NAALAIYA THIRAN PROJECT - 2022
19ECI01-PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

GAS LEAKAGE MONITORING AND ALERTING SYSTEM

PROJECT REPORT

Submitted by

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ANNA UNIVERSITY: CHENNAI 600025

NOVEMBER 2022

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BONAFIDE CERTIFICATE

Certified that this report **"GAS LEAKAGE MONITORING AND LEAKAGE DETECTION SYSTEM USING IOT"** is the Bonafide work of **GOKULAN P(1904009), JAYANTH A(1904016), KISHORE R(1904022), PRIYAKANTH G(1904037)** who carried out **19EC101 Professional Readiness for Innovation, Employability and Entrepreneurship** project offered by IBM and Anna University ,Chennai.

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PROJECT CALENDER

Phase	Phase Description	Week	Dates	Activity Details
1	Preparation Phase (Pre-requisites, Registrations, Environment Set-up, etc.)	2	22 - 27 Aug 2022	Creation GitHub account & collaborate with Project repository in project workspace
2	Ideation Phase (Literature Survey, Empathize, Defining Problem Statement, Ideation)	2	29 Aug – 3rd Sept 2022	Literature survey (Aim, objective, problem statement and need for the project)
		3	5 - 10th Sept 2022	Preparing Empathy Map Canvas to capture the user Pains & Gains
		4	12 - 17 Sept 2022	Listing of the ideas using brainstorming session
3	Project Design Phase -I (Proposed Solution, Problem-Solution Fit, Solution Architecture)	5	19 - 24 Sept 2022	Preparing the proposed solution document
		6	26 Sept - 01 Oct 2022	Preparing problem - solution fit document & Solution Architecture
4	Project Design Phase -II (Requirement Analysis, Customer Journey, Data Flow Diagrams, Technology Architecture)	7	3 - 8 Oct 2022	Preparing the customer journey maps
		8	10 - 15 Oct 2022	Preparing the Functional Requirement Document & Data- Flow Diagrams and Technology Architecture
5	Project Planning Phase (Milestones & Tasks, Sprint Schedules)	9	17 - 22 Oct 2022	Preparing Milestone & Activity List, Sprint Delivery Plan
6	Project Development Phase (Coding& Solutioning, acceptance Testing, Performance Testing)	10	24 - 29 Oct 2022	Preparing Project Development - Delivery of Sprint-1
		11	31 Oct - 5 Nov 2022	Preparing Project Development - Delivery of Sprint-2
		12	7 - 12 Nov 2022	Preparing Project Development - Delivery of Sprint-3
		13	14 - 19 Nov 2022	Preparing Project Development - Delivery of Sprint-4

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CHAPTER 1
INTRODUCTION

1.1 PROJECT OVERVIEW

In the model, Arduino UNO R3 is used as a microcontroller which controls all the setup in the board like a brain. By the use of Arduino IDE dump the Arduino code to the microcontroller. MQ7 gas sensor is used to detect the Carbon monoxide in the environment, MQ135 sensor is used to detect Carbon di oxide and H2S in the air. In the 1st case, By the use of Rf transmitter and receiver imported wireless connection for sending and receiving the data which was sensed by the gas sensors. After receiving the data, the Vibration motor vibrate for the sake of alert the worker. In the 2nd case, when sensor sense the toxic gas, it will send the message to the authority by using the ESP8266.

1.2 PURPOSE

To Save the workers working in hazardous conditions like Steel factories. This proposed model will immediately alert the worker by vibration. Worker suddenly intimated and go away from the toxic environment. From the ALERT message, the authority sends the rescue team to the hazardous area.

CHAPTER 2
LITERATURE SURVEY

2.1 EXISTING SOLUTION

In the existing solution, in case of leakage of toxic gases in the industries it will be detected by the common sensor placed in the corner or at one part of the industry. Then the common buzzer/alarm intimate the worker. But this emergency alert may be inaudible to those workers who works near the machines. And the authority does not know what will happen in the hectic environment.

2.3 PROBLEM STATEMENT DEFINITION

In the system, it could do two processes simultaneously for to alert the worker by the Vibration motor and send the message to the authority at the same time. So, to save the valuable worker's lives from the cause of dangerous gas and send the rescue team to that spot to rectify the accident.

2.3 SUMMARY

RF module to transmit & receive the measured data of CO2. By Web server they monitor sensor readings with the help of ARM7 microcontroller. GSM module SIM900 is used to send SMS. Using "Net beans" and "SQL" to monitoring the measured value of CO2 and send the alert message to the SMART WATCH. To show the measured data in monitoring window in IDE. Monitoring the measured values of CO2 and CH4 in smart watch. Sensor readings are displayed in LCD. People who are all surrounding the industries are saved. Sometimes the worker didn't see the smart watch during the work.

CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a collaborative visualization used to express clearly what one knows about a particular type of user. It externalizes knowledge about users in order to create a shared understanding of user needs, and aid in decision making.

Empathy maps are split into 4 quadrants (Says, Thinks, Does, and Feels), with the user in the middle. Empathy maps provide a glance into who a user is as a whole. The ***Says*** quadrant contains what the user says or what he needs. The ***Thinks*** quadrant captures what the user is thinking throughout the experience. The ***Does*** quadrant encloses the actions the user takes. The ***Feels*** quadrant is the user's emotional state.

The empathy map for GAS LEAKAGE MONITORING AND ALERT SYSTEM FOR INDUSTRIES is shown in Fig 3.1

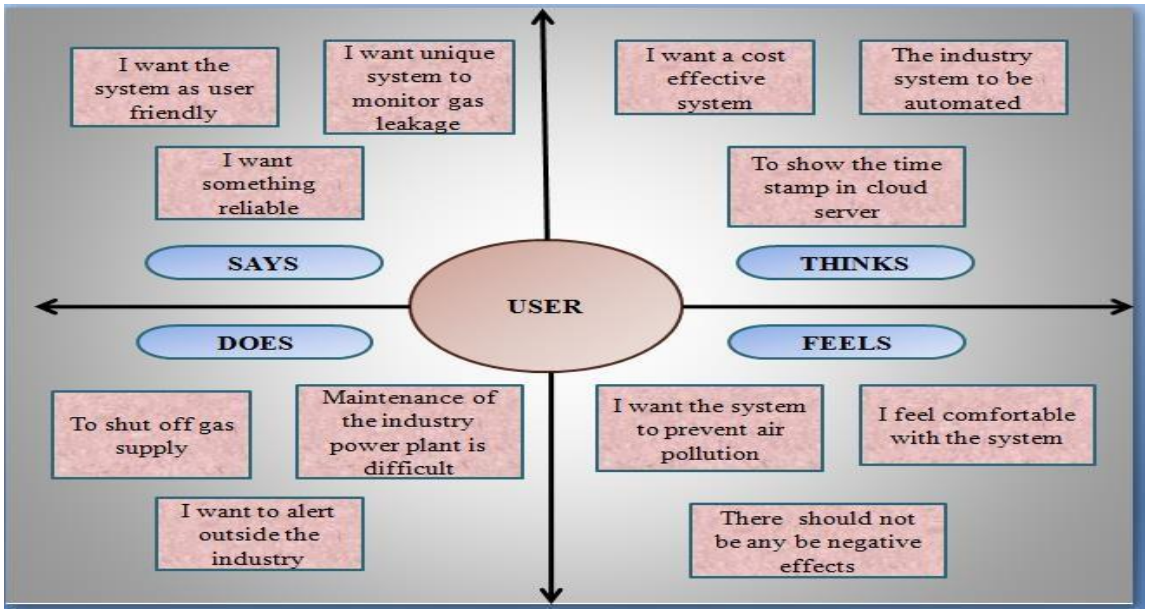

Fig 3.1 Empathy map

3.2 IDEATION AND BRAINSTORMING

Ideation is often closely related to the practice of brainstorming, a specific technique that is utilized to generate new ideas. Brainstorming is usually conducted by getting a group of people together to come up with either general new ideas or ideas for solving a specific problem or dealing with a specific situation. A principal difference between ideation and brainstorming is that ideation is commonly more thought of as being an individual pursuit, while brainstorming is almost always a group activity. Both brainstorming and ideation are processes invented to create new valuable ideas, perspectives, concepts, and insights, and both are methods for envisioning new frameworks and systemic problem solving.

The Ideation chart for GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES is shown in Table 3.2.

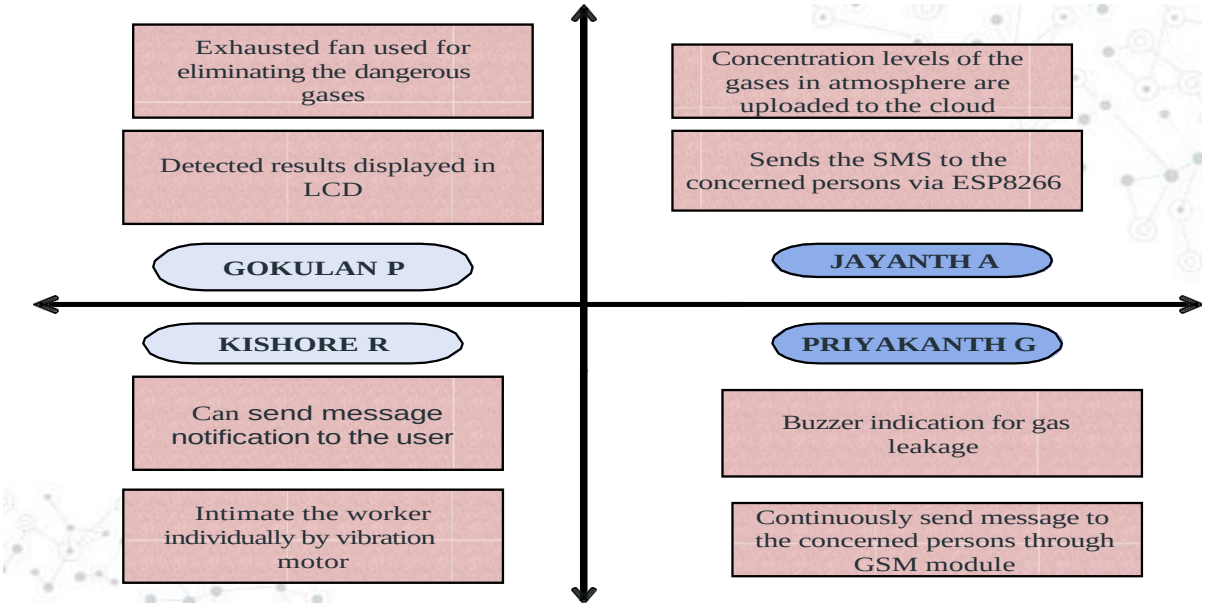

Fig 3.2 Ideation and Brainstorming

3.3 PROPOSED SOLUTION

The proposed solution for GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES is shown in table 3.3

Table 3.3 Proposed Solution

S. No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	Leaks are thought to be extremely harmful because they have the potential to build up to an explosive concentration. The suggested solution is utilized to construct an effective system and an application that can watch for leaks and notify the workers.
2.	**Idea / Solution description**	The gas sensors will be fitted at different locations to track gas leaks. The suggested system initiates an automatic control response upon 0.001% LPG leakage Detection. With the help of a stepper motor-driven mechanical handle,

		the valve can be closed automatically. By employing a relay and stepper motor in tandem to cut off the house's electric power, we are able to increase human security. We are also employing a GSM module to send an alarm message via SMS (Short Messaging Services) to the users informing them of the LPG leak, and a buzzer is given to notify the neighbors in case the customers are not there.
3.	**Benefit of this System**	The key benefit of this system over the manual approach is that it completes every step automatically and responds quickly. And the buzzer will work efficiently to reduce the level of hazardous range due to the leakage.

4.	**Novelty / Uniqueness**	User friendly and easy to operate. Instigating the study of CCD technology for visible-range natural gas detection. Buzzer will have more alerting range
5.	**Social Impact / Customer Satisfaction**	It is economical Simple installation and the efficient results are guaranteed and ensured.
6.	**Business Model (RevenueModel)**	Energy security is currently one of the objectives in actual practice due to the broad deployment of the urban natural gas industry. The analysis of the pressure, temperature, and flow rate of gas leakage over time under steady-state and dynamic settings was done using the gas leakage model. Because everyone can understand how to utilise the product, it is simple for them to use it correctly for their safest

		organization.
7.	**Scalability of the Solution**	Setting up quick communication tools with the closest fire station and other relief station to ensure the quickest reaction in the event of an accident and in the emergency situations. Even when there is a greater gas leak, the product detects precise readings and successfully warns the workers and will help the people to alert more quickly.

Table 3.3 Proposed Solution

3.4 PROBLEM SOLUTION FIT

The Problem solution fit simply means that one have found a problem with the customer and that the solution one have realised for it actually solves the customers problem. The problem solution fit is an important step towards the Product-Market Fit. The structure of problem solution fit is given below.

Customer state fit: To make sure one understands the target group, their limitations, and their currently available solutions, against which one is going to compete.

Problem-Behavior fit: To help one to identify the most urgent and frequent problems, understand the real reasons behind them and see which behavior supports it.

Communication-Channel fit: To help one to sharpen the communication with strong triggers, emotional messaging and reaching customers via the right channels.

Solution guess: Translate all the validated data one has gathered into a solution that fits the customer state and his/her limitations, solves a real problem and taps into the common behavior of the target group.

The Problem solution fit for GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES is shown in table 3.4.

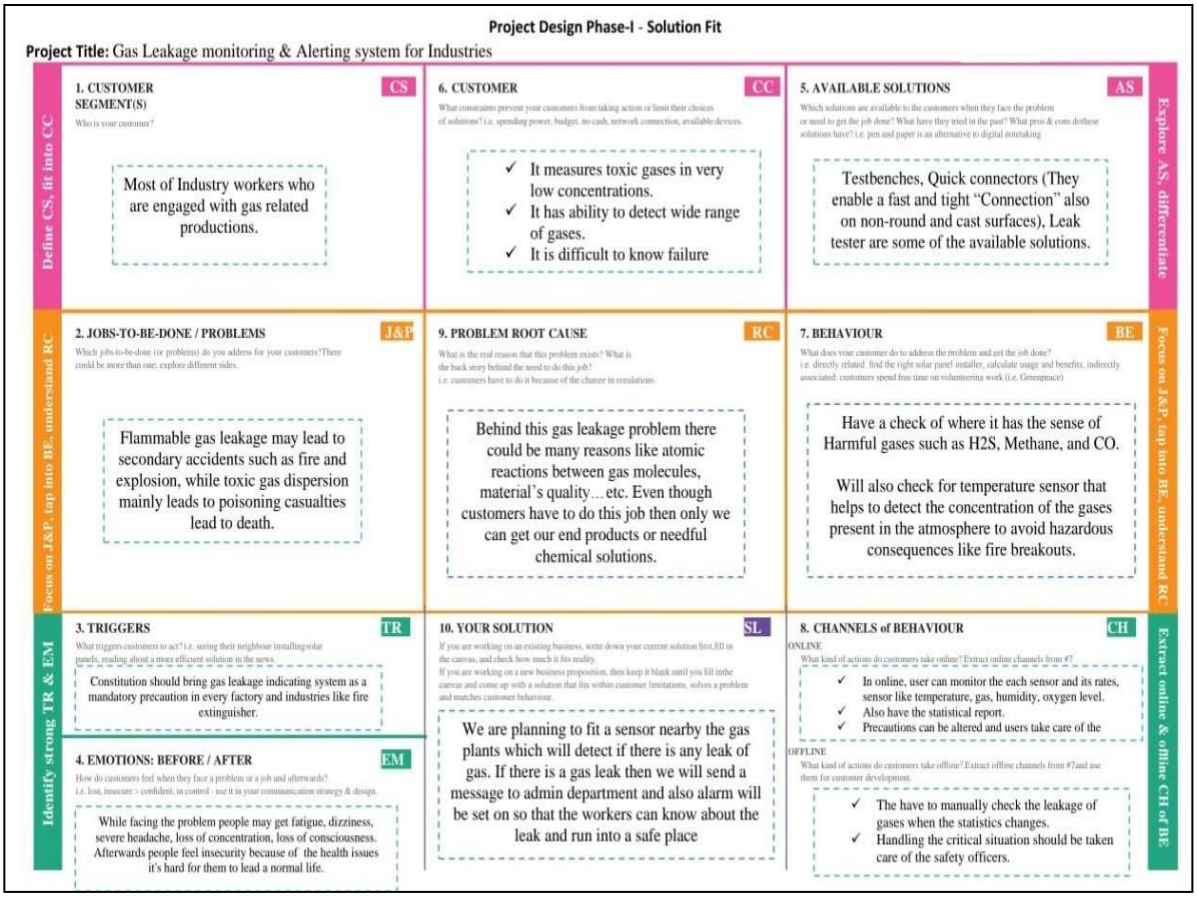

Fig 3.4 Problem Solution fit

CHAPTER 4
REQUIREMENT ANALYSIS

Requirements analysis is very critical process that enables the success of a system or software project to be assessed. Requirements are generally split into two types: Functional and Non-functional requirements.

4.1 FUNCTIONAL REQUIREMENTS

These are the requirements that the end user specifically demands as basic facilities that the system should offer. All these functionalities need to be necessarily incorporated into the system as a part of the contract. These are represented or stated in the form of input to be given to the system, the operation performed and the output expected. They are basically the requirements stated by the user which one can see directly in the final product, unlike the non-functional requirements.

The following table 4.1 shows the functional requirements for GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES.

Business Requirements	**User Requirements**	**Product Requirements**
The said system can be deployedin homes, hotels, factory units, LPG cylinder storage areas, and so on. The main advantage	The gas leakage detection system can be optimized for detecting toxic gasses along withupgrading them with smoke andfire	Detecting gasses is necessary regardless of your business role or individual purpose.

of this IoT and Arduino-based application is that it can determine the leakage and send the data over to a site. It can be monitored, and preventive measures can be taken to avoid any disaster.	detectors to identify the presence of smoke and fire. Ensuring worker safety is important but making using ofthe right technology is even more vital.	Certain technologies at play make such IoT devices what they are, and ifyou want to indulge in IoT application development, you must know what they are and what purpose they can fulfill.

Table 4.1 Functional Requirements for the Gas leakage monitoring & alerting system for industries

4.2 NON-FUNCTIONAL REQUIREMENTS

These are basically the quality constraints that the system must satisfy according to the project contract. The priority or extent to which these factors are implemented varies from one project to other. They are also called non-behavioral requirements.

They basically deal with issues like Portability, Security, Maintainability, Reliability, Scalability, Performance, Reusability, Flexibility.

- **Data Collection:**

  We will collect the required data using a variety of sensors.

- **Data analysis:**

  Store data must be examined in order to raise alarms as needed.

- **Data monitoring:**

  The user must be shown the collected data for monitoring.

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAMS

A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and the routes between each destination. Data flowcharts can range from simple, even hand-drawn process overviews, to in-depth, multi-level DFDs that dig progressively deeper into how the data is handled. They can be used to analyse an existing system or model a new one. Like all the best diagrams and charts, a DFD can often visually "say" things that would be hard to explain in words, and they work for both technical and nontechnical audiences, from developer to CEO. That's why DFDs remain so popular after all these years. While they work well for data flow software and systems, they are less applicable nowadays to visualizing interactive, real-time or database-oriented software or systems. There are four main elements of a DFD — external entity, process, data store, and data flow.

- **External entity**

An external entity, which are also known as terminators, sources, sinks, or actors, are an outside system or process that sends or receives data to and from the diagrammed system. They're either the sources or destinations of information, so they're usually placed on the diagram's edges. External entity symbols are similar across models except for Unified, which uses a stick-figure drawing instead of a rectangle, circle, or square.

- **Process**

Process is a procedure that manipulates the data and its flow by taking incoming data, changing it, and producing an output with it. A process can do this by performing computations and using logic to sort the data, or change its flow of direction. Processes usually start from the top left of the DFD and finish on the bottom right of the diagram.

- **Data store**

Data stores hold information for later use, like a file of documents that's waiting to be processed. Data inputs flow through a process and then through a data store while data outputs flow out of a data store and then through a process.

- **Data flow**

Data flow is the path the system's information taken from external entities through processes and data stores. With arrows and succinct labels, the DFD can show the direction of the data flow.

The data flow diagram for IOT based smart crop protection system using for agriculture is shown in following figure 5.1

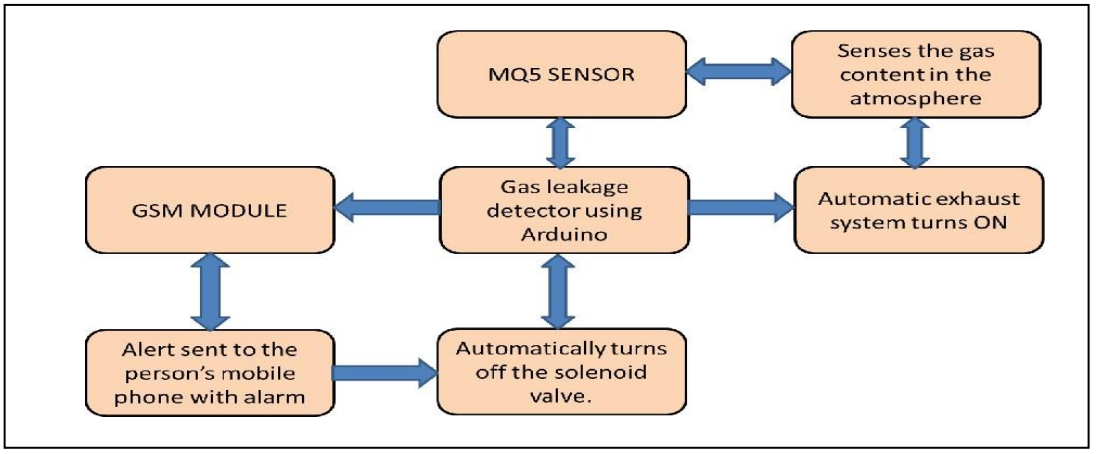

Fig 5.1 Data Flow Diagram for Gas leakage monitoring & alerting system for industries

5.2 SOLUTION AND TECHNICAL ARCHITECHTURE

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

• Find the best tech solution to solve existing business problems.

• Describe the structure, characteristics, behaviour, and other aspects of the software to project stakeholders.

• Define features, development phases, and solution requirements.

• Provide specifications according to which the solution is defined, managed, and delivered.

The figure 5.2 shows the solution architecture of GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES

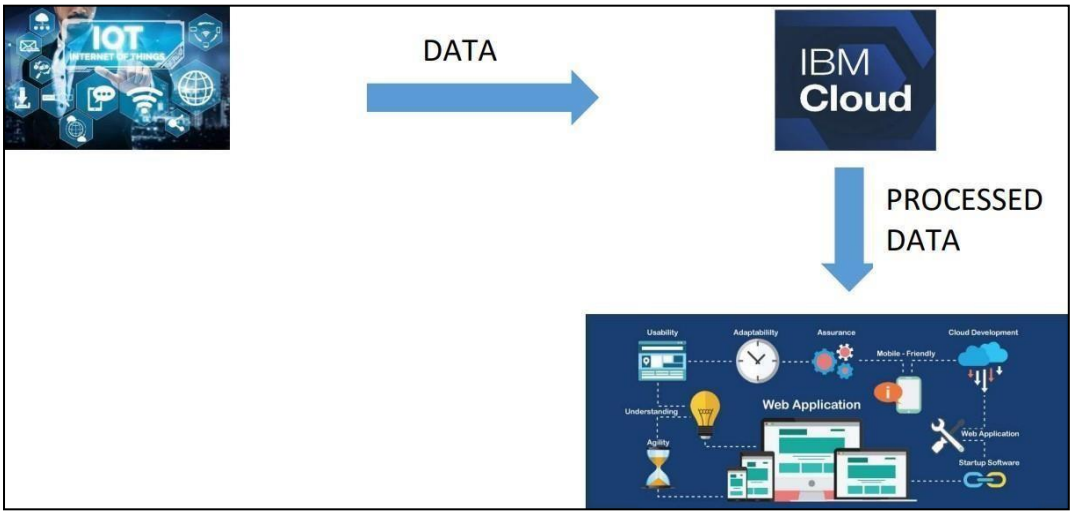

Fig 5.2 Solution Architecture of IoT based smart crop protection system

Table-5.1: Components & Technologies:

S.NO	Components	Description	Technology
1	User Interface	How user interacts with application e.g.Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript /Angular Js / React Js etc.
2	Application Logic-1	Logic for a process in the application	Java / Python
3	Application Logic-2	Logic for a process in the application	IFTTT
4	Application Logic-3	Logic for a process in the application	THINGSPEAK
5	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
6	Infrastructure (Server / Cloud)	Application Deployment on Cloud	Local, Cloud Foundry, etc.

Table-5.2: Application Characteristics:

S.NO	Characteristics	Description	Technology
1	Scalable Architecture	We can implement in Industries, Hotels,Public places	IOT (Internet of Things)
2	Availability	To Detect leakage 24/7 for interruptedservices we have implemented in distributed servers (cloud)	IBM cloud
3	Performance	If we implemented in industries, it needsmany gas sensors to detect	

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION

Sprint planning is an event in scrum that kicks off the sprint. The purpose of sprint planning is to define what can be delivered in the sprint and how that work will be achieved. Sprint planning is done in collaboration with the whole scrum team.

The sprint is a set period where all the work is done. However, before leap into action it is necessary to set up the sprint. It needs to decide on how long the time box is going to be, the sprint goal, and where it is going to start. The sprint planning session kicks off the sprint by setting the agenda and focus. If done correctly, it also creates an environment where the team is motivated, challenged, and can be successful.

The Table 6.1 shows the sprint planning and estimation of GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES.

Table 6.1 Sprint planning done for Gas leakage monitoring & alerting system for industries

SPRINT PLAN	
Identify the Problem	1
Prepare an Abstract, Problem Statement	2
List a required object needed	3
Create a Code and Run it	4

Make a Prototype	5
Test with the created code and check the designed prototype	6
Solution for the Problem is Found!!	7

Table 6.1 Sprint planning done for Gas leakage monitoring & alerting system for industries

6.1 SPRINT DELIVERY SCHEDULE

The sprint delivery plan is scheduled accordingly as shown in the below table **6.2** which consists of the sprints with respective to their duration, sprint start and end date and the releasing data.

Table 6.2 Sprint Delivery Schedule

SPRINT	TOTAL STORY POINTS	DURATION	SPRINT START DATE	SPRINT END DATE (PLANNED)	STORY POINTS COMPLETED (AS ON PLANNED END DATE)	SPRINT RELEASE DATE (ACTUAL)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	03 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

CHAPTER 7

RESULTS, CODING & SOLUTIONING

7.1 Configuring the Application to Receive the Data from Cloud

Node red flow created to get values

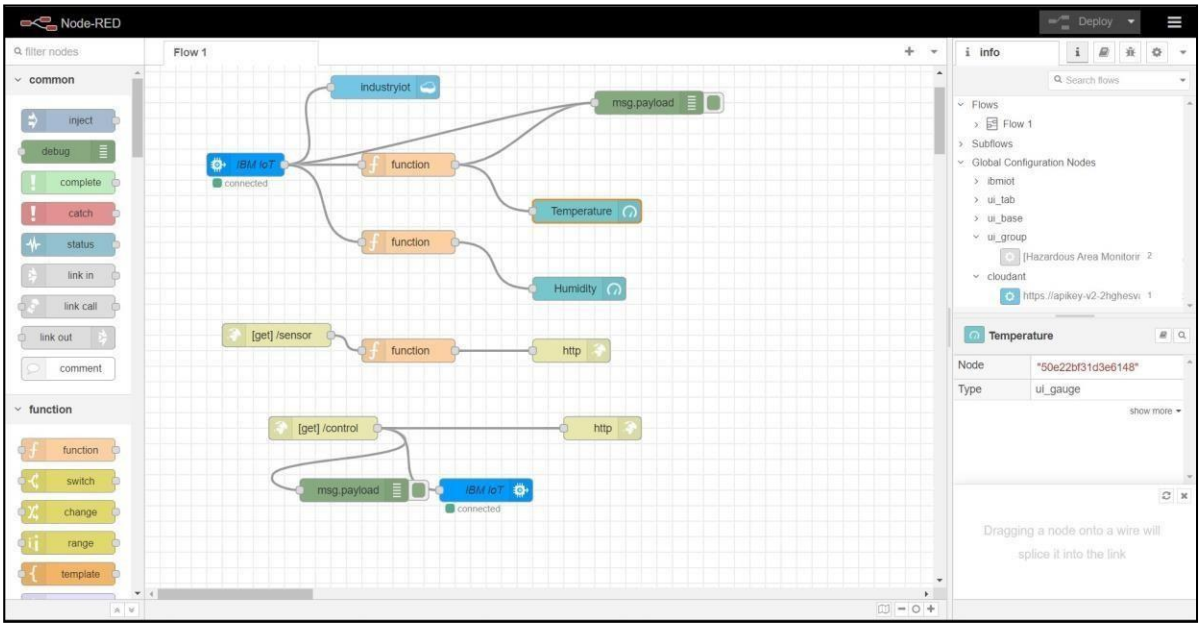

Fig 7.1 Node red flow created to get values.

Configuring function to fetch the desired value

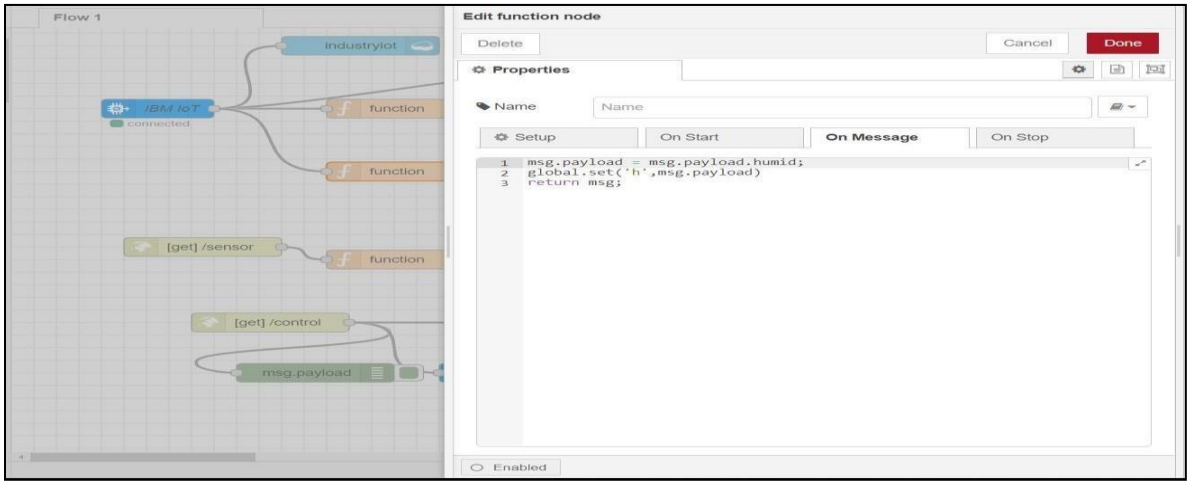

Fig 7.2 Configurating function to fetch value

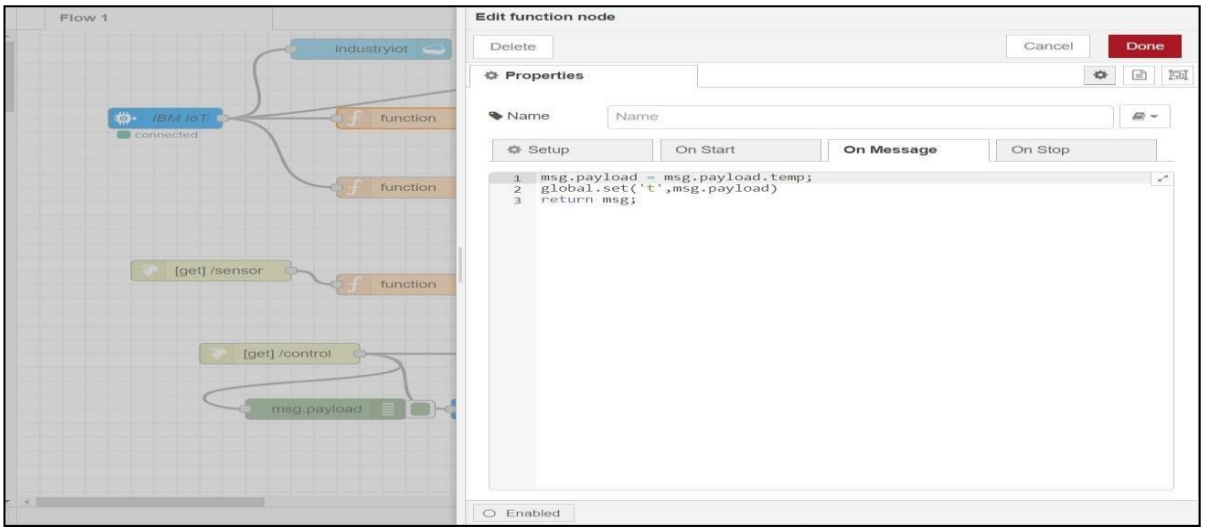

Fig 7.3 App blocks to render the values and display it in app

An online flow editor powered by Node-RED is available for developing JavaScript functions. Applications components can be shared or saved for later use. Node.js is used to build the runtime. JSON is used to store the flows that are created in Node-RED. MQTT nodes can establish properly configured TLS connections as of version 0.14**.**

7.2 IFTTT web application creation

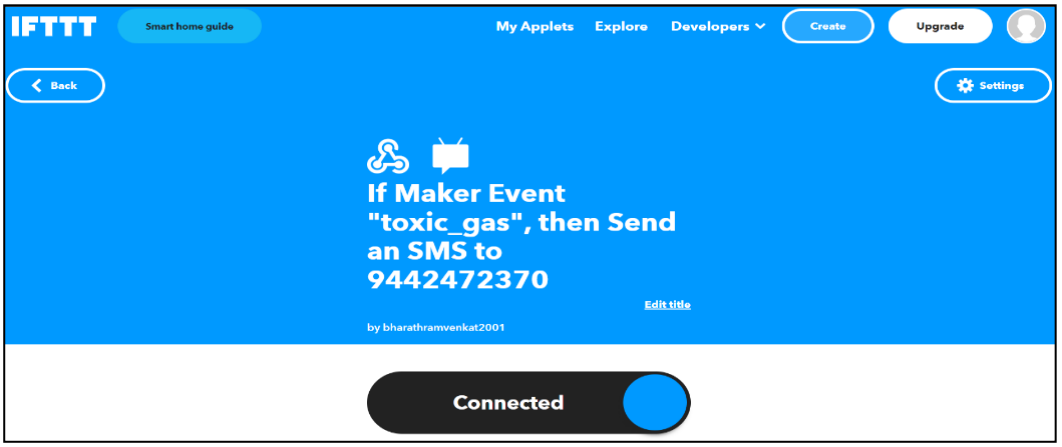

Fig. 7.4 IFTTT interface in system to connect with ESP8266

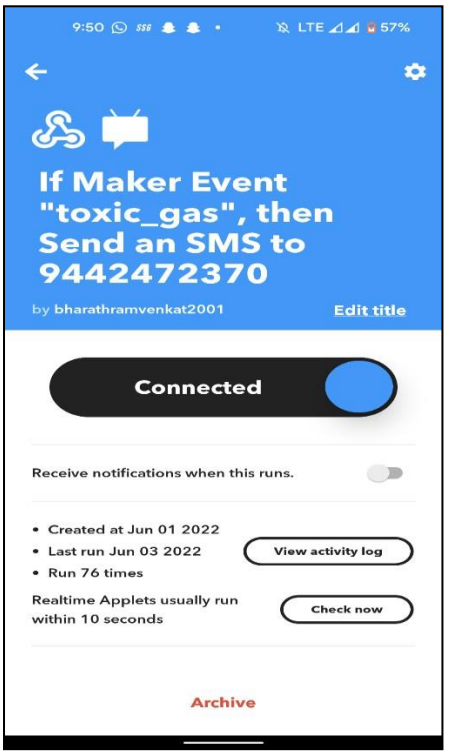

Fig. 7.5 IFTTT interface in mobile to connect with ESP8266

IFTTT stands for “If This Then That.” Basically, if certain conditions are met, then something else will happen. The “if this” part is called a trigger, and the “then that” part is called an action.

This android application should be installed in the receiver’s mobile phone. In that application, change the required things such as enter the receiver mobile number, create event name, and type the message that is needed to be sent. After all stuffs are done, generation of link is to be done and copy the link in the ESP8266 code.

IFTTT is so easy to use that anyone can learn it in minutes. Only one account is required. From there, just a few clicks and process is done. Install the IFTTT app on any Android or iPhone, or use the IFTTT website. Connect to any Apple, Facebook, or Google account to sign in, or sign in with personal email address. From the home screen or website dashboard, select Explorer to search for the applet. User can enter what they are looking for in the search bar or browse for a list of

popular IFTTT applets. Select an applet. Grant permissions for the app or service that the applet is accessing. Follow the instructions on the screen.

A link like this will be generated in the IFTTT application, "/trigger/toxic_gas/json/with/key/fGbn4jDEOUXeSJ6cbcyaEe8LRstwFx7Zqq2wdUjmr6F"

The link should be pasted in the Arduino transmitter code which is connecting both the Arduino and ESP8266.

7.3 SENSOR VALUES

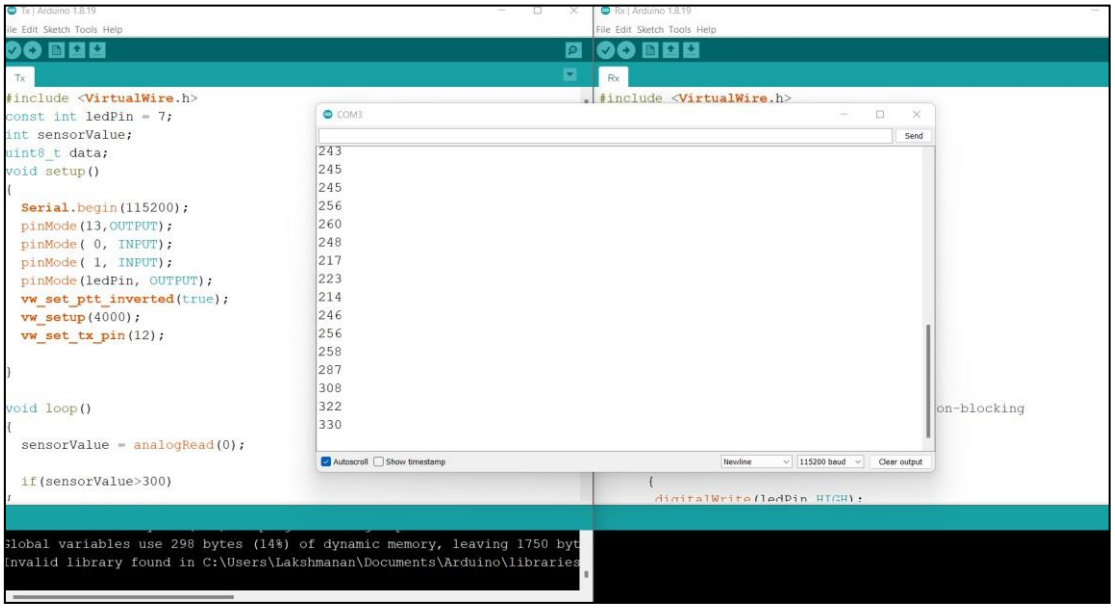

Fig. 7.6 MQ7 and MQ135 Sensor values depicting CO2

Fig 7.6 shows the real sensor values and print that in the serial monitoring window. By use of MQ7 and MQ135 sensors calculate the real time values. It may vary according to the atmosphere. Less than 1000ppm of CO2

level in air is the inhale capable of Human. If the level goes above 1000ppm it may cause dangerous effect to humans. Hence, the MQ135 sensor range is useful for the workers who are working in the Industrial environment. As well as MQ7, Normal level in air is 0 to 500ppm, if the value goes above, it will affect human. Then give the sensed values to the Arduino in the A0 pin. Arduino read the analog values and print it in the serial monitoring window.

7.4 OBSERVED OUTPUT

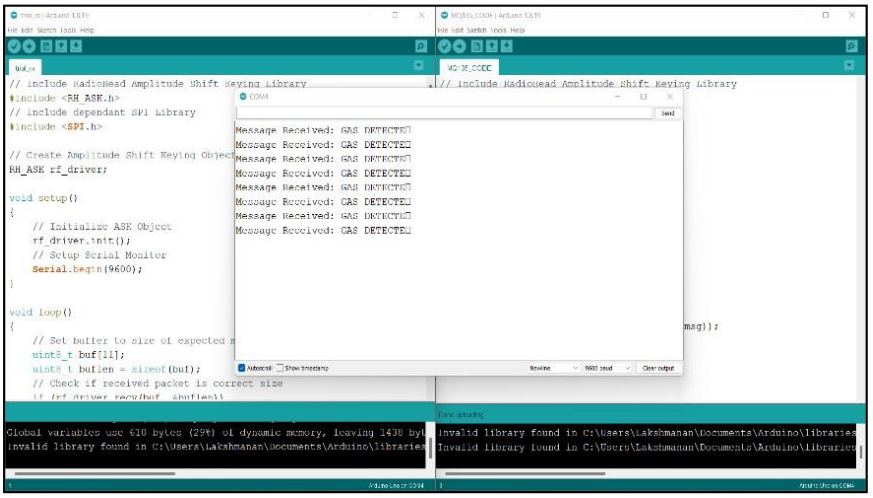

Fig. 7.7 Receiver output for gas detection

Fig 7.7 shows the displayed output. After the character is received by the RF transmitter, the DC vibration motor which is connected to Arduino start vibrate and alert the worker as well as the print the message in the serial monitoring window. This shows the character is received correctly.

7.5 Uploading Data to the ThingSpeak server

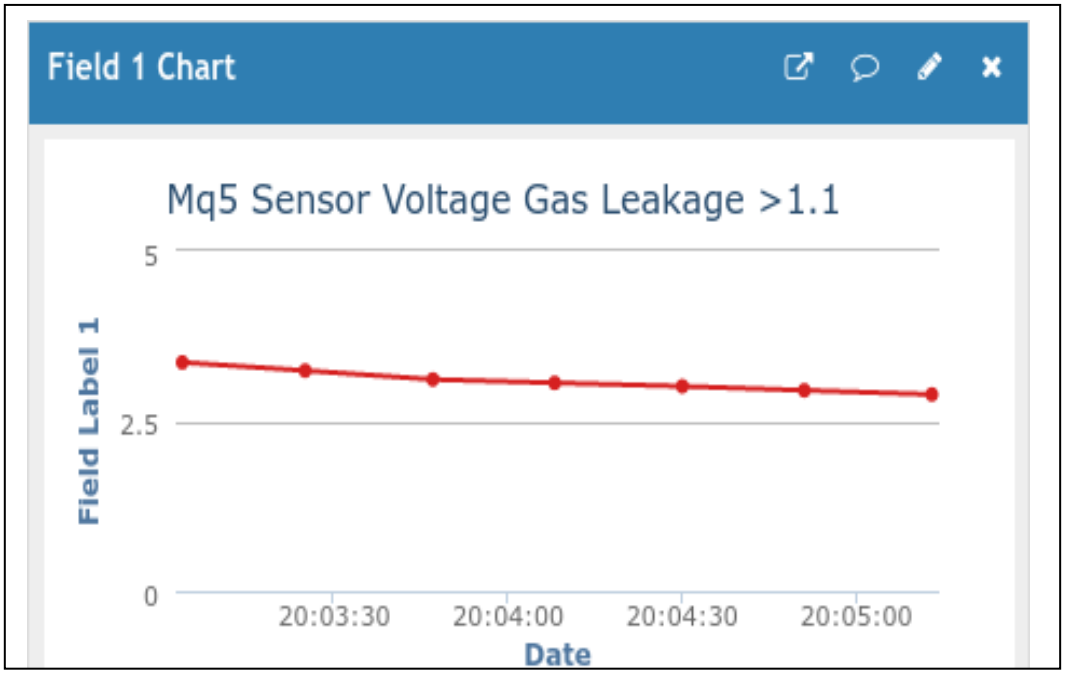

Fig 7.8 Sensor values

ThingSpeak is free, open-source software that lets people talk with internet-connected gadgets. It was created in Ruby. By giving an API to both the devices and social network websites, it makes data access, retrieval, and logging easier. In order to facilitate IoT applications, Io Bridge initially introduced ThingSpeak in 2010. The mathematical computer programmer MATLAB from MathWorks is integrated with ThingSpeak, enabling users to analyses and visualize uploaded data using MATLAB without having to buy a MATLAB license from MathWorks.

CHAPTER 8

TESTING

8.1 TEST CASES

From the below figure 8.1 it can be seen that the message received by the authority when the toxic gases detected by the sensors.

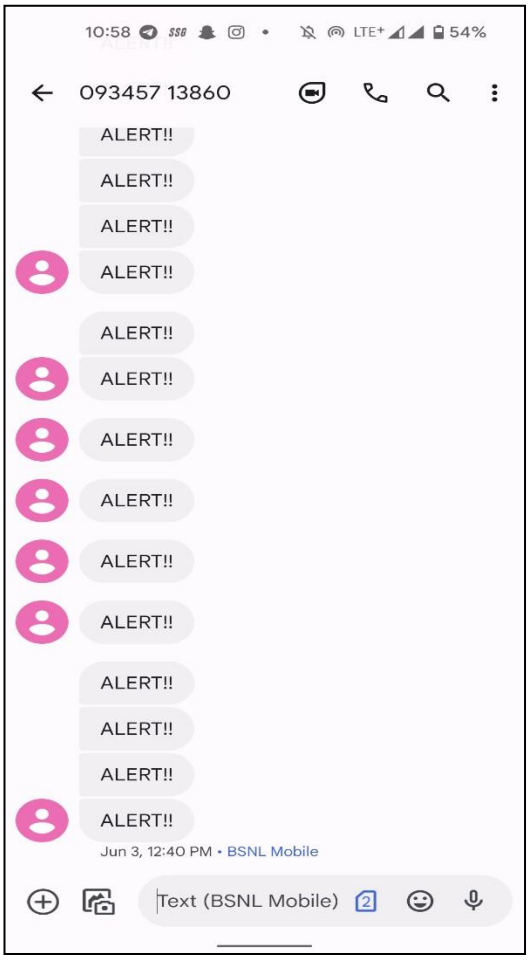

Fig 8.1 Received message

CHAPTER 9

ADVANTAGES AND DISADVANTAGES

9.1 ADVANTAGES

- Among the various benefit of a gas detection system, 24 by 7 gas level monitoring is the most effective and helpful. With a gas detection system, one can easily keep a watch on all areas. Even if you have a remote area. Most of the time you will have to monitor the gas levels and warn your personnel of a risky setting before they enter.
- While you get the edge to keep a watch over gases in advance, you will have the benefit of reducing speculating the potential risks on the job.Get real-time alerts about the gaseous presence in the atmosphere
- Prevent fire hazards and explosions
- Supervise gas concentration levels
- Ensure worker's health
- Real-time updates about leakages
- Cost-effective installation
- Data analytics for improved decisions
- Measure oxygen level accuracy
- Get immediate gas leak alerts

9.2 DISADVANTAGES

- It also produces toxic chemicals fumes and greenhouses gases may cause serious damage to various environmental entities
- Human Health Effects: NG is an asphyxiant it may cause unconsciousness, brain injuries and even death due to oxygen depletion.

CHAPTER 10
CONCLUSION

Safety is the best measure to prevent accidents. There are many accidents occurred due to leakage of gases around the world. Technology can also play a major role in saving a life from this toxic environment. This Proposed system model overcomes those incidents. This is a low-cost, low power, lightweight, portable, safe, user friendly, efficient, multi featured and simple system device for detecting gas. The adjustment in, carbon monoxide, Carbon-di-oxide will be recognized by separate sensors and can be resolved. Fig. 8.1 shows the SMS notified when harmful gases levels have been raised from normal level to harmful level. And also, authority sends rescue team to that area. With the help of this system, the critical situations can be solved quickly over the manual methods, which require large amount of time.

CHAPTER 11
FUTURE SCOPE

We suggest utilizing a MQ6 gas detection sensor to build the system, connectingit to an Arduino Uno microcontroller and LCD display.

The gas sensor in our system is used to find any gas leaks. As soon as it detects agas leak, the gas sensor sends a signal to the microcontroller. This signal is processed by the microcontroller, and an alert message is then shown to the user on the LCD.

SOURCE CODE

```
#include <LiquidCrystal.h>
LiquidCrystallcd(5,6,8,9,10,11);

int redled = 2;
int greenled = 3;
int buzzer = 4;
int sensor = A0;
int sensorThresh = 400;

void setup()
{
pinMode(redled, OUTPUT);
pinMode(greenled,OUTPUT);
pinMode(buzzer,OUTPUT);
pinMode(sensor,INPUT);
Serial.begin(9600);
lcd.begin(16,2);
}

void loop()
{
  int analogValue = analogRead(sensor);
```

```
Serial.print(analogValue);
  if(analogValue>sensorThresh)
  {
digitalWrite(redled,1);
digitalWrite(greenled,0);
    tone(buzzer,1000,10000);
lcd.clear();
lcd.setCursor(0,1);
lcd.print("ALERT");
delay(1000);
lcd.clear();
lcd.setCursor(0,1);
lcd.print("EVACUATE");
delay(1000);
  }
  else
  {
digitalWrite(greenled,1);
digitalWrite(redled,0);
noTone(buzzer);
lcd.clear();
lcd.setCursor(0,0);
```

```
lcd.print("SAFE");
delay(1000);
lcd.clear();
lcd.setCursor(0,1);
lcd.print("ALL CLEAR");
delay(1000);
  }


}
```

Git Hub link:

https://github.com/IBM-EPBL/IBM-Project-8417-1658918617

Demo Video link:

https://drive.google.com/drive/folders/1bwoKWIiVhtkx8BRDABJGFg2QNp_kfUv8

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