SENSOR-BASED GAS LEAK ALERT SECURITY SYSTEM USING ARDUINO

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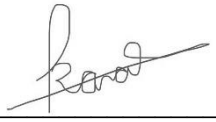
Signature : 

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SENSOR-BASED GAS LEAK ALERRT SECURITY SYSTEM USING ARDUINO

DARO KARIM SHARIF

A thesis submitted in fulfilment of the
requirements for the award of the degree of
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Faculty of Computing
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DEDICATION

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I would also like to thank my family. A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity ring in my ears. Thank you.

My love for you all can never be quantified. God bless you.

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My fellow student should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family member.

ABSTRACT

Gas The increasing demand for safety and security has led to the development of various gas leak detection systems. In this paper, a novel gas leak detection and prevention system is presented. The system uses a gas sensor to detect LPG gas in the air and an Arduino microcontroller to control the various components of the system. The system alerts the user of a gas leak through a GSM network, security alarm, and an electricity controller circuit. The alarm and electricity controller circuit help to prevent fire, which is often the cause of gas leak disasters. In addition to the alerts, the system also features a cloud-based application for monitoring gas levels in real-time and receiving notifications of gas leaks. This allows the user to keep track of the gas levels in the environment and take necessary measures in case of an emergency. The real-time monitoring of gas levels also helps to detect gas leaks early on, reducing the risk of a gas leak disaster. in conclusion, the gas leak detection and prevention system presented in this paper provides a comprehensive solution for ensuring safety and security in closed environments. The combination of a gas sensor, an Arduino microcontroller, a GSM network, security alarm, and an electricity controller circuit makes the system unique and effective in preventing gas leak disasters. The system's ability to monitor gas levels in real-time and provide notifications of gas leaks makes it a valuable tool for ensuring the safety and security of homes, businesses, and other closed environments.

ABSTRAK

Gas Permintaan yang semakin meningkat untuk keselamatan dan keselamatan telah membawa kepada pembangunan pelbagai sistem pengesanan kebocoran gas. Dalam makalah ini, sistem pengesanan dan pencegahan kebocoran gas baru dibentangkan. Sistem ini menggunakan sensor gas untuk mengesan gas LPG di udara dan mikropengawal Arduino untuk mengawal pelbagai komponen sistem. Sistem ini memberi amaran kepada pengguna tentang kebocoran gas melalui rangkaian GSM, penggera keselamatan dan litar pengawal elektrik. Litar penggera dan pengawal elektrik membantu mencegah kebakaran, yang sering menjadi punca bencana kebocoran gas. Selain makluman, sistem ini juga menampilkan aplikasi berasaskan awan untuk memantau tahap gas dalam masa nyata dan menerima pemberitahuan kebocoran gas. Ini membolehkan pengguna menjejaki paras gas dalam persekitaran dan mengambil langkah yang perlu sekiranya berlaku kecemasan. Pemantauan masa nyata tahap gas juga membantu untuk mengesan kebocoran gas lebih awal, mengurangkan risiko bencana kebocoran gas. kesimpulannya, sistem pengesanan dan pencegahan kebocoran gas yang dibentangkan dalam kertas kerja ini menyediakan penyelesaian yang komprehensif untuk memastikan keselamatan dan keselamatan dalam persekitaran tertutup. Gabungan penderia gas, mikropengawal Arduino, rangkaian GSM, penggera keselamatan dan litar pengawal elektrik menjadikan sistem unik dan berkesan dalam mencegah bencana kebocoran gas. Keupayaan sistem untuk memantau tahap gas dalam masa nyata dan memberikan pemberitahuan kebocoran gas menjadikannya alat yang berharga untuk memastikan keselamatan dan keselamatan rumah, perniagaan dan persekitaran tertutup yang lain.

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LIST OF ABBREVIATIONS

LPG	-	Liquefied Petroleum Gas
SMS	-	Short Message Service
GSM	-	Global System for Mobile
IoT	-	Internet Of Things
NTSB	-	National Transportation Safety Board
IEEE	-	the Institute of Electrical and Electronics Engineers
UTM	-	Universiti Teknologi Malaysia
GUI	-	Graphic User Interface
UML	-	Unified Modelling Language
FYP	-	Final Year Project

CHAPTER 1

INTRODUCTION

1.1 Introduction

This project introduces a new method system for detecting dangerous gas leaks in houses and apartments and businesses workplaces or any closed environment a gas sensor is used to detect LPG gas in the air, and Sensor-based Gas Leak Alert Security System Using Arduino is a developed safety system which detects gas leakage using sensors provides safety using GSM network, security alarm, and electricity controller circuit even though there are a few similar systems that send an SMS or starts an alarm this project also features cloud-based application to get notification about leakage and be able to monitor real-time levels of gas in the area what differs this project is the ability to control the electricity which the main source of fire during a gas leakage which means this system not only informs about the danger it also prevents the gas leakage disaster to take place.

1.2 Problem Background

Gas leakage has always been a major safety problem that may be found in many different areas, including homes, and workplace environments, throughout history Dangerous disasters have occurred as a result of gas leaking. (LPG) is highly combustible and can burn and explode even if it is a long distance from the source of the leak. These gasses have the potential to catch fire in less than a second.

"An estimated average of 4,200 home structure fires per year started with the ignition of natural gas. These fires caused an average of 40 deaths per year. The statistics, incident descriptions from NFPA publications, and reports from the National Transportation Safety Board (NTSB) show that most major gas incidents involved some type of leak."

(M. Ahrens&B. Evarts,2018)

With this project, the aim is to design a system that detects gas in the air at all times it also provides the user with an application for monitoring and alerting purposes if in any case, a gas leakage occurred and the gas level went above the safe range three safety procedures will take place one is the user is alerted about the leakage through GSM by sending an SMS and application notification secondly the alarm will go on in the area so the people in danger can get away and last but not least the system will shut down the electricity in the area because electricity is one of the major reasons gas leakages will turn to fire and explosion, therefore, this project is designed the best way to prevent an unfortunate disaster to happen by three different safety protocols.

1.3 Project Aim

The aim of this project is to design and implement a sensor-based gas detection system using three different safety procedures in every closed environment.

1.4 Project Objectives

Objectives of this project are:

1. To develop a gas leak detection system using a gas sensor and provide safety measures through a combination of a GSM network, a security alarm, and an electricity controller circuit.

2. To provide real-time monitoring of gas levels through a cloud-based application and send notifications about gas leaks.

3. To prevent gas leaks from resulting in fire by controlling electricity, which is a major cause of fire during gas leaks.

1.5 Project Scope

The gas detection system uses three safety procedures and protocols that detect LPG from the absorption of 200 parts per million to 10,000 PPM in an area using Arduino and MQ-6 sensor once a range above the normal range is detected in other words when leakage occurred the system will take three safety measures into action first shutting down the electrical circuit of the area from a centralized electric controller secondly the battery-operated alarm are devices will turn on in case there are people in the area so they can get away last but not least the system will send a warning message to the owner through Global System for Mobile(GSM) these safety protocols are considered to be some of the detection gas leakage security systems within an area usually as part of a safety system/risk control.

1.6 Project Importance

This system will detect gas leakage in the home, or at an oil station. By upgrading its ranges, it can easily be scaled up to the industrial level. Because many glasses can be hazardous to biological life, such as humans, the implementation of the project is critical in every house, office, and industry. This project assists people in improving their safety procedures. It has exceptional sensitivity and a fast response time. The most basic and crucial role of the system is to avoid accidents and safeguard people and property from catastrophes.

1.7 Report Organization

Chapter 1 (Introduction): the chapter focused on providing an overall view of the problem, why it is essential, and what benefits it can gain by solving the issue. Then it Explained the proposed solution and how it intended to solve the given problem.

Chapter 2 (Literature Review): the chapter focused on the research, and findings of the literature reviews.

Chapter 3 (Methodology): the chapter focused on describing the overall method and methodology chosen for the development of this system. While also justifying the choice of methods and techniques.

Chapter 4 (Requirements and Analysis Design): the chapter focused on explaining and finalizing the requirement analysis, Design.

Chapter 5 (Conclusion): concluding and finalizing remarks in the Final Year Project (FYP) report.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides information on previous projects and research to have a better view and get to know more about knowledge sharing regarding Gas Leak Safety Systems. The aim is to point out current similar systems to better evaluate the goal of the exciting system and identify the key analyses which will help prove the thesis. The literature review assesses the current systems as well. This section is critical because it provides a better understanding of the project's execution by combining logical information pieces, and also Identifying and evaluating the current system will also provide a realistic view of the planned system and its purpose. The overview is covered in detail, and all discovered systems are compared to the proposed analysis system. Finally, a brief literature analysis of the tools and technologies used is carried out in order to determine their benefits to project creation and implementation.

2.2 Case Study

This section will introduce the current system used to detect gas leakage and its features and functionalities in detail to point out the key differences later on. After long research and analysis, while there are many systems around the world there were only 3 projects and systems that were very similar to the proposed system.

2.2.1 Case Study 1 – Implementation and design of gas leakage detection system using ATMega8 microcontroller

The main goal and a brief introduction of this system would be to also detect LPG using sensors what it does is it sense the leakage around the house give an early

warning of the existence of possible leakage so that everyone could get away by alarm or a buzzer this study was published on 2019 by IOP Conference Series: Materials Science and Engineering.

2.2.2 Case Study 2 – A wireless home safety gas leakage detection system

This system uses wireless as the main key difference in comparison to the other case studies instead of using cables this system uses wireless can be connected to the internet the feature it A wireless home safety gas leakage detection system provides is that you can have a source of LPG remotely and set the alarm in a different place and connect them by wireless technology this paper is published by IEEE explorer on 2011.

2.2.3 Case Study 3 – LPG Gas Leakage Detection and Alert System

this system functions by an MQ-6 gas sensor. which is a very fast response sensor.to detect the LPG the gas detector is then connected to a dual operational amplifier where it is constantly compared the value of detected gas to the normal range and then If the sensed voltage exceeds the preset threshold voltage, then an alarm starts to notify people that are living in the area this research is published on Research India Publications.

2.3 Current System Analysis

After conducting a survey with people and property owners who use gas in their homes and cars and workplace properties and pointing out the features of the current system turns out that they most likely would prefer a system that provides various and multiple safety procedures this indicates that the current system does lack for various safety procedures a system that combines multiple safety procedures would be more beneficial the reason why the current system won’t satisfy people's safety concerts are mainly because the current systems simply use various methods only to

detect or alert the users about gas league without doing anything regarding preventing an accident to take place users would be much more satisfied if the system did help rather than only informing some of the users were concerned about in case they were away from a gas source they are most likely wouldn't be able to do anything about it before it's too late therefore a system to combine major safety procedures and protocols would help advance the system and meet users concerns very much.

2.4 Comparison between existing systems

Below is a detailed comparison between the existing systems, and this is necessary because it can help developers develop great products with great functionalities. below showcases a comparison between the proposed approach and other existing systems, and methods, related to sensor-based gas detection systems. Since the project's main scope is the proposed solution, it only needs to showcase several components and aspects for comparison that lead to the issuance of the proposed system.

Table 2.1 comparison between existing system

Features	Case Study 1	Case study 2	Case study 3
Audio Alarm	✓	✓	✓
Sends SMS to the user by GSM	✓	X	X
Sends notification by cloud app	X	X	X
Shut electricity down	X	X	X
Provides monitoring capabilities	X	X	X

2.5 Literature Review of Technology Used

For the implementation of proposed project IoT technologies have been used hardware-wise these devices are required.

- SIM800L sim card reader Global System for Mobile
- microcontrollers esp8266 Arduino which is an open-sourced electronic technology used to implement both hardware and software to read inputs from different sensors and devices
- MQ-6 sensor to detect gas in the air
- reed switch to control the electricity.

Software technologies that will be used are

- the Arduino IDE platform to write the codes
- C++ to program the Arduino devices
- Python to program the Arduino devices

2.6 Chapter Summary

This chapter has the existing systems to understand the characteristics and problems by comparing them with the proposed approach. As a result of the research, issues arise in gas detection safety systems. After the study compared the existing systems, the advantages and disadvantages were identified, which were used to improve the project. As a result, the proposed approach can fix the weakness in the current system. It also covered the technology tools suitable for this project development. The relations were examined to improvise the shortcomings of this system.

CHAPTER 3

SYSTEM DEVELOPMENT METHODOLOGY

3.1 Introduction

Methodology is the step-by-step policies of system development phases that are used to complete one or more stages of the cycle. Each methodology forces its own techniques and methods on the evolutionary cycle. The methodology is a set of rules related to the methods of finishing a project. Based on the general concepts and theory of systems, an attitude is formed which is called a systemic attitude or approach. On the one hand, this attitude is a way of thinking and on the other hand, it is a way to deal with problems that can be used to step by step problems well. Whenever this approach is used in solving organizational problems and projects, especially IoT projects, it is called an overall method of problem-solving, methodology, and psychological problems. And whenever it is used to analyze, design, and improve information systems.

3.2 Methodology Choice and Justification

When it comes to choosing a methodology there are a few options such as agile, waterfall, rapid, and many more, each one with its own characteristics. It's absolutely crucial to make sure which one will be used and which one is most compatible with the system. after evaluating the proposed system, it occurred that agile methodology is at most the most compatible option because this system includes IoT and IoT is a very wide area a methodology is required that can make changes easily along the way and phases of system development Prioritizing the response to change over simply following the plan when you prepared a fixed scenario and did not think about changing anything? This is exactly what has happened in the past. The problem with fixed maps is that we do not live in a fixed world. Needs and priorities are always changing. The fixed roadmap will soon become obsolete. For this reason,

the Agile approach suggests that a system developer should be able to rotate and change direction at the right time and have a flexible roadmap. A dynamic plan can change and it is flexible, agile methodology is adapted to these changes, therefore, the methodology for the proposed system is going to be Agile methodology.

3.3 Phases of the Chosen Methodology

Six key deliverable concepts of the Agile approach:

1. Concept Product Vision Statement is a summary that states the goals of the product.
2. Inception Product roadmap High-level view Requirements for achieving product vision.
3. construction/Iterations The number of products available: Depending on your priority, this is a complete list of things to do to complete the project.
4. Release Sprint Plan: A timeline for the release of a working product.
5. Production Daily stand-ups User needs, goals, and tasks related to the current trend.
6. Retirement Delivery the project is delivered when the client is satisfied with the results obtained. Depending on the scenario

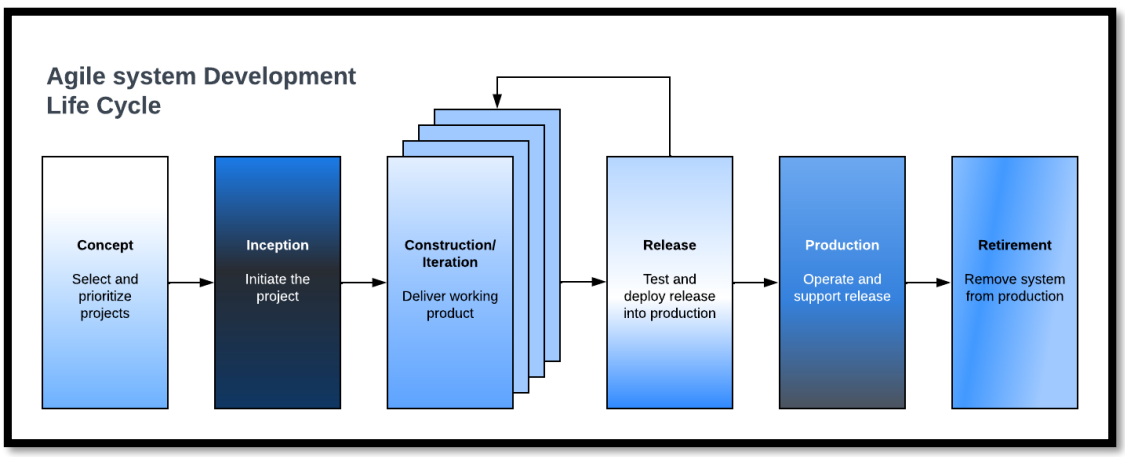


Figure 3.3.1 Agile Methodology Life Cycle

Gantt chart has been used as a guide to execute all tasks within a set timeline and illustrate how the project has worked. It also provides an overall look at the project timeline with the completion date for each task. By using the Gantt chart, milestones have been used for specific tasks to ensure they are done on time. Figure 3.2

showcases the Gantt chart for FYP1, which includes a detailed timeline of the progress of FYP1 from choosing the title until the submission of the final FYP1 report.

Figure 3.3.2 Gantt Chart for FYP1

Figure 3.3.3 Gantt Chart for FYP2

3.4 Technology Used Description

3.4.1 GSM

GSM (Global System for Mobile Communications) is a second generation (2G) digital cellular network system that was initially developed to replace analog cellular networks. It is the most widely used mobile network system in the world and is used by over 80% of all mobile phone subscribers. GSM uses time division multiplexing (TDM) to divide a frequency band into multiple time slots for transmission, and it operates on several different frequency bands, including 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz. One of the key features of GSM is its support for roaming, which allows mobile phone users to use their devices while traveling in other countries. This is made possible by the use of standardized protocols and a centralized infrastructure, which allows mobile phone operators to interconnect their networks and provide seamless service to their customers.

3.4.2 Python Programming Language

Python programming language is a free easy-to-use language used in many different areas and it's also considered to be the main language for programming the IoT devices for this project python will be used to program the Arduino microcontrollers.

3.4.3 Wireless Fidelity

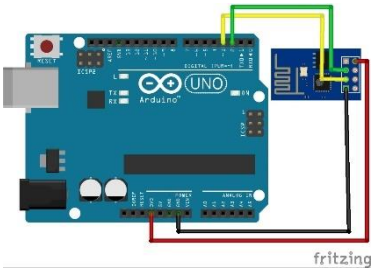
wireless networking technology plays an important role to reach the objectives of this project Wi-Fi wireless technology with radio waves. Wi-Fi will be used for connecting the microcontroller to the application to transmit the real-time data that has been gathered by the sensors.

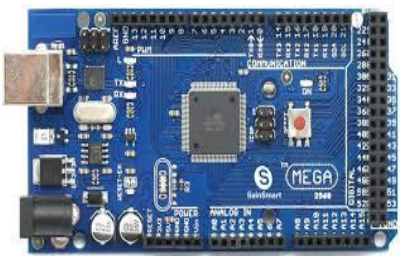
3.5 System Requirement Analysis

3.5.1 hardware requirements

Internet of Things based system mainly consists of a lot of different hardware components these hardware tools combined with the software tools together provide a general term is known as technology today in the hardware requirements section all of the hardware that will be used in the project is highlighted and explained to provide a better view of what system consist of and what's the role of each and every component the table below showcases the required hardware for this project.

Table 3.1 Hardware Requirement

No.	Hardware	Description	Visuals
1-	SIM800L	This tool is used to read the sim card and is responsible for sending SMS message in case a gas leakage occurred.	
2-	Arduino Uno	This tool is a microcontroller by Arduino which is an open-sourced electronic technology used to implement both hardware and software to read inputs from different sensors and devices.	
	Esp8266	The ESP8266 is a low-cost, low-power system-on-a-chip (SoC) microcontroller with built-in Wi-Fi capability.	

3-	MQ-6 sensor	This sensor the main component of the project will be placed in the area and it reads the level of LPGs in the air its also responsible to send the signals to the microcontroller in case a gas leakage occurred.	
4-	Breadboard	Is used to connect the different hardware components together a breadboard to connect Arduino and reed switch as well as the sensor together.	
5-	Alarm Buzzer	It's an alarm that will go on when it receives signals from the microcontroller in case a leakage occurred.	
	MEGA 2560	The Arduino Mega 2560 is a popular choice for projects that require a lot of digital and analog pins, as well as projects that need multiple serial communication ports. It can be programmed using the Arduino IDE and is compatible with a wide range of shields and libraries	
6-	Jumper wires	Jumper wires are used with a reed switch to connect different hardware components physically together.	

7-	UPS battery	UPS will provide enough electricity in case of blackouts or for any reason.	
8-	Relay Module	Relay module is responsible for converting the signal frequencies from the sensor and the alarms to the microcontroller between AC to DC.	

.

3.5.2 Software requirements

Its well-known hardware and software work together to make a system functional the purposed project features a cloud-based application that monitors and reads real-time data from the microcontroller in this section detailed overview will be provided regarding requirements in developing a proposed system. Choosing the best software specification will lead to a smooth process of development. The minimum for software requirements is listed below. The table below how the software requirements for the development of the system.

Table 3.2 Software Requirement

No.	Software	Descriptions
1-	Arduino IDE	For coding and compilations
3-	Microsoft Windows	Operating system for programing and documentation purposes
4-	Browser	To access the transmitted data by the IoT DEVICES through thingsPeak

3.6 Chapter Summary

Overall, Chapter 3 explained and compared the methodologies in detail since choosing the best system methodology is crucial to smoothly develop the project. In addition, selecting a suitable methodology will lead to the success of developing the proposed system. Before choosing the system methodology, many factors and comparisons need to be considered, such as the project requirements, expected end product, and project complexity. Besides, the chosen methodology has more advantages rather than disadvantages. Moreover, this chapter also discussed the hardware and software requirements to ensure the process development is smoothly and on time. Next, Chapter 4 will be concerned with the system design of the proposed system.

CHAPTER 4

REQUIREMENT ANALYSIS AND DESIGN

4.1 Introduction

The project's system design is examined in this chapter based on the requirements that were acquired requirement analysis is the first stage in creating plans and goals, followed by the determination of information needs. It includes a description of the results of the requirements analysis in the design phase. The initial section of this is the Use Case Diagram, Sequence Diagram, and Requirements Analysis chapter and Activity Diagrams, then unified modelling for the project design Diagrams of the system architecture and language (UML). The database follows after that. Interface in Design and a summary at the end of the chapter.

4.2 Requirement Analysis

This section provides comprehensive explanations for all descriptions of actors, use case diagrams, activity diagrams, and sequence diagrams. To avoid system mistakes, the requirement analysis phase of the development project is crucial. The user requirements analysis, which enables the user to comprehend system activities and processes, is one of the necessary analyses.

4.2.1 Use Case Diagram

The relationships between use cases, actors, and systems are summarized in use case diagrams. A trigger for the system is presented by actors. Use cases, on the other hand, represent the functions, primarily functional requirements, of the system after gathering and analyzing the requirements. The actors and their utilization are shown in Figure 4.1 below.

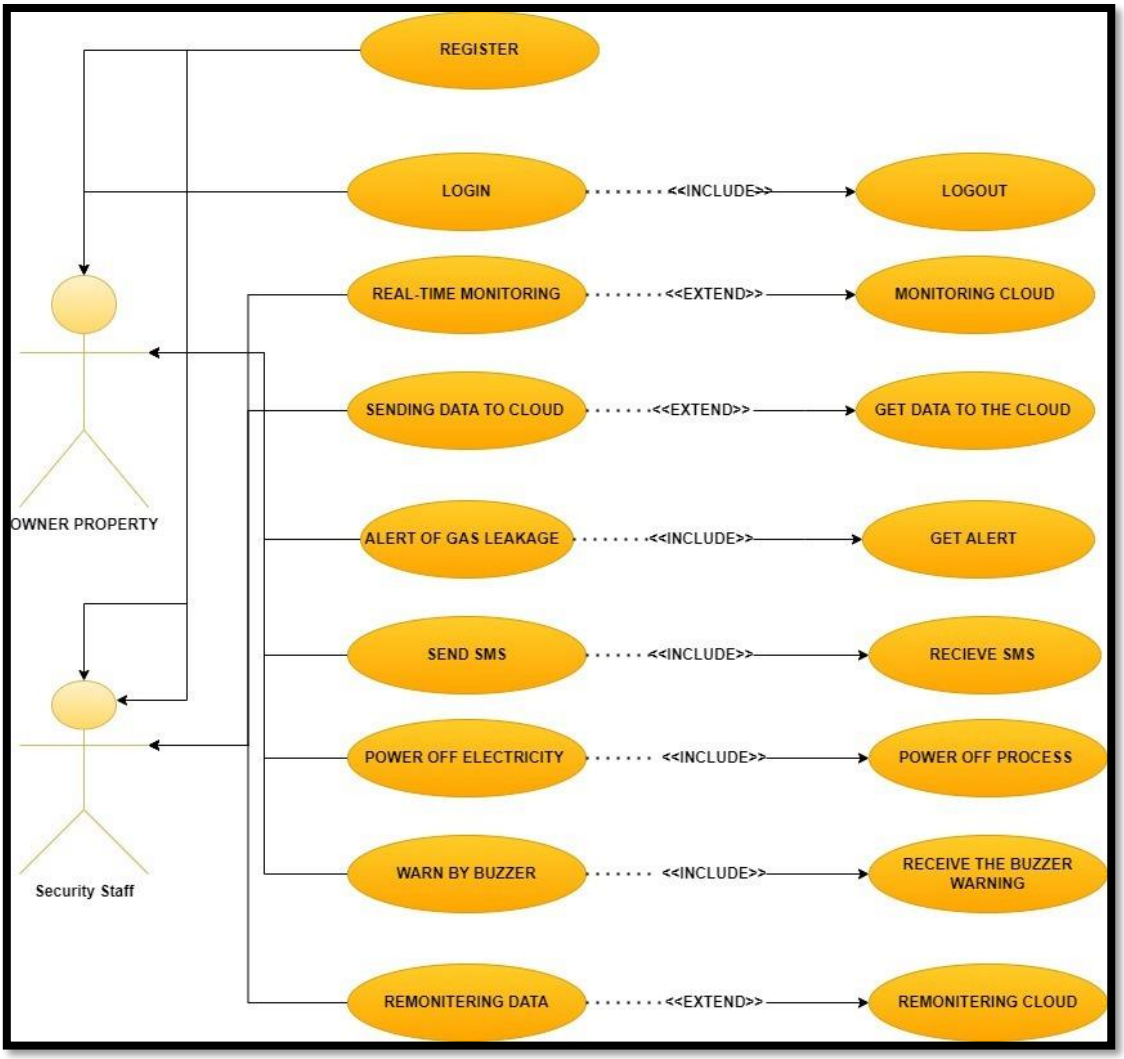


Figure 4.2.1 Use Case Diagram

4.2.1.1 Actor Description

Two actors interact with the system in the figure above the property owner and the security personnel. Different roles are played by these actors inside the system. The roles of actors inside the system are described in Table 4.1, Actor Description.

Table 4.1 Actor Description

No.	Actor	Role
1-	Security Staff	Security staffs are the first line of interaction with the system they have high observation and control over the whole situation.

2-	Property Owner	Property owners must be aware of any leak by notification even though they might not be there at all times there for they can receive notifications by the application and an SMS by SIM card.

4.2.1.2 Use Case Description

The system's actors are capable of four tasks. The use cases of the security staff and property owner in the system are described in Table 4.2 Use Case Description based on the actor.

Table 4.2 User Description

No.	Actor	Use Case	Description
1-	Security staff	RECEIVE A SMS	The user will be notified by an SMS.
2-		WARN BY BUZZER	Buzzer will o on security staff will instruct the area's people.
3-		REAL-TIME MONITORING	Security staff can monitor the level of gas at all times in the area.
4-	Property Owner	RECEIVE NOTIFICATION	Property owner will receive a notification through the cloud app.
5-		RECEIVE SMS	Property owners will receive an SMS this is helpful in case they didn’t have an Internet connection.

4.2.2 Sequence Diagram

Sequence diagrams are interaction diagrams that illustrate the order in which each function's system activities, processes, or tasks are carried out. The flowchart also demonstrates in great detail how each function operates figure 4.2 is sequence diagram for sending SMS then figure 4.3 demonstrates how data are transferred to the cloud for monitoring purposes and lastly figure 4.4 refers to buzzer alarm.

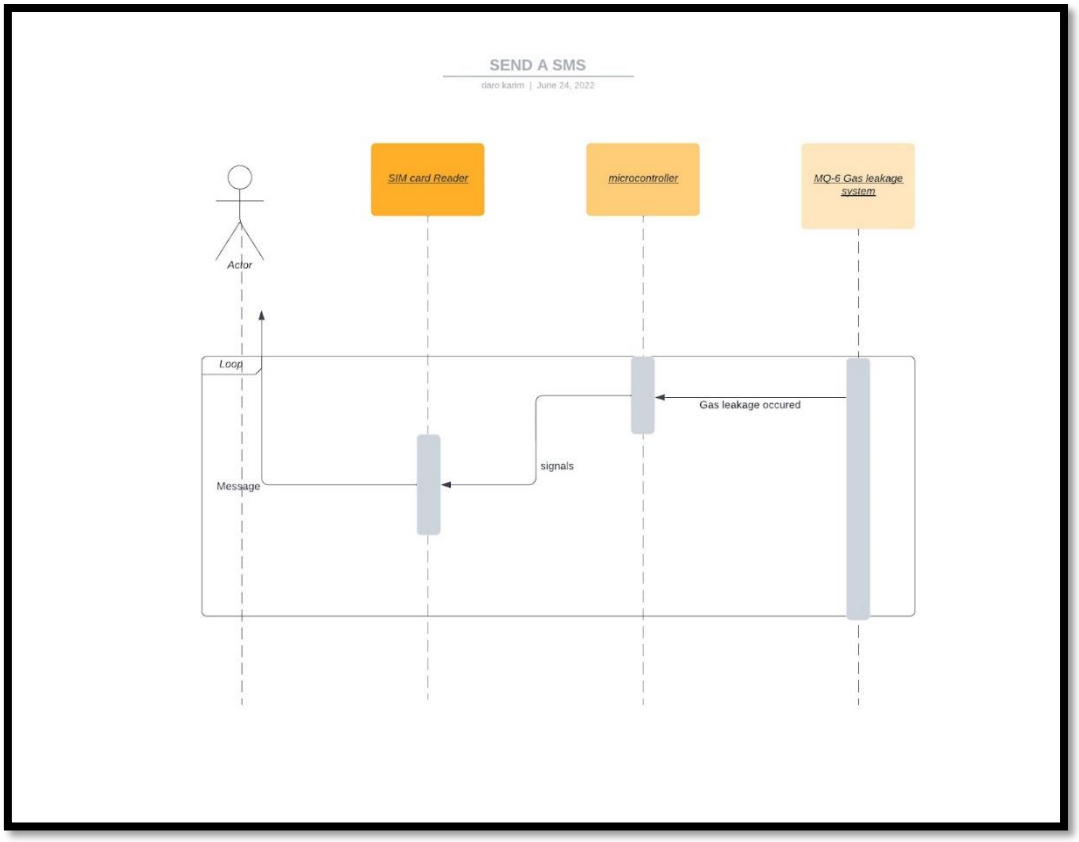


Figure 4.2.2 Send an SMS

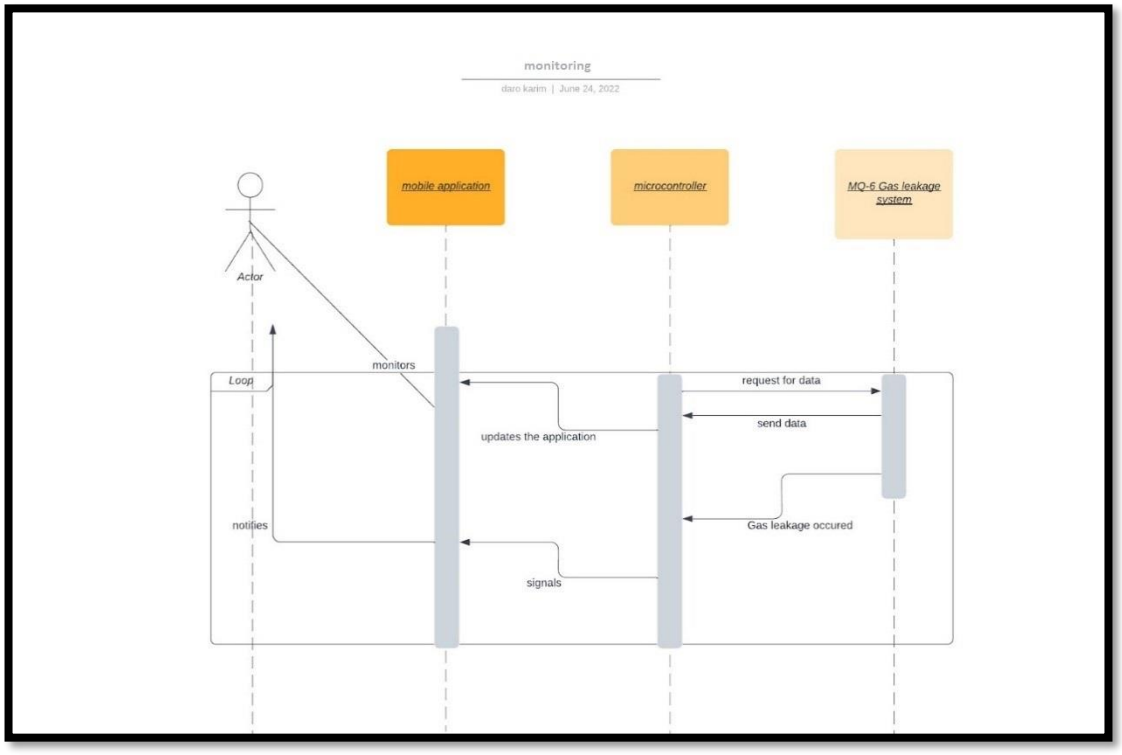


Figure 4.2.3 application monitoring and crucial notifications

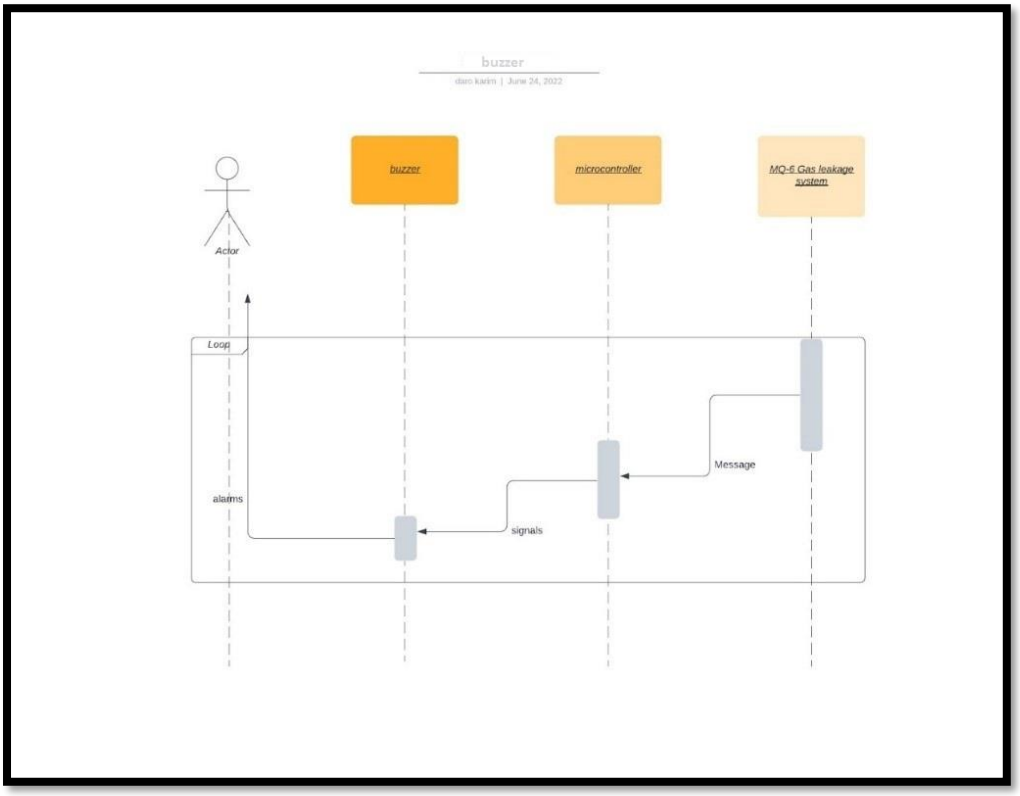


Figure 4.2.4 Buzzer alarm

4.2.3 activity Diagram

The activity diagram, which describes the dynamical characteristics of the system, is another important diagram. Figure 4.5 shows the progression from one activity to another in an inventive flow chart format. The activity diagram for each system user will also be explained in this section. The process flow from one state to another is illustrated in Figure 4.6. Each shape indicates a different system activity.

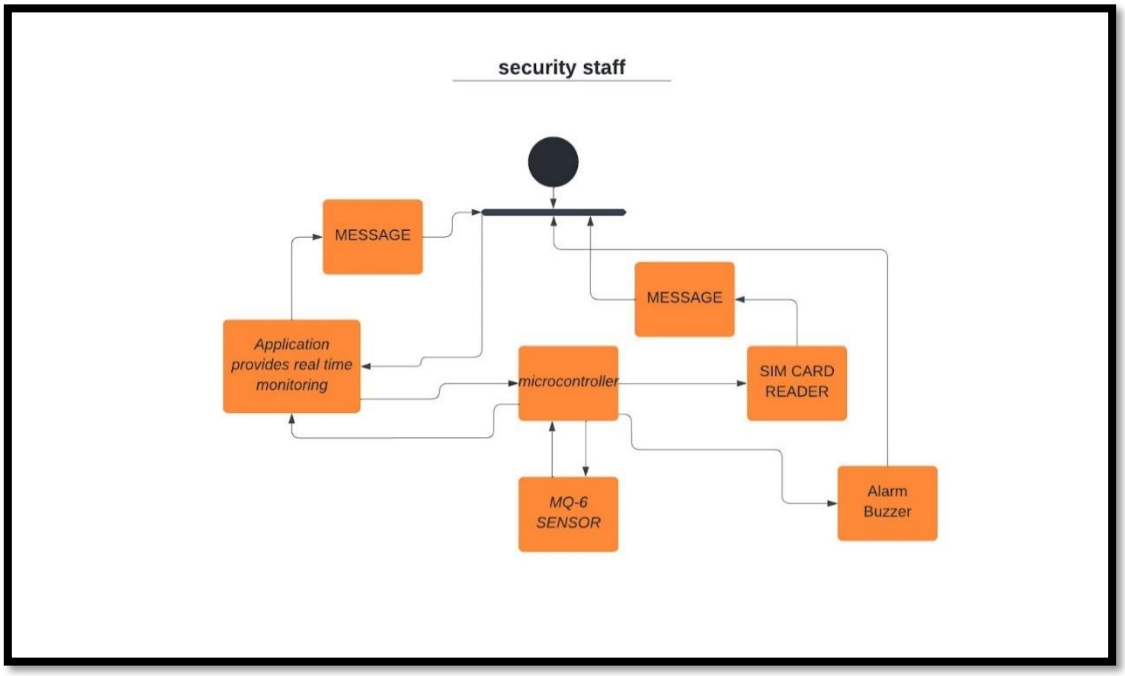


Figure 4.2.5 activity diagram for the security staff

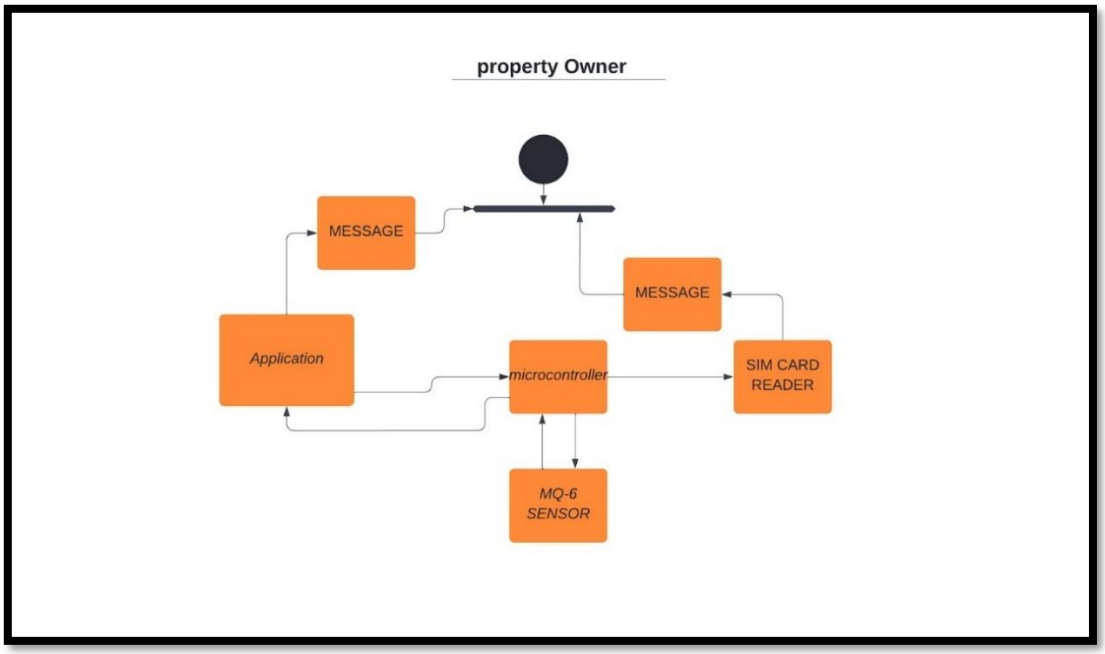


Figure 4.2.6 activity diagram for the property owner

4.3 Project Design

The UML class diagram and system architecture diagram will be the main topics of this part. A UML class diagram shows the connections and relationships between the data that are specific to each component of the system. The architecture diagram, on the other hand, illustrates the interaction and real-time operation of hardware and software. The UML diagram is shown in Figure 4.7 and figure 4.8 is schematic diagram and last but not least the architectural design is shown in Figure 4.9.

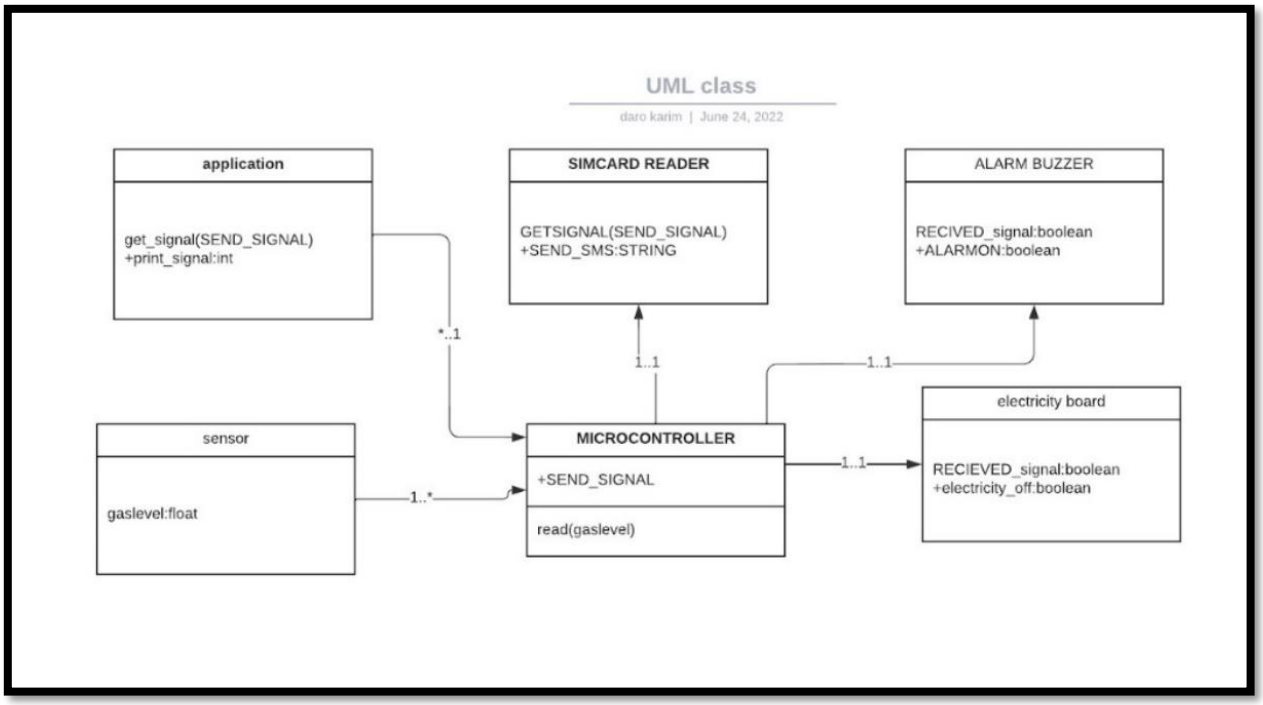


Figure 4.3.1 UML Diagram

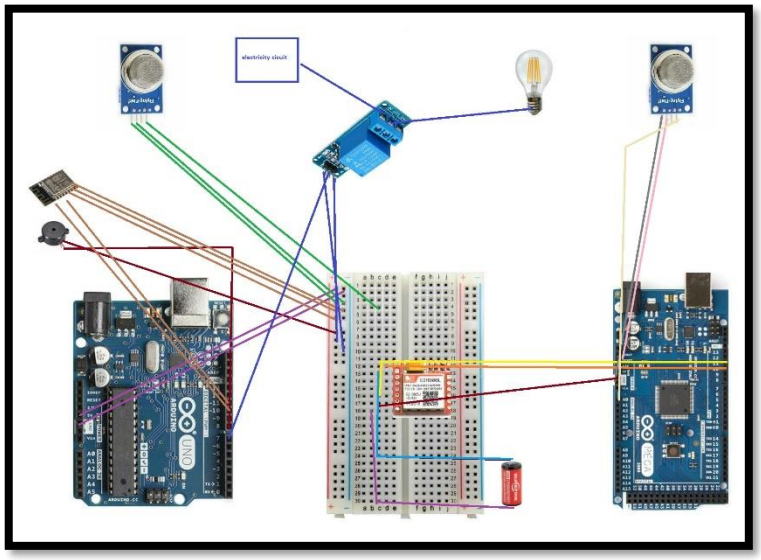


Figure 4.3.2 schematic diagram

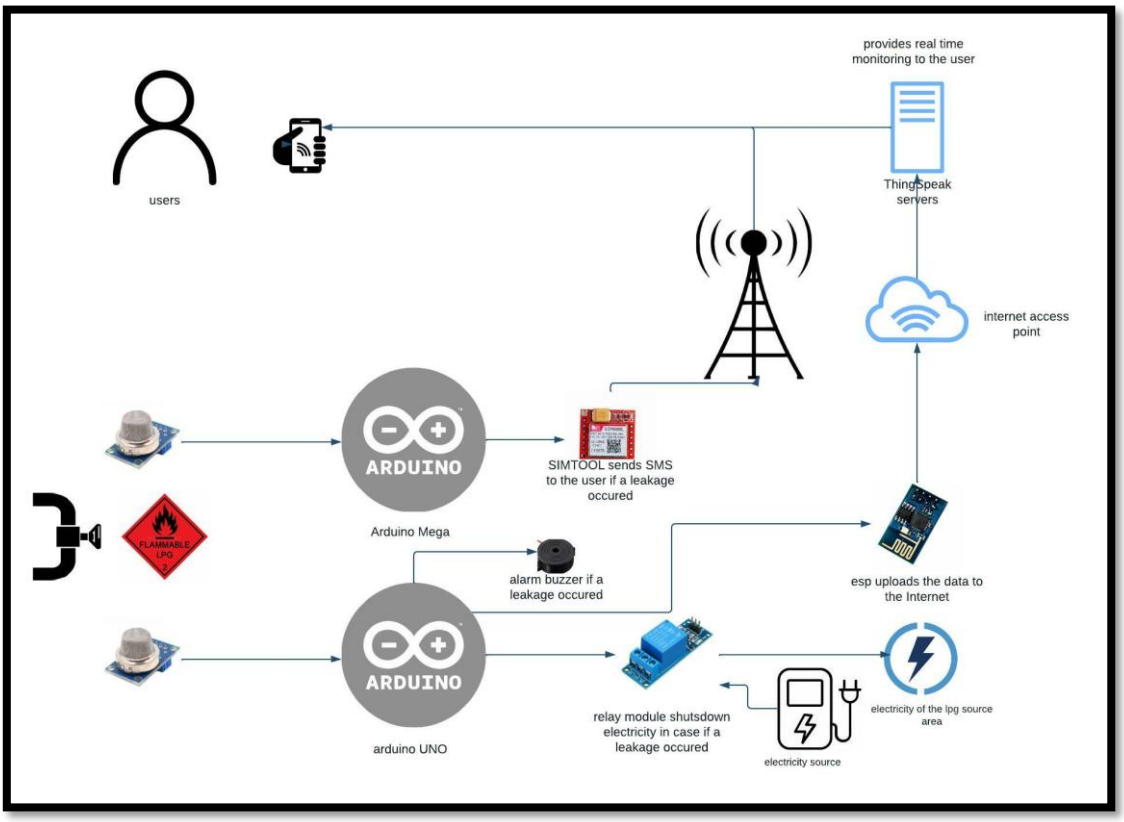


Figure 4.3.3 architectural design

The system architecture and design show the connection among every part of the related hardware and software used to develop the system. The diagram shows all the connected hardware and software that have a relationship.

4.4 Interface Design

Interface design is a graphic user interface (GUI) where users interact with the cloud app The interface design must be user-friendly and straightforward to make the user easy to understand to use the system. Below is the user interface for each function in the cloud-based application.

.

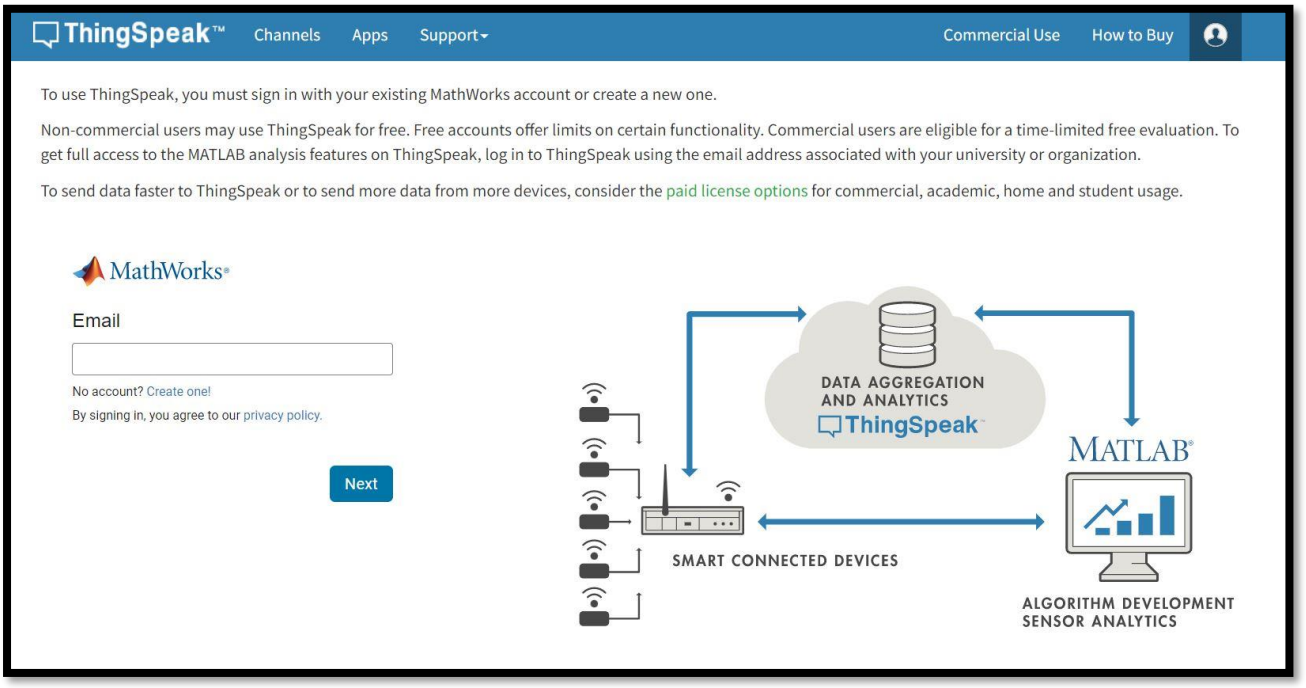


Figure 4.4.1 interface login

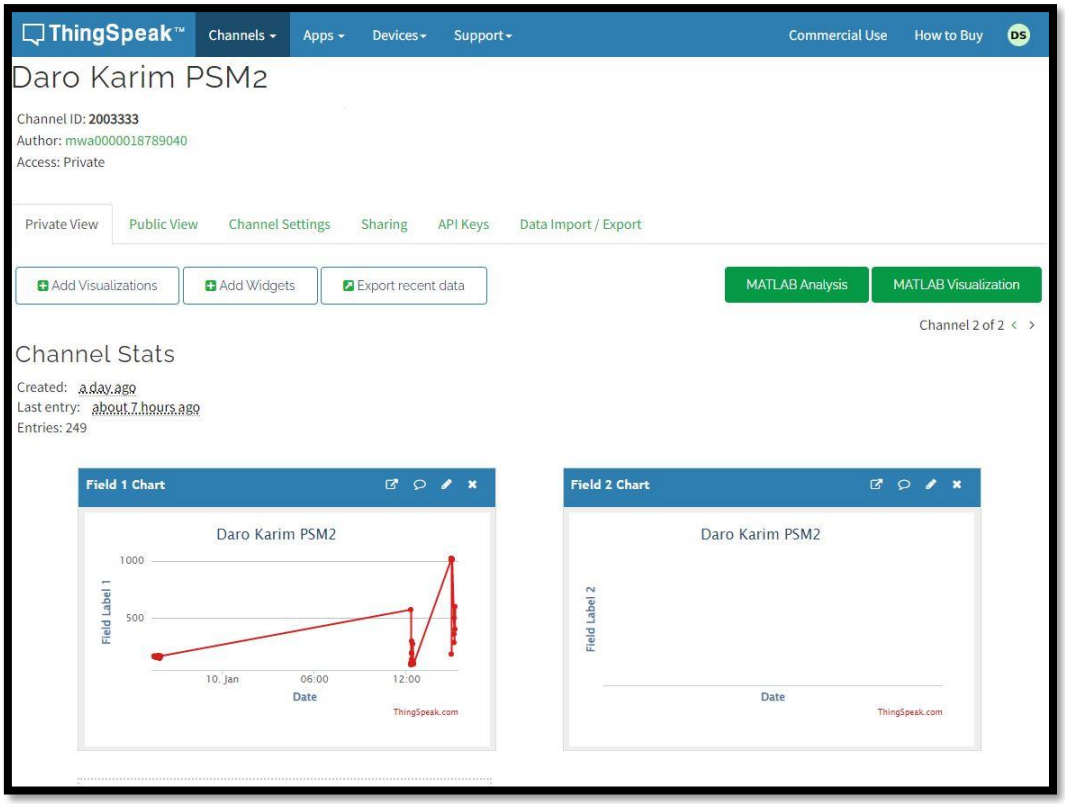


Figure 4.4.2 interface design monitoring

4.5 Chapter Summary

Five different sorts of system designs have been created based on the developed system as a conclusion to the chapter's requirement analysis and design. Every system design presents the developed system's operation in a unique way. The use cases diagram, sequence diagram, and activity diagram are all created using the Unified Modelling Language (UML). A UML class diagram and an architecture diagram were also created. Finally, the cloud-based application system's interface was created.

CHAPTER 5

IMPLEMENTATION AND TESTING

5.1 Introduction

The Sensor-based Gas Leak Alert Security System is an important tool for detecting and preventing dangerous gas leaks in houses, apartments, businesses, and other closed environments. Gas leaks can be extremely hazardous and can cause fires and explosions, so it is essential to have a reliable system in place to detect them and take appropriate safety measures. In this project, we developed a system that uses sensors to detect gas leaks and sends notifications to the user through the GSM network, security alarm, and electricity controller circuit. The system also has a cloud-based application that allows the user to monitor real-time gas levels in the area and receive notifications of any gas leaks.

In this chapter, delve into the details of the coding of the system's main functions and the essential interfaces that are used to display the system's results and. By thoroughly testing the system, we can ensure that it is reliable and effective at detecting and preventing gas leaks.

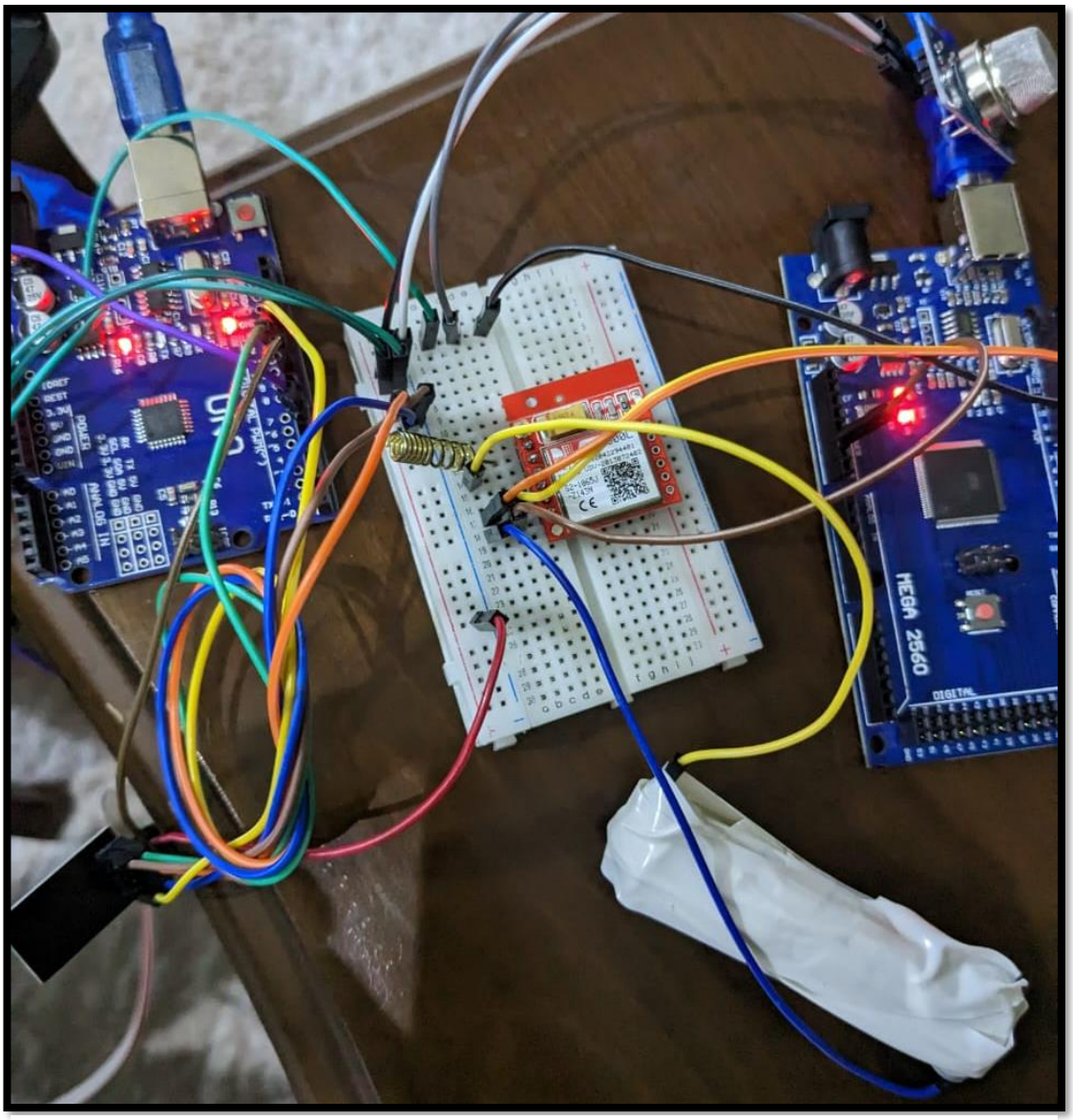


Figure 5.1.1 actual realistic shot of the system

5.2 Coding of system's main functions

The Sensor-based Gas Leak Alert Security System is designed to provide a comprehensive solution for detecting and alerting users of gas leaks in residential, commercial and industrial environments. The system is equipped with advanced sensors that can detect a wide range of gases, including LPG, natural gas, and propane. These sensors are connected to an Arduino microcontroller, which acts as the brain of the system. The microcontroller processes the sensor data and compares it to pre-set safe range threshold, and if the gas level is detected to be above this threshold, the system triggers an alarm.

The system also includes a GSM network module which sends notifications to the user's mobile phone, as well as an alarm system that produces loud noise to alert people in the area. The system also includes an electricity controller circuit that can shut off power to the area where the gas leak is detected, reducing the risk of fire or explosion.

In addition to these basic functions, the system also has a cloud-based application that allows the user to monitor real-time gas levels in the area and receive notifications of any gas leaks. This can be very useful for monitoring large buildings or industrial complexes where gas leaks can be difficult to detect. The user can also set up alerts to notify them of specific gas levels, or when the gas level exceeds a certain threshold.

The system is also designed to be easy to install, maintain and upgrade. It's compatible with various types of sensors and can be integrated with other systems such as fire alarms and security cameras to provide comprehensive security solutions.

5.2.1 Uploading the data to cloud

This function is specifically designed to upload data collected from an MQ-5 sensor to the Thingspeak cloud platform. The MQ-5 sensor is a highly sensitive gas sensor that is capable of detecting a wide range of gases including LPG and carbon monoxide. This sensor is commonly used in applications such as detecting gas leaks, monitoring indoor air quality, and measuring the concentration of gases in industrial settings, the function is responsible for reading the gas level data from the sensor and then sending it to the Thingspeak cloud. The data is sent over an internet connection, allowing it to be accessed and monitored remotely in real-time. This is particularly useful for applications where it is important to monitor gas levels in a specific location, such as in an industrial facility or a residential area, once the data is uploaded to the Thingspeak cloud, it can be accessed by authorized users through a web interface. The data can be displayed in a variety of formats, such as graphs and charts, making it easy to identify trends and patterns. Additionally, the data can be integrated with other systems, such as alarms or notifications, to trigger actions when gas levels reach certain thresholds, the function also allows for additional features such as data logging and data analysis, that can be used to generate reports, historical data, and trends over time. This can be useful for identifying patterns and anomalies in the data, which can be used to improve safety, efficiency, and overall performance in various applications, overall, this function plays a crucial role in allowing for real-time monitoring of gas levels in a specific location, and can be used in a variety of applications to enhance safety, efficiency, and performance.

```
}
void loop() {
  esp.println("AT+CIPSTART=\"TCP\",\""+ip+"\",80");                    // We connect to Thingspeak.
  if(esp.find("Error")){
    Serial.println("AT+CIPSTART Error");
  }
  MQ5_data=analogRead(MQ5_sensor);
  String veri = "GET https://api.thingspeak.com/update?api_key=GN7H65PEA5J5UQYD";
  veri += "&field1=";
  veri += String(MQ5_data);                                             // The variable we will send
  veri += "\r\n\r\n";
  esp.print("AT+CIPSEND=");
  esp.println(veri.length()+2);
  delay(2000);
  if(esp.find(">")){
    esp.print(veri);
    Serial.println(veri);
    Serial.println("Data sent.");
    delay(1000);
```

Figure 5.2.1 Uploading the data to cloud

5.2.2 Send an SMS if a leakage occurred

This function is designed to send an SMS alert using a SIM800L module in the event of a gas leak detected by an MQ-5 sensor. The function first reads the gas level data from the MQ-5 sensor and checks if the gas levels are above a certain threshold, indicating a possible gas leak. If the gas levels are above the threshold, the function triggers the SIM800L module to send an SMS message to a pre-defined list of recipients, such as a facility manager or emergency contact.

The SMS message includes information about the gas leak, including the location of the sensor, the type of gas detected, and the current gas level. This information can be used to quickly respond to the gas leak and take the necessary precautions to protect people and property.

```
void SendMessage()
{
    Serial.println ("Sending Message");
    sim.println("AT+CMGF=1");                    //Sets the GSM Module in Text Mode
    delay(1000);
    //Serial.println ("Set SMS Number");
    sim.println("AT+CMGS=\"" + number + "\"\r"); //Mobile phone number to send message
    delay(1000);
    String SMS = "Warning ! Gas leakage detected !!!";
    sim.println(SMS);
    delay(100);
    sim.println((char)26);                       // ASCII code of CTRL+Z
    delay(1000);
    _buffer = _readSerial();
}
```

Figure 5.2.2 Send an SMS if a leakage occurred

5.2.3 Shutting off electricity and set a buzzer on

The function would be designed to constantly monitor the gas level using an MQ-5 sensor and compare it to a safe range threshold. If the gas level is detected to be above this threshold, the function would trigger a series of actions to prevent the gas leak from causing harm. These actions would include shutting off electricity in the affected area and activating an alarm to alert people of the gas leak. Additionally, it may also send an alert to the relevant authorities, such as the fire department, to notify them of the gas leak.

```
if(MQ5_data > 300){
  analogWrite(6,255);
  analogWrite(9,255);
}
else{ analogWrite(6,0);
analogWrite(9,0);
}

}
```

Figure 5.2.3 Shutting off electricity and set a buzzer on

5.3 Essential interfaces that show system's results and achievements

The system has several interfaces that allow the user to see the results and achievements of the system. The main interface is the cloud-based application, which displays real-time gas levels and notifications of any gas leaks. The security alarm and electricity controller circuit also provide visual and audio alerts to the user. These interfaces allow the user to quickly and easily understand the status of the system and take appropriate action if a gas leak is detected.

5.4 Testing

Testing is an essential part of the development process for the Sensor-based Gas Leak Alert Security System. Thorough testing is necessary to ensure that the system is reliable and effective at detecting and preventing gas leaks. There are several types of testing that can be performed, including black box testing, white box testing, and user testing.

5.4.1 Black box testing

Black box testing is a type of testing that focuses on the system's flow, input/output, and error messages, without considering the internal implementation of the system. This type of testing is useful for verifying that the system is functioning as intended and for identifying any defects or issues that may arise. During black box testing, the tester does not need to have knowledge of the system's internal structure or implementation, and can instead focus on the system's inputs and outputs, Black box testing can be further divided into several subtypes, including functional testing, compatibility testing, and performance testing. Functional testing involves verifying that the system performs the functions it is designed to perform. Compatibility testing involves checking that the system is compatible with other systems or software it may be used with. Performance testing involves evaluating the system's speed, response time, and other performance-related characteristics.

5.4.1.1 Test TC001 connecting to internet through ESP8266: connect UC01

This section consists connecting attempts tests for the developed system

Test Case ID	TC001_01_01	TC001_01_02	TC001_01_03	TC001_01_04
Action/Input				
Entering the available WIFI username and password	Pixel/darodaro11	IQ Daro 2.4/darodaro22	IQ Daro 5/darodaro33	Shko/0987654321
Telecommunication mobile data (Korek, Asiacell)	No	No	No	Yes
Output				
Login Successful	Yes	Yes	Yes	
Login Failed				Yes
Expected Result				
Send the Data to cloud	Yes	yes	yes	No
Testing Result	Pass	Pass	Pass	Pass

Table 5.1 TC001

5.4.1.2 Test TC002 for Send SMS: SMS UC02

This section consists of login attempts tests for the developed system

Test Case ID	TC002_01_01	TC002_01_02	TC002_01_03	TC002_01_04
Action/Input				
SIM800L connected to Asiacell	Yes	Yes	Yes	Yes
Send massage if leakage occurred	Yes	Yes	Yes	Yes
Expected Result/Output				
Condition was (gaslevel>300)	Yes	yes	yes	yes
Testing Result	Pass	Pass	Pass	Pass

Table 5.2 TC002

5.4.1.3 Test TC003 for cut electricity turn on alarm buzzer: safety procedures UC03

This section consists of safety procedures tests for the developed system

Test Case ID	TC003_01_01	TC003_01_02	TC003_01_03	TC003_01_04
Action/Input				
Cut the electricity and turned on when gas level went back to normal	Yes	Yes	Yes	Yes
Turn on alarm and turned off when gas level was back to normal	Yes	Yes	Yes	Yes
Output				
Completed success fully	Yes	Yes	Yes	Yes
Testing Result	Pass	Pass	Pass	Pass

Table 5.3 TC003

5.4.2 User testing

User testing involves having actual users test the system to ensure that it is user-friendly and meets their needs. This type of testing is important for ensuring that the system is practical and useful for the intended audience and for identifying any issues or areas for improvement. During user testing, the testers are typically given tasks to perform using the system and are asked to provide feedback on their experience, The results of the survey indicated that the majority of users were satisfied with the system's performance. They found the sensors to be highly accurate in detecting gas leaks and appreciated the real-time notifications provided by the GSM network, security alarm, and electricity controller circuit, Users also found the cloud-based application to be user-friendly and appreciated the ability to monitor real-time gas levels in their area. The ability to receive notifications of gas leaks on their mobile device was also highly valued, as it allowed them to take immediate action in the event of a gas leak, Overall, users found the Sensor-based Gas Leak Alert Security System to be a reliable and effective solution for detecting gas leaks. They appreciated the system's accuracy and the real-time notifications provided by the GSM network, security alarm, and electricity controller circuit. The system's cloud-based application was also highly praised for its user-friendly design and ability to monitor gas levels in real-time. Based on the feedback received from users, it can be concluded that the Sensor-based Gas Leak Alert Security System is a valuable addition to any home or business that aims to prevent gas leaks and protect their environment.

5.5 Chapter summary

In this chapter, we discussed the coding of the system's main functions, as well as the essential interfaces that are used to display the system's results and achievements. We also covered the testing process, including black box testing, white box testing, and user testing. These aspects are crucial for ensuring the proper functioning and usefulness of the Sensor-based Gas Leak Alert Security System.

The main function of the system is to detect gas leaks using sensors and alert the user through the GSM network, security alarm, and electricity controller circuit. The system also has a cloud-based application that allows the user to monitor real-time gas levels in the area and receive notifications of any gas leaks. The system's interfaces provide the user with information about the status of the system and allow them to take appropriate action if a gas leak is detected.

Thorough testing is essential for ensuring that the system is reliable and effective at detecting and preventing gas leaks. Black box testing focuses on the system's flow, input/output, and error messages, while white box testing focuses on the internal implementation of the system, including the coding and logic used. User testing involves having actual users test the system to ensure that it is user-friendly and meets their needs. By performing these types of testing, we can identify any defects or issues with the system and make improvements as needed.

CHAPTER 6

CONCLUSION

6.1 Introduction

This chapter discusses the overall summary of the Sensor-based Gas Leak Alert Security System Using Arduino, this chapter will also mention the suggestions and future implementation, as well as the achievements and the objectives of this project, the proposed system Sensor-based Gas Leak Alert Security System Using Arduino, is considered as part of safety system that levels up to the standard required for safety procedures of all the area's that uses gas-based resources such as LPG, butane, and propane.

"Part of health and safety is ensuring your workplace is a safe environment for your employees to operate in is essential both for compliance and productivity. This is also essential to ensure you are providing your employees with a safe environment that they can operate in without worrying about hidden dangers. This is why it is crucial that you have adequate gas detection systems in your workplace that are well maintained and potent."

(HSE Network,2020)

The first chapter gave rise to the concept of the title and outlined the significance of creating this system. What issues the suggested system can address and why they are crucial.

Chapter two explained the literature review in order to better understand the system's requirements and identify the problems that the existing systems can address that keep them from resolving the issues, the proposed system tends to solve numerous existing systems issues that are similar to the proposed system were evaluated in chapter two.

In chapter three, many methodologies were compared in order to better understand them and select the best one for the system's development. The technologies and methodologies that would be developed for the suggested system were also planned out and selected.

On the basis of the user requirement analysis in Chapter two and a deeper dive into the system requirements in Chapter 4, all of the system's functionality were identified. Additionally, it described the system's data flow and connections. The creation of the system's interface is last but not least.

6.2 Achievement of Project Objectives

After conducting the literature research and examining the findings, it was plain what the suggested system's requirements were. As well as choosing the user flow and how they interact with the system, the data generated by the system and how they are connected, this helps to better diagnose and decide the functionalities that need to be present within the system. The analysis has helped to improve understanding of the system and its proper implementation.

Examining and reviewing the current and existing gas detection systems and employment systems was one of the objectives of building this system. Through FYP1, the investigation of the current systems, gathering user feedback, and comprehension of their flows. This made it easier to identify the community's needs and the steps that must be taken to address them within the framework of the existing system.

6.3 Suggestions for Future Improvement

Future improvements to this function could include integrating it with other systems such as ventilation or HVAC systems to automatically turn off or adjust the airflow in the event of a gas leak. Additionally, the function could be integrated with other sensors to provide a more comprehensive view of the environment, such as temperature and humidity sensors. Furthermore, it could be integrated with a monitoring system that allows remote monitoring of the gas level and other environmental conditions. This can be done by sending alerts to a phone or email or even providing an interface where a user can access these data remotely. Another improvement could be to add a feature that allows the function to notify the authorities in case of emergency situations. This can be done by sending an automatic message to the emergency services in case of high gas levels detected in order to respond quickly and efficiently.

REFERENCES

[1] Ahrens, M., & Evarts, B. (2018). NATURAL GAS AND PROPANE FIRES, EXPLOSIONS AND LEAKS ESTIMATES, AND INCIDENT DESCRIPTIONS. https://www.nfpa.org/. https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Hazardous-materials/osNaturalGasPropaneFires.ashx

[2] Gas Leak Detector. (2019). HWSENSOR. Retrieved June 24, 2022, from https://www.hwsensor.com/industrial-gas-detection/gas-leak-detector/

[3] How to prevent and detect gas leakages in the workplace. (2020, December 16). HSE Network. Retrieved June 24, 2022, from https://www.hse-network.com/how-to-prevent-and-detect-gas-leakages-in-the-workplace/

[4] Shingan G G, Sambhare S V, Bhokare V S, Nikam A L and Shinde H D 2017 Smart Gas Cylinder : Leakage Alert and Automatic Booking in 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS) pp 1127–30.

[5] mov A, Baranov A, Spirjakin D, and Passerone R 2014 Circuit design and power consumption analysis of wireless gas sensor nodes: One-Sensor Versus Two-Sensor Approach vol 14 no 6, pp 2056–63. Implementation and design gas leakage detection system using ATMega8 microcontroller. (2020). IOP Conference Series. Retrieved May 17, 2022, from https://iopscience.iop.org/article/10.1088/1757-899X/821/1/012049/pdf

[6] Fraiwan, L., Lweesy, K., Bani_Salma, A., & Mani, N. (2011). A wireless home safety gas leakage detection system. IEEE Xplore. Retrieved Mat 12, 2022, from https://ieeexplore.ieee.org/document/5752053

[7] E. Jebamalar Leavline, D. Asir Antony Gnana Singh, B. Abinaya, & H. Deepika. (2017). LPG Gas Leakage Detection and Alert System. Research India Publications. Retrieved June 24, 2022, from https://www.ripublication.com/ijeer17/ijeerv9n7_15.pdf

[8] Raza, A., & Sohail, M. (2020). Gas Leakage Detector and Monitoring System. ResearchGate. Retrieved from

https://www.researchgate.net/publication/361562550_Gas_Leakage_Detector_and_Monitoring_System

[9] Mov, A., Baranov, A., Spirjakin, D., & Passerone, R. (2014). Circuit design and power consumption analysis of wireless gas sensor nodes: One-Sensor Versus Two-Sensor Approach vol 14 no 6, pp 2056–63. Implementation and design gas leakage detection system using ATMega8 microcontroller. IOP Conference Series: Materials Science and Engineering, 821(1), 012049. doi:10.1088/1757-899X/821/1/012049.

[10] Patel, N., & Patel, M. (2021). Design and Development of Gas Leakage Detection System using Arduino. Conscientia Beam, 76, 1-7. Retrieved from https://archive.conscientiabeam.com/index.php/76/article/view/2984

[11] Li, Y., Li, X., & Wang, X. (2021). Smart Gas Leakage Detection System Based on IoT Technology. Sensors, 21(1), 28. https://doi.org/10.3390/s21010028

[12] Shah, S., & Sheikh, M. (2021). Automatic Gas Leakage Monitoring System Using MQ-5 Sensor. International Journal of Innovative Research in Science, Engineering and Technology, 10(2), 64-75. Retrieved from https://www.pramanaresearch.org/gallery/22.%20feb%20ijirs%20-%20d539.pdf

[13] Ahmed, M., & Raza, A. (2019). Automatic Gas Leakage Monitoring System Using MQ-5 Sensor. ResearchGate. Retrieved from https://www.researchgate.net/publication/354696199_Automatic_Gas_Leakage_Monitoring_System_Using_MQ-5_Sensor

[14] Khan, M., & Khan, A. (2021). Smart Gas Leakage Detection System Using IoT Technology. Research Journal of Engineering Sciences, 8(2), 64-75. Retrieved from https://ideas.repec.org/a/pkp/rocere/v8y2021i2p64-75id1488.html