



**UGANDA INSTITUTE OF INFORMATION AND
COMMUNICATION TECHNOLOGY**

FINAL YEAR PROJECT REPORT

GAS LEAK DETECTION SYSTEM [GLDS]

BY

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**A FINAL YEAR REPORT SUBMITTED TO UGANDA INSTITUTE OF
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FULFILLMENT FOR THE AWARD OF DIPLOMA IN ELECTRONICS AND
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ABSTRACT

The proposed project aims to develop an advanced gas leak detection system utilizing cutting-edge sensor technology and Internet of Things (IoT) integration. This system will employ highly sensitive sensors capable of detecting low concentrations of combustible gases i.e. liquefied petroleum gas. These sensors will be connected to a central processing unit for continuous data analysis and GSM module and buzzer for triggering alerts when gas levels exceed safety thresholds along side real time monitoring. The suppressor fan is a reversed polarity fan that will suck the gas from the affected environment before it causes harm.

The modular design of the system ensures ease of integration with existing safety infrastructure and scalability for larger deployments. By enhancing early detection capabilities, this gas leak detection system aims to significantly mitigate the risks associated with gas leaks, ensuring the safety and security of individuals and properties.

DECLARATION

We the undersigned solemnly declare that this project proposal is based on our own work carried out during the course of study under supervision of Mr. KAWERE GERALD

We further certify that;

- i. The work in this proposal is original and has been done by us under general supervision of our supervisor.
- ii. The work has not been submitted to any other institution for award of the any other degree, diploma or certificate.
- iii. We have followed the guidelines provided by the by the institution in writing project proposals.
- iv. Whenever materials (data, theoretical analysis and text) from other sources were used, a credit is given to them through citation and giving their details in the reference.

PROJECT MEMBERS
DATE

SIGNATURE

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APPROVAL

The project proposal has been checked and submitted with approval of the academic supervisor

Mr. KAWERE GERALD

Signature:

Date:

DEDICATION

The proposal work is dedicated to our families, lecturers, friends and team mates who have been a constant source of support and encouragement during the challenges of school and life. We are truly thankful for having you all in our lives. Your unconditional love and good examples have taught us to work hard for the things that we aspire to achieve.

ACKNOWLEDGEMENT

First and foremost, we would like to thank the Almighty God for the gift of life especially during the Course of our study period. It has been Gods guidance and protection until this point for the report submission and course completion at large.

Secondly, we wish to extend our gratitude to our supervisor Mr. KAWERE GERALD for allowing the team to take the project, his continued supervision, support and guidance has led to the successful completion this research proposal on time.

Great thanks to the team members for their tireless efforts, advice, financial support and positive critics which has led to a smooth and successful completion of this research

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LIST OF ACRONYMS.

GLDS- Gas leak detection system.

GSM- global system for mobile communication.

RPF-reversed polarity fan.

IoT- internet of things.

LPG- liquified petroleum gas.

CNG- compressed natural gas

CHAPTER 1

1.1 INTRODUCTION.

Gas leaks are a significant safety concern in residential, commercial and industrial setting with potential for fires, explosions and health hazards.

Majorly fires occur in our communities and blame is taken to be explosives, electricity and fire lit by humans forgetting the major catalyst which is the liquid petroleum gas [LPG] which is highly flammable and leads to wide spread of fires even if a mere spark from other sources appear. Liquid petroleum gas [LPG] is mostly used in various sectors which include;

- Residential sector. For cooking and heating.
- Commercial sector. Such as restaurants, resorts, and other commercial establishments.
- Industrial sector. For manufacturing industries that use it for heating and other several purposes.
- Recreational sector. Mostly in recreational vehicles, campers, boats, other outdoor equipment such as grills and heaters.
- Transport sector. Where it is used as an alternative source of fuel.

This gas doesn't only cause fires but also health and environmental problems once it escalates into the atmosphere.

Liquid petroleum gas is majorly obtained as a bi product in refinement of crude oil.it is fed into gas cylinders under pressure and then put into various uses as shown above.

1.2 BACKGROUD OF THE STUDY

In Uganda, the adoption of natural gas is on the rise, supported by government initiatives to diversify energy sources and reduce reliance on biomass and other traditional fuels. Despite its benefits, natural gas poses substantial safety risks if not properly managed. Gas leaks, if undetected, can result in severe accidents, causing loss of life, property damage, and environmental pollution.

Existing detection methods in Uganda are often inadequate, relying on outdated technology that lacks the sensitivity and reliability needed for effective monitoring and most systems stop just on detecting the gas and sending alerts which looks inefficient in its setting. This study seeks to bridge this gap by introducing a state-of-the-art gas leak detection system that leverages modern sensor technology and IoT integration for real-time monitoring and early detections through embedding a GSM module for alerts, and RPF to suppress the detected gas before it causes harm.

1.2 PROBLEM STATEMENT

The problem is faced in all homes where gas is used as an alternative fuel. For the case of very busy environments such as market areas, this problem is very common.

The effects of the gas are evident in the form of suffocation and flammability when ignited and this leads to loss of lives and property.

To our concern, manual checks are prone to human errors and the existing systems lack real time monitoring which leaves gaps in detection.

The utilization of natural gas as a primary energy source is growing in Uganda, driven by its efficiency and relatively lower environmental impact compared to other fossil fuels. However, its increased use comes with leakage challenges in form of suffocation and flammability when ignited and this leads to loss of lives and property.

The absence of an efficient and reliable gas leak detection system in Uganda presents a significant safety risk. Current detection methods are often unable to detect low concentrations of gas leaks, leading to delayed responses and increasing the likelihood of accidents. The lack of real-time monitoring and remote alert capabilities further escalates the problem, limiting the ability to prevent and manage gas leak incidents effectively. There is an urgent need for a robust solution that can provide timely and accurate detection of gas leaks to safeguard lives and properties hence the need for this proposed solution.

1.4 OBJECTIVES

1.4.1 General Objective

- i. The main objective of this study is to design and implement a highly reliable and advanced gas leak detection system that enhances the safety and security of natural gas usage in Uganda through real-time monitoring and early detection of gas leaks.

1.4.2 Specific objectives

- To detect and suppress gas leaks using the RPF before it causes harm in the affected environment.
- To develop a gas leak detection system using sensitive sensors capable of detecting low concentrations of uncombusted LPG
- To evaluate the system's performance in various environments and ensure its scalability for large-scale deployments.
- To prevent further depletion of gas from the cylinder since the system notifies you when there is a leakage.

1.5 SIGNIFICANCE OF THE STUDY

This study is of great significance as it addresses a critical safety issue associated with the growing use of natural gas in Uganda. By developing an advanced gas leak detection system.

The study aims to significantly reduce the risk of gas-related accidents, thereby protecting lives, properties, and the environment.

The successful implementation of this system will enhance public confidence in natural gas as a safe energy source, potentially accelerating its adoption and contributing to the country's energy diversification efforts.

Furthermore, the project will set a precedent for the adoption of modern safety technologies in Uganda, fostering innovation and improving overall safety standard

1.6 SCOPE

The scope of this project includes the design, development, and testing of the gas leak detection system within residential places with a possibility of being scaled to commercial, and industrial settings. The study will cover the integration of sensor technology and GSM module to send alerts once leaks are detected, and the application of machine learning techniques to enhance detection capabilities, reversed polarity fan (RPF) to suppress the gas once detected. The project will also include a comprehensive evaluation of the system's effectiveness and scalability, ensuring its adaptability to different scales of deployment across several industrial, commercial and residential setting.

1.7 JUSTIFICATIONS

The need for this solution is anchored on the following key points:

1. **Enhancing Public Safety:** The proposed gas leak detection system aims to significantly reduce the risk of accidents caused by gas leaks, thereby protecting lives and properties in residential, commercial, and industrial settings.
2. **Supporting Energy Transition:** As Uganda transitions to using more natural gas, ensuring safe usage is essential. This project supports government initiatives by providing a reliable solution for gas leak detection, fostering confidence in natural gas as a safe energy source.
3. **Addressing Technological Gaps:** Current gas leak detection methods in Uganda are outdated and unreliable as human checks are prone to errors since the gas cannot be seen. This project introduces modern technologies, including advanced sensors to improve detection accuracy and responsiveness.
4. **Economic Benefits:** Preventing gas leak incidents can save significant costs related to property damage, medical expenses, and operational disruptions, contributing to economic stability and growth.
5. **Environmental Protection:** Early detection and response to gas leaks will minimize methane emissions, a potent greenhouse gas, thus protecting the environment and supporting sustainable development goals.
6. **Promoting Technological Innovation:** The project sets a precedent for adopting modern safety technologies in Uganda, encouraging further innovation and enhancing safety standards across the country.

7. Scalability and Integration: The system's modular design ensures scalability and easy integration with existing safety infrastructure, making it a versatile solution for various environments and deployment scales

CHAPTER 2

2.1 LITERATURE REVIEW

Gas leakage is a major problem within the industrial sector, residential premises, and gas-powered vehicles like CNG (Compressed Natural Gas) buses and cars where the use of gas has become an important source of energy (STET, 2012) to the afore mention area in this era. The issue of Liquefied Petroleum Gas leakage has been so disastrous that it has resulted in serious harm, including the loss of life and property worth millions of dollars around the world. The catastrophic pipeline explosion has happened in different parts of Nigeria in that resulted into death and injure of many people and loss of property.

Gas is the most commonly used fuel in Nigerian homes and industry in which some required measures have to be strategized in other to protect against incidents and accidents such as suffocation and explosion associated with its usage. LPG is a highly inflammable gas made up of a mixture of butane (C_4H_{10}) and propane (C_3H_8) through butylene and propylene and another hydrocarbon present in small quantity, due to the odorless of these chemical ethyl mercaptans is added as an odorant to give a powerful scent so that when leakage occurs it can be perceived , however in a situation of the minimum quantity of gas leakage, some people have a poor sensing ability to perceive and so, more reliable and effective device use in detecting gas (gas leakage detector) has to be installed in homes, industries, and vehicles of LPG usage to avoid explosion. LPG leakage refers to several factors such as leakage in the pipe, hose not properly fixed, and hearing of whistling or hissing sound around the cylinder, valve not fitted properly.

There are different ways of detecting gas leakage in which there has been existing LPG detector which only sound out an alarm when there is leakage and there is still improvement that could be made to the existing ones, in which a microcontroller activates the alarm and send a message through SMS to the appropriate personnel.

The crux of the paper is to create a device that can detect LPG leakage as part of a safety measure and automatically send an SMS to the appropriate personnel and will activate an alarm immediately after gas leakage is detected in other to prevent wastage of the gas and also explosion which could lead to

damaging of properties and other calamities. The focus of this work is to design a system that monitors gas leakage in an enclosed system using an Arduino Uno microcontroller and an alarm system are used to alert people within leakages neighbourhood while SMS will be sent to the premises owner or safety organization to towards making

2.2 Liquid Petroleum Gas Detection

Liquid petroleum gas is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and specifically as a vehicle fuel (it is often referred to as Autogas). It is an odorless gas due to ethyl mercaptan is added as an odorant to be easily detected when leakage occurs for safety precaution. LPG is made by refining petroleum or wet natural gas and is almost entirely derived from fossil fuels sources being manufactured during the refining of crude oil as theory emerged from the natural state. It was classified as a hazardous material because of its explosive potentials when under pressure, due to this hazardous property leading to fire explosion. The gas detection process was made by the chemically infused paper that change its colour when it's been exposed to gas before the development of the electronics gas detector. The electronics leakage detector was an active approach to initial fault detection in other to achieve the utmost safety of humanity and properties as a whole they introduced an android base automatic gas detection). different approaches have been used alongside several research in the detection of leakage and were also implemented alongside some incident toward some decades. The existing leakage detection is optical sensor method, cable sensor, negative pressure, vapor sampling, signal processing, mass volume, and pressure point analysis, in which have been implemented using a different framework. Some groups of researchers have classified the technology as two fitting categories, which are software and hardware method but research continues and to technical nature research effort which led them to three group methods.

2.3 Classification of Leakages Detection

There are different classes of leakage detection which have been used to monitor the leakage, several criteria are classified into their classification, some of which are critical principles and abilities needed from humans. The

detection is classified into three, which are automated detection, manual detection, and semiautomated detection. Automated Detection involves monitoring of detecting leakage without the help of the operator, once the detector device is installed and been connected to the display of the personnel in charge and can be automatically shut down from the display unit. (SCADA); Manual Detection - These are methods in which the device can only be operated by humans. Like thermal imager or light detection and ranging (Lidar) devices; Semi-automated detection – solutions that necessitate a certain amount of input or assistance in carrying out certain tasks (e.g. statistical or digital signal processing methods) (Batzias et al., 2011). The technology used in leakages detection can be classified into two categories which are, Direct method and the Indirect method The direct method is making use of a handheld detector by the patrol team along the pipeline and in the aspect of the very long pipeline, the airplane mounted optical imaging device is used along the pipeline for measuring gas emanation for fast result.

CHAPTER 3

3.1. INTRODUCTION

In this chapter, the methodology will deal with techniques and tools used to execute and develop a system that detects LIQUIFIED PETROLEUM GAS [LPG] leakages.

3.2. SYSTEM STUDY

The proposed system will use an Arduino microcontroller detector system to sense the gas with the help of a sensor. In which the MQ2 sensor used in this system interfacing with Arduino is implemented in this project and the signal from the sensor is sent to the microcontroller which is connected to communicate and send a signal to the buzzer to sound an alarm when there is leakage and also send a message through the GSM module.

The GSM module is a piece of hardware that connects to a remote network, this does not involve an internet or hotspot WIFI which makes it more recommendable than the IOT leakage method which has could fail due to network failure and unaffordable equipment to low-income earners and also has a quick response gas leakage.

In this research work, the hardware component to be used is Arduino Uno Micro-controller, GSM Module (SIM800), MQ2 Gas sensor, Buzzer, Power Module, Stripped Vero board, Female and Male Pin header, Power Switch, connectors, suppressor fan that will disperse and pull out the gas before it causes harm in the affected environment and Lithium Polymer Rechargeable Battery.

3.3. RESERCH METHODS.

We shall do research about existing GLD systems and this will help us gather literature and from the related literatures we shall be able to develop our system.

3.3.1. GROUP DISCUSSIONS

We will always be meeting as a group to discuss the project and we shall allocate each of the

group member a responsibility on what to research about as we progress with the project implementation. We shall also hold meeting to plan on how we can meet our research budget and each member will contribute a suggested fee so as we can be able to get all the required components to build our prototype.

Table 1. weekly time of our activities.

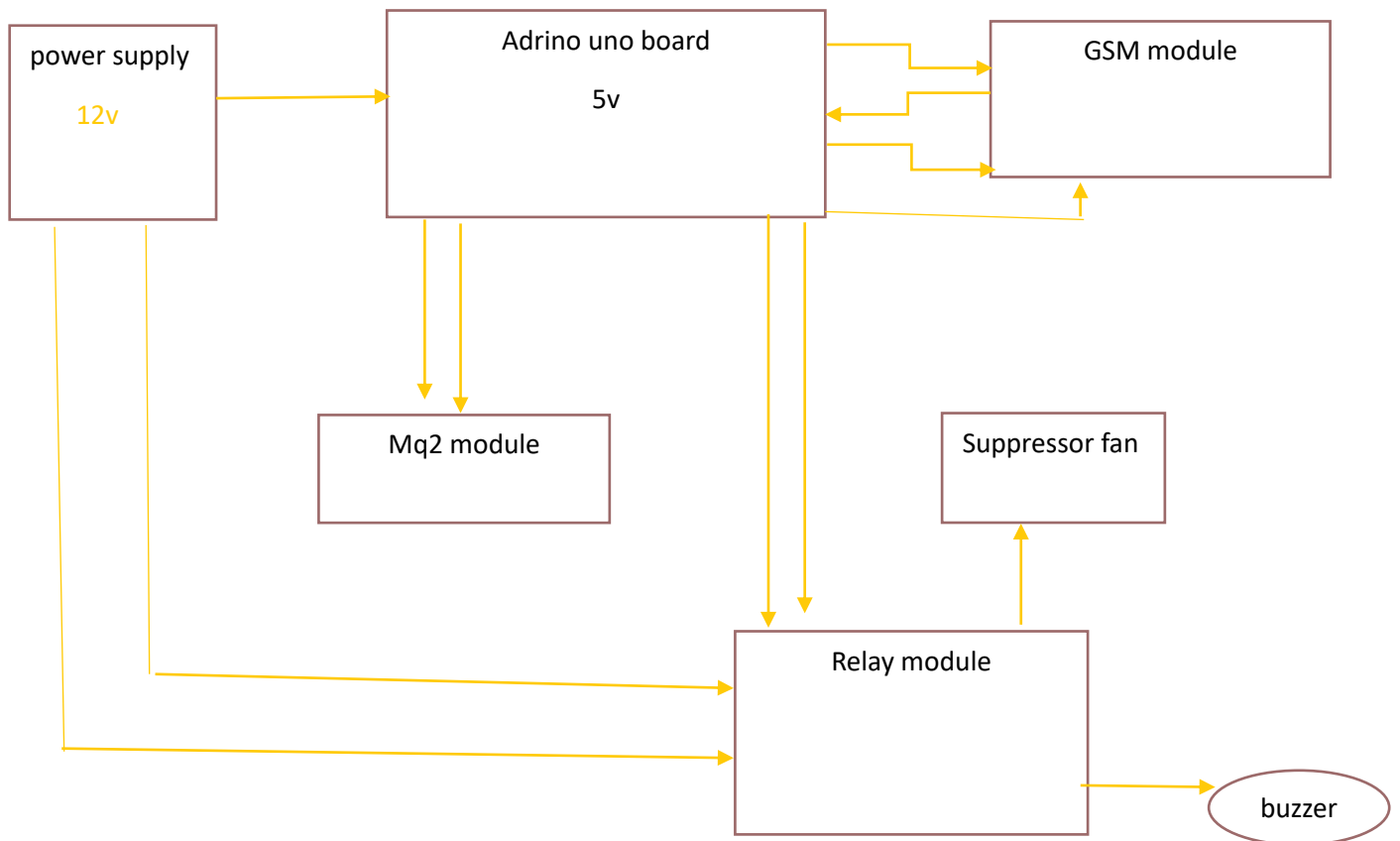
| Day | Activity | Personal responsible/Meeting |
|-----------|---|---------------------------------|
| Monday | Assignment of research areas to members | Namwanga Florence |
| Tuesday | Members do their individual research | All members |
| Wednesday | Members do their individual research | All members |
| Thursday | Members do their individual research | All members |
| Friday | Presentation of your research ideas and a well written report | All members on google meet |
| | Compiling the individual research to a research proposal | Burusya Ezra and kivumbi Ismael |
| Saturday | Building on a prototype | Physical meeting. |

3.3.2. CONSULTATION

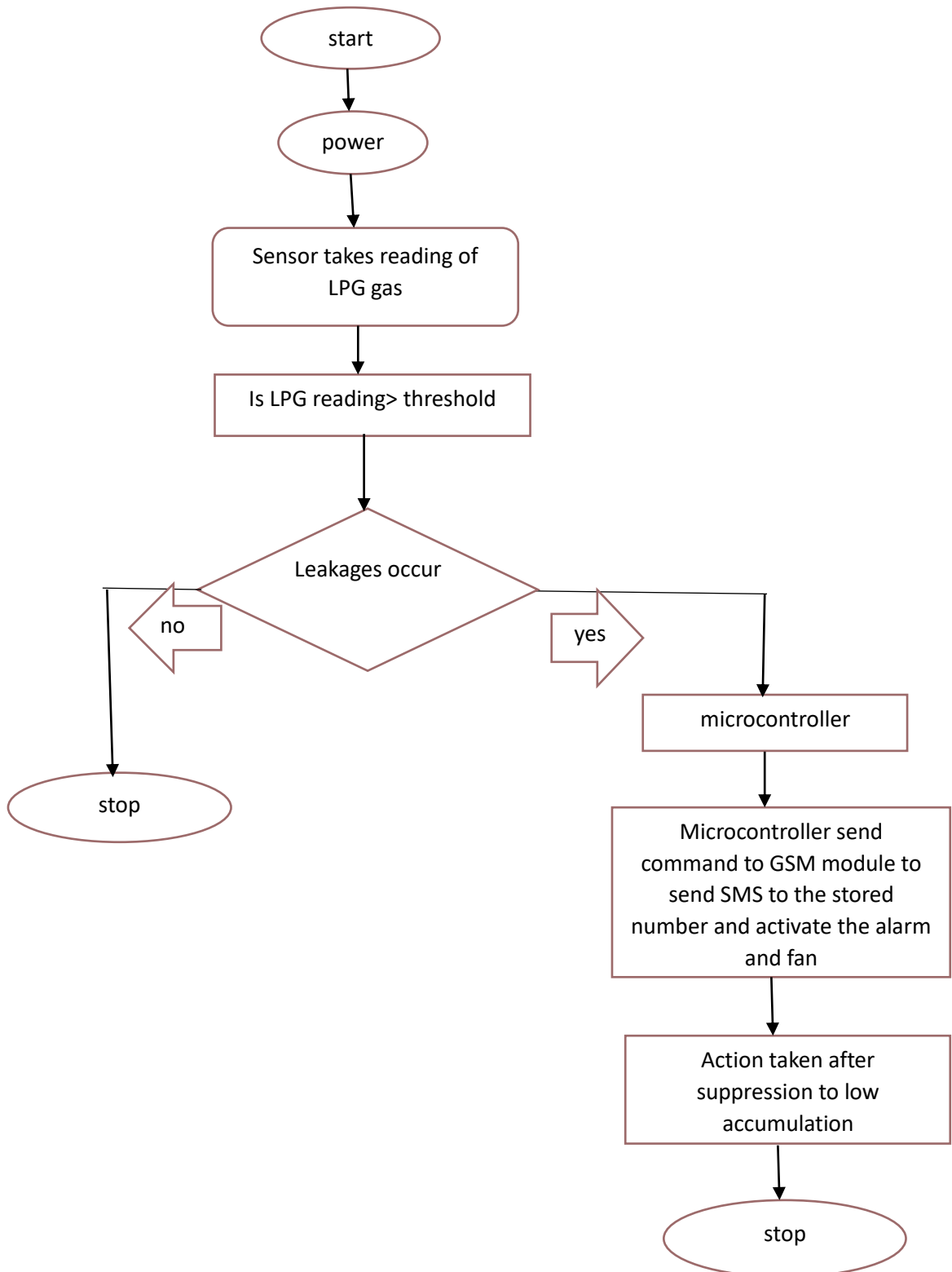
we shall be making consultations from our project supervisor and other lecturers plus the internet in order to get some technical support from them. We also intend to make consultations from other people that have a great knowledge in electronics so that they can give us technical advice.

3.4. SYSTEM DESIGN

Block diagram.



Operation algorithm



3.5. MATERIALS

3.5.1. Power supply

One power supply unit (12V) is designed in order to supply power to the Arduino and other units of the system including the suppressor fan.



Figure.1.1

3.5.2. Arduino uno board

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328 microcontroller and is developed by Arduino.cc, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digital which can be programmed to design any system with additional sensors.

It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analogue inputs, a power jack, and a reset button. This contains all the required support needed for the microcontroller. It is used as the brain of the automatic system.

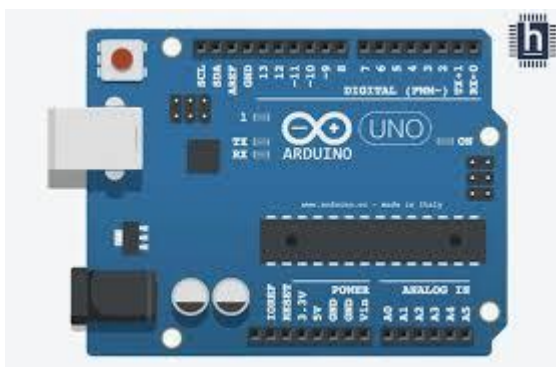


Figure1.2

3.5.3. MQ2 sensor module

This MQ2 LPG/smoke sensor is a metal oxide semi conductor (MOS) type gas sensor mainly for detecting liquified petroleum gas (LPG) or smoke.



Figure.1.3

3.5.4. Relay module

This is the automatic switching module that activates the suppressor fan automatically.

It switches from 5v to 12v to activate the suppressor fan.



Figure.1.4

3.5.6. Gsm module

The GSM module is a piece of hardware that connects to a remote network, this does not involve an internet or hotspot WIFI which makes it more recommendable than the IOT leakage method which has could fail due to network failure and unaffordable equipment to low-income earners and also has a quick response gas leakage.



Figure.1.5

3.5.7. Suppressor fan



This will be reversed polarised to suppress the gas before it causes harm to the affected environment.

Figure.1.6

3.5.8. Buzzer

To make an alarm warning in case gas leakage is detected.



Figure1.7

3.6. APPENDICES

3.6.1. TIME FRAME

This shows how we shall progress in doing our project from April 2024 to October 2024.

3.6.2. WORK PLAN

Table 2

| ACTIVITY | MONTHS | | | | | | |
|----------------------------|--------|-----|------|------|--------|-----------|---------|
| | April | may | June | July | august | September | October |
| Finding a problem | | | | | | | |
| Literature review | | | | | | | |
| Proposal submission | | | | | | | |
| project planning | | | | | | | |
| Project design | | | | | | | |
| project implementation | | | | | | | |
| Project testing | | | | | | | |
| Project presentation | | | | | | | |
| Final project presentation | | | | | | | |

3.6.3. PROJECT ESTIMATED BUDGET

Table 3

| Component | quantity | Unit price (UGX) | Actual price (UGX) |
|----------------------|---------------------------------|------------------|--------------------|
| MQ2 sensor | 1 | 20000 | 20000 |
| 12v dc battery | 1 | 45000 | 45000 |
| Adrino uno | 1 | 65000 | 65000 |
| Fan | 1 | 40000 | 40000 |
| GSM module | 1 | 80000 | 80000 |
| Jumper wires | 2 | 7500 | 15000 |
| Testing gas cylinder | 1 | 45000 | 45000 |
| Soldering gun | 1 | 25000 | 25000 |
| Soldering wire | 1 roll | 30000 | 30000 |
| Buzzer | 1 | 45000 | 45000 |
| Stationary | ½ ream | 7500 | 7500 |
| Transport | Aid our travel to get materials | 50000 | 50000 |

| | |
|--------------------|---------------|
| Grand total | 467500 |
|--------------------|---------------|

Note: this has-been generated basing on online shopping prices at Jiji Uganda and other several dealers in the items

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