı tehlikelere maruz kalmaktadır. Bu gazların ölçülebilir miktarlarının varlığı, işçilerin sağlığına zararlı olabilir ve hatta ölümcül olabilir. Bu proje, toksik gaz eşiğinin ötesindeki değerlerin tespit edilmesi durumunda otomatik yanıt mekanizmasına odaklanmaktadır. Bu çalışma, bu kirliliğin tespiti durumunda bir alarm mekanizması tasarlamayı amaçlamıştır. İlk hipotez, H2S'in Doğal Gaz'ta her zaman değişken miktarlarda bulunduğunu öngörür. Hemen, acil durum önlemleri alınmadığında maruz kalmalar ölümcül olabilir**.** Otomatik yanıt mekanizmaları, tüm çalışanların yanı sıra güvenlik görevlilerinin de uyarılmasını sağlayabilir. Acil yanıt sistemini kontrol etmek ve etkinleştirmek için bir mikroişlemci tasarlanmıştır. Bir MD2 sensör sistemi bir devrede bağlanır. Bu sensörler, belirli bir zamanda gazın konsantrasyonunu açığa çıkaran bir ekrandaki bilgi ile ilgilidir. Eşik seviyesinin ötesinde, yanıtı etkinleştirmek için uyumlu alarm ile birlikte bir SMS mesajı gönderilir. Genel işlem Python'da programlanır ve bir Raspberry mikroişlemcisi ile kontrol edilir. Sistemin beklenen verimliliği , çift SMS yazılı mesaj ve alarm sistemi nedeniyle % 97 yanıt ile % 90'dır.

Anahtar Kelimeler: Güvenlik ; H2S; mikroişlemci; MQ2 ; raspberry pi; sensörler

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LIST OF ABBREVIATIONS

IOT: Internet of Things

RPI: Raspberry Pi

ADC: Analog to Digital Convertor

LPD: Liquefied petroleum gas

CHAPTER 1

INTRODUCTION

This chapter talks about the introductory background, statement of the problem for this research, the aim of the study, the importance and limitation of the study and as well the general overview of the study.

1.1 Background

Horbah, Pathirage, and Kulatunga (2017) in their study made mention of the fact that the working environment of a typical oil gas company is dangerous and unpredictable due to human activities, various technological activities taking place simultaneously at fields, as well as environmental challenges and circumstances. These activities inevitably have repercussion that may endanger workers life, destruction of properties, reduce socio-economical activities and in some cases polluting the environment. In their view, emphasis on safety precautions and the ability to predict as well as to detect leakages of gas are a very vital factor to consider in the oil and gas industry in other to avoid accidents. They also found out that maintaining equipment, supervising safety were canon mg the additional factors to be considered to reduce accident in the oil and gas industry.

Knížek et al., (2018) in their study made mention of natural gas is a mixture of hydrocarbon gas fundamentally of methane. The mixture sometimes contains high levels of alkanes and in some cases a little level of carbon dioxide, nitrogen, helium, and hydrogen sulfide. Natural gas is a nonrenewable fuel recourse that happens to naturally exist in cruse oil, volcanic gas, and can also be created in the microbial breakdown of some proteins when oxygen is not present as well as excreta under intense hot temperature and pressure. Natural gas beside it been used for as fuel for vehicles, it also is used as fuel for heating and generation of electricity. Natural gas is one of the raw materials in plastics productions.

For natural gas to be used as fuel in most cases, requires some process to of separations of the different individual constitutes. The constituent is compounds such as butanes, pentanes ethane propane, it also contains hydrocarbons, hydrogen sulfide carbon dioxide water vapour helium and nitrogen.

Hydrogen sulfide is an aromatic, combustible and very poisonous gas. It can, however, be perceived as a spoiled egg and posses a great of degree danger to humans. Hydrogen sulfide happens to naturally exist in cruse oil, volcanic gas, and can also be created in the microbial breakdown of some proteins when oxygen is not present and also excreta. Hydrogen sulfide also exits in natural gas and some water wells. It is denser than air for which reason it gathers in low-lying and confined ineffectively ventilated zones, for example, telephone chambers, sewer vents, sewer lines, and underground phone and electrical vaults and in the oil fields. It has a different level of danger is posses to human depending on the duration of exposure, the concentration of the gas as well as the health condition of the individual (Asthmatic patient).

In Low concentrations, it irritates eyes and respiratory system. When it is in moderate concentration increasingly extreme eye and respiratory impacts which can result in challenges in breathing, nausea, coughing and throwing up. But when highly concentrated, the harmful effect if within a few minutes, the effect ranges from extreme difficulty in breathing to an eventually lost life.

Hydrogen sulfide happens to be a very colourless rotten egg scentless like gas, it a highly flammable gas but exposure to concentrations 700 ppm of this gas will course a instate death. It harmful is more devastating when a person is exposed to Hydrogen sulfide in an enclosed area (Hsu and Robinson, 2019).

Mill (2002) reported in their research of an incidence where a hydrogen sulfide took the life of construction works when they were accidentally exposed to high concentrations of this gas. In their report, there was a leakage of the gas generated for a septic tank. In their report several others were injured as a result of the exposure to this gas, this incident happed in Georgia-Pacific Naheola mill in Pennington, Alabama in the on 16 of January 2002.

Jamadagni et al. (2019) in their research attempted improving the existing ways of using internet of things to mointor gas leakage. In the writers view, the existing systems of gas detection are not able to detect gas leakages in long pipelines, they therefore soughted to solve this challenge by increasing the number of sensors in their gas detection system. The researches in their study, utilized M2Q sensors and fire sensor to detect gas leakage and prevent fire respectively. The researchers used a Raspberry pi together with the sensors to achive the gas leakage detection system. In their system sms is sent to users when gas and smook is detected.

1.2 Problem

Hydrogen sulfide had over the years cause the death of many personnel in the oil and gas industry. This has been because of the fact that personnel had depended on its odour to detect it leakages, this has however not been reliable enough to detect the gas and human may not be sensitive enough to sense the harmless levels of this gas. The presence of hydrogen sulfide and other flammable gas leakages and in the past year's course fire outbreaks, environmental pollution, suffocation and eventual loss of human life.

Reports of petroleum-related gas leakages by the Japanise Safety Institute revealed an increasing number of accidents coursed gas leakages in the oil and gas industry in recent times. In their report, a study in the year 2013 to 2015 revealed a drastic increase in accident coursed by gas leakages in during those years. a similar study in India also revealed a rise in accident coursed by gas leakages in between the year 2014 and 2015 in Chennai, India (Adekitan et al., 2018).

1.3 Aim of the Study

This project aims at developing a Raspberry pi based syetem to detect LPG, to mimic Hydrogen sulfide leakage in an oil and gas field. The Raspberry Pi initiates an SMS response to the safety control unit to ensure immediate action is taken.

1.4 Significance of the Study

There are other ways of sensing these gases in the oil field, but most of these methods of gas detection are very expensive to implement. This study seeks to implement a raspberry pi based gas leakage detection system in the oil and gas industry. The proposed systems will detect the presences off leaking gas, send messages to both the control room and the fire tenders offices to enhance safety in gas the oil and gas industry. The findings of this study provide valuable guidance for researchers and industrial practitioners to identify mechanisms by which they can improve existing safety at the work environment.

1.5 Limitations of the Study

During this study, a number of limitations were encountered due to time constraints, hardware and logistics.

- The study is limited to the sensing of natural gas, Hydrogen sulfide and LPG.
- The study is limited MQ2 gas sensor
- This study is limited to Raspberry Pi 3 Model B Vi2
- This study is limited to ADS1115 analog to digital convertor
- Internet of Things is limited to the ubiquitous internet.
- The use of the Internet of Things (IoT) is applied within a limited frame. The database contains limits for H_2S only whereas testing gas is a mixture of several gases. This is accounted for by the non-separation of gaseous phases in the case of the project.

1.6 Overview of the Study

The thesis comprises of 6 chapters in all: Introduction, Related Research, Theoretical Framework, Systems Development, System Implantation, and Results, Conclusions and Recommendations.

Chapter 1 gives the brief overall of natural gas and Hydrogen sulfide systems, the problem as well as the approach this thesis aims at using to solve the problem. The chapter continues to outline the significance of this thesis, its limitations as well as the overall overview of the entire thesis.

Chapter 2 looks at studies carried out by other researchers. Various research already published in this subject area was analyzed, examined. Their findings with the missing gaps in those subject were mentioned.

Chapter 3 is the theoretical framework of the study.

Chapter 4 explains the system development and architecture

Chapter 5 How the system was implemented in described and with the aid of diagrams.

Chapter 6 the system was tested and the results and findings were discussed. The thesis concludes with recommends as well as suggestions for future studies.

CHAPTER 2

RELATED RESEARCH

This chapter focuses on the harmful gas in the oil and gas industry as well as methods employed to detect them. It also elaborates on other researches conducted on this subject by other researchers.

2.1 Harmful Gases

Gorski and Schwartz (2019) studied the effect of pumping gas into a car. This study revealed the emission of fumes or gases, which caused notable damages to health such as leukaemia. These gas fumes where that of benzene gas which is not the only product of combustion. Other gases such as Nitrogen dioxide (NO_2) are common in the atmosphere. NO_2 has the doesn't react readily at room temperature. The mixture in the atmosphere produces acid rain and decomposition of the ozone layer. Irritation of the respiratory tract and lungs leading to pneumonia and influenza could result from the inhalation of toxic gases. Carbon monoxide (CO) is a waste product of fuel combustion; once inhaled leads to disruption of blood transport across the body leading to damage of body organs: heart and brain mostly as stated by Leghrib, 2010.

Harmful substances exist in a vapour state of matter. The study here deals with harmful gases. Benzene is a flammable aromatic organic molecule which may exist in a liquid or gaseous state. Its molecular formula C_6H_6 reveals a nonpolar structure for the molecule making it effective to be used in the processing of organic polymers and synthetic molecules. At room temperature and pressure, benzene is colourless or yellowish. Being denser than air, spillage of Benzene leads to deposition on a low level. Its low solubility makes it harmful when it contaminates water bodies. Tobacco smoke and fuel combustion lead to benzene evacuation. Exposure to benzene leads to damage of body cells and the immune system. A typical loss of white blood cells may be attributed to benzene inhalation for workers at risk (Dedecker et al., 2019).

Carbon monoxide CO is also a waste product from incomplete combustion. Carbon dioxide is a colourless and odourless, thought to be the most widely spread. CO is as dense as air therefore readily soluble in the air so poisonous and termed the silent killer. CO serves in the industry as a reducing agent exposing the users in the production processes presence in mines is due to the slow combustion of coal. It is also used in enormous quantities as a cheap chemical reducing agent, for example in steel production and other metal refining and heat treatment processes, and in the production of methanol by reaction with hydrogen. (Nandi et al., 2019)

Hydrogen sulphide is a colourless gas with a strong pungent egg smell detected by olfaction at ratios of 0.1ppm. H_2S is deadly for concentrations above 60ppm. Inhalation of such quantities of H_2S lead to paralysis of the olfactory glands and exposure can lead to instant paralysis. H_2S is slightly heavier than air, and thus fixed detectors are usually mounted 1 to 1.5 metres from the ground, or near potential sources of leaks. H_2S is a product of organic matter decomposition, extraction of oils and commonly found as an impurity in natural gas and tunnels. It is a constituent of biogas and found in large quantities in sewage treatment works, pumping stations, press houses, boiler houses, and virtually anywhere where sewage is being treated. It has some industrial uses and is produced as a by-product in others. H_2S is thus as other gases a serious thread to anyone exposed to it. The impact of the exposure as described by OECD is as follows in Table 2.1

Table 2.1: Impact of H_2S Concentration (HSC ACTS, 2019)

Concentration of H2s/Ppm	**Impact on the inhaler**
[0.001– 0.13]	The impact is variable as this range is within the odorant threshold level.
[1.00 – 5.00]	The affected person suffers from severe headaches due to prolonged exposure. The odour is much more repulsive, followed by nausea.
[20– 50]	Inhalation of causes irritation of the respiratory tract: nose, throat and lungs, followed by a loss of appetite, nausea and consequent fatigue.
[100 – 200]	Inhalation of causes severe damage on the thoracic path as the odour becomes more severe and irritating.

Table 2.2: Impact of H_2S Concentration (HSC ACTS, 2019)

Concentration of H2s/Ppm	Impact on the inhaler
[250 – 500]	The pulmonary system may suffer terrible damage such as oedema. At this stage of inhalation. Prolonged exposure is lethal as the nervous system becomes paralysed
500	The irritating smell is severe, lungs are damage combined with all other first-order effects. Dizzy behaviours, staggering and unconsiousness result after exposures between 4-8 hours.
[0500 – 1000]	The heart suffers damage at this stage with combined first-order effects. The reaction may be controllable within 48 hours with strict medical attention. Respiratory paralysis and heart failure may occur.

Other toxic gases include sulphur dioxide, sulphur Hexa-fluoride, volatile organic compounds, freons, nitrous oxides, mercaptans, hydrogen chloride, hydrogen fluoride, hydrogen cyanide, carbon dioxide, ammonia, fluoride, arsine, just to name a few. All these have side and dangerous effect on the health of anyone exposed to it.

Cheng and Wang-Li (2019) in their study described ammonia, NH_3 is an alkaline gas with density compared to that of air in the ratio 1:2 which is 0.59. The threshold safety inhalation value is 25ppm beyond which interaction with the gas becomes fatal. Acids and alkalines generally react to form salts and gases. The reaction between ammonia and other gases such as halogens help in either dissipating the deadly gas of making it negative impact more pungent. Ammonia gas at levels of 15% is termed flammable as such can be used in explosives. Various applications ranging from use as fertiliser, fibres man.

Ammonia is flammable with an LEL of 15%. It is produced in vast quantities all over the world to provide fertilisers, urea for resins, explosives and fibres such as nylon. It is also used as a refrigerant gas: this application is increasing with the demise of CFCs. Another application is to maintain the sterility of water supplies after treatment with chlorine and sulphur dioxide.

2.2 Types of semiconductor sensors

Toxic gases when inhaled are very detrimental to the wellbeing of the consumer. Proper techniques of detection are thus required to assure everyone in contact is safe. Two methods can be used to check for the presence of toxic gases viz: the use of analytical methods i.e. simple physical tests or solid-state sensors.

- **Solid-state semiconductor**

Solid-state semiconductor gas sensors are an innovation for modern-day science proceeding from the first generation sensors used since 1968 (Grassi et al., 2007). A change in the partial pressure of a system is due to the presence or absence of a gaseous phase constituent in a given mixture. It's worth noting, the monitoring of pressure variations can be done using the ionic exchange potential. This potential expressed in voltage can be measured using semi-conductors. Naoyoshi Tagushi's studies reveal the use of SnO_2 can be used as gas sensitive material. Post findings led to the application of various gases in the framework of gas leaks detections. A couple of metal oxides were tested including Tin Oxide SnO_2, Zinc oxide ZnO, Iron Oxide Fe_2O_3 etc. Each these oxides were used as a semiconductor material. Such sensors proved to be more efficient due to their corrosion-resistant properties. Silicon is a fast being replaced as the most efficient semiconductor material leading to a wide range of operations for the conception of robust equipment among which gas sensors. This application is cost-effective as well.

- **Nanosensor**

Zhenyu et al. (2019) in their study explained that a nanosensor happens to be measuring device that translates data about an undetermined gas (that is, type, concentration) into various forms of signals (digital or analogue) biased on factors such us amalgamation of some gas detection principles, scientific study of some materials as well as manufacturing innovations. In the writer's view, nanosensors are efficacious ways to detect harmful gas in large quantities and for this reason, this sensor type is increasingly becoming popular in the field of gas detection. The researchers however made mention of some drawback associated with these sensors they said, these kinds of sensors have to get too hot, are poor in selectivity and has a low response. The writers however proposed solutions to these challenges in their work. In conclusion, the said there are missing gaps in the area of gas sensing, technologies regarding gas sensing and models of mechanisms utilized in the sensing gas must be improved.

2.3 Gas detection(Gas Sensing Principle)

Semiconductors allow for the exchange of ions from one medium to another The flow off ions induce a potential difference whose intensity could be measured: such is the principle used in gas sensors (Nasef and Hegazy, 2004). The sensitive layer in contact with the gas upon detection impact the physicochemical interaction leading to the responses via electrical pulses. Gas is detected through two main approaches, the hardware and software also known as non- continuous and continuous methods respectively. In the hardware parts, humans, dogs and gadgets are employed n the detection of the leakages. Whereas the continuous part, split into two parts, the internal and external pipeline computerized leakage detection system. The reasons for choosing a particular detection method is dependent on the location, the level of accuracy needed, sensitivity and how strong the detection system must be. Table 2.2 is a summary of the various gas detection methods

Table 2.2: Leak detection and location systems

Non-Continuous	**Continuous**	
Inspection by helicopter	External	Internal

Smart pigging	Fibre optic cable	Pressure point analysis
Trained dogs	Acoustic sensor	Mass balance method
	Sensor hose	Statistical system
	Video monitoring	RTTM and E-RTTM system

CHAPTER 3

THEORETICAL FRAMEWORK

The effectivity of every concept lies in the understanding of the concepts applied and used. This chapter focuses on the theoretical concepts behind the project. Designing of a microprocessor: it's functioning and design. Programming is done using python amplified signals through Raspberry Pi. Raspberry is an easier and effective way of modelling and controls remote sensing systems.

3.1 Python Programming Language

Python since its first release in 1991 by Guido Van as a general-purpose programming language, has been wildly used and a preferred programming language because of its code readability simple syntax, indentation and white spacing (Virtanen et al., 2019). It is an interpreted programming language which executes instruction directly and freely without having to be compiled. It is also very useful for both small and large projects. It is a very efficient memory management language which is object-oriented as well as procedural (Wang et al., 2019).

It is used in developing Graphical User Interfaces, websites as well as other web application programs (Rose and Hildebrand, 2015). It has a number of advantages over other programming languages, some of which are its easy readability and therefore can be maintained as well as update easily. It supports a variety of programming paradigms and it as well supports multiple platforms. It has an enormous, easy to use and readily standardized library to assist users to undertake complex projects easily. Despite is usefulness it is open source and is very useful for both prototype software development and actual software implementation. Python has many advantages as aforementioned, conversely, like other programming languages, has its own inadequacies. It does not have some inherent features that other present-day programming languages have. Consequently, there is a need to utilize Python libraries, modules, and structures to quicken custom programming to the advancement of the user (Team et al., 2016). Additionally, a few examinations have demonstrated that Python is slower than a few broadly utilized programming languages such as Java and C++. Some sets will have to alter in other to accelerate Python application by making changes to the source code for customization.

3.2 Raspberry Technology

Raspberry technology is a single-board computer technology (SBC) designed by the raspberry foundation enabling engineers to achieve greater flexibility for readily available costs. Although the Raspberry Pi was initially intended for the improvement of teaching computer science, it is currently utilized in assorted projects: engineering, logistics sector, art exhibition, and medical sector just to mention a few. Is supports a number of operating systems including Windows, Linux, BSD, Risc OS and Debian (Cox and Johnston, 2018).

Raspberry Pi was first released in February 2012, Raspberry Pi Model B first generation. The Raspberry Pi had received massive patronage because of its low cost and performance. An added advantage it has is that by adding a couple of peripherals the Raspberry Pi functions as a complete working computer with Raspbian, a Debian-based Linux as its operating system. It is usual described as a Single Board Computer (SBC), implying that it runs a full operating system and adequate peripherals to execute instructions. Some versions of the Raspberry Pi are network bootable if it has a file storage system such as a micro SD card (Vogiatzaki and Krukowski, 2014).

Perna et al (2018) described Raspberry Pi is a powerful SBC with 8.56 cm – 5.398 cm – 1.7 cm as it dimensions which makes it a suitable device to fit into an electrical junction box for home automation systems. Daryanavard and Harifi (2018) in their research made mention of the fact that although very powerful with a processor constructed on SoC chips known as BCM2851, Raspberry pi is very affordable with its price ranging between 5$ to 35$ depending on the model. The Raspberry Pi with its functions as a personal computer needs a power supply, display unit and some basic input devices such as keyboard and mouse. However, it may not need display unit, mouse and keyboard when used as a Web server. When used a web server, the Raspberry Pi connects with a number of single-purpose devices such as sensors to form a network. It functions as a fully functional computer and therefore connects to other peripheral devices to accomplish as purposes. It is used in the design and construction of systems such as home automation systems, arcade machines, games, security systems. Additionally, it used in the robotic field, hobby projects, server/cloud server, print server, security monitoring, web camera, wireless access point internet radio, temperature monitoring and other interesting automation systems that require no human interventions to operate. (Zouai et al., 2019).

3.2.1 Power supply

It is possible to power the Raspberry Pi with a number of different power sources that produce output current of 700mA. (Vujović and Maksimović, 2015). Among the devices capable of powering raspberry pi up are PC USB port, mobile phone charger, and backup batteries. Sometimes, the amalgamation of energy from AA alkaline batteries can be used to power the raspberry up so long they are capable of generating the requisite current.

3.2.2 Power modes

There are four power modes of the raspberry pi and the states of the processor and the memory of the raspberry pi in these four moods are explained in Table 3.1 below.

Table 3.1: Power modes of Raspberry Pi (Pajankar, 2017)

Power mode	CPU	ARM11
The run mode	All functions accessible	All functions accessible
The standby mode	Not all functions are accessible (the clock)	Interrupt signal can be executed
The shutdown mode	All functions are not accessible	All functions are not accessible
The dormant mode	The core is shut down	Caches are powered up

3.2.2 Operation system

Raspberry Pi can run on a number of operating systems. However, Raspbian is one of the dominant operating systems it runs is a Debian-based Linux based operating system. Raspberry pi has preinstalled ready to use software such as python, java, and scratch. The operating system has both a command-line interface and a graphical user interface (Aqel et al., 2018). Other third-party operating systems such as Ubuntu mate, windows 10 IOT core, weather Station, ICHIGO JAM RPI, and Snappy Ubuntu core just to mention a few are executable on Raspberry Pi.

3.2.3 Models of Raspberry Pi

Pajankar (2017) in his study classified Raspberry pi is into three models, namely Pi Zero, model A and model B. These individual models further have assorted products. Table 3.2 describes the models and products.

Table 3.2: Models of Raspberry Pi (Pajankar, 2017)

Model	Products	Release Date
Raspberry Pi A	Raspberry Pi 1 Model A	2013
	Raspberry Pi 1 Model A+ revision 1.1	2014
Raspberry Pi B	Raspberry Pi 1 Model B revision 1.2	2012
	Raspberry Pi 1 Model B+ revision 1.2	2014
	Raspberry Pi 2	2015
	Raspberry Pi 3	2016
Raspberry Pi Zero	Raspberry Pi Zero	2015
	Raspberry Pi Zero W	2015
	Raspberry Pi Zero WH	2016

3.2.4 Features of Raspberry Pi

Raspberry Pi has Broadcom BCM2837 64-bit Quad-Core Processor as its microprocessor and runs on 3.3Volts as its processor operating voltage. It operates on 5Volts, 2Amps from any power source capable of providing that voltage. It has a Flash Memory 16Gbytes SSD memory card usually used to store the operating system. The Raspberry Pi has a fast-Internal RAM of 1Gbytes DDR2 which makes it a fast option among another SBC. It also has clock frequency 1.2GHz the raspberry pi contains a GPU which as Dual Core Video Core IV Multimedia Co-Processor which provides Open GLES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high- profile decode. This make is able to display 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure. With regards to connectivity, the raspberry pi makes use of 10/100 Ethernet, BCM43143 (802.11 b/g/n Wireless LAN) for wireless connectivity. It also has installed 4.1 Bluetooth technology which in some case can be utilized for connectivity. For input-output, it has four 2.0 USB sockets, a 3.5mm Jack for audio and HDMI for video display. The device has an onboard 15-pin MIPI Camera Serial Interface (CSI-2) that can be used to connect the camera as well as a Display Serial Interface (DSI). 15-way flat flex cable connector with two data lanes and a clock lane for display connector. Figure 3.3 is a pictorial explanation of the features of the raspberry pi.

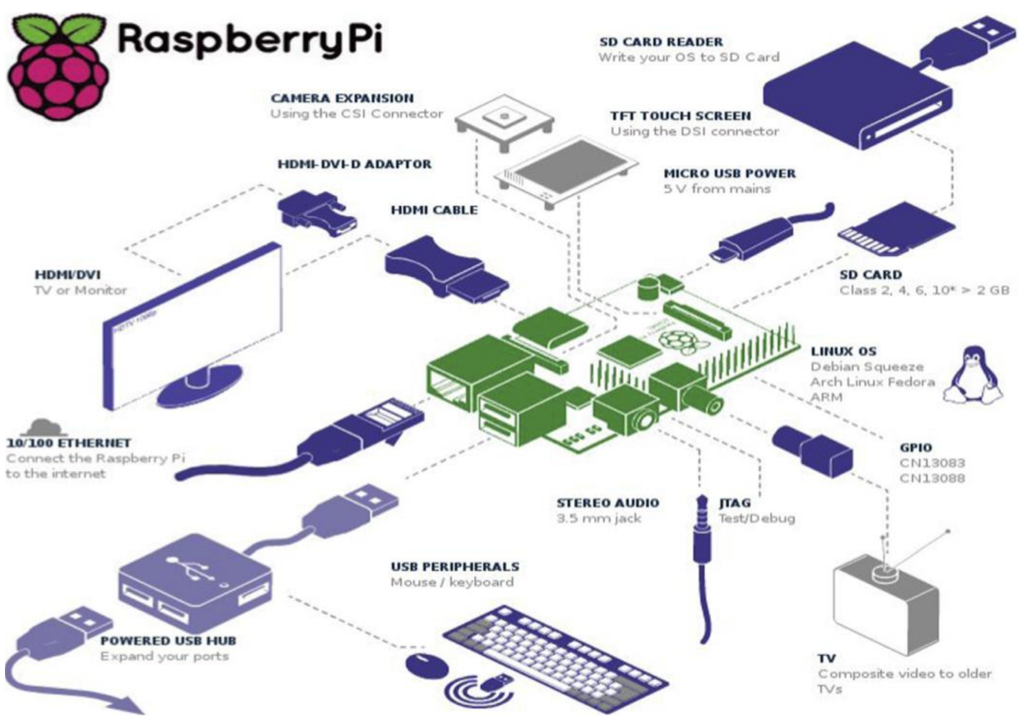


Figure 3.3: The components and features of Raspberry Pi (Pajankar, 2017)

3.2.5 Sensitivity of the Raspberry system

The use of Raspberry enables us to convert signals into readable digital codes for prompt reaction and application of the results. The present project aims at defining a sensory level for the gas volumes capable of initiating an alarm response in turn for prompt action. Raspberry has been used over the years for similar projects involving speech recognition and other human sensory functions. Code is written using the Python language. The code is found in the annexe Coding converts the reaction into sets of figures and data which can be read. Inferentially these codes are automated to function and stimulate the device to work. (Rose et al., 2018)

3.3 Design and Function of a Microprocessor

Microprocessors are termed the thinking pad of every automated system. Microprocessors function as part of the integrated motherboard to read, analyse and convert signals received to effectively provide solutions to live events. Microprocessors are built as a unit of transistors and electronic components assembled into a silicon chip. This combination is made efficient by programming to operate under specified conditions for functions varying from storage to data processing(Wade, 2015) From the 1970s till date Microprocessors have progressed from simple instruction processing devices to autonomous functioning devices. From 1974 to 1979 Intel processors termed the 80series evolved from First Generation to second-generation processors capable of fetching information, decoding the information and executing predefined steps to achieve units. A few semiconductors were added to the basic units to achieve such efficiency. Such processors were used in the first devices such as MC68000 Motorola.

Third generation microprocessors operated from 1978 and used mostly for large scale industrial processes. The Fourth-generation microprocessors had the assembly of a larger number of transistors to operate in several cycles some processes. The Fifth-generation processors as used nowadays operate millions of transistors in well assembled and automated processes.

Table 3.3 Microprocessors of the pass generation

NAME	YEAR	TRANSISTORS	DATA WIDTH	CLOCK SPEED
8080	1974	6,000	8 bits	2 MHz
8085	1976	6,500	8 bits	5 MHz
8086	1978	29,000	16 bits	5 MHz
8088	1979	29,000	8 bits	5 MHz
80286	1982	134,000	16 bits	6 MHz
80386	1985	275,000	32 bits	16 MHz
80486	1989	1,200,000	32 bits	25 MHz
PENTIUM	1993	3,100,000	32/64 bits	60 MHz
PENTIUM II	1997	7,500,000	64 bits	233 MHz
PENTIUM III	1999	9,500,000	64 bits	450 MHz
PENTIUM IV	2000	42,000,000	64 bits	1.5 GHz

In this case, we design a microprocessor capable of reading through the Python coded signals. Signals which in turn are amplified using the Raspberry technology. Microprocessors hail the 20^{th} century which their smart features to accommodate and solve effectively users' purposes.

Microprocessors are classified according to their functionalities, design criteria and application. We have Complex Instruction Set Microprocessors – CISC, Reduced Instruction Set Microprocessors – RISC, Application Specific Integrated Circuit, Superscalar Processors and Digital Signal Microprocessors – DSP's. A microprocessor whose function is to achieve low scale activities is termed a complex instruction set microprocessor. Such a device aids in downloads, uploads and data recovery from memory chips. Microprocessors which function for specific commands function as Reduced Instruction Sets capable of completing the information at a faster rate such is the case with our microprocessor. However, these functions can be modulated to perform more complex operations and so are termed superscalar microprocessors. Such processors use multipliers splitting up the processing unit into various operational units to perform several instructions.

In coding language, digital signals can be converted to analogue and vice-versa. Microprocessors used for this perform complex mathematical processes to ensure results are achieved. This category of processors is termed Digital Signal Multiprocessors commonly used in home appliances, audio and video devices, TV sets and telecommunication devices.

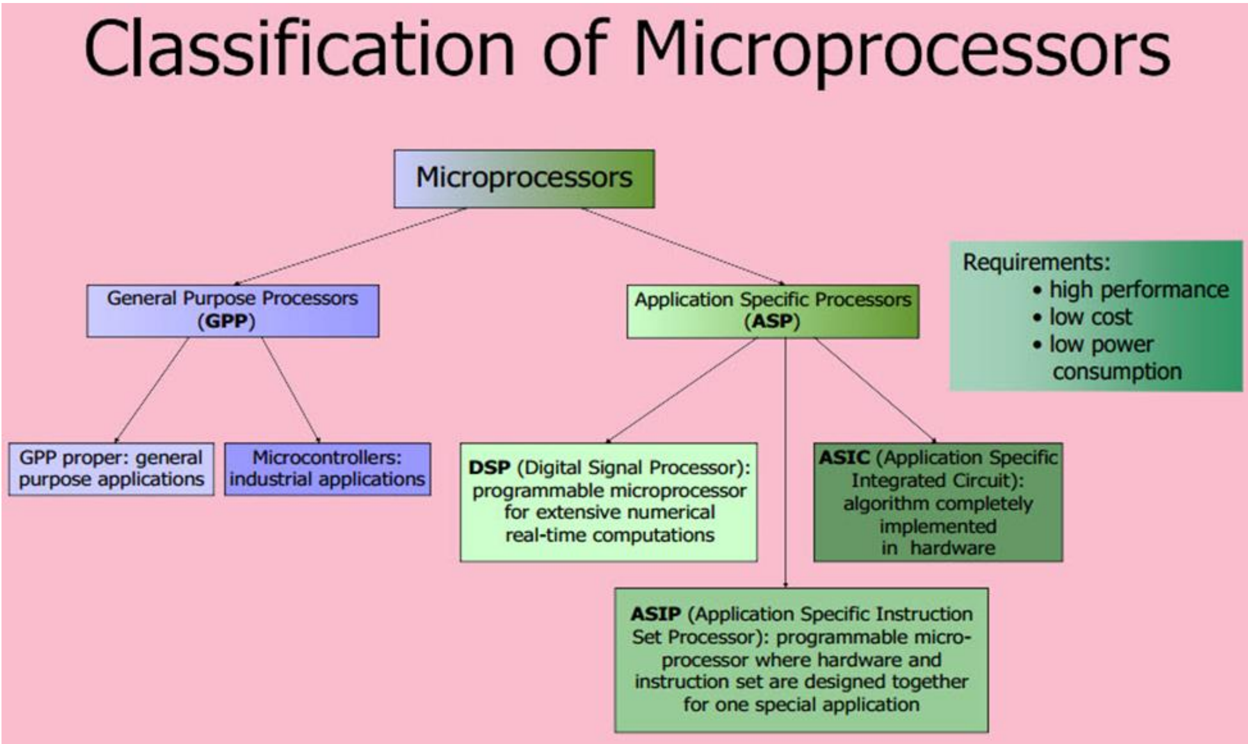


Figure 3.4: Classification of Microprocessors (Elprocus, 2019)

3.3.1. Gas sensor microprocessor

The Micro-processor functions as Reduced Instruction Sets capable of completing the information at a faster rate such is the case with our microprocessor. The set of instruction are defined through coding such a set of parameters will be run. The structure of a RISC is shown in figure 3.5

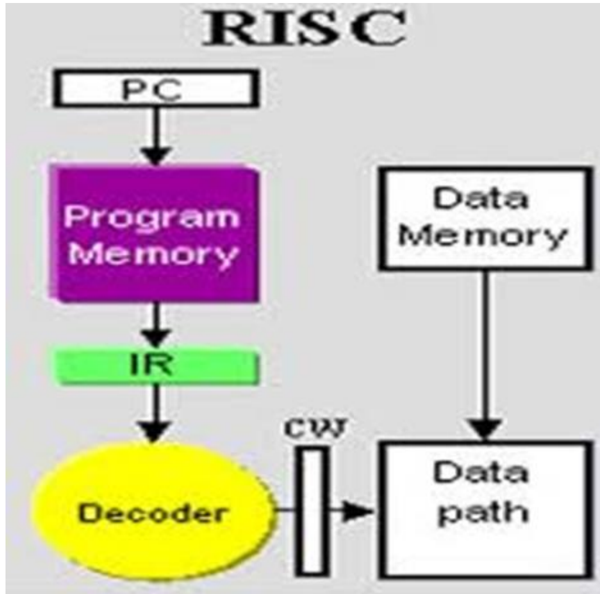


Figure 3.5: Operating Mode of a Reduced Instruction Set Microprocessor (Elprocus, 2019)

Figure 3.5 shows a standard Reduced Instruction Set Microprocessor flow chart. From a PC the program is designed and coded. Coding is saved into a component of the computer's memory. The signal is transmitted through an IR receiver and decoded then amplifies to be read by the data path reader. A stream of data is received from the other end of the sensor. The data received will be interpreted to correspond with threshold levels of the gas in the surrounding with effective responses alert. Figure 3.6 shows a more detailed structuring of the device and program.

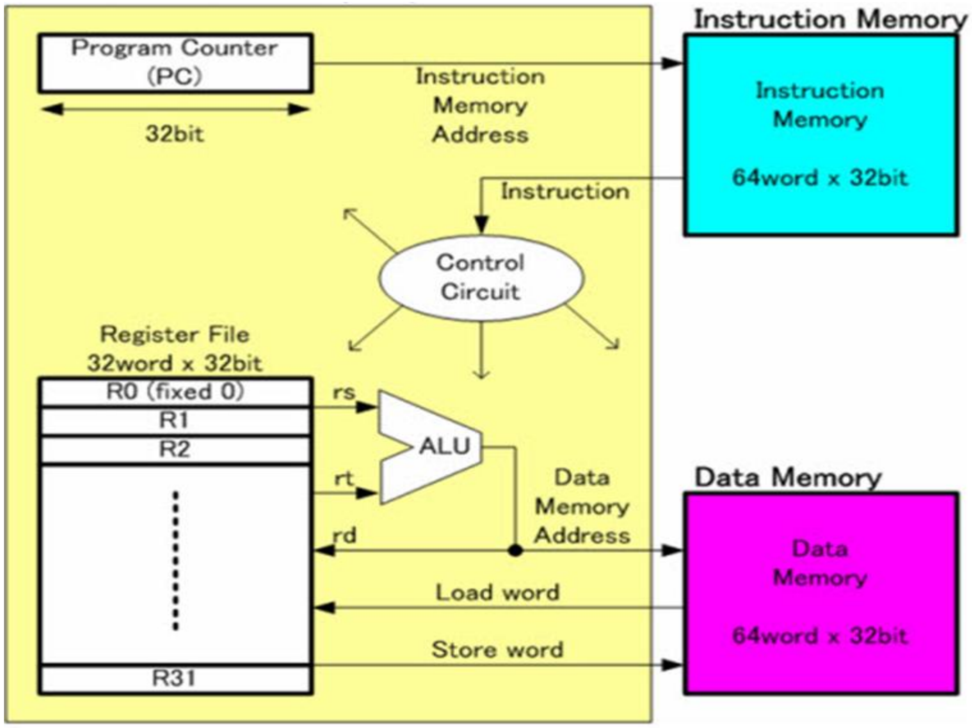


Figure 3.6: Functional Unit of Reduced Instruction Set Microprocessor (Elprocus, 2019)

3.4 The Internet of Things

Kevin Ashton in 1999 introduced the internet of things to describe a system in which sensors and devises are connected to the internet ubiquitously. He farther explained that computers, the internet, and the environment depend on humans for information (Atzori et al., 2017).

Tidd and Bessant (2018) also explain the internet of things as an increasing technology because daily new devices are and sensors are connected to the internet to facilitate and make homes, offices and our environment smarter. These in the researcher's view, these go a long way to improve services, security, energy consumption and facilitating the comfort of inhabitants of a home. Raja and Mandour (2019) also made mention of how the invention of Smart Home Automation System (SHAS) has resolved a number of problems in our environments and homes in recent times. Silva et al. (2018) also think smart home is of the main aspects of Internet of Things, which comprises of appliances and sensors interconnected in a network with the help of software to make a home smarter and comfortable. Figure 3.7 explains how sensors and devises are interconnected with the help of the internet forming internet of things.

Figure 3.7: A figure of Internet of Things

The internet of things applies therefor to the automation of real-life processes to ensure efficiency, user care, protection and comfortability with one of the main applications being smart homes.

Pavithra et al. (2016), lay emphasis on the use of the Internet of things as a solution to Gas Detection in Power Plants. Application of IoT to such events helps make the systems more effective and dynamic. At first, a microcontroller would be used to simply detect the presence of gases linked to an alert system. IoT helps through a preset database with threshold levels of toxic gases is used.   An integrated gas sensor can be used for the various gases. The gases once in the surrounding are detected at the source: sensed data acquisition unit which in our case is a Raspberry Pi system. Data is received, transferred to the processing unit termed gateway for the threshold value to be confirmed. The value recorded is passed on to the display for proper action to be undertaken.

Considering separation of the gases is not done at the processing level, Liquified Petroleum Gas LPG is used with corresponding limit values of various toxic gases included. The sensors capt the gases with insitu alert in case of a limit overlay.

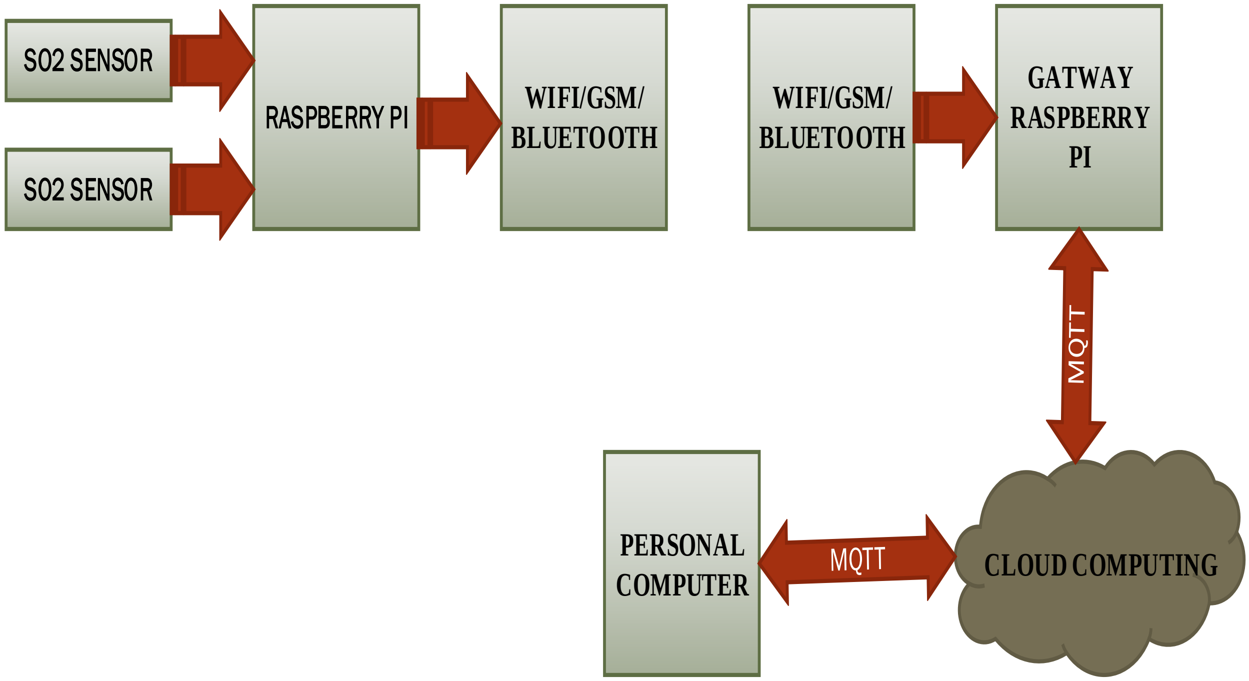


Figure 3.8: IOT Representation of Toxic Gas Detection (Pavithra et al., 2016)

CHAPTER 4

DEVELOPED SYSTEM

The methodology for the developed system would be discussed. The system entails a number of main components, some of which are hardware such as MQ2 sensors, Raspberry Pi, ADS1115 Analog to voltage convertor as well as the software part.

4.1 System Architecture

The system is made up of various parts as explained in Figure 4.1 below. The system is made up of MQ2 sensors that detect the presence of gas, sends and analog data to the Analog To Digital Converter (ADS1155) in other for the analog data to be converted to a digital data. This digital data in the read by the raspberry pi (which only take the digital signal at it GIOP) which displays the output the sensors as well as the concentrations of the gas. When the gas detected passed the required limit, a buzzer sounds an alarm and an LED lighted indicating danger. The system sends an SMS to the appropriate persons to control the gas leakage. And the software part of the systems constitutes a number of python libraries as well as a python three code to help the system.

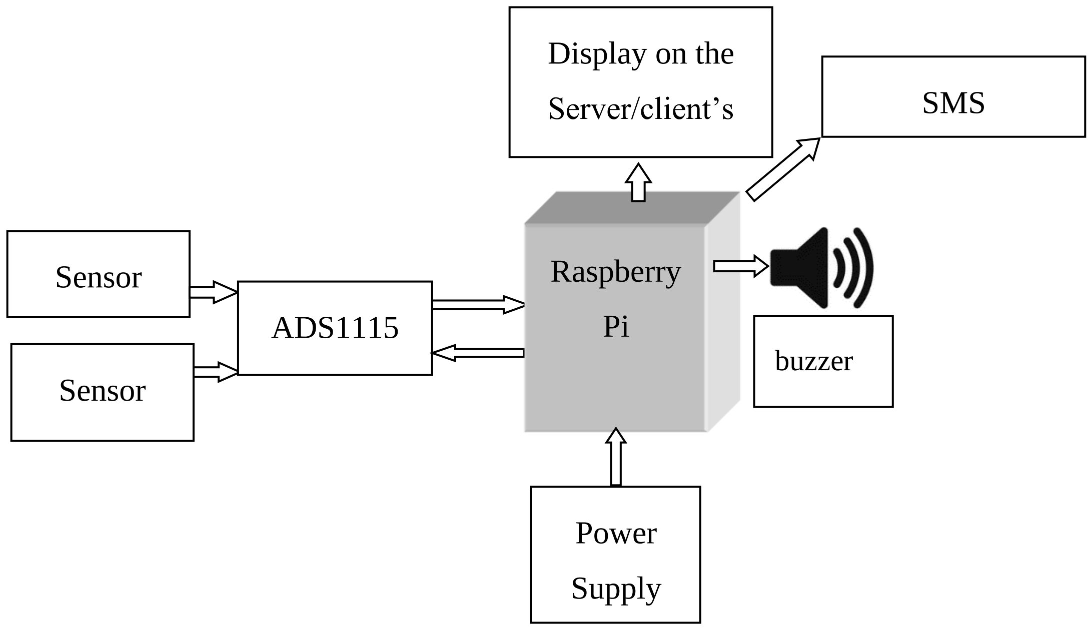


Figure 4.1: Block diagram of the developed system

4.2 System Technology

Some technologies were utilized to actualize this developed system. These assisted in setting up of the installation of the raspberry pi, the collection of data for the MQ2 sensors and displaying these data on the client screen as well as send SMS to the appropriate person in case of an alarm.

4.2.1 Hardware

4.2.1.1 Raspberry technology

The Raspberry Pi although a small computer is exceptionally effective and powerful. having the measurements of credit card, it is designed to inspire students toward the fundamental computer education (Fletcher and Mura, 2019).

The Raspberry Pi is produced by the Raspberry Pi Foundation in Great Britain. It is a device that connects to display and other peripherals. It has the capability of doing everything a desktop computer can do. It is capable of browsing the internet, making spreadsheets, playing games, watching high definition videos, word processing etc.

The Raspberry Pi has two models namely model A and model B with the difference only in the USB port.

Designing the set up requires a USB Connector 2.0, an SD-RAM Memory chip of 256MB, an HDMI or Composite RCA, a 3.5 mm Jack, a Dual Core Video Core IV Microprocessor. The required exploiting system used is LINUX. Using the Raspberry Pi saves from the stress of complex processing set-ups. It is rather in the form of a mini-motherboard of the size of a credit card. Such a set-up is easily accessible and manageable. Browsing capacity, games anchoring and video output are of sound quality. The Raspberry is thus a combined software and hardware component which aids in processing complex programming systems as well as reading and processing codes. RPI is an invention which dates from February with a first Model, called Model B first generation. It is a low cost and high-performance device which couples peripheral functions as well. Such functions help process full PC codes via Raspbian; a Linux based Debian OS. RPI is described as a Single Board Computer with a network bootable file storage system. (Vogiatzaki and Krukowski, 2014).

Software programs in the operating system are used to control this GPIO. The GPIO connects to assorted electronic devices and components. It also supports a variety of features such as interrupts, USB UART, SPI etc.

This has prompted the popularity of the Raspberry Pi in computer science education as well as with industry, researchers, model developers, gamers and the inquisitive. Because of its cost, it easily to be experimented with and damages due to wrong connection are tolerated then to have a personal computer blown up. The Raspberry Pi has become a core component of many complex projects in recent years. Figure 4.2 is a block diagram of the Raspberry pi whiles Figure 4.3 shows a picture of the Raspberry pi and labels the various components of the pi.

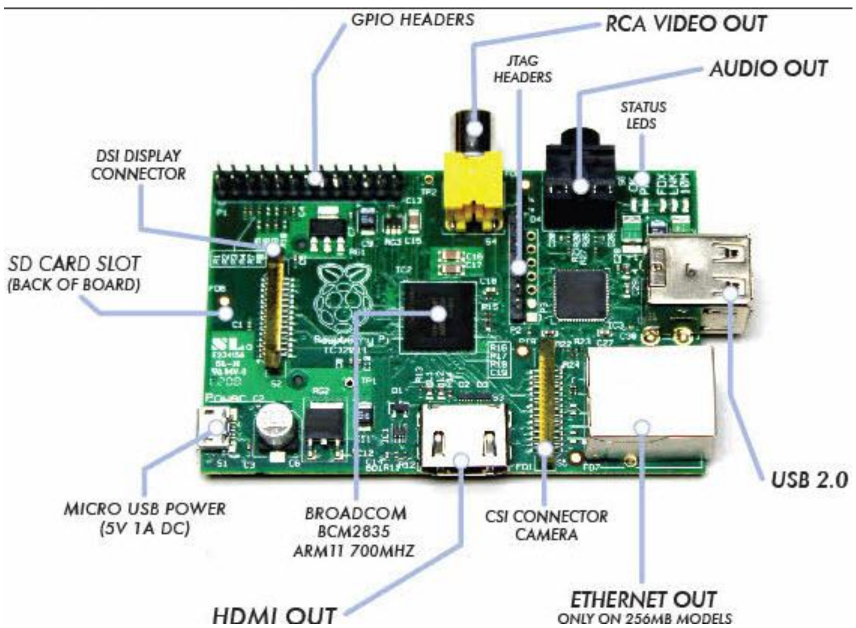


Figure 4.2 Hardware Specifications of Raspberry Pi (Edgefxkits, 2018)

4.2.1.2 ADS1115 technology

The device is useful microcontrollers that have not an analog-to-digital converter. It gives an output of 16-bit data at 860 samples/second via I2C interfacing. It can be configured to amalgamate four inputs into as allows for it gain amplifier to be programmable. It runs on a range voltage (between two and five volts).

Programmable operating modes:

Samples per second: 8 – 860 samples per second is the variable allocate of time taken by each sample. This parameter when altered with the range stated above to any value such as 200 for instance, each transmission will last for 1/200 seconds. In essences the lower the sample rate the longer the period.

Input Channel: There are 4 input pins (A0-A3). The pins are configured to allow four inputs to read from when performing a transfer of data. The ADS1115 can read both single-ended and differential data.

Differential mode: ADS1115 reads the potential difference between two of the input pins.

The single-ended readings mode: ADS1115 reads the potential difference between a single input and ground.

PGA– Programmable gain amplifier: Voltage on input pins is usually output from the amplifier and converted to the 16-bit ADC. This amplification gain can be programmed to change permitting measurement of small voltages to rise in resolution.

The ADS1113 had a couple of modes in which it converts data: In one of the conversions modes, (the conversion the Raspberry Pi uses). The conversated data is stored inside a register in the ADS1115 the Raspberry pi uses that date when it requires. The other mode known as the continuous conversion, the analog to digital convention never stops, it is repeated.

ADS1115 has an internal built oscillator as well as a low-drift voltage reference. It also consumes a current of 150µa over a voltage range of 2.0v to 5.5v. Figure 4.4 is a pictorial view to the ADS1115.

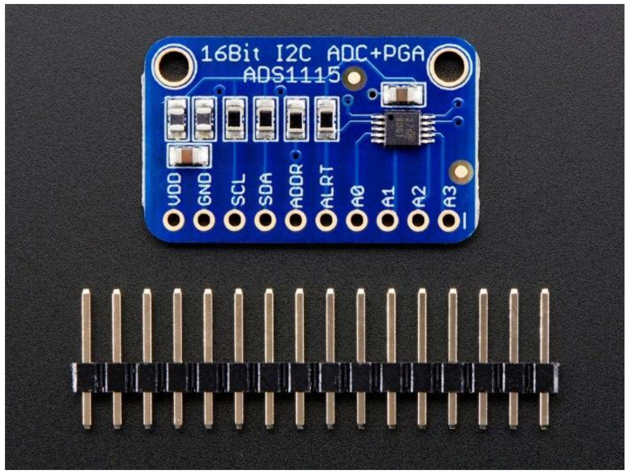


Figure 4.4: ADS1115 16-Bit ADC - 4 Channel

4.2.1.3 MQ2 sensors technology

MQ2 or chemi-resistors is a Metal Oxide Semiconductor (MOS) gas detector. Gas is detected when the resistance of the sensing material is varied in the presence of gas. A voltage divider is used to determine the concentration of the gas detected. Figure 4.5 below is a picture of the MQ2 sensor.

Figure 4.5: MQ2 Sensors

MQ2 operates on 5V DC/ 800mW power. It used in the detection of LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide with varying concentrations levels (200 to 10000ppm).

Table 4.1 MQ2 Gas sensor specifications

Quantity	**Value and unit**
Operating voltage	5V
Load resistance	20 KΩ
Heater resistance	33Ω ± 5%
Heating consumption	<800mw
Sensing Resistance	10 KΩ – 60 KΩ
Concentration Scope	200 – 10000ppm
Preheat Time	More than 24 hour

- ***Mode of operation***

During exposure of tin dioxide to high temperatures, the tin dioxide absorbs oxygen on its surface, this allows donner electrons in the surface of the sensing materials are attracted towards the absorbed oxygen. This phenomenon seizes the electric current flow from sensing material. When gas is in existence, the density of the absorbed oxygen reduces because of the reaction between it and the gas. This phenomenon courses electrons to flow on the surface of the tin oxide. The MQ2 sensor has both analog and digital output. (digital for combustible gas and analog for gas concentration). The analog output voltage is directional to the concentration of smoke/gas.

The sensitivity of the sensor can be calibrated with the help of the blue nob as shown in figure 4.6 below and Figure 4.7 is the picture of the pin of the MQ2 sensor.

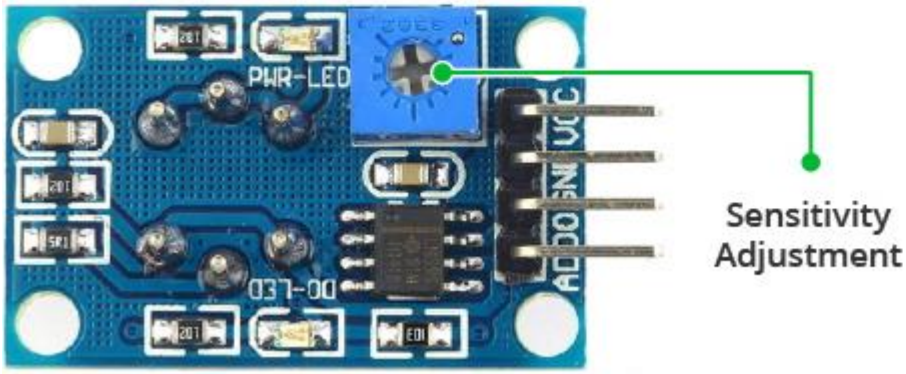


Figure 4.6: MQ2 sensors

Figure 4.6: MQ2 sensors pin

VCC 5 V.

GND Ground Pin.

D0 digital data of detected combustible gases.

A0 analog voltage proportional detected gas concentration.

4.2.2 Software

4.2.2.1 Linux operating system

Anand et al. (2012) in their study describes Linux as a free and open-source Unix-like software, primarily developed in C and assembly developed around Monolithic (Linux kernel) by Linus Torvalds. It is a multilingual software first released on September 17, 1999. Linux was initially created to be used by personal computer base on the Intel x86 design but currently runs on a variety of devices ranging from mainframes, supercomputer, mobile devices, embedded devices to servers (Tolu, 2018).

4.2.2.2 Raspbian operating system

Raspbian is an open-source operating system, is related to the Debian class of Unix-Like operating systems created by the Raspberry Pi establishment and optimized for Raspberry Pi. The most recent adaptation is Raspbian Extend with PIXEL/2018-06-27. Raspbian is the best working framework for Raspberry Pi and has almost 35,000 software are embedded.

4.2.2.3 Programming languages

Raspberry Pi uses a number of programming languages in its operation. Python is the most recommend language for people using Raspberry Pi for the first time as suggested by the Raspberry PI foundation. Essentially, all programming language that can be fun on ARMv6 complied can be run Raspberry Pi. (Upton et al., 2016).

4.2.2.4 Python

Python 1 was the starting set of Python dialect discharged but nearly not ins use anymore. (Ghaleet al., 2018) Python 2 happens to be the moment discharge of Python programming language with the most recent version being Python 2.7.12. Python 3 is the third discharge of Python dialect with the most recent version being Python 3.5.2. Indeed, in spite of the fact that Python2 scripts will run without major changes in python 3. Python 3 overhauled Python 2 with a number of changes such as the sentence structure and the actual structure of the programming language. The Python establishment from time to time updates Python 2 in respects to bug fixes and security patches.

This makes Python 2 the best Python dialect within the programming community nowadays. There are Python libraries for most work require in programming, they all work with Python 3 and Python2.

4.2.2.5 Socket in python

Standard python libraries are installed to facilitate the communication between client and server easier. The socket server module is a system utilized by a network of servers. variety of protocols as us HTTP and SMTP. The protocol used in transitions was the Transmission Control Protocol (TCP). The TCP protocol has two advantages, which all that it is a very reliable means of communication and it ensures that data is delivered in order. Figure 4.7 is a_diagram explaining the steps involved in socket API calls and data flow for TCP(Koza, 2017).

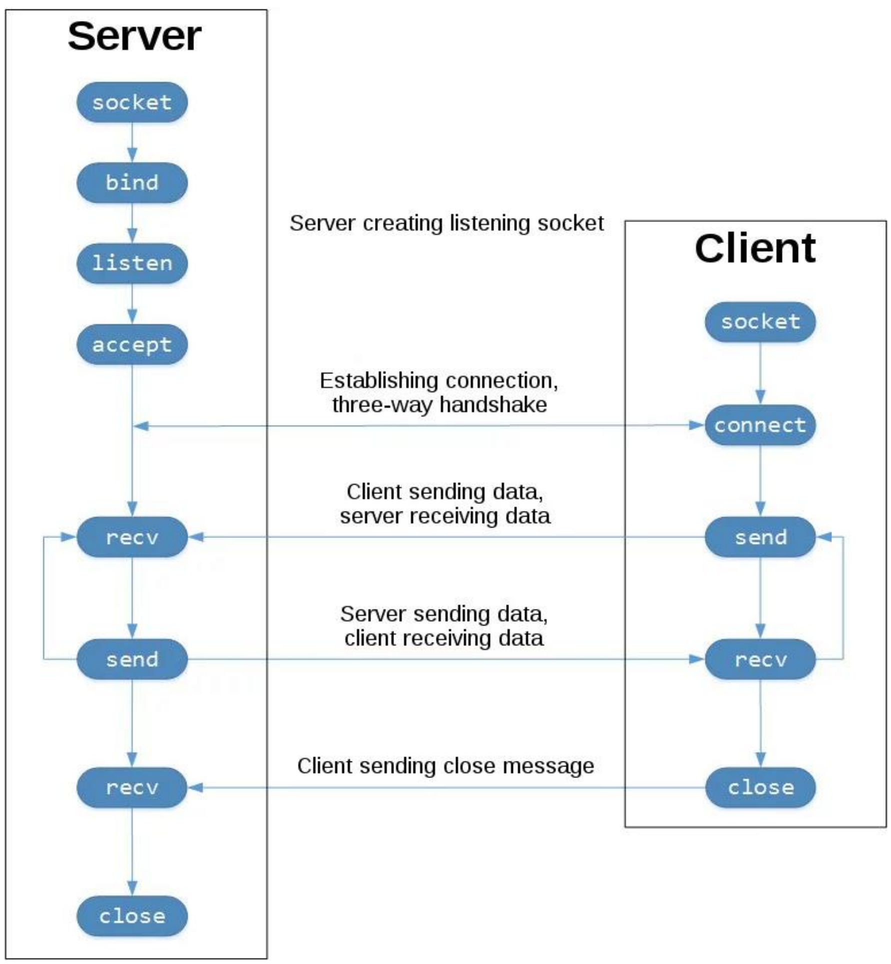


Figure 4.7: Socket API calls and data flow for TCP:

4.2.2.6 Twilio python library

To ensure the system to transfer SMS from the system to authorized persons, the Twilio python library was imported and deployed. This library supports python 2.7 and beyond.

Install the Library

In other to install the python library for the SMS API the following codes were executed in a terminal.

```
# sudo pip install twilio

#sudo easy_install twilio

Alternatively

#python setup.py install

#pip install twilio==5.7.0
```

An account must then be created to attain account id and authentication token me attain to ensure text transition. There are basically 5x and 6x python helper library currently in exitance.

This is a link of the demonstation of the developed syetem
https://www.youtube.com/watch?v=n7UtbZ1SQsk&feature=youtu.be

4.3 Flow Chart of the System

This flow chart is a graphical sequence of movements showing the steps involved in the developed system. It also shows the stages involved in the developed system to be able to sense gas, display the concentration levels of the gas displayed by the various MQ2 gas sensors on both the server and client as well as send SMS to. Figure 4.8 shows the flowchart of the developed system to detect gas.

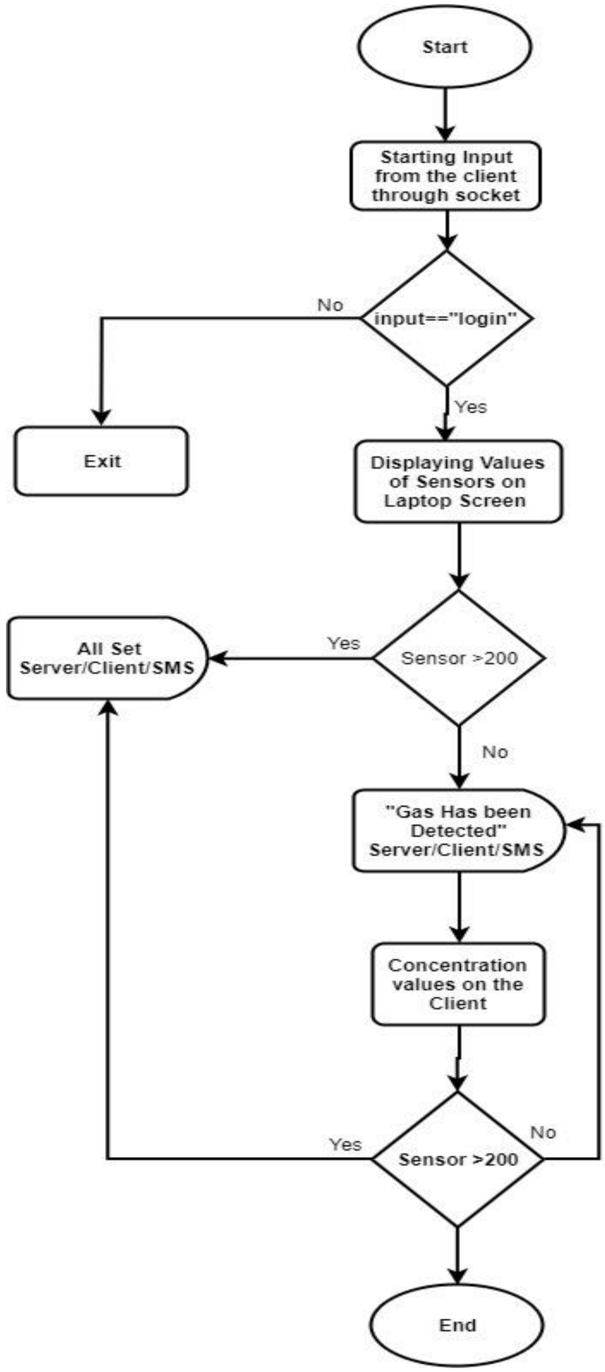


Figure 4.8: Flow chart of the developed system

CHAPTER 5

IMPLEMENTATION OF DEVELOPED SYSTEM

In this chapter, is the process of installing the system was explained. There is a description of the system's functionalities and operations. Screen captures of different stages are displayed to appear how the system was developed.

5.1 Setting up Raspberry Pi

A Pi 3 Model B was used in building this system**,** it has a RAM of 1GB capacity which is a quad-core processor as well. This enables it to handles bigger operating systems us as Ubuntu and Microsoft 10. The Raspberry 3 Pi has four USB port and HDMI port for video output.

Power supply: A 5V1 2.5A micro-USB power supply was used to power the raspberry pi. USB keyboard: A USB keyboard was used in the system. USB mouse: A USB mouse was used in this system. MicroSD card: A 16 GB microSD card was used of storage in this system. NOOBS requires a minimum of 8GB storage. MicroSD USB card reader: Was used to connect the microSD card to a computer in order to install the downloaded the operating system. A monitor: A fifteen-inch monitor was used for display.

An HDMI cable to serial convertor was used to aid in the connection of the monitor to the Raspberry Pi . An Ethernet cable: For connection to the internet, an RJ45 internet cable was used. Connection with the Internet does not require configuration.

Steps carried out to set the Raspberry Up

Step 1: Formatting the microSD card:

The initial step was to reformat the microSD because mostly new microSD cards come with some irrelevant files on them. Therefore reformatting it completely delete and clear all files on the microSD.

Step 2: Download NOOBS.

NOOBS was then downloaded and installed onto the microSD. Once it this was done, the microSD card was plugged it into the Raspberry Pi. The operating system was then configured. NOOBS can be accessed through https://www.raspberrypi.org/downloads/.

Step 3**:** Initializing Raspberry Pi

The microSD card was inserted into the card socket of the raspberry Pi 3. A USB keyboard and USB mouse were plunged into the USB ports.

An HDMI to serial converter was utilized in connecting the Raspberry Pi to a monitor. An RJ45 Ethernet cable was used to connect the Raspberry Pi to the internet.

Alternatively, a WiFi adapter of the Raspberry Pi could have been used to connect the system to the internet. The 5.1 volts 2.5 amps micro USB power supply was used power up the Raspberry Pi to boot it.

Step 4**:** Download Raspbian. Raspbian was downloaded and installed on the Raspberry Pi 3. It contains pre-compiled software and over hundreds of projects use Raspbian as their operating system. Figure 5.1 is a picture of Raspbain been Downloaded and installed. Once the installation was completed the Raspbian automatically began to boot.

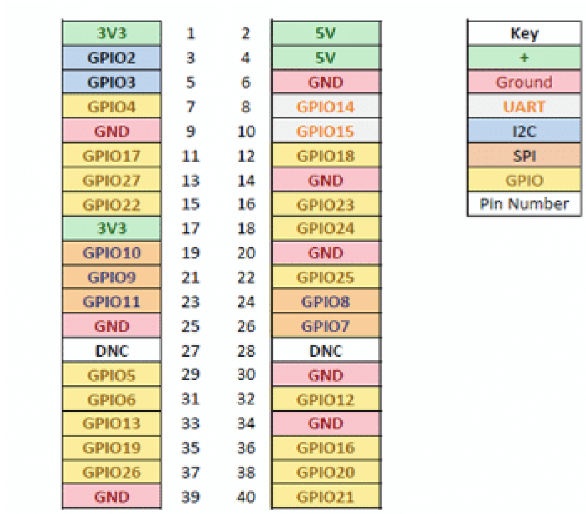
Step 5: Configuring Raspberry Pi 3: Upon completion of the boot process, the location, date, and time.is done were configured to suit the local setting.

Menu **-→** Preferences **→** Raspberry Pi Configuration **→** Localisation **→** Set Locale, Set timezone and Set Keyboard are selected to set location, local time and keyboard language respectively.

After reconfiguring the Raspberry Pi, the system was rebooted. Once the Raspberry Pi was restarted, it was ready to be used.

5.1.2 Configuring and using GPIO Pins

The Raspberry Pi 3, has 40 GPIO pins in total. Below is the GPIO pinout diagram of Raspberry Pi 3 used in this system.



3V3	1	2	5V
GPIO2	3	4	5V
GPIO3	5	6	GND
GPIO4	7	8	GPIO14
GND	9	10	GPIO15
GPIO17	11	12	GPIO18
GPIO27	13	14	GND
GPIO22	15	16	GPIO23
3V3	17	18	GPIO24
GPIO10	19	20	GND
GPIO9	21	22	GPIO25
GPIO11	23	24	GPIO8
GND	25	26	GPIO7
DNC	27	28	DNC
GPIO5	29	30	GND
GPIO6	31	32	GPIO12
GPIO13	33	34	GND
GPIO19	35	36	GPIO16
GPIO26	37	38	GPIO20
GND	39	40	GPIO21

Key
+
Ground
UART
I2C
SPI
GPIO
Pin Number

Figure 5.2: Label of GPIO

GPIO: are the standard pins use to input and output data into and out of raspberry pi. They generally do not have predefined purposes.

I2C: (Inter-Integrated Circuit) pins are synchronous packet-switched, single-ended serial computer bus that ensures connection and communication to hardware modules that support I2C Protocol, usually multi-master and multi- slave bus. It is used for inter-board communication within short distances.

SPI: (Serial Peripheral Interface Bus) is used to ensure synchronous serial communication to SPI devices within short distances usually, in embedded systems.

UART: (Universal asynchronous receiver/transmitter) are serial pins utilized in transmitting asynchronous communication signals between the Raspberry Pi and other devices.

The power pins output 3.3volts and 5volts DC power from Raspberry Pi.

GND: used to connect the device to the ground electrically.

DNC: (do not connect) they are usually left unconnected.

5.1.2.1 Configuring GPIO

With raspberry Pi B+ configuration of the general-purpose input out pin was not necessary. However, the latest update of the Raspbian must be installed to ensure updates of the proper running of the GPIO. To do so the following commands were run.

```
# sudo apt-get update

# sudo apt-get upgrade

# sudo apt-get install rpi.gpio
```

5.1.2.2 Configuration of Raspberry Pi's I2C

The I2C pins were activated by the following steps bellow.

Step 1: (In a terminal) `#sudo raspi-config`

Step 2: Advanced ptions--- I2c--- Enable.

***Step 3*:** Reboot system.

Figures 5.3 and 5.4 are screenshots of the confirmation of I2c in the GPIO of the Raspberry pi

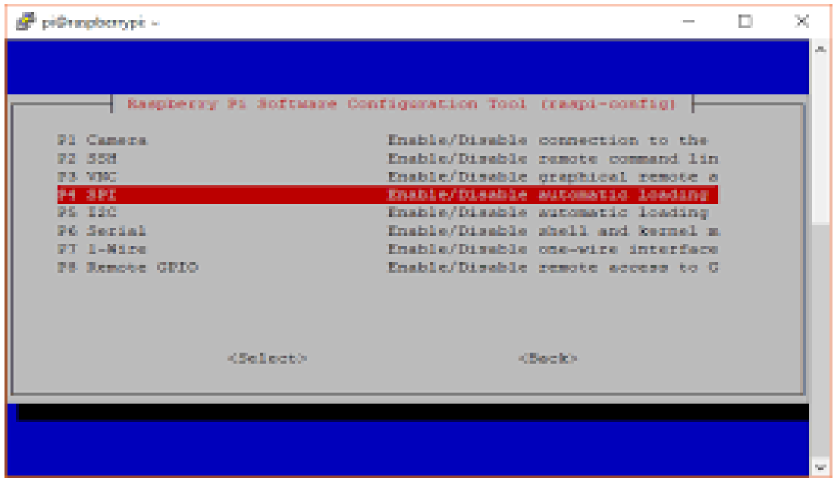


Figure 5.3: Configuring I2c

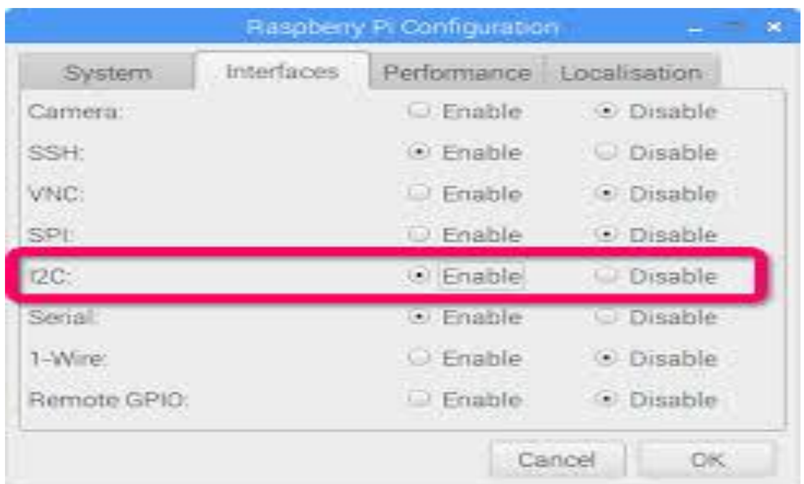


Figure 5.3: Configuring I2c

5.1.2.3 Configuring Raspberry Pi SPI

The SPI pins were activated by the following steps bellow.

Step 1 (In a terminal) `#sudo raspi-config`

Step 2 Advanced options--- SPI --- Enable.

Step 3: Reboot system.

Figure 5.3 is a screenshot of the SPI configuration

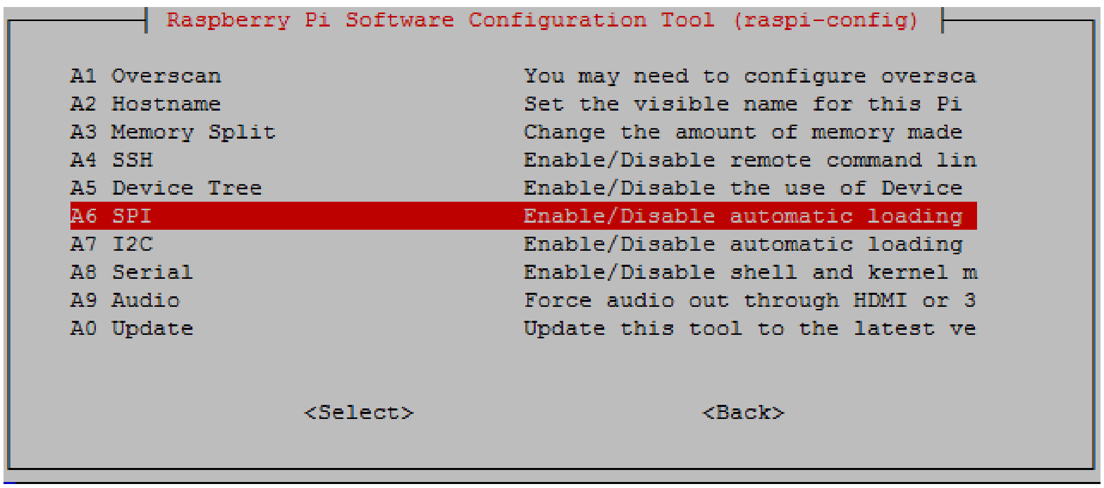


Figure 5.3: Configuring SPI

5.2. Connecting ADS1115 and MQ2 sensor to the raspberry pi

3.3V pin on the raspberry pi was connected to the Vcc ADS1115, and the GND was connected to GND on the raspberry pi. SCL and ADS pins on the ADS1115 are then connected to the to pin 5 and 3 respectively on the raspberry pi

The analog output from the MQ2 gas sensors was the connected to (AO) to pin A0, A1, A2 and A3 on the ADS1115. The ground pins and the Vcc pins of the sensor are then connected to the ground and 3V respectively to complete the connections.

5.3 I2C Addresses

To address the I2C interface of the raspberry pi the following commands were executed in the terminal of the Raspberry pi

```
# sudo i2cdetect –y 1
```

```
#sudo i2cdetect –y 0
```

Addr pin- slave address

Ground - 1001000 (0x48)

VDD - 1001001 (0x49)

SDA - 1001010 (0x4A)

SCL - 1001011 (0x4B)

The hexadecimal addresses of the individual pins above indicate all of the 4 ADS1115 can be connected on the same bus.

- **Python Packages**

Some python packages were run to ensure that the ADS1115 can be communicated to by the Pi with the help of the python program.

```
#sudo apt-get install ipython python-numpy python-scipy python-matplotlib
#sudo ipython
# sudo pylab
```

- ***Adafruit Raspberry Pi Python Libraries***

Some Adafruit packages were run to ensure that the ADS1115 can be communicated to by the Pi's I2C with the help of the python program.

sudo apt-get install git

cd Documents

git clone http://github.com/adafruit/Adafruit-Raspberry-Pi-Python-Code.git

- ***ADS1x15 library function calls***

`readADCSingleEnded(channel, pga, sps) function read`

This function takes a single reading from the ADS1115 from the input pin specified by channel, and at the specified pga (programmable gain amplifier) and sps (samples per second) settings. Note that the pga and sps values must take the discrete values listed in the datasheet.

sps: 8 16 32 64 128 250 475 860

pga: 6144 4096 2048 1024 0512 0256

If you specify a pga or sps value that is not one of these values then the value will default to 250 for sps, and 6.144 for pga.

```
readADCDifferential(chP, chN, pga, sps)
```

Takes a single differential reading, the reading returned is the difference between input pins chP (positive channel) and chN (negative channel). Note that the allowed channel combinations are:

Table 5,1 below enlist in a tabular form the connection of the various devices of the developed system

Table 5.1: Wiring RFID RC522 to GPIO

ADS1115	**MQ2(sensor1)**	**MQ2(sensor2)**	**MQ2(sensor3)**	**GPIO**
Vcc	----	----	----	1
SCL	----	----	----	5
SDA	----	----	----	3
GND	GND	GND	GND	6
A0	A0	----	----	----
A1	----	A0	----	----
A2	----	----	A0	----
A3	----	----	----	----

Figure 5.1 is the circuit diagram of the developed system; it shows how the connection is made between the sensors and the ADS1115 analog to digital convertor and how the ADS1115 also interfaces the Raspberry pi. Further shows the connection between the client and the server (Raspberry Pi). The figure additionally illustrate the SMS API and how the server, the client and the mobile phone of the authorized person receives information about the state of the systems and alerts them when there is gas leakage.

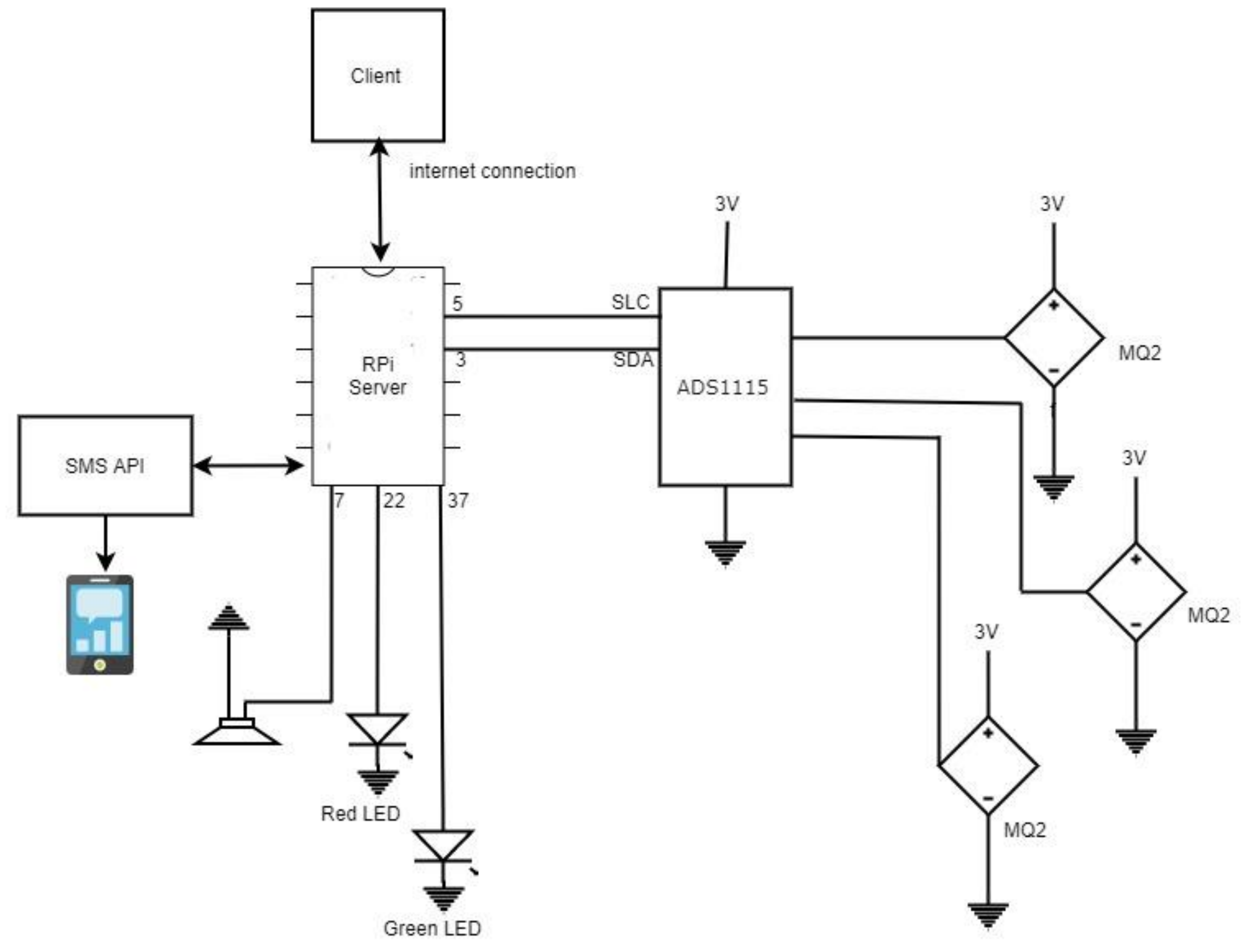


Figure 5.4: Wiring diagram of the developed system

5.4 Discussion

Soh et al (2019) in there study observed during the implementation of their developed system, that data collected from MQ-5 and MQ-2 gas sensors the need time of heating sensors to in other for the data to be stable. This is their view causes the sensors to have inconsistent initial values making it difficult to synchronize the data collected for the sensors.

When all devices were connected as designed, the system was tested and the values of the MQ2 sensors were observed. The following observations were made. The MQ2 sensors are not a state of the act sensors, implying they have not been tested and certified, they were made of cheap materials and easily went faulty. Training of the system to was difficult because of the inconsistent initial value recorded from the sensors The system, however, was trained and calibrated to detect the presence of LPG. When gas is detected, by any of the MQ2 sensors, the buzzer sounds an alarm, the red led light starts to blink and an SMS is sent by the SMS API. The complete system is secured through a login E-mail to confirm a number for the SMS to be sent to and telnet based authentication from the client to connect to the server. In the proposed system gas leakage can be monitored and also controlled. Figures 5.5 to 5.11 are a display of the states of gas detected by the system.

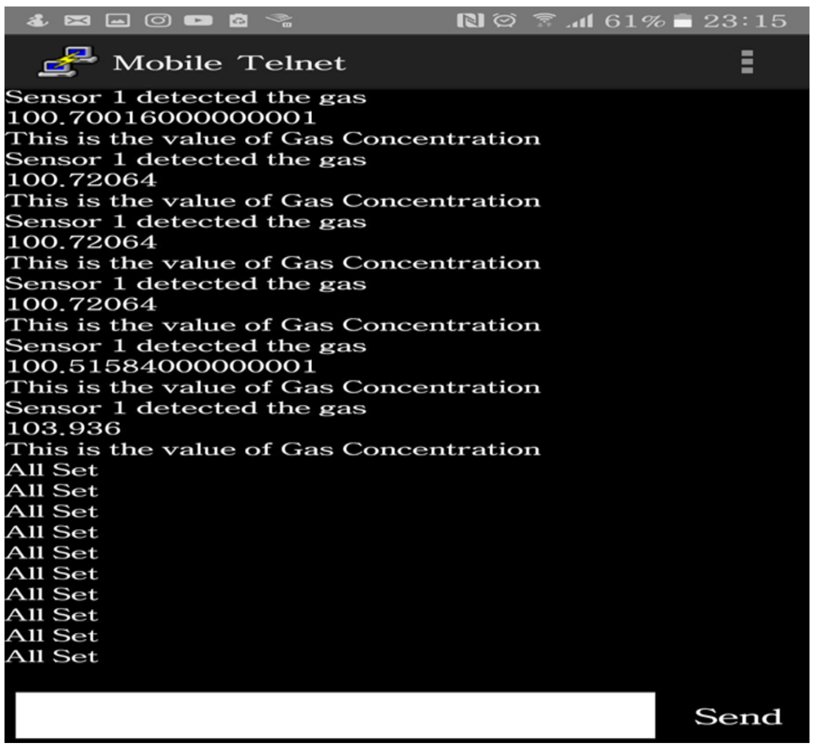


Figure 5.5 Client’s monitor when no gas is detected

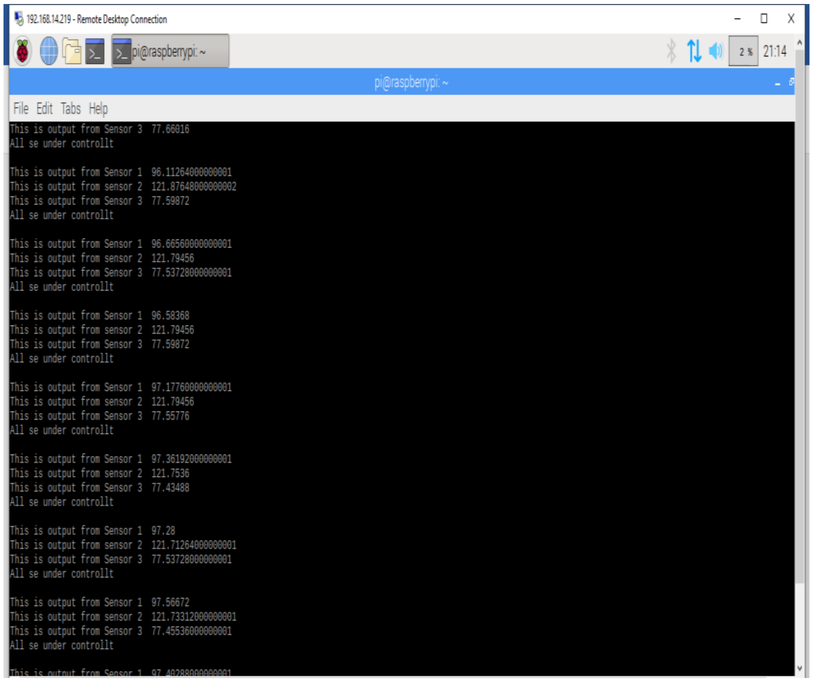


Figure 5.6: Server's monitor when gas is not detected

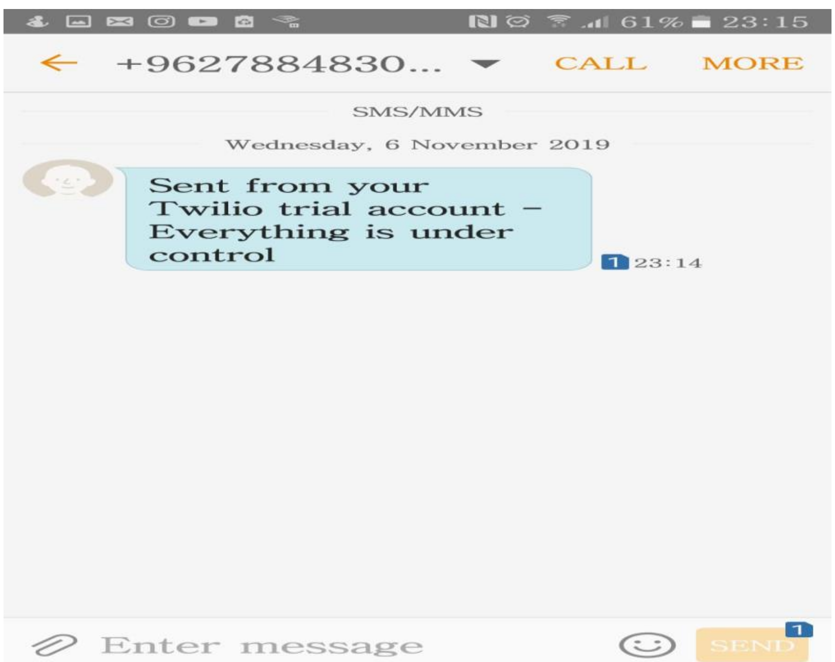


Figure 5.7: SMS when gas is not detected

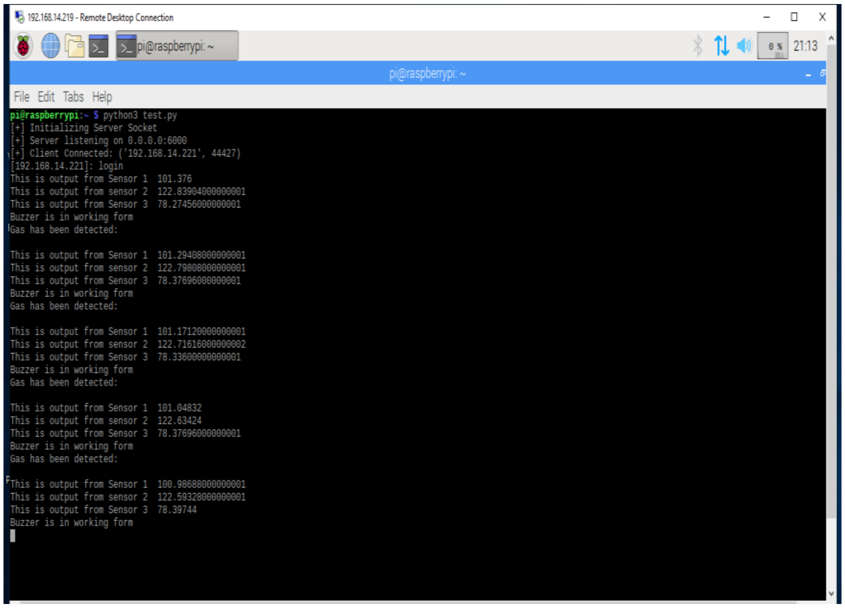


Figure 5.8: Server's monitor when gas is detected

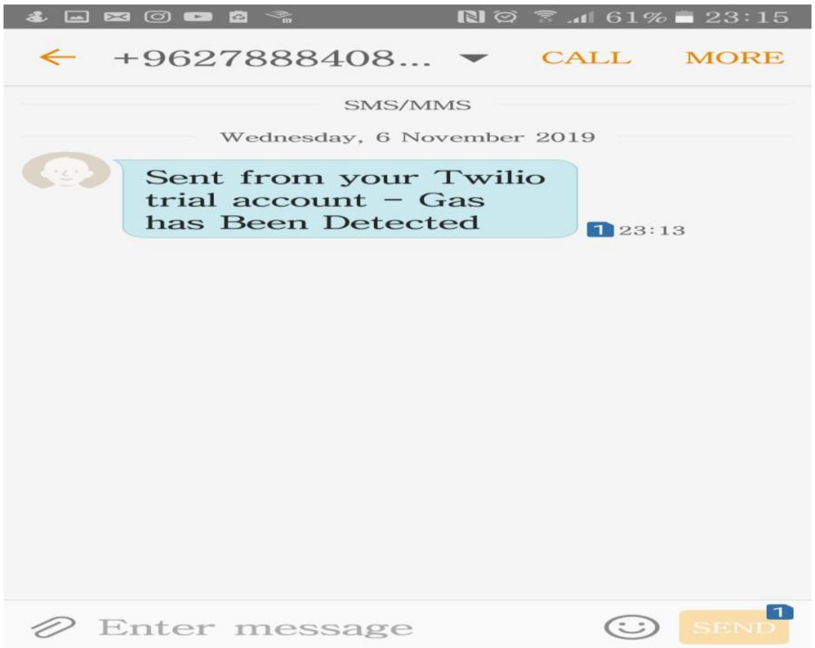


Figure 5.9: SMS when gas is detected

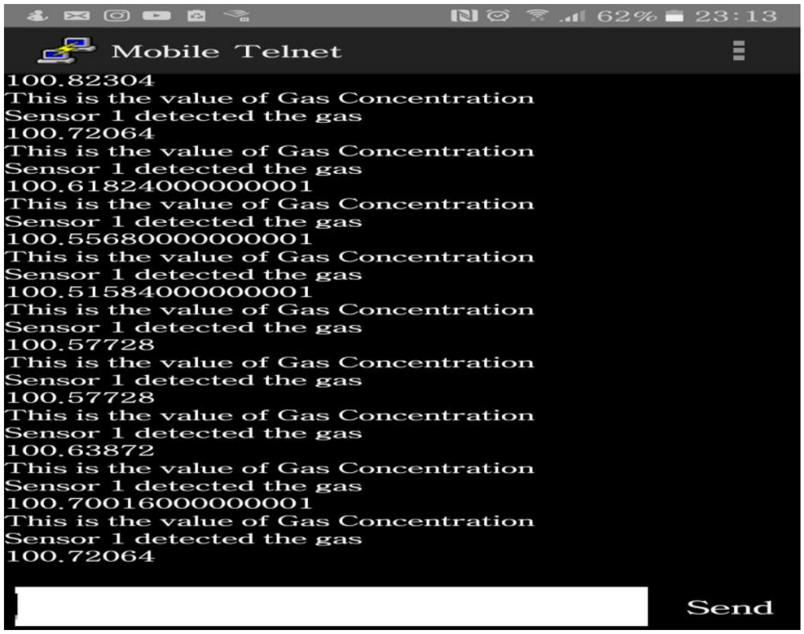


Figure 5.10 Client's monitor when no gas is detected

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

Chapter six is a brif conclusion to this thesis as well as some recommendation made to enhance safety in the oil and gas industry. Some recommendations also made for future researches.

6.1 Conclusion

A Raspberry pi unit was used in this project to solve the inherent effect of noxious gases in the environment. Designing the instrument went from the hypothesis of fight and flight responses which is not always effective. Toxic gases may be inhaled by several means at the workplace, on the street after, at a gas seepage point and much more. The project aimed at designing a gas detecting system using the Raspberry Pi device together with to detect and initiate a response alert towards lethal values of Hydrogen Sulphide (H_2S) which when inhaled causes immediate negative effects on health and life. The system was designed as a prototype to detect LPG because H2S gas is very harmful to humans and scarce to get.

The lethal value for H_2S is considered to be 100ppm equated to 2.8316846592 grams per cubic foot (g/ft^3), 0.01 centigrams per millilitre (cg/mL), 0.01 centigrams per cubic centimetre (cg/cm^3) considering working in an Oil and Gas field or any other fluid media.

A system of sensors is connected in parallel to an analog to digital signal converter board. The sensors are of magnitude 300, can detect variations up to 5V of DC. The simulation is done with 3 sensors yields effectivity for values of gas of 1mg for a first trial. For efficiency of the system, we got the values apprehended to 0.01 cg/cm^3.

The sensors receive the input signal such that the values of LPG detected are displayed on the monitoring screen. A corresponding response is generated for values above the lethal value of 0.01 cg/cm^3.

The detection of values beyond the threshold are recorded and an SMS alert is sent to the Safety Officer in charge. Efficiently the systems in-acts a prompt response with strict and immediate action such as shutting up of the effluent valve.

The end aim is a dynamic system for which the levels of impurities, toxic gases in a fluid can be detected onsite with the corresponding action. Gas content levels are monitored effectively and progressively.

6.2 Recommendations

It is recommendable for the system to be more efficient to undertake the following:

- Instructing and training the safety officers to the functioning of the devices.
- Connecting the SMS alert to an Alarm pitch controller for general purposes.
- Get the personnel acquainted and upgraded with fast safety and accurate measures to be taken whenever the need arises.
- Expand the gas detection system to the affluent stream, by modifying the rates of detection and other parameters on Oil and Gas production industry.

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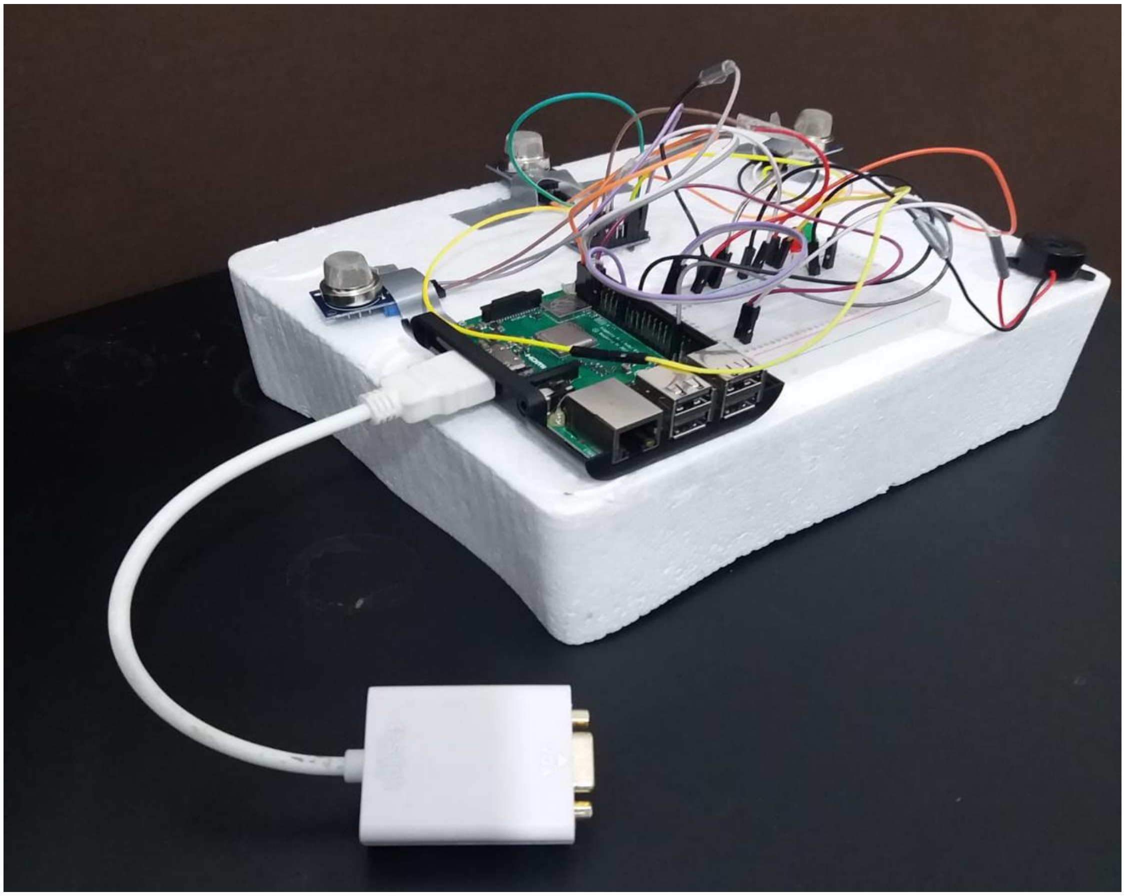
APPENDICES

APPENDIX 1

APPENDIX 2

Snap Shot of the Developed System



APPENDIX 3

APPENDIX 4

SOURCE CODE OF THE DEVELOPED SYSTEM

```
#!/usr/bin/env python3

import RPi.GPIO as GPIO

import time

import math

import Adafruit_ADS1x15

adc = Adafruit_ADS1x15.ADS1115()

GPIO.setwarnings(False)

GPIO.setmode(GPIO.BOARD)

buzzer=7

led_red=22

from twilio.rest import Client

account_sid = 'AC166345fc028fb1bc9208c50e11e339d1'

auth_token  = '31b69bac1e5a37e304246beeab8f2bfb'

client = Client(account_sid, auth_token)

GPIO.setup(buzzer,GPIO.OUT)

GPIO.output(buzzer,0)

GPIO.setup(led_red,GPIO.OUT)

GPIO.output(led_red,0)

led_green=37

c=0

d=0
```

```
e=0
f=0
GPIO.setup(led_green,GPIO.OUT)
GPIO.output(led_green,GPIO.LOW)
import socket
from select import select
def recv(sock):
    data = ""
    while True:
        cData = rs.recv(1024).decode()
        if cData == "\r\n":
            break
        data += cData.rstrip().casefold()
    return data
def sensor_data():
  pin_0=adc.read_adc(0, gain=GAIN)
  pin_1=adc.read_adc(1, gain=GAIN)
  pin_2=adc.read_adc(2, gain=GAIN)
  pin_3=adc.read_adc(3, gain=GAIN)
  pin_0=pin_0*0.02048
  pin_1=pin_1*0.02048
  pin_2=pin_2*0.02048
  pin_3=pin_3*0.02048
```

```
    return (pin_0,pin_1,pin_2,pin_3)

def buzzer_ring():

    GPIO.output(buzzer,1)

    time.sleep(0.8)

    GPIO.output(buzzer,0)

    time.sleep(0.4)

    print("Buzzer is in working form")

def led_testing():

    GPIO.output(led_red,1)

    time.sleep(0.8)

    GPIO.output(led_red,0)

    time.sleep(0.4)

def message():

    message = client.messages.create(body="Gas has Been
        Detected",from_='+14437753694',to='+905338554396')

def message_for_all_set():

    message = client.messages.create(body="Everything is under
        control",from_='+14437753694',to='905338554396')

print("[+] Initializing Server Socket")

sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM, 0)

sock.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR, 1)

host = "0.0.0.0"

port = 6000
```

```
sock.bind((host, port))
sock.listen(5)
print("[+] Server listening on {}:{}".format(host, port))
GAIN = 2
connection = [sock]
while True:
    readSock ,writeSock, errorSock = select(connection, connection, [])
    for rs in readSock:
        if rs == sock:
            clientSock, clientAddr = sock.accept()
            connection.append(clientSock)
            print("[+] Client Connected: {}".format(clientAddr))
        else:
            try:
                data=rs.recv(1024).decode().rstrip().casefold()
                print("[{}]: {}".format(rs.getpeername()[0], data))
                if rs in writeSock:
                    if "login" in data:
                        while True:
                            (pin_0,pin_1,pin_2,pin_3)=sensor_data()
                            print("This is output from Sensor 1 ",pin_0)
                            print("This is output from the sensor 2 ",pin_1)
                            print("This is output from the Sensor 3 ",pin_2)
```

```
# print("This is output from the sensor 4 ",pin_3)
 if pin_0 > 200:
     pin_0=(str(pin_0)+"\n")
     rs.send("Sensor 1 detected the gas\n".encode())
     rs.send(pin_0.encode())
     buzzer_ring()
     led_testing()
     if c==0:
         message()
         c=c+1
     rs.send("This is the value of Gas Concentration\n".encode())
     print("Gas has been detected:\n")
     f=0
 elif pin_1 > 150:
     pin_1=(str(pin_1)+"\n")
     rs.send("Sensor 2 detected the gas\n".encode())
     rs.send(pin_1.encode())
     buzzer_ring()
     led_testing()
     if d==0:
         message()
         d=d+1
     rs.send("This is the value of Gas Concentration\n".encode())
```

```
    f=0
    print("Gas has been detected:\n")
elif pin_2 > 150:
    pin_2=(str(pin_2)+"\n")
    rs.send("Sensor 3 detected the gas\n".encode())
    buzzer_ring()
    led_testing()
    if e==0:
        message()
        e=e+1
    rs.send(pin_2.encode())
    rs.send("This is the value of Gas Concentration\n".encode())
    print("Gas has been detected:\n")
    f=0
elif pin_3 > 150:
    pin_3=(str(pin_3)+"\n")
    rs.send("Sensor 4 detected the gas\n".encode())
    rs.send(pin_3.encode())
    rs.send("This is the value of Gas Concentration\n".encode())
    print("Gas has been detected:\n")
    f=0
else:
    print("All set\n")
```

```
                rs.send("All Set\n".encode())
                if f==0:
                    message_for_all_set()
                    f=f+1
                GPIO.output(buzzer,GPIO.LOW)
                GPIO.output(led_red,GPIO.LOW)
                GPIO.output(led_green,GPIO.HIGH)
                time.sleep(0.8)
                GPIO.output(led_green,GPIO.LOW)
                time.sleep(0.4)
                c=0
                d=0
                e=0
            time.sleep(0.5)
        else:
            print("Have you been gone mad or drank\n")
            rs.send("Have you been gone mad or drank\n".encode())
except:
    print("[!] Client went offline")
    GPIO.output(buzzer,GPIO.LOW)
    GPIO.output(led_red,GPIO.LOW)
    connection.remove(rs)
    rs.close()
```