ABSTRACT

The study was carried out to design and implement a fire plus hazardous gas detection system as a measure to curb the destruction of properties and lives in homes and industries. The system includes various functionalities that make it suitable for use in a country like Zimbabwe where a number of properties have been lost due to fires and a lot of these fires have started due to gas leakage. The inhalation of Liquid Petroleum Gas in excess is really a burden as this causes an increase in the number of deaths per year by deteriorating health. In the compilation process, the major idea used was to put together sensors (flame, gas), wires, liquid crystal display, global system for mobile communications modem and other necessary components to function as one entity with the sole purpose of detecting gas and fire and also put measures to deal with them. The first functionality of the system was to detect fire using a flame sensor and this would activate the sprinkler to sprinkle water on the affected area to reduce the effect of the fire as well as sending a message through a global system for mobile communications modem and sounding a buzzer. The other functionality is to detect gas then it activates a cooling fan as well as sending a message to the directed destination and sounding a buzzer to alert of the danger. To reduce the concentration of the gas that would have leaked, a cooling fan is used to provide fresh air in the process. An MQ2 gas sensor was used to detect gas and on testing the system it gave adequate information and timely alert as messages on detecting the gas leakage. The use of the liquid crystal display was to display the values of the gas and fire. It also displayed a notification that gas or fire had been detected and if a message had been sent to the authorized phone number. For future development, it was recommended to implement a system which has sensors that sense the direction where the heat is coming from such that when fire is detected a sprinkler points and sprinkles the water in the right direction. It was also recommended to make use of a number of high quality flame and gas sensors.

DECLARATION

I, MUNASHE DELIGHT MUNGWARIRI (R154603P) hereby declare that I am the sole author of this dissertation. I authorize the Midlands State University to lend this dissertation to other institutions or individuals for the purpose of scholarly research.

Signature: .... Date: ..../............/............

APPROVAL

This dissertation entitled "Fire plus hazardous gas detection system with an SMS alert" by Munashe Delight Mungwariri meets the expectations governing the award of the degree the BSC in Computer Science Honours Degree of the Midlands State University, and is approved for its contribution to knowledge and literal presentation. The writer also acknowledges the full ownership by Midlands State University of the ideology used.

Supervisor......................................

DEDICATION

I dedicate this project to the Information Technology and Fire and Gas fighting departments to which the technology in this project can become a major building block of at large and my Computer Sciences lecturers that made it possible for me to ensure the completion of these educational endeavors by imparting knowledge that was implemented. Mostly I dedicate this project to my parents who have shown unwavering support during the course of this degree program.

ACKNOWLEDGEMENT

My deepest thanks go to those who made it possible for me to complete the project, on which this document is based. To my supervisor Mr. M. Giyane, I am grateful for his continuous technical and rational guidance, method inculcation and support with regards to the knowledge and expertise acquired during the making of this project. I owe my gratitude to my father, mother and siblings for believing in me and for all the financial assistance they put to see the project to the end. To my friends I appreciate the motivation and assistance that they offered through research and notions. Above all, I extend my hat tip to the Almighty for the great motivation and love l attained from him during the course of this project.

Table of Contents

List of Figures

List of Tables

List of Appendices

Glossary of Abbreviations

IDE – Integrated Development Environment

IR –   Infrared Sensor

I/O – Input Output

USB – Universal Serial Bus

ADC – Analog to Digital Converter

TX – Transmit

RX – Receive

PC – Portable Computer

GSM – Global System for mobile communication module

GND – Ground

LPG – Liquid petroleum gas

DC – Direct Current

Chapter 1: Introduction

1.1 Introduction

The unsafe leakage of gas as well as the breaking out of fires has caused a wide damage to nature in the previous years and only that has encouraged the manipulation of artificial intelligence. Ismail, Jyotiromoy and Deka (2014) express that the manipulation of Artificial Intelligence has led to the production of agents, systems and robots that lessen mankind risk and effort. Scientists have been working tirelessly on designing the systems that reduce hazards that have been endangering humans and property day in day out. This project is focusing on the protection and the management of the environment in the sense of making a fire plus hazardous gas detection system that will be giving instant Short Message Service updates to the relevant authorities and also sound an alarm as an alert measure for danger warning. This piece of project illuminates how an Arduino board and its corresponding modules is used to exhibit how sensors detect and the usage of actuators in exploiting the necessary action to the environment.

1.2 Background of Study

Human interaction in most life deeds is getting less and less in this era due to the engagement of AI in different fields. According to Rong Li and Lin (2014), the science and technology industry always comes up with a developed model in almost every minute that is made as a substitute to the human division in various aspects. The human populace has seen many problems and among them there is fires and dangerous gases as the most critical and key ones. Home accidents caused by fire have now become more common in our daily lives. It developed as an area of distress for the writer after spotting the difficulties currently being faced by the majority in loss of property where by the homes get burnt due to leakage of gases like liquid petroleum gases and fires then there is also difficulties in contacting fire fighters or there is late response from fire fighters. Sakupwanya (2014) gives details on a house that got burnt in Harare's suburbs of Budiriro due to lighting a match stick when the power was cut and an explosion happened because of the gas leakages that have been happening in the house without their knowledge. In order to cut these types of hazards, this system is used to detect gas leakages in the surroundings as well as fires then will undertake a necessary measure to reduce the destruction of properties. Shrivastava (2013) goes on to explain that sometime back Sercei Tseng proposed a smart house monitor and manager (SHMM) system centered on the ZigBee. In this work all the sensors (gas and flame sensors) and actuators are joined by a ZigBee wireless network but this was limiting as it only worked to users

with ZigBee trans receivers only. The controlling software of the writer's development will be fashioned with some logic that can be cultured by grasping the notion of making us of an Arduino board.

1.3 Problem definition

After a much needed reflection into the home and industrial sectors in the country it was found that the technological way of solving the wide destruction and losses of properties through gas leakages and fire outbreaks is the use of the internet of things concepts. If proper action is not taken on time this can lead to even loss of life so the eradication of fire before it spreads away will shun these disastrous effects. According to Cullen (2012) the inhalation of Liquid Petroleum Gas in excess is really a burden as this causes an increase in the number of deaths per year either by deteriorating health or the gas would have caused fire. Saikei (2010) brings to light the issue of many companies in the industries that could not recover their documents due to fire and homes that were burnt to ashes due to late response from the authorities. Here the student proposes a system that detects gas as well as fire outbreaks and alert authorities in time so that proper action is taken to control it

1.4 Aim of research study

The leading aim of this study is to develop a well-structured system capable of detecting leaking gas and fire within a short period of time after they start then sends an instant SMS to the authorities automatically for action to be taken before it spreads.

1.5 Objectives

- To detect liquid petroleum gas using gas sensor
- To detect fire using a flame sensor
- To alert the authorities through instant messages
- To sound an alarm once gas or fire is detected
- To get rid of the gas through fanning
- To get rid of the flames through extinguishing

1.6 Instruments and Methods

A few steps will be engaged in the assembling of this project and they include:

1. Reviewing of fire and gas detection systems – this progression caters for the pursuit of the numerous kinds of fire and gas detector systems that are able to assist in attaining the set goal of

the project. The fire and gas detector should not be too complex, it has to be simple and straight forward. Once fire or gas is detected, the process of sounding the buzzer, opening the sprinkler and starting the exhaust fan is not supposed to take time.

2. Designing of the fire and gas leakage detecting system functionality – The system is constructed using an Arduino Uno board and it will be comprising of sensor sections and power supply. This is for the reason that an Arduino Uno board is stress free to programme and it does not call for difficult type of programming for the system to work as compared to raspberry pi and Plc.

3. Develop the system circuit – prior the manufacturing of the system, a proposal in design form has to be created and this has to be prepared on paper. The circuit of the proposed diagram ought to be drawn and a list of all the needed modules has to be accumulated. The process can be completed through following a few steps which include drawing the circuit and listing the hardware requirements which follow

- Buzzer
- Flame sensor
- Gas sensor
- GSM Modem
- Resistors
- LCD display
- Arduino Uno
- Servo motor
- Fan

4. The programming language that is to be used is C language and this will be coded on the Arduino Uno board and the components will be assembled in a similar way they would have been put in the drawn system circuit.

1.7 Justification and rationale

The fire and gas detecting system helps in the detection of the fire and gas as it is capable of sensing these two hazards precisely providing a quick solution to minimize the danger as compared to time taken by humans. This project was preferred so as to help decrease the losses of property experienced by many homes and industries when a fire breaks out or to reduce deteriorating health cases whereby people inhale

a lot of LPG. An Arduino board is more desirable as compared to raspberry pi and Plc. for this type of a project since it is not hard to code, user friendly and a bit cheap to procure the required hardware.

1.8 Time Plan

Time expected to start and finish the project is as follows;

Table 1.1 Time plan

Activity	Start	End	Duration (Weeks)
Project Proposal	24 Aug 2018	5 Sept 2018	2
Planning	05 Sept 2018	24 Sept 2018	2
Analysis	25 Sept 2018	15 Oct 2018	3
Design	20 Oct 2018	10 Nov 2018	3
Coding	2 March 2019	12 April 2019	6
Testing	15 April 2019	22 April 2019	1
Maintenance	25 April 2019	Ongoing	Ongoing

1.9 Expected Expenditure

Table 1.2 Expected expenditure

Component	Amount (USD)
Arduino Uno	15
Flame Sensor	6
GSM Module	20
Breadboard	10
Gas sensor	6
LCD	4
Servo Motor	20
Potentiometer	1
Connecting wires	1
Buzzer	2
Spraying bottle	1
Fan	5
Total	**91**

1.10 Summary

It can be concluded that the fire plus hazardous gas detection system can be implemented in several locations of the environment. This is prepared to attain the aim of decreasing the threat of losing properties and getting sick through the inhalation of hazardous gas. They can be used in offices, labs and even in homes. They make a provision of a better detection mechanism of dangerous gases and fire flames afore they turn out to be overpowering. This then becomes rational the perspective that detectors are extra aware than humans and their response rate cannot be disquieted by anxiety, emotions or adrenaline.

Chapter 2: Literature Review

2.1 Introduction

Chapter two takes into play an in depth assessment of tools like hardware and software that are put together to make the Fire plus hazardous gas detection system. The functioning idea of this project is clarified in such a way that any layperson is capable of following in order to understand how the components are linked so as to get the functioning model. Problem analysis and the discovery of solutions turn out to be easy provided such an easy complete report of the components involved is given.

2.2 History of Fires and Gases

According to Daobo (2008), a fire is an adversity which happens in any place burning all things and often but not always transpires with gas explosions. Boxall and Weik (2010) outline some materials that can be the basis of infernos such as computer components, chemically produced items, gases, clothes, wood and furniture. Fire hazards and gas explosions still occur in industries and homes regardless of quite a number of safety measures that have been put into place. Fires and gases generally lead to environmental pollution and exceptional dispersion of hazardous or dangerous substances (Saikei, 2010). A lot of different causes like machine error and human errors can lead to fire and gas explosion accidents. A number of common sources of fire include;

- Storing explosives in inappropriate environments.
- Excessive use of electric devices until they overheat.
- Possession of igneous stuff (LP gases) near ignition sources.
- Short circuiting and overloading electrical circuits.

2.3 Primary Fire and Gas Detection Techniques and Devices

The provided documented history shows that the populace has gained knowledge that the detection skills that were used before to detect gas and fire were of much help in controlling these hazards. New York was the major metropolis that made use of an assistant early fire detecting system through a telephone line as early as 1847 (Asif, 2014). According to Chowdhury (2014), a fire detector alarming system which revolved on the printing register of Samuel Morse was laid by Moses G. Farmer and William Channing in March 1851.The system comprised of sixty-four

kilometers cables which provided the link between the central station and signal boxes which were around forty. According to Bonn (2011), William B. Watkins designed the first ever electrical fire sensor which was worth to be used in the business industry. Watkins established a distantly supervised fire detecting system by means of heat detectors then this led to the starting of his Boston Automatic Fire Alarm Company which is now known as AFA standing for Automatic fire alarm company. The devices that were used for the detection and protection technologically improved as time went on in this business of fire alarm and surveillance. According to Patent (2012), an analysis conference was held in 1959 which proposed a scheme of analyzing fire that was centered on ignition (explosion), growth of fire and dispersal. They also investigated comparative gas ageing effects, driving forces and mitigation measures.

2.4 Flame and gas detection

The endeavor being to protect lives and assets, a robust flame and gas detecting system is absolutely necessary. By using the current automatic fire and gas detecting systems projects, the genuine worry is wrong detection due to the kind of flame sensors being used. The current assessment shows factors encouraging wrong alerts and helpful schemes are suggested (Queen, 2008). This brought about the motive for developing new fire and gas detection tactics with the provision of protection against fire in the future. Numerous kinds of devices can be put into place to detect fire and gases, these include

2.4.1 Optical Flame Detectors

For quite some time optical fire sensors were being used as apparatus of primary fire recognition frameworks. According to Rong Li et al (2014), optical fire sensor identifies flames from long distances that go as far as 60 metres. This identification of fire real quick from a long distance is due to the speed of light. Various kinds of optical fire sensors are used to record the radiation in diverse frightening situations that are created by the fire. To come up with the detailed radiation, some unquestionable tactics are applied. These are; Threshold vitality flag examination, flickering recurrence investigation, correspondence to reminisced otherworldly researches, a handful among these tactics are exploited to meet the final goal which is the provision of solid and exact data.

2.4.2 IR Flame Detection

Cullen (2012) outlines that a rise in temperature can be detected as fire by Infrared detectors. Things like ovens, heaters and incandescent lights also release heat which equates to fire in IR emission wavelength. The final objective is to work on these issues hence the use of diverse parameter examination and statistical procedures. Mostly infrared detectors are used indoors so as to avoid biased results as it can get detect the light from the sun.

2.4.3 UV/IR Flame Detection

To anticipate false cautions, a perceiving channel that functions at 2.7μm is supplemented to the UV locator. Although this may seem this way, this modernism has its constraints and disservices as every single type of flame can have a different attribute. For illustration; fire from hydrogen generates a sizable ration of radiation in the form of UV with close to zero IR then fire from coal generates slight UV and a significant amount of Infrared radiation. The UV / IR indicator fuses flags and compares signs with recognized alternative sources caused by incorrect precautions (Keith, 2010).

In this project it was decided to use an ordinary normal flame sensor that detects as far as 85 cm and it can also be attuned to 0 sensitivity. This flame sensor was chosen because of its low asking price and it also met the minimum requirements of the project.

2.5 Gas Sensors

There are a lot of gas sensors, but the most common series is the MQ series. By using these sensors, gases such as carbon monoxide (CO), LPG, smoke, methane alcohol, etc. are all observed. Shrivastava (2013) outlines that these sensors are all 6 pin sensors and have the same interfacing circuit, same footprint and are cheap. The detection of these sensors relies on resistance change which is the moment gas interacts with the sensing material.

2.5.1 MQ Series GAS Sensors list
MQ2 Sensor of Gas

This MQ2 detects butane, methane, LPG and smoke. This sensor is sensitive to gases that are combustible and flammable**.**

MQ 3 Sensor of Gas

Alcohol-sensitive, ethanol, smoke

MQ 4 Sensor of Gas

Methane and CNG/natural gas sensitivity.

MQ 5 Sensor of Gas

Natural gas and LPG sensitivity.

MQ 6 Sensor of Gas

LPG, natural gas, coal gas and butane sensitive

MQ 7 Sensor of Gas

Carbon monoxide sensitive

MQ8 Sensor of Gas

Hydrogen gas sensitive

MQ9 Sensor of Gas

Sensitive for Carbon Monoxide, flammable gasses.

MQ131 Sensor of Gas

Sensitive to Ozone

MQ135 Sensor of Gas

For the quality of the air. Benzene, ammonia, alcohol and smoke awareness.

MQ136 Sensor of Gas

Sensitive to Hydrogen Sulfide gas.

MQ137 Sensor of Gas

Sensitive to Ammonia.

MQ138 Sensor of Gas

Benzene, toluene, alcohol, acetone, propane, formaldehyde gas and hydrogen gas are sensitive to this sensor of gas.

From the MQ series gas sensors mentioned earlier on, the writer made use of the MQ2 gas sensor. Though the focus is mainly on detecting LP gas, the writer found it wise also to use a gas sensor that can detect combustible and flammable gases.

2.6 Gaps identified in Zimbabwe's Fire and Gas detection systems

The technology of fire and gas detection currently being used only detect and sound alarms only as alerts. The major problem being they lack a way to notify the authorities instantly as soon as fire or gas is detected hence there is slow response from the authorities in terms of dealing with the gas or fire.

2.7 Proposed Fire and gas detection system

The following figure shows the fire and gas detection system block diagram. The system consists of sensors for fire and gas detection, control unit (Arduino), network module and power supply.
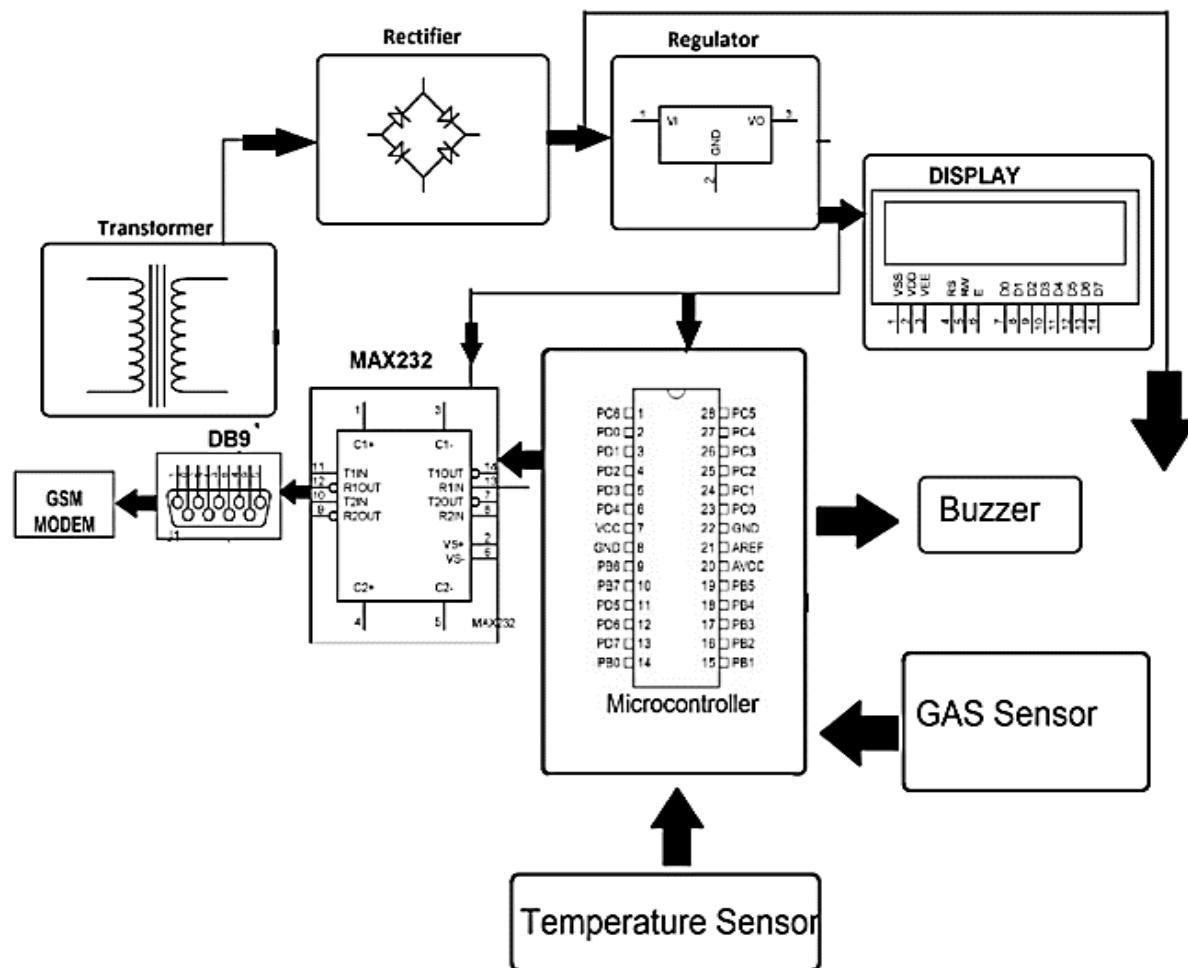
Figure 2.1: Block diagram of fire and gas detection system
Source: Queen 2008

The Arduino sends a signal to the GSM module and the GSM has to acknowledge a signal back to the Arduino. MQ2 sensor is used to detect gas leaking in the atmosphere around. After detecting the gas leakage, a signal is transmitted to the ADC unit of the Arduino Uno which then activates devices connected to it such as a buzzer and a GSM module. And in case of fire burst the fire flames are detected by the flame sensor and activates the buzzer and water sprinkler. The GSM module then sends a cautioning message to the appropriate authorities. If the gas or fire is fruitfully stopped then the whole system is reset so as to reach its initial stage (Queen, 2008).

2.8 Summary

The knowledge of compiling the system was obtained by means of referring to other prototypes and methods used by various writers. This helped come up with the components and methods that are both cost efficient and system compatible. The writer also made use real life examples of were the system can be implemented to avoid property damage and the risk of losing lives. As for what the literature review phase has to offer in terms of software and hardware evaluation, the process was a success.
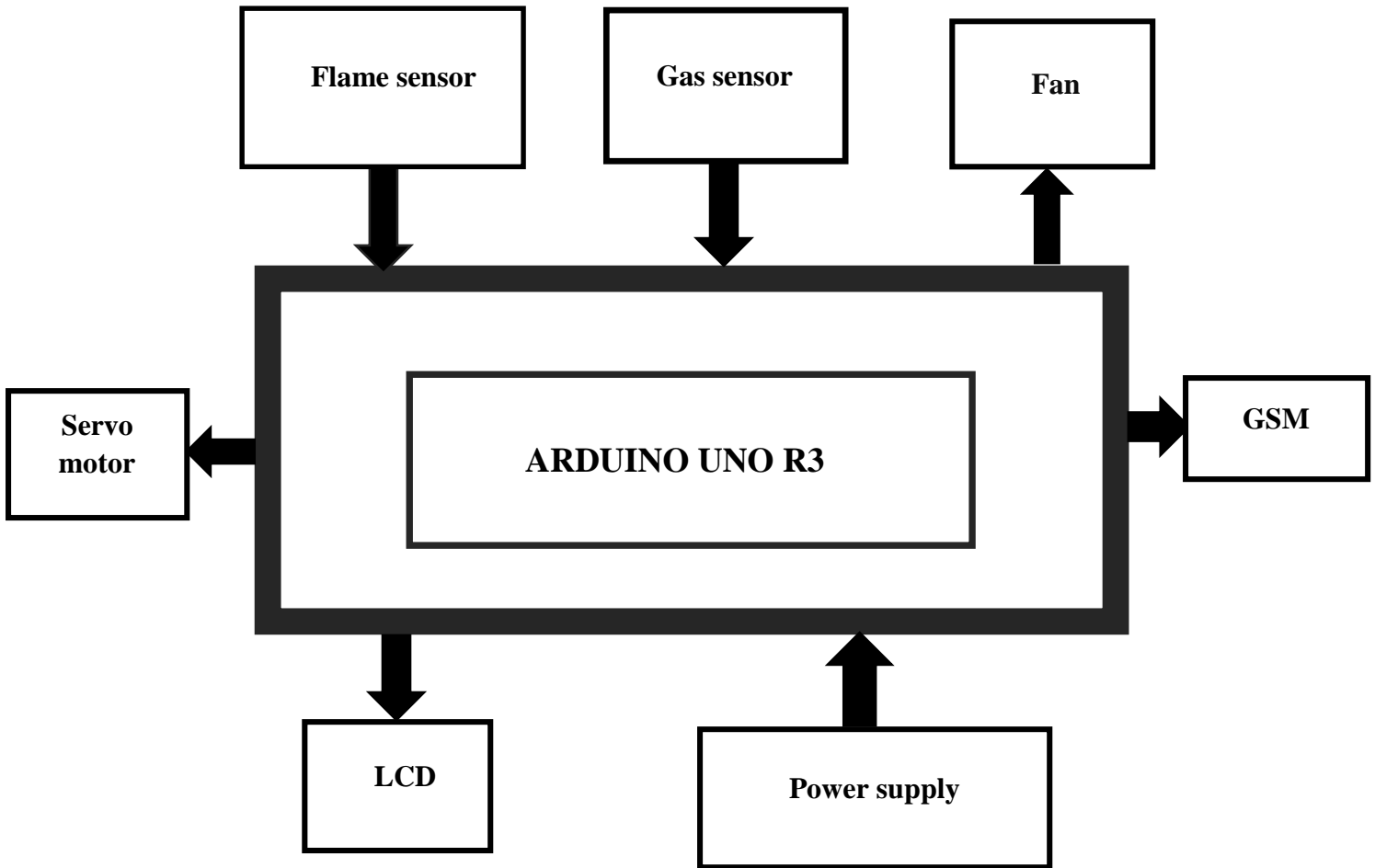
Chapter 3: Methodology

3.1 Introduction

The former section of this document generates literature review by providing research on the same type of projects prepared by other authors to clarify how they have progressed in developing their systems. It can also be concluded that the developer learnt some lessons and picked some recommendations through observing the way taken by these other authors to implement their systems. This current chapter analyzes the basis for a fire plus dangerous gas detection and immediate text messaging warning system. It will be describing and illuminating how each and every component joins with others and how it will be exchanging information or commands with the Arduino Uno module. The entire system's block drawings and flow chart are shown in this chapter.

3.2 System Structure

The whole fire and gas detection system comprises of essential constructing blocks. For the project to be a success these constructing blocks act as the main parts. These main components are listed below:

- Buzzer
- Flame sensor
- GSM modem.
- Gas sensor
- Power supply
- Arduino Uno
- Fan
- Servo motor

The block diagram showing the connections of the system is as follows:

```
        ┌──────────────┐   ┌──────────────┐   ┌──────────────┐
        │ Flame sensor │   │  Gas sensor  │   │     Fan      │
        └──────────────┘   └──────────────┘   └──────────────┘

  ┌──────────┐        ┌──────────────────────────────┐        ┌──────────┐
  │  Servo   │        │                              │        │   GSM    │
  │  motor   │        │      ARDUINO UNO R3          │        └──────────┘
  └──────────┘        └──────────────────────────────┘

              ┌──────────────┐        ┌──────────────────┐
              │     LCD      │        │   Power supply   │
              └──────────────┘        └──────────────────┘
```

Figure 3.1 System block diagram

3.2.1 Control Unit: Arduino Uno Board

The focal control unit to develop this project is the Arduino Uno and it enables communication among all the supplementary components that are integrated on it. The Arduino Uno comprises of a physical circuit board that is programmable and an integrated development environment where code that is uploaded on the physical board is written (Boxall, 2013). The aid of a breadboard is needed since an Arduino has a few ports on it so connecting all the wires on the Arduino will create an overload. The Arduino is responsible for processing all the signals received from the sensors available and then it activates the right action to be taken accordingly. The following picture shows what an Arduino Uno looks like.

.

Figure 3.2: Arduino Uno
Source: Boxall 2016

3.2.1.1 Programming the Arduino Uno R3

According to Arduino Reference Guide (2019), the Arduino IDE is a platform for developing software that is will be programmed on the microcontroller hardware. A compiler and C/C++ code editor are also on this programming tool. The code which is written to the Arduino board is developed on this Arduino IDE thus it determines its functions and how to control all the other connected devices. A laptop or a desktop computer is the most suitable for the installation of the Arduino IDE program. It is used to verify errors on the written code, compiling it and then uploading it to the microcontroller through the connection of a RS232 port or USB and this depends on the kind of the model. The next figure shows the Arduino IDE.
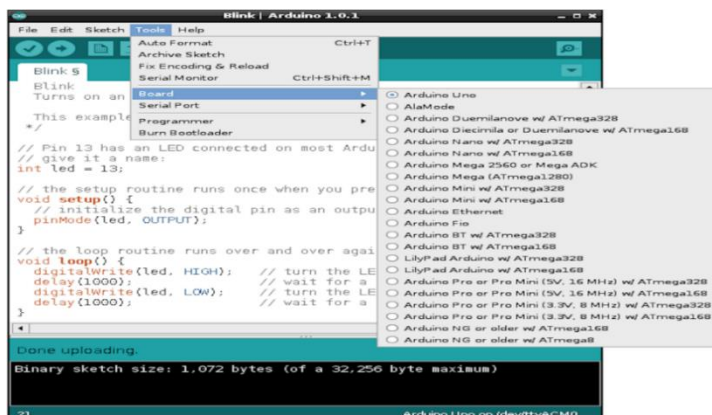
Figure 3.3: Arduino IDE

3.2.2 Communication device: Global System for Mobile communication/Global Packet Radio Service module

According to electronics hub (2017), a GSM/GPRS Module is a device or a chip that can be used to convey information between the microcontroller and the GSM / GPSR Network. According to Forouzan (2002), a GSM is a structural design that serves the purpose of mobile interaction. A GPRS is an addition of GSM that facilitates mobile internet files diffusion. It also needs a Subscriber Identity Module card that stimulate communication in the network just like a cellphone. It comes with an International Mobile Equipment Identity number that is used for identification same as those that are found on mobile phones. GSM SIM800 is the model which was chosen as it seemed more perfect for use in this project. The structure and specifications of the GSM SIM800 are as shown in the next figure.

Fig. 3.4 SIM800 GSM/GPRS Module
Source: Rhydolabs 2019

i)   **SIM800 GSM/GPRS Module features**

According to rhydolabs (2019), the general specifications of SIM800 GSM/GPRS Module are as follows;

- Favor for keypads up to 5 * 5 * 2

- A full UART port function can be configured to two separate serial ports

- Audio channels with microphone input and receiver output

- One sim card interface

- Supports Bluetooth function

- Support one PWM

- supply 3.4 V – 4.4 V

- Frequency bands gprs multi-slot class 12

- Serial port are used for data stream AT commands

3.2.3 Power Supply

The importance of a power source is not to be undermined as it was one of the fundamentals that was used and also put into consideration was the cost, battery life and how the battery can be charged. It was also noted that Nickel-cadmium (NiCad), lithium polymer (LiPo), and nickel-metal hydride (NiMH) are the main known types of rechargeable batteries. The best option to use considering the life span and economic wise was the lithium polymer. A typical power supply is shown in the following figure.

Figure 3.5 Power supply
Source: Rong Li et al 2014

3.2.4 Servo Motor

According to Ravi (2016), servos function through the sending of electrical pulses over a control wire and the pulses are minimum pulse, maximum pulse and repetition rate. The servo can rotate to 90 degrees, 180 degrees and can rotate up to 270 degrees depending on the set degree level. The servo has as much capacity to move all sides (clockwise and anti-clockwise) and only in a neutral position does it have this potential. Manse (2015) says a usual servo has 3 wire which include the positive wire, the negative wire (ground) and the data pin. The servos also come in different sizes depending on their application areas. In the proposed project the use of the servo is to pull the spraying bottle so that it sprays water when fire is detected.

3.2.5 Fan

The fan's purpose in this particular project is to reduce the concentration of gas around by blowing away some air so that when it goes below the threshold value the buzzer stops ringing and the gsm stops sending messages.

Figure 3. 1 Cooling Fan
Source: Ravi 2016

3.3 Design of buzzer, flame sensor

The system is an arrangement of a servo motor, fan, flame sensor, gas sensor, a liquid crystal display and buzzer, all attached to the Arduino Uno R3 board. When the flame sensor detects a flame, the buzzer produces sound and the servo motor is activated therefore starting the sprinkler to extinguish the flames. According to Cullen (2012), the flame sensor unit detects infrared wavelengths produced by the flame. The buzzer was made to have two pins which are the negative and positive. Pins 8 and ground on the Arduino are engaged to the buzzer so that it works properly. The servo motor has three pins and the other two are positive and negative whilst the other one which takes the commands is connected to port 10 on the Arduino. Three pins out of four pins on the flame sensor are connected to pins 7, 5V and ground on the Arduino. The process of catering for the fire can be understood easily as shown below:

- If a fire is detected = start buzzer, send sms and activate servo motor (sprinkler).
- Else = Continue inspecting the flame sensor for feedback until it becomes too low.
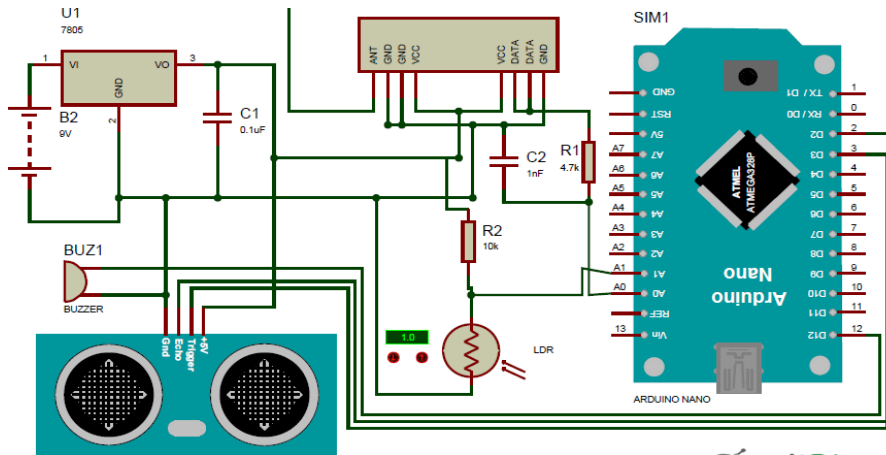
Figure 3.7 Buzzer, flame sensor
Source: Teaching Electronics 2017

3.4 Design of buzzer, gas sensor

The system is also a combination of a gas sensor, a buzzer and a fan and as noted before all these components will be connected to an Arduino Uno board. The gas sensor has 4 pins but only 3 were connected and can use around 5 Volts. The voltage the sensor outputs depends on the concentration of the gas i.e. the greater the gas the higher the output voltage and the lower the gas the lower the output voltage. To make it easy a threshold was set were if that value is passed then the buzzer sounds as a notification that concentration has gone too high. The MQ2 gas sensor on detecting liquid petroleum gas, the buzzer will sound, a sms is sent to the recommended receiver and the fan is activated.
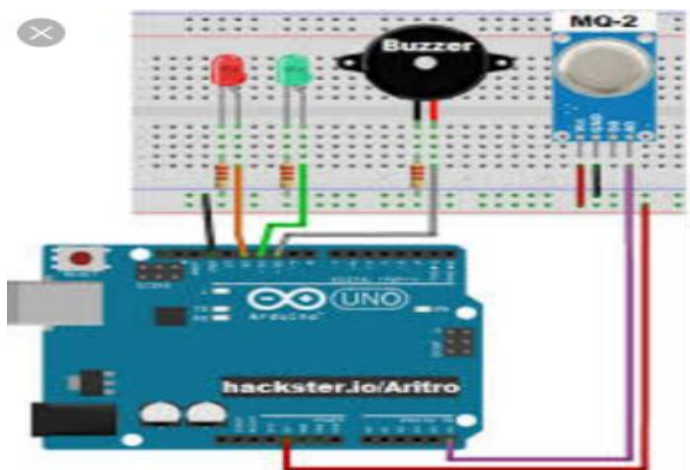
Figure 3.8 Buzzer, gas sensor
Source: Teaching Electronics 2017

3.5 Power supply connection

The ideal power source to supply an Arduino should provide 6-20 volts (Ghassaei, 2008). Using more than 12 V is though discouraged since it can cause the voltage controller to overheat and harm the whole board.


Figure 3.9 Power Supply Unit connected to Arduino
Source: Arduino forum 2018

3.6 System Flowchart

The way the system flows is as follows, the fire is lit and the flame sensor has to detect it then the lcd displays that messages are being sent and the GSM sends to the set phone number as long as the flame sensor detects flames, the buzzer rings and the servo motor is activated to press the extinguishing bottle. Almost the same process happens for the gas because the gas is sprayed around the sensor so when the gas sensor senses the gas, the lcd shows the value of the detected gas and it also displays that messages are being sent whilst the GSM is sending the messages to the set phone number. The fan starts rotating to reduce the concentration of gas around. A system flow chart is shown in the coming figure.

.
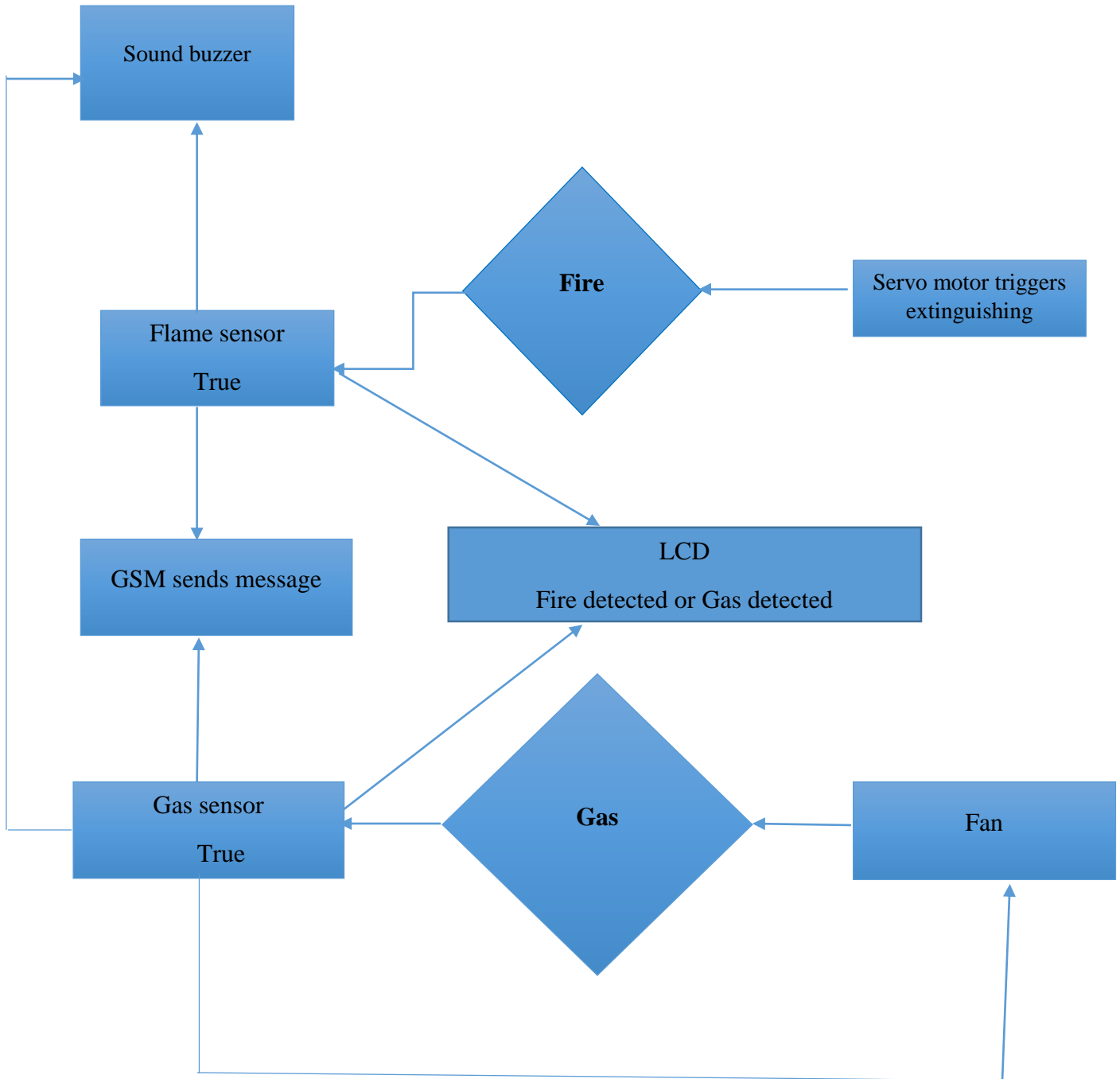
Figure 3.10 System Flowchart

3.7 Information gathering techniques used

The researcher collected data using a set of different techniques. The information gathering techniques used are as follows;

i) **Field visits to buildings with fire and gas detection systems**

Site visits were done to take a look at the systems in the different buildings.

Observations from field visits

- Most systems only have an alarm system

i) **Interviews**

Relevant staff members at the fire department in the city council of Harare were conversed with in order to collect the necessary and required information.

Observations from interviews

- Most of the fire and gas detection systems that were examined only sound the buzzer when either fire or gas is detected but there are no temporary control methods that can be used as the buzzer rings.

- The other problem that was discovered from the current fire and gas detection systems is that the sensors are not being constantly checked if they are working therefore sometimes gas leakages sometimes go unnoticed and the lack of repair on these sensors is due to financial constraints.

- Another finding was that the response time from the authorities is a bit long and sometimes in the case of fire the brigades fail to bring the water.

3.8 Summary

This chapter gives an insight on the connections of each and every component and the Arduino Uno to give a better understanding on how this project is going to work. Information gathering tools played a crucial role in compiling information useful to this project. The next chapter segment is the Results and Analysis phase where prototypical results are provided to guarantee the proper working of each component as planned.

Chapter 4: Results and Analysis

4.1 Introduction

The methodology which is the previous chapter explains how every major component is connected to the Arduino. This chapter brings about the results that are found from the modelling of the system and circuit tests. It also involves the measuring of the real system performance so as to compare the results with the anticipated results and this helps in identifying if the objectives were met. The complications and limitations that were met during the testing of the system are also mentioned in this chapter.

4.2 System Analysis

The distance covered by the flame sensor in use is about 50 centimeters around it so a flame sensor that covers a wider radius is needed. The duty served by the flame sensor is detecting flames or fire in the environment. Since the system could detect the flame, sound the buzzer, send a sms and put off the fire through extinguishing it proved to be efficient and effective. The other thing is the sensor needed constant updates so as to make sure it maintains the set standard state. The same goes for the gas sensor which serves the purpose of detecting the slightest gas leak around. The procedure went well because after gas detection it could sound the buzzer, send a sms and a fan could blow some air to reduce the concentration of gas in the environment.

4.3 Technical issues observed on the prototype

The system should be implemented on some small fires to evade the possible damage to components such as the breadboard as they are created by plastic. The gas sensor also needs to be adjusted now and then to make sure it detects the smallest possible concentration of gas in the area. The gsm is having trouble sending the messages since the network available is not 3G and this is kind of a drop back in what is expected of it.

4.4 System Expectations Vs Actual

The anticipated system was not really met as the system had a few loopholes. The end product was supposed to function as a wireless system and there were supposed to be quite of flame and gas sensors so as to detect fire and gas from all sides respectively. Due to financial constraints only one flame sensor and one gas sensor was used to make the detections. Since the flame sensor is one it can only detect fire that is near it in the radius of about 10 cm. The system on detecting either fire or gas using the flame sensor and the gas sensor respectively it rings the buzzer, sends a message and this is shown on the liquid crystal display, it also starts the fan if it is gas that has

been detected or the servo would rotate therefore triggering the extinguisher and all this came out as expected.

4.5 Simulation Test Runs

The links between the components of an Arduino were simulated before the whole system was put together and some results were attained. An Arduino IDE was used to make this possible on the components below.

4.5.1 Flame sensor testing

For the detection to start, a code is uploaded to the flame sensor through the Arduino. This code contains the distance where the fire sensor has to start sensing the fire in its radius. The fortunate part is the flame sensor got tested up to 60 cm whilst using a fire lighter and it responded well but 10 cm was later set as the sensitivity radius. So when a fire is lit in the proximity of the flame sensor in this case 10 cm, for positive results the buzzer has to sound and that will mean a fire has been detected. The following images show the testing of the flame sensor.
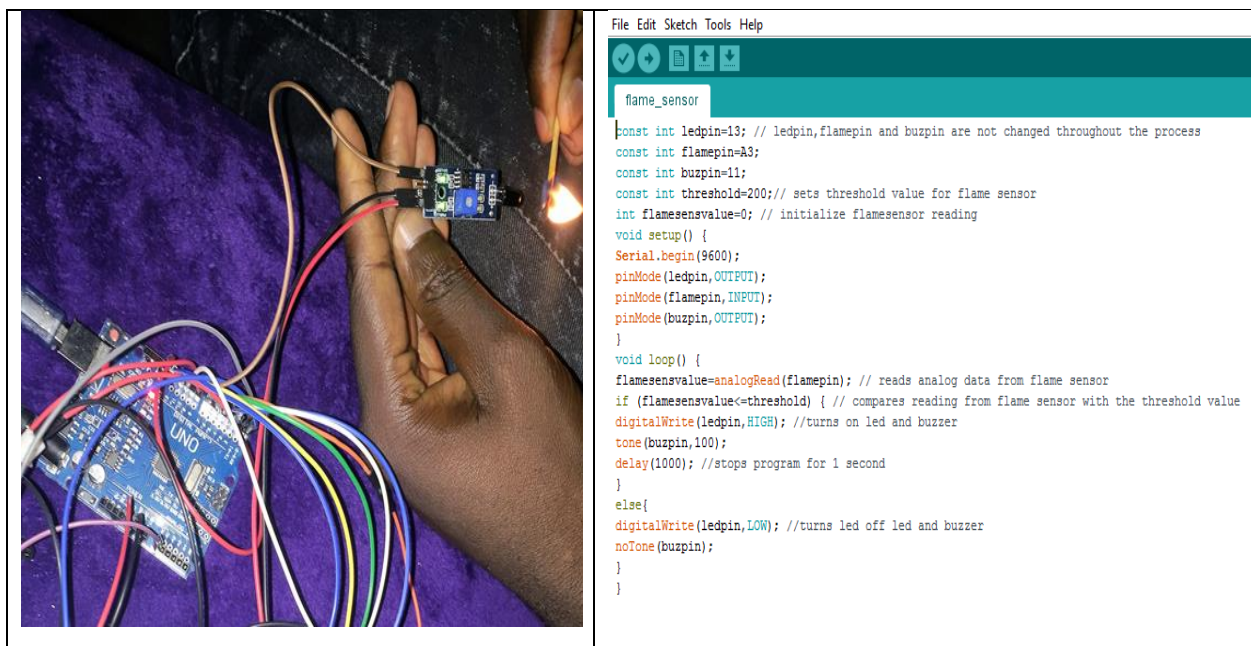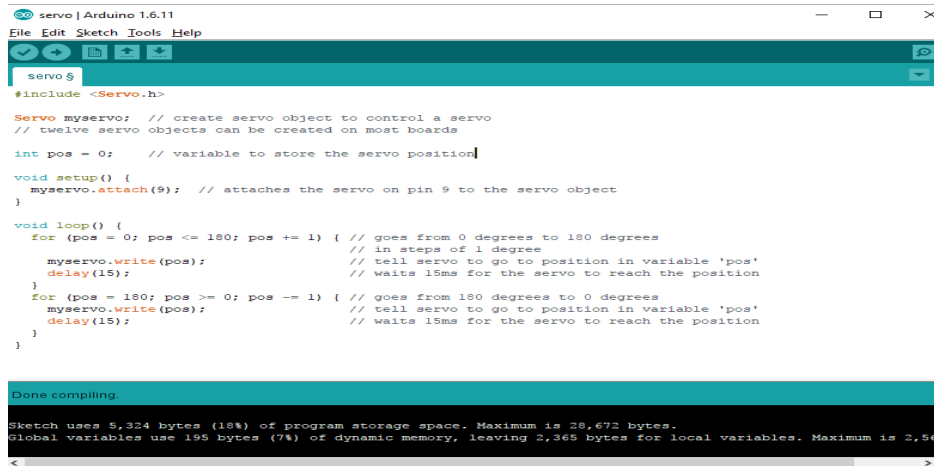

File Edit Sketch Tools Help

flame_sensor

```
const int ledpin=13; // ledpin,flamepin and buzpin are not changed throughout the process
const int flamepin=A3;
const int buzpin=11;
const int threshold=200;// sets threshold value for flame sensor
int flamesensvalue=0; // initialize flamesensor reading
void setup() {
Serial.begin(9600);
pinMode(ledpin,OUTPUT);
pinMode(flamepin,INPUT);
pinMode(buzpin,OUTPUT);
}
void loop() {
flamesensvalue=analogRead(flamepin); // reads analog data from flame sensor
if (flamesensvalue<=threshold) { // compares reading from flame sensor with the threshold value
digitalWrite(ledpin,HIGH); //turns on led and buzzer
tone(buzpin,100);
delay(1000); //stops program for 1 second
}
else{
digitalWrite(ledpin,LOW); //turns led off led and buzzer
noTone(buzpin);
}
}
```

Figure 4.1 Flame sensor testing

4.5.2 Servo control testing

The code for the servo to work was uploaded in the Arduino IDE interface. The role of the servo motor was to control the extinguishing bottle in order to sprinkle water or stop depending on whether there is fire or

not. The screenshot of code put below made the function of servo motor successful.

Figure 4.2 Fire extinguisher control code

4.5.3 Gas sensor testing

A code is uploaded on the Arduino with all the specifications for the gas sensor to be able to sense gas in its set radius. The challenge being faced by the gas sensor is that it was also affected by humidity around so sometimes its value below the threshold changed. For the gas sensor to be able to detect, gas is opened and upon detection the buzzer sounds. The image below shows how the gas sensor was tested.

Figure 4.3 Gas sensor testing

4.5.4 GSM testing

The purpose of the GSM in this whole system was only to send messages to the directed number once a flame or gas has been detected. As long as gas or flame is still being detected the GSM continued to send messages to alert the authorities and it could only break sending the messages when there was nothing being detected. The following sketch shows the code used for testing the GSM and a picture of the LCD updating that a message is being sent.
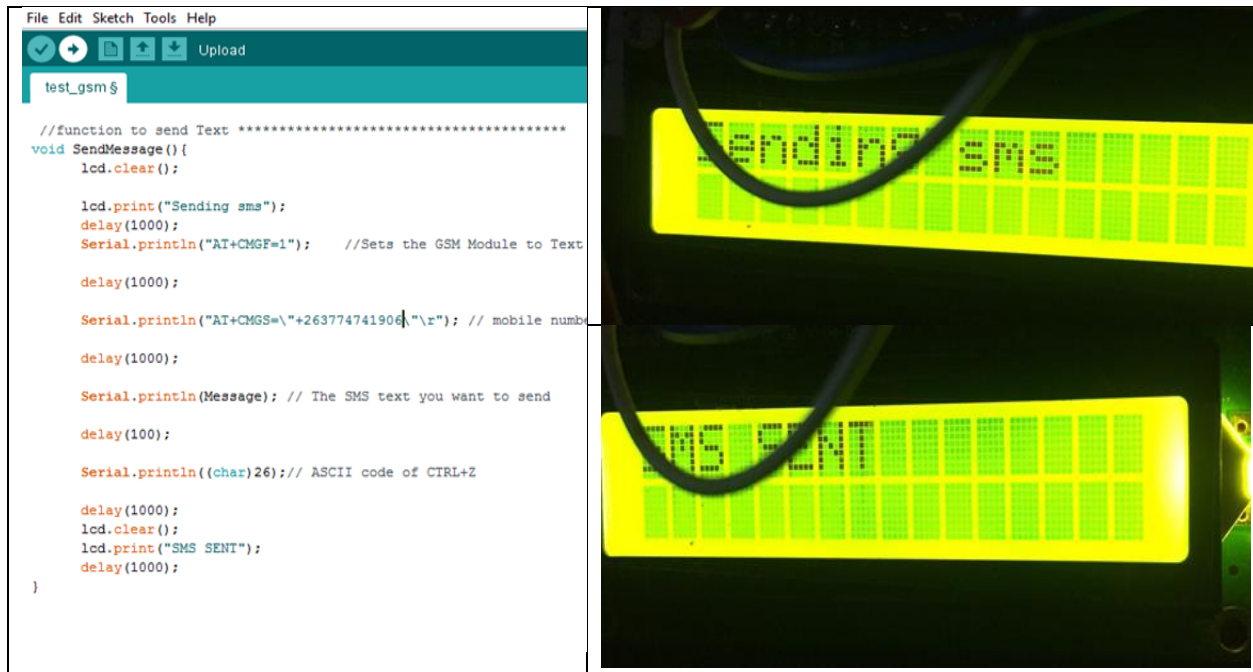
Figure 4.4 GSM testing

4.6 Summary

A lot of aspects were put into consideration during this testing phase. For instance, the gas sensor is affected by humidity around as well so sometimes when the gas sensor was connected it could start sound the buzzer instantly because the humidity around will be over the set threshold. In order to deal with this issue a higher threshold was then set. The fan speed to fan the gas was also determined by the power being supplied to it, if more power was provided then it rotated faster. Above all, most of the expected results were met on the actual system.

Chapter 5: Conclusion and Recommendations

5.1 Overall achievement

The target of this project was to create a fire and gas detection system that has a fan, sprinkler and a sms texting operation on detection of either gas or fire so as to reduce the destruction of properties to a greater extent. To reach this target, a flame sensor was to detect fire, the buzzer was to sound to alert that there is some danger around, the gsm was to send a message to the authorities reporting the detection, and the servo motor was to trigger the sprinkler to try and take care of the fire. In addition to reaching this target, a gas sensor was to detect liquid petroleum gas, the buzzer was to sound as a danger warning sign, the fan was to try and fan the gas in its radar as a gas concentration reduction technique and also messages were to be sent over and over again as long as the sensors detected something. All these activities were accomplished through use of Arduino Uno, Arduino IDE and the other integrated components. It can be safely said the system managed to achieve its purpose.

5.2 Objectives achieved

The writer outlined a number of important objectives in the building and design phase that were to be achieved by the end of the project. These objectives guided how the project was to be done and they were also used as measures of progress so as to make the project a success. Just for recap, below are the objectives against achievement signs or the success reached as far as the project is concerned;

To detect liquid petroleum gas using gas sensor – the main challenge was the threshold value needed to be changed depending on the environment were the gas sensor is being used but this objective was achieved very well.

To detect fire using a flame sensor – the flame sensor detected flame that was at close range and this became a bit of a problem because it was also supposed to detect fires from a distance but above all the objective was attained.

To alert the authorities through an instant message – as soon as either gas or fire or both were detected, a message was sent to the authorities reporting what will be taking place. For as long as the fire remained or the gas remained, the messages could be sent over and over again until a measure to take care of the gas or flame completely has been taken.

To sound an alarm once gas or fire is detected – To achieve this objective a buzzer was used to sound therefore providing an alert to those in the range of hearing it.

To get rid of the gas through fanning – when the gas sensor detected the gas it triggered the fan to get rid of the gas so as long as the gas was around the fan continued to fan until the gas value went down below the set threshold value.

To get rid of the fire through water sprinkling – when the flame sensor detected a flame it triggered a servo motor to change direction there by pressing the extinguishing bottle to let water out and this could continue happening as long as a flame is being felt nearby.

5.3 Recommendations

The system achieved its goal and worked as proposed but the writer is recommending a few things with respect to the number and quality of the components that can be used. The use of one gas sensor and one flame sensor as detectors of gas and fire respectively is not enough as these have certain distance they can detect up to, so a number of sensors are needed so as to make the system effective and efficient. The use of a battery to provide power source can be substituted by use of solar or electricity that can supply much voltage that can sustain the proper working of the system. The servo motor struggled to press the extinguishing bottle to deal with the detected flame so an automatic fire extinguisher which is bigger is recommended.

5.4 Future scope

The project was started with the aim to build a system that could detect the fire and gas as well as managing these hazards before the intervention of humans provided the fire brigades are delayed to take action from the time they receive the danger notification message from the GSM. The creation of systems like this provides a chance to reduce the destruction of the environment or properties and this generally reduces the work load of humans. The use of automated fire extinguishers can also reduce the dangers of losing life and also can control the fire such that it does not grow to be uncontrollable therefore making it a simple activity. The writer though with little experience believes that these types of systems can be used as firefighting system and gas fighting systems but with a lot of sensors being put into use so as to detect quickly. An efficient fire and gas detecting system should involve a collection of components that should be communicating and working together in the mission of gas fanning and fire extinguishing. Furthermore, a system like that will require special facilities and features to be able to detect the amount of heat being produced by the fire even if the fire is at a distance from the sensor. Concerns like these were not inside the scope of this project but they can be of use in projects to come.

5.5 Summary

The system was implemented successfully and it can be used in many different places as a measure of safety especially in a country like Zimbabwe where sometimes the authorities usually take quite some time to

react to issues like a building under fire. It will be wise to use a system like this one which detects the fire and can sprinkle water to take care of the fire as they wait for the authorities. The inclusion of a gas sensor and a fan in this system also makes the system a valuable asset that can be used for the betterment of the lives of many because too much concentration of liquid petroleum gas may lead to explosions thereby causing uncontrollable fire so gas detecting is also a good precautionary measure to avoid infernos.

APPENDICES

Appendix A: User Manual

The purpose of the user manual is to help in how the fire and gas detection system is set up and how it is supposed to work.

Instructions:

1. Connect the flame sensor and the gas sensor to their defined ports on the Arduino
2. Connect the buzzer and the fan to their defined ports as well
3. Connect the LCD including the potentiometer that deals with the contrast of the LCD
4. Connect the GSM but leaving out the RX and TX cables
5. Connect the Arduino cable to the machine and load code
6. Connect the RX and Tx cables of the GSM to the TX and RX of the Arduino respectively
7. Wait for the GSM to start blinking once in every 3 seconds so as to know that it has picked network
8. For testing purposes light up a match stick to test the flame sensor and use some gas to test the gas sensor
9. To see if the system has functioned correctly it should sound a buzzer, send a message, start a fan if it is gas or sprinkle water if it is fire

Appendix B: Full Code

```
#include <LiquidCrystal.h>

#include <Servo.h>


//defining Arduino pin to which analog pin of MQ2 gas sensor is connected *****************

const int firethreshold=200;// sets threshold value for flame sensor

#define RELAY1 13

int buzzer = 8;



int flame_sensor = 7;

int fireSensorValue = 0;



int MQ2pin = A0;    // select the input pin for the potentiometer

int GassensorValue = 0;  // variable to store the value coming from the sensor

const int gasThreshold = 150;

const String Message = "default sms";



// Declare the Servo pin

int servoPin = 10;

// Create a servo object
```

Servo Servo1;

```
//LCD **************

// initialize the library by associating any needed LCD interface pin

// with the arduino pin number it is connected to

const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

//**************

/******************************************
 *
 * setting the status of digital pins of Arduino and configure
 * Baud rate for Serial communication with PC for displaying status of flame and gas detection
circuits.
 */

void setup()

{
```

```
Serial.begin(9600); // sets the serial port to 9600

// We need to attach the servo to the used pin number

Servo1.attach(servoPin);

pinMode(buzzer, OUTPUT);

pinMode(RELAY1, OUTPUT);

pinMode(flame_sensor, INPUT);

lcd.begin(16,2);          //initialise LCD; where (16,2) tells the LCD type such as 16x2 block LCD
display

delay(2000); // allow the sensors to warm up

lcd.print("home safety");

delay(2000);

}


//function to send Text ***************************************
void SendMessage(){

    lcd.clear();


    lcd.print("Sending sms");

    delay(1000);

    Serial.println("AT+CMGF=1");    //Sets the GSM Module to Text Mode
```

```
delay(1000);

Serial.println("AT+CMGS=\"+263732741906\"\r"); // mobile number

delay(1000);

Serial.println(Message); // The SMS text you want to send

delay(100);

Serial.println((char)26);// ASCII code of CTRL+Z

delay(1000);

lcd.clear();

lcd.print("SMS SENT");

delay(1000);

}
```

```
//function to detect fire ****************************

void fireDetected(){

    lcd.clear();

    lcd.println("Flame detected...! take action immediately.");

    Message = "Flame detected...! take action immediately.";

    SendMessage();

    delay(5000);  //delays to flash the LED




 }



 void gasDetected(){

    lcd.println("Gas detected...! take action immediately.");

    Message = "Gas detected...! take action immediately.";

    SendMessage();

    delay(5000);  //delays to flash the LED

  }
```

//main function or the loop that starts and maintains the controlling of system
****

```
void loop()

{

  //reset fireSensorValue and GassensorValue values

    Servo1.write(0);

   fireSensorValue = 1;

   GassensorValue = 0;

   fireSensorValue= digitalRead(flame_sensor); // reads analog data from flame sensor

   GassensorValue = analogRead(MQ2pin);

   if (fireSensorValue ==0 ) { // compares reading from flame sensor with the threshold value

      lcd.clear();

     lcd.print("fire detected");

     lcd.setCursor(0, 1);

     lcd.print(fireSensorValue);

     Servo1.write(0);
```

```
  delay(1000);

  Servo1.write(180);

 fireDetected();

 tone(buzzer,100);

 // Make servo go to 90 degrees

 Servo1.write(0);

 delay(1000);

 Servo1.write(180);



//delay(1000*fireSensorValue); //stops program for 1 second

 }



else if(GassensorValue > gasThreshold){

  lcd.clear();

  lcd.print("gas detected");

  lcd.setCursor(0, 1);

  lcd.print(GassensorValue);

  delay(1000);

  gasDetected();

  digitalWrite(RELAY1, LOW);
```

```
    tone(buzzer,100);

    lcd.clear();

    delay(GassensorValue);

     }

  else{

  noTone(buzzer);

  digitalWrite(RELAY1, HIGH);

  }




  // print the number of seconds since reset:

  lcd.clear();

  lcd.print(fireSensorValue);

  lcd.setCursor(0, 1);

  lcd.print(GassensorValue);

  delay(1000);

}
```

```
/*

 * GSM connections

 * RX of gsm -------------------> TX of arduino

 * TX of gsm --------------------> RX of arduino

 *

 *

 *

 */
```

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