Gas Leakage Monitoring and Alerting System for Industries

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

The Internet of Things (IOT) is a network of devices, cars, and home appliances that have the hardware, software, actuators, and networks necessary to communicate with one another, function together, and exchange information. IOT entails expanding the Internet network beyond traditional devices like workspaces, workstations, smartphones, and tablets to any variety of physically stupid or non-web enabled physical devices and everyday objects. These modern devices can communicate with each other and link to the Internet, allowing for remote monitoring and control. The industries benefit from this project's assistance in tracking hazardous gas emissions. The gas sensors will be integrated to monitor the gas leakage so that we can prevent the discharge of gases in different regions. The administrators will be alerted and given the location if a gas leak is found in any region. The administrators can view the sensor settings via the web application.

1.2 Purpose

The main goal of the project is to construct a gas leakage detector utilizing a microcontroller and a gas sensor. The system will sound an alarm or buzzer if it detects a gas leak or the smell of any gas. If a gas leak is detected, the system will sound an early warning alarm. The MQ-6 gas sensor is used to detect gas leakage since sensors must have signals from gas leaks in order to function. Gas leaks can be detected by the device, which will then display them on the LCD screen, sound an alarm, and occasionally buzz.

CHAPTER 2

LITERATURE SURVEY

Asmita Varma et.al [1] [2017] have stated that IoT technology is being used to create a Gas Leakage Detector with Smart Alerting techniques that call, text, and email the relevant authority and have the potential to foresee hazardous situations so that people can be made aware in advance by performing data analytics on sensor readings.

Suma V et.al [2] [2019] have introduced a novel system that automatically reserves a cylinder when the gas is about to run out by sending a notification to the gas company through Wi-Fi using an Internet of Things approach. Additionally, sensors are utilized to find gas leaks in residential buildings. The user will receive an SMS if a gas leak is automatically detected. One of the most widely utilized networks in the world is Wi-Fi. Consequently, a load cell has been utilized to continuously check the weight of the LPG gas.

Huan Hui Yan et.al [3] [2014] have proposed a construction of system which indicates the presence of methane and carbon monoxide gas and detected using the combustible gas sensor (MQ9). By using an Arduino Uno as the system's main microcontroller and Zigbee to transmit data from the gas sensor to the monitoring system, which displays the results on LabVIEW's graphical user interface, this sensor will be able to determine the gas concentration and operate in alarm, autonomous control, and monitoring systems.

Shruthi Unnikrishnan et.al [4] [2017] have proposed a system that would be useful to regularly monitor LPG usage and to alert about any dangers that may arise as a result of LPG leakage given the high demand for and use of LPG. This method informs the user how much LPG is still available, allowing them to take the necessary action. Since LPG is a very dangerous and combustible gas, this system

will sound an alarm when there is a leak so that action can be done to prevent an explosion.

Md Danish Akhter et.al [5] [2015] have proposed a methodology where the Zigbee Network and a sensor are used in this automated gas leakage monitoring system to transmit data. The data is acquired by a sensor, and it is continuously monitored. Through a Zigbee device, the data is transferred. There are several security threats and attacks on the data transmission infrastructure in modern planet. This study will provide a better method for protecting data sent over a specific distance against unauthorized access. It also focuses on the wireless connection that can be used to leverage Zigbee technology to identify gas leakage in a plant or industry.

Nikhil Binoy C et.al [6] [2021] have stated that gas leakage hazards are a common occurrence in companies. These include the oil and gas sector, the petrochemical sector, and even factories that produce combustible and poisonous waste. These leaks may result in severe losses to the life of all living beings. In this study, a rover that goes outside the pipeline to measure gas leaks and continually transmit the observed data to a local server utilizing an IoT platform is used to monitor gas leaks.

Shital Imade et.al [7] [2018] have stated that IOT technology is used to upgrade the existing safety standards. The creation of this prototype was intended to completely eradicate any major or minor risks resulting from the emission of harmful and dangerous gases into the environment, revolutionizing environmental safety. With the use of IOT technology, we developed a Gas Leakage Detector for society that can analyze sensor data and use Smart Alerting to text the appropriate authorities when a leak is detected. This system will be able to recognize any gases present in the immediate vicinity using gas sensors. This will prevent the primary dangerous problem from developing.

Juhi Chaudhary et.al [8] [2019] have created a Gas Leakage Detector for society using IOT technology that can look at sensor data and use Smart Alerting to SMS the proper authorities when a leak is discovered. Using gas sensors, this system will be able to identify any gases that are present nearby. By doing this, the main dangerous issue will not arise.

Luay Fraiwan et.al [9] [2011] have proposed a device that is intended for use in households where using heaters and appliances that use natural gas and liquefied petroleum gas (LPG) may be risky. The technique can also be used for other LPG and natural gas-dependent industrial or plant activities. The two primary parts that make up the system design are the receiving module and the detection and transmission module. The detection and transmission module searches for the change in gas concentration using a specialized sensor circuit created for this purpose.

M Athish Subramanian et.al [10] [2020] have proposed IoT-based gas detection technologies in order to safeguard people and their surroundings. A simple yet reliable solution is provided by a gas leakage detection system that uses an Arduino Uno controller and MQ5 gas sensor. The system is also coupled with cloud storage for data collecting, storage, and analysis. When the threshold limit is reached, the user is informed. The amount of gas released is converted from parts per million (PPM) to volts through the Arduino IDE. The user is alerted using both a buzzer or LED for physical notification and an application for quick notification over the internet.

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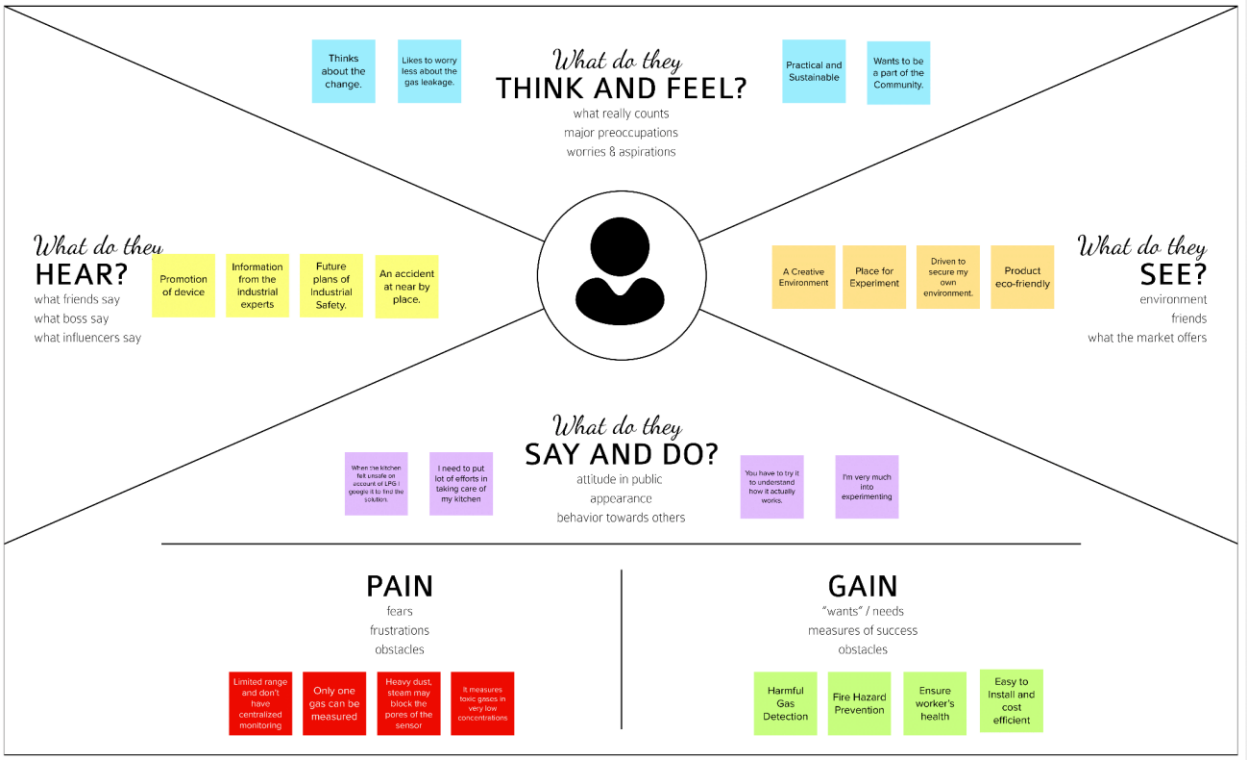
CHAPTER 3
IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

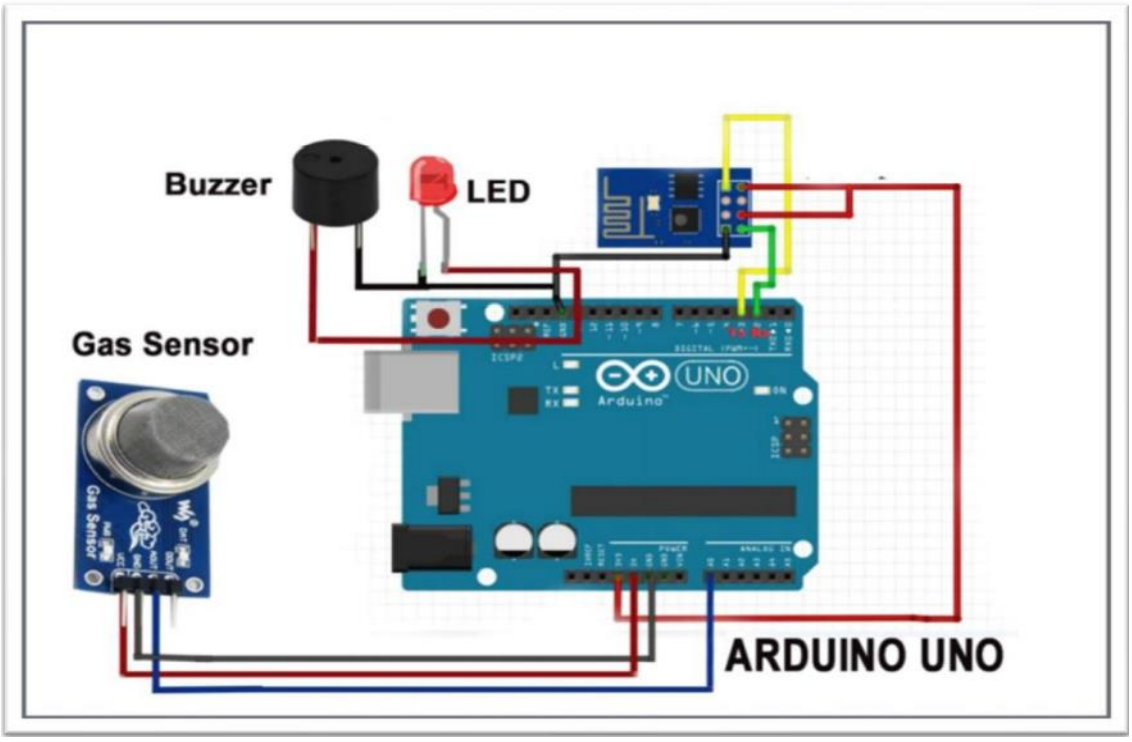


3 .2 Ideation & Brainstorming

The Internet of Things aims to simplify life by automating all of the little tasks that we encounter. As much as IoT aids in task automation, its advantages can also be extended to improve current safety standards. Safety has always been a top consideration when designing a home, a building, an industry, or a city. It can be extremely dangerous for certain gases to be present in the atmosphere at higher concentrations. These gases may be toxic after exceeding the specified concentration limits, flammable under certain temperature and humidity conditions, or even contribute to local air pollution issues like smog and poor visibility, which can lead to serious accidents and have a negative impact on people's health. The majority of societies have fire safety measures. But it can be used even after a fire has started.

We developed a system using sensors that can detect gases like LPG, CO2, CO, and CH4 in order to have control over such situations. This system will be able to identify gas leaks and alert users via audible alarms as well. This system can alert the user if there are excessive amounts of harmful gases present in the environment. System can send a message to society administrators informing them of the situation before an accident occurs.

Gas detector sensors, an Arduino board, an ESP8266, and a cloud server make up the system. All flat member users can be registered on our system by a single society authority person. The administrator of the society can add information about each flat's users, including their username, phone number, and flat sensor information. Each sensor's threshold value can be set by society admin. Each flat can be equipped with system hardware. The value per time can be sensed by sensors. Values can be sent from the system to a cloud server. The sensor values' existence at the threshold value can be checked by the server. The server can instruct the hardware to buzz the alarm if the sensor value can exceed the limit. Additionally, the server notifies the user.



The goal of creating this prototype was to revolutionize environmental safety by eliminating any major or minor hazards brought on by the release of toxic and

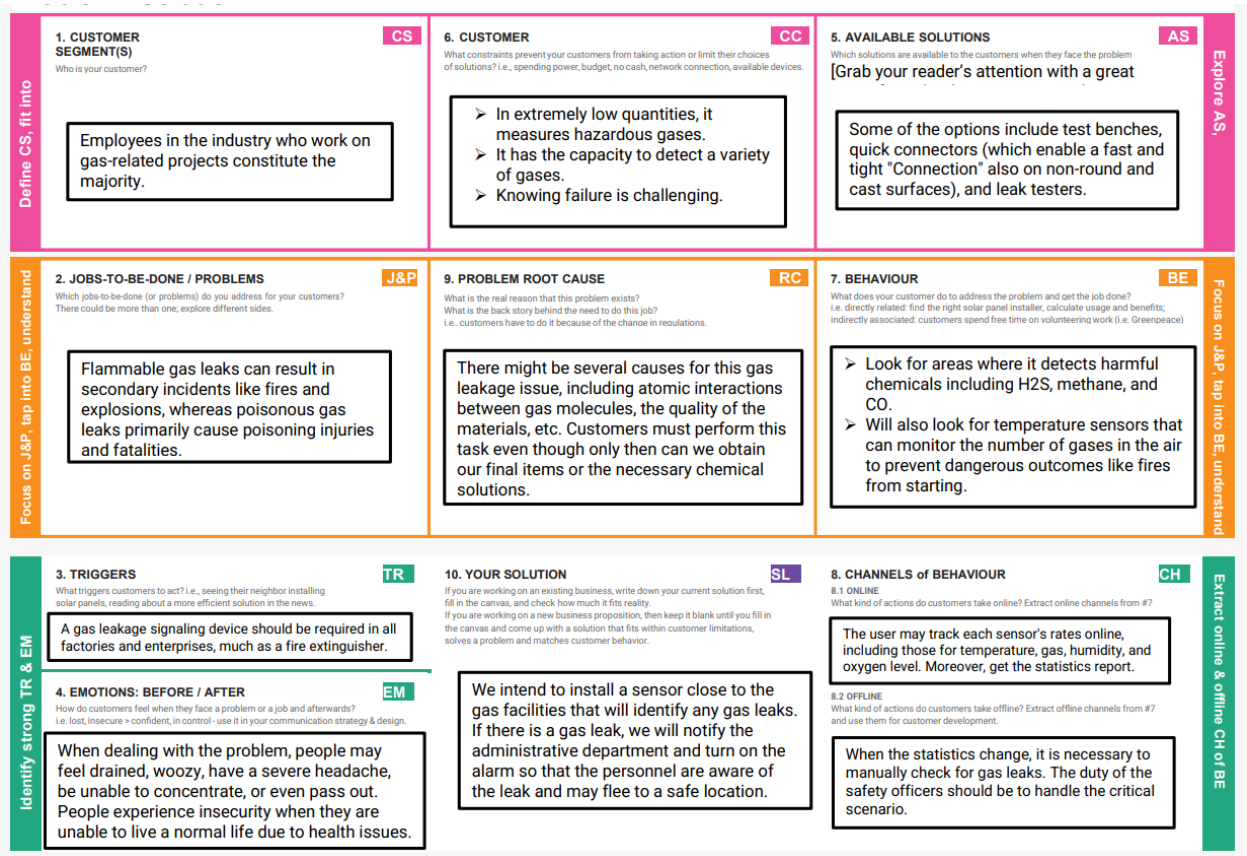
harmful gases into the environment. We created a Gas Leakage Detector for society using IOT technology, and it has the ability to perform data analytics on sensors and Smart Alerting techniques that send text messages to the relevant authorities. Using gas sensors, this system will be able to identify any gases present in the surrounding area. This will shield us from the main harmful issue.

3.3 Proposed Solution

S. No.	Parameter	Description
1	Problem statement	In order to work effectively on major crises rather than worrying about monitoring or gas leaks, employees who work in busy industries that are packed with gas-whether harmful or harmless need a way to continuously monitor their gas pipelines and detect early signs of leakage in their surroundings. This will reduce the manpower of that industry and foster peace.
2	Idea/solution	In order to work effectively on major crises rather than worrying about monitoring or gas leaks, employees who work in busy industries that are packed with gas-whether harmful or harmless need a way to continuously monitor their gas pipelines and detect early signs of leakage in their surroundings. This will reduce the manpower of that industry and foster peace.
3	Novelty	Although there are many existing solutions to this issue, none have been able to meet customer needs. Some solutions only detect certain gases, while others fail to notify the primary department, and still others experience delays. Our solution will alert the workers even if there is a small gas leak, notifying the industry person as well as the fire fighters so they can take control of the situation.

4	Social impact/Customer satisfaction	For the employees and the community that surrounds or is associated with the industries, our solution will be very beneficial. Our solution will stop major catastrophes like the Bhopal Gas Tragedy, saving countless lives. The goal of this project is to relieve the workers' mental strain so they can relax or focus on other tasks.
5	Business model (Revenue model)	Since industries are the primary audience for our solution, we have scheduled visits to inform them of the advantages of our products. So that they can aware of the importance of this solution and use it.
6	Stability of the solution	Because the solution we've offered will be the foundation or starting point of any upgraded version, it can be integrated for additional future use.

3.4 Problem Solution Fit



CHAPTER 4
REQUIREMENT ANALYSIS

4.1 Functional Requirements

FR No.	Functional Requirement	Sub Requirement
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Hardware Requirement	Optical, Soil, Ultra flow meter
FR-4	Software Requirement	Pressure point, Flow change, Statistic
FR-5	User Welfare	Calibration No poisoning of teh sensor Reliable in all environmental conditions Easy to use

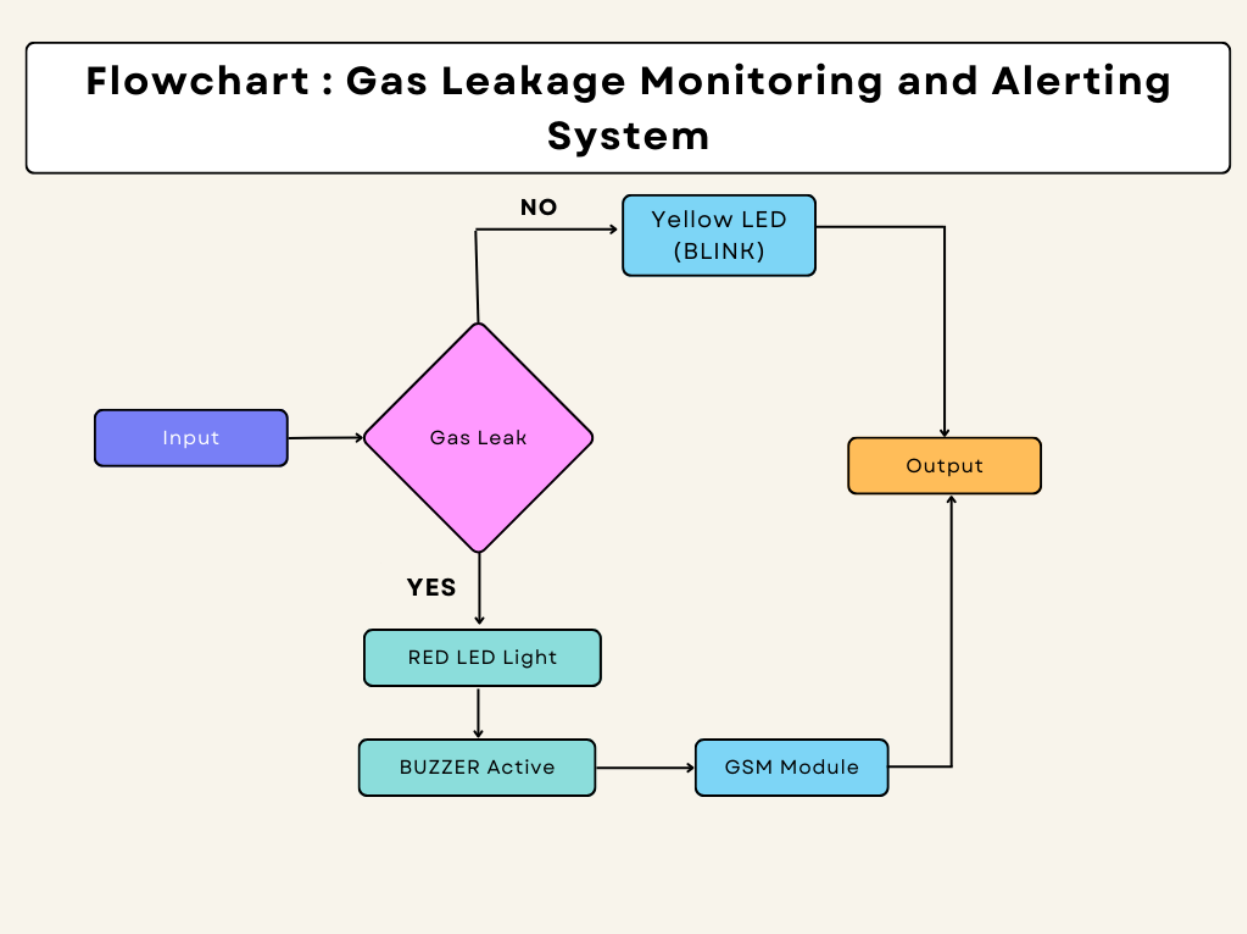
4.2 Non-Functional requirements

NFR No.	Non-functional requirement	Description
NFR-1	Usability	The sensor-enabled technology reduces the likelihood of gas explosions, which pose a high danger of casualties both within and outside the premises.
NFR-2	Security	The gadget is designed to be used in homes where natural gas and liquid petroleum gas (LPG) heaters and appliances could pose a concern.

NFR-3	Reliability	The Gas Leakage Detection System (GLDS) can find leaks in residences, businesses, or factories. Soon as the leakage occurs, GLDS notices it and immediately notifies users of the situation.
NFR-4	Performance	A wall-mounted device installed near the floor; the Gas Leakage Detector has an alert set at 20% of the lower explosive limit. The built-in sensor identifies leaks instantly and notifies the user less than five minutes later, far before they can result in mishaps.
NFR-5	Availability	Although easily found on the market, an LPG leakage detector circuit is very expensive. Here is a simple, low-cost Gas Leakage Detection circuit that you can construct.
NFR-6	Scalability	The system demonstrates the need for completely reliable gas detection warning systems. To prepare for power outages, a backup power source can be added to the system architecture. Additionally, the gas sensor can be calibrated so that a particular gas, rather than the LPG and other multiple gases it detects, is detected.

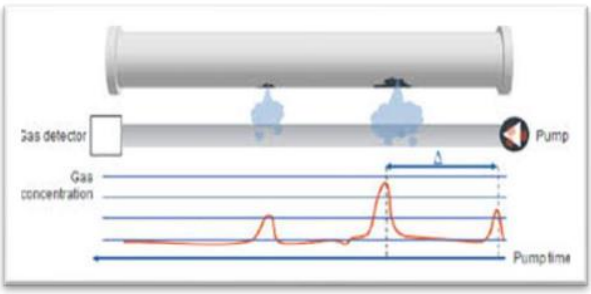
CHAPTER 5
PROJECT DESIGN

5.1 Data Flow Diagrams

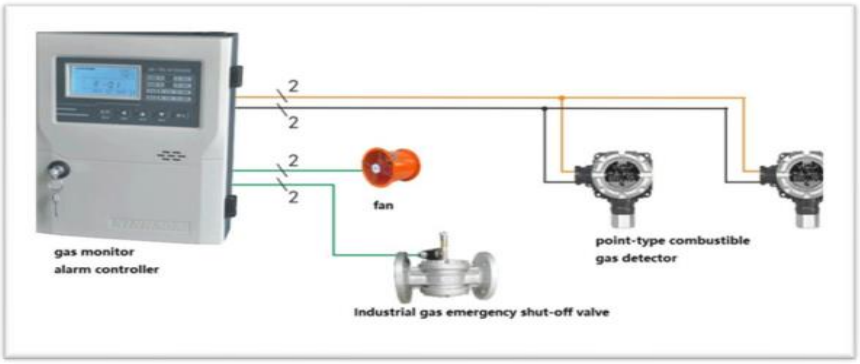


5.2 Solution & Technical Architecture

Workers who are engaged with a busy industry packed with gas either harmful or harmless needs a way to monitor their gas pipelines continuously and detect early if there is any leakage of gas in their surroundings so that they can work efficiently on major crises rather than worrying about monitoring or leakage of gas, this will indeed reduce the manpower of that industry and create a peaceful environment.



The system can be taken as a small attempt in connecting the existing primary gas detection methods to a mobile platform integrated with IoT platforms. The gases are sensed in an area of 1m radius of the rover and the sensor output data are continuously transferred to the local server. The accuracy of MQ sensors is not up to the mark thus stray gases are also detected which creates an amount of error in the outputs of the sensors, especially in case of methane. Further the availability and storage of toxic gases like hydrogen sulphide also creates problems for testing the assembled hardware. As the system operates outside the pipeline, the complication of system maintenance and material selection of the system in case of corrosive gases is reduced. Thus, the system at this stage can only be used as a primary indicator of leakage inside a plant.


2
2
2
2
fan
gas monitor
alarm controller
point-type combustible
gas detector
Industrial gas emergency shut-off valve


Install Gas Detector
Get Gas Leak Detected
Take Action
TC-800-FLP
SMS

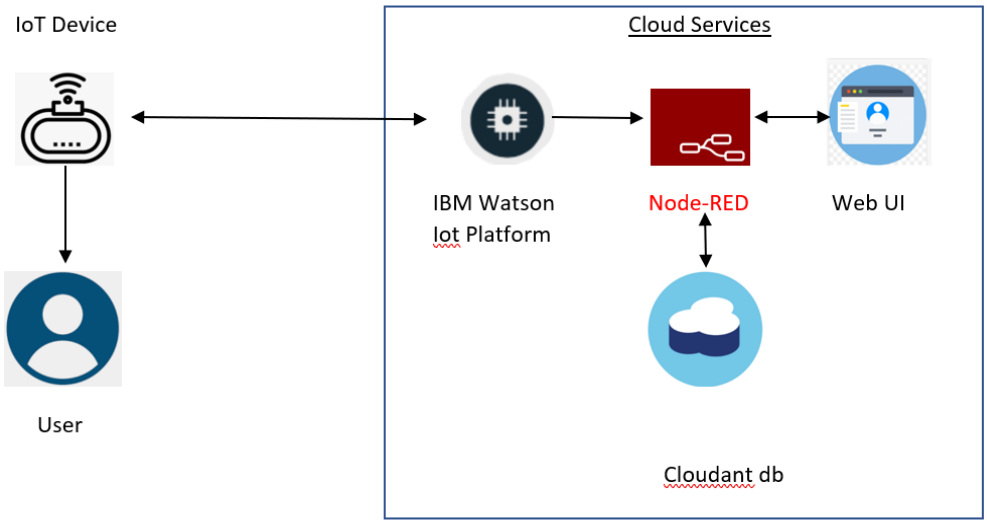

IoT Device
Cloud Services
IBM Watson
Iot Platform
Node-RED
Web UI
User
Cloudant db

Table-1 Application Characteristics

S.No	Characteristics	Description	Technology
1	Open-Source Frameworks	Creating mobile applications, setting up IoT devices, programming IoT devices, storing data in the cloud	IBM Watson, Node Red, IBM Cloud, and MIT
2	Security implementations	Using encryption technology for security	SHA-256
3	Scalable architecture	The application can load as many members as they are logged in	IBM-Watson, MIT
3	Availability	Application offers 24/7 service	IBM Watson, Node Red, IBM Cloud, and MIT
4	Performance	Alerting with correct timing	IoT, IBM, and Watson

Table-2 Components & Technologies

S. No.	Component	Description	Technology
1	User Interface	Mobile App	MIT
2	Application Logic-1	Gathering information about emission of gases	Python
3	Application Logic-2	Alarms	IBM Watson
4	Cloud Database	Cloud database service	CloudantDB by IBM

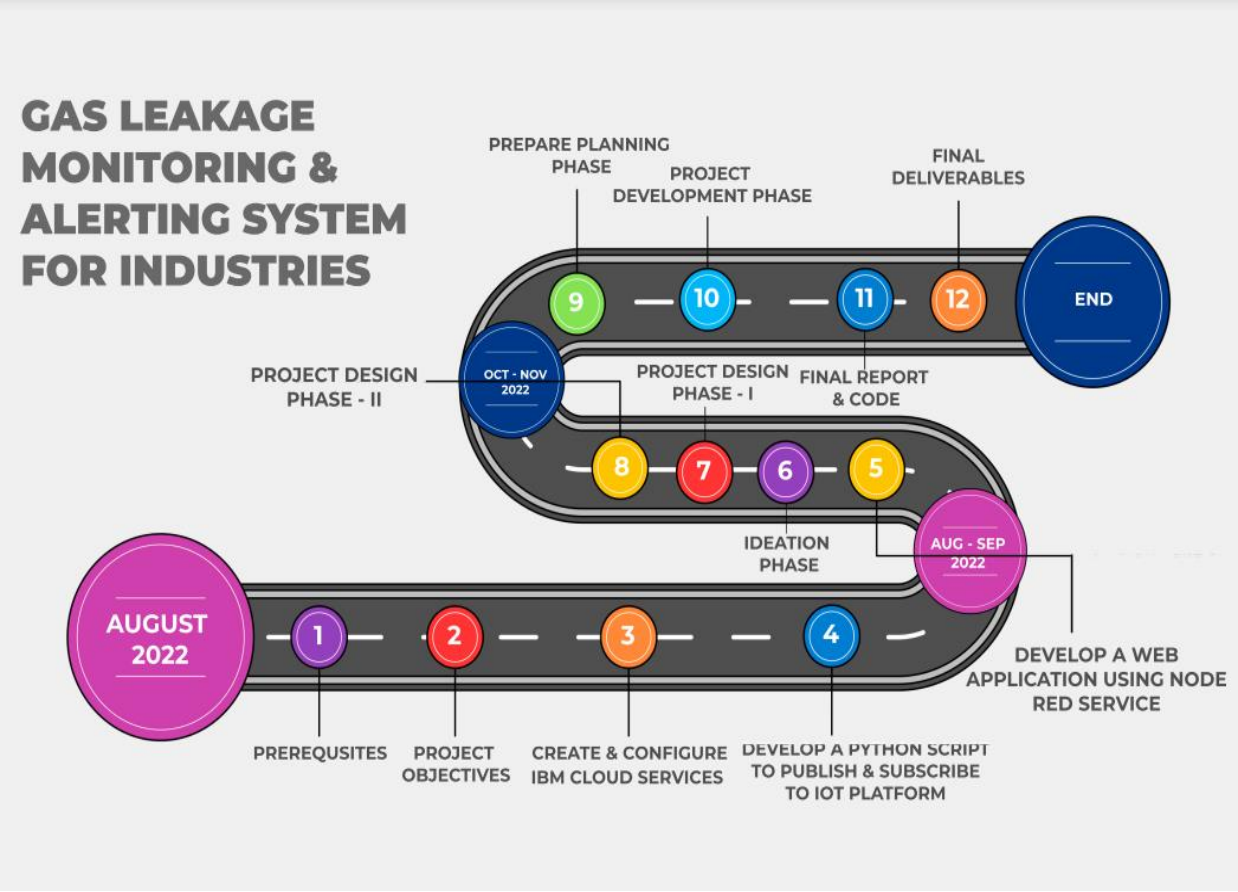
5.3 User Stories

	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
OBJECTIVES	Make a goal or activity list	Detecting gas leaks protects personnel and the environment from potentially hazardous exposure.	Gas leak detection sensors are integrated with microcontrollers that will give a warning to the user whenever there is a gas leak, and display warning information in liquid form.	A gas leak detection system detects potentially hazardous gas leaks using sensors. When a dangerous gas is detected, these sensors usually provide an audible alarm.	In case of a gas leak, an alarm management system performs a series of actions
NEEDS	Make a list of needs you want met	Preventing fire hazards	Detection of harmful gases	Measurement of oxygen levels	Alerts for gas leaks as soon as possible
FEELINGS	Describe the emotion you expect the customer to feel	Happy about this solution	Implemented the solution and promoted the positive aspects of this project	Happy	The project is being encouraged and good feedback is being provided.
BARRIERS	Consider a potential challenge to your goal	Higher officials	Companies in the commercial sector	The fumes are poisonous by nature and may make people unconscious or even kill them if taken in big amounts.	Additionally, gaseous bursts are another catastrophe that everyone, whether they are at home or at work, would wish to avoid at all costs.

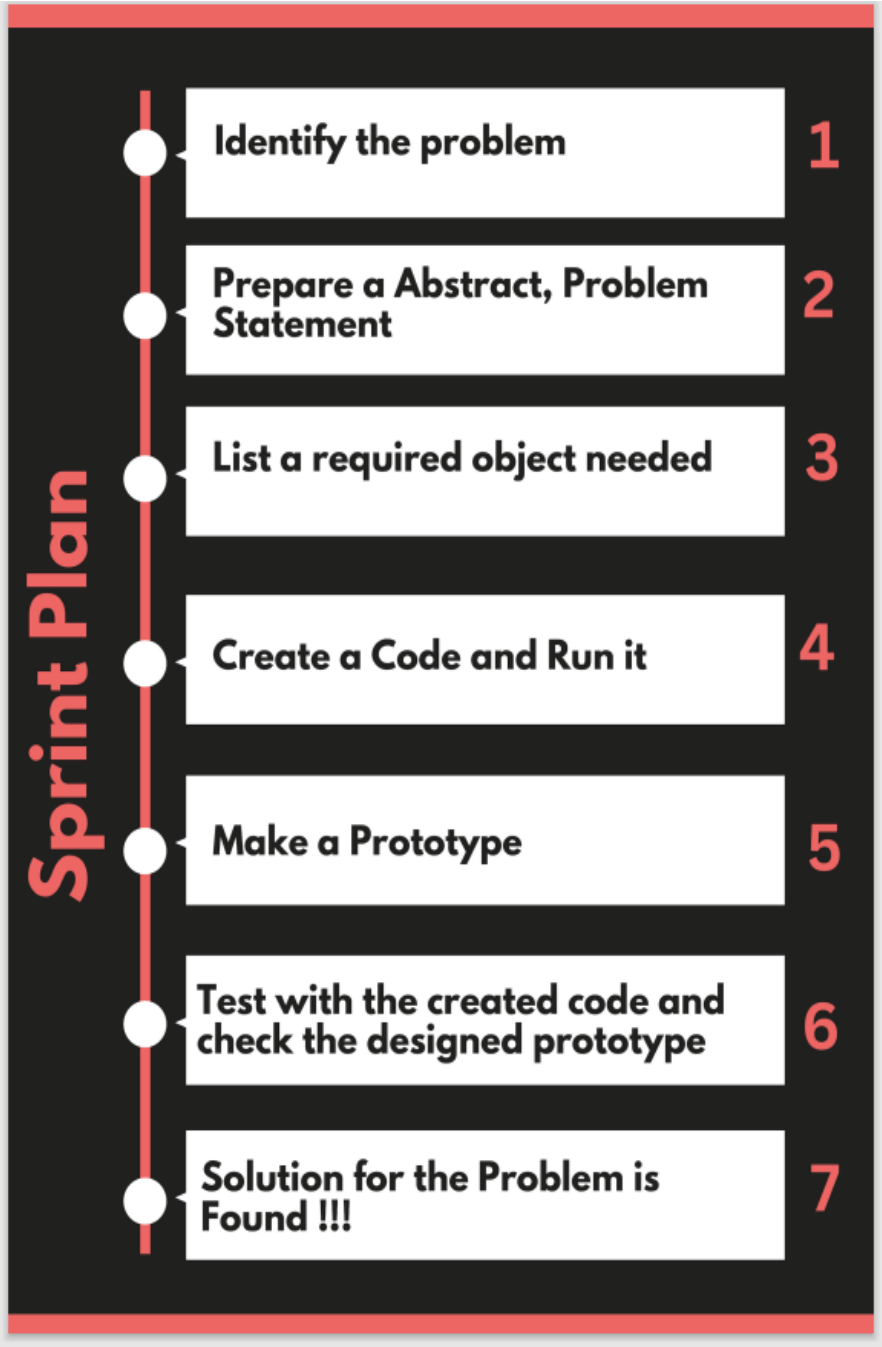
CHAPTER 6

PROJECT PLANNING AND SCHEDULING

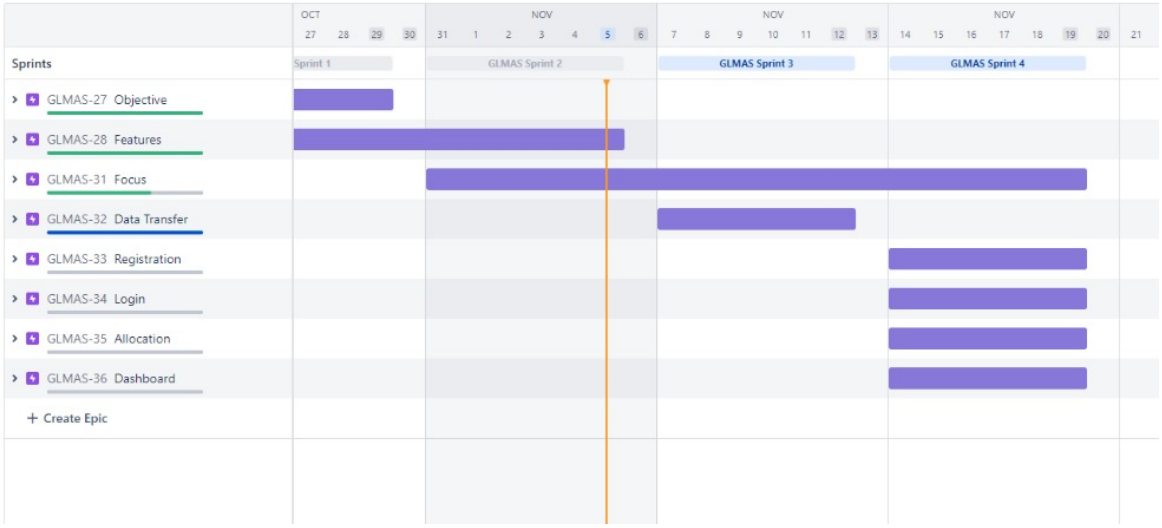
6.1 Sprint Planning & Estimation

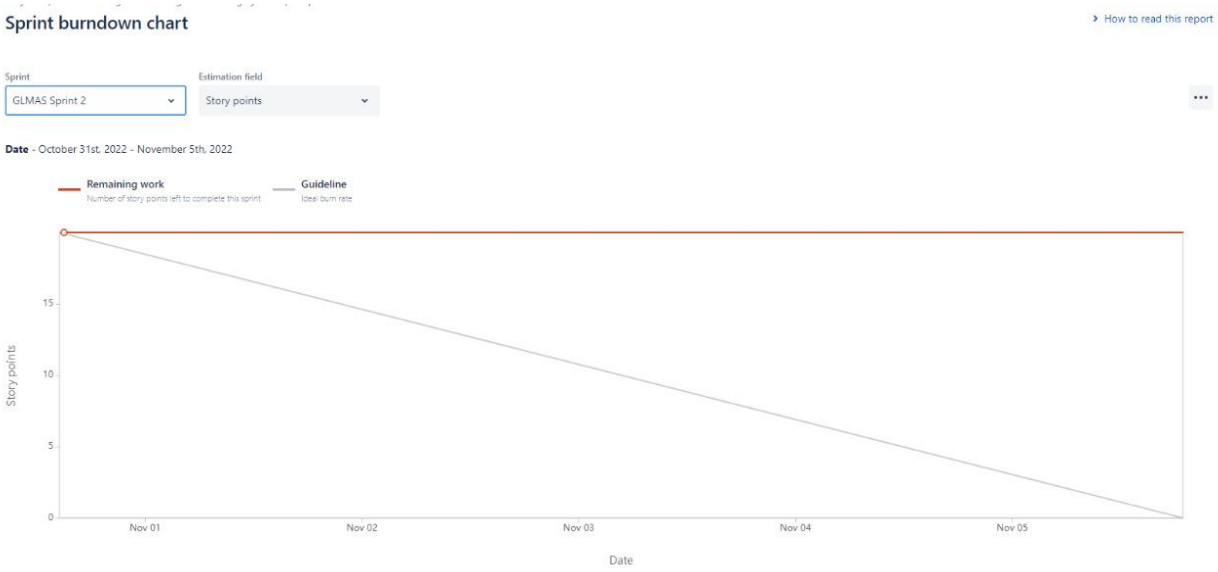


6.2 Sprint Delivery Schedule



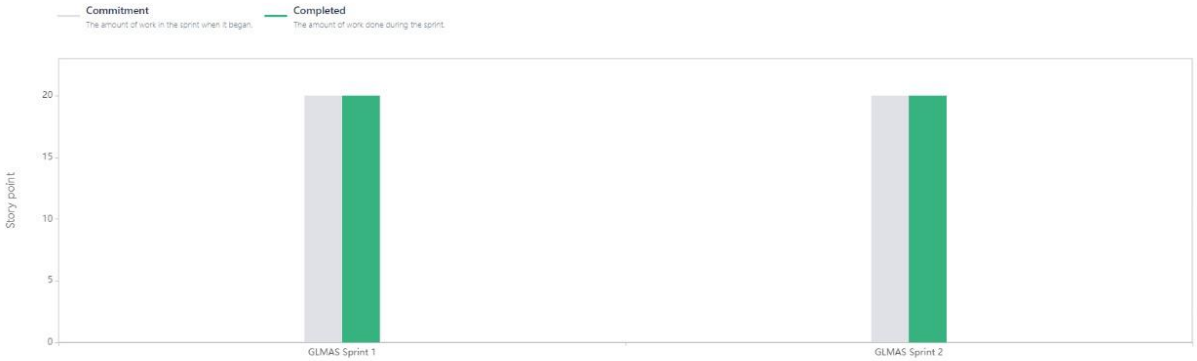
6.3 Reports from JIRA





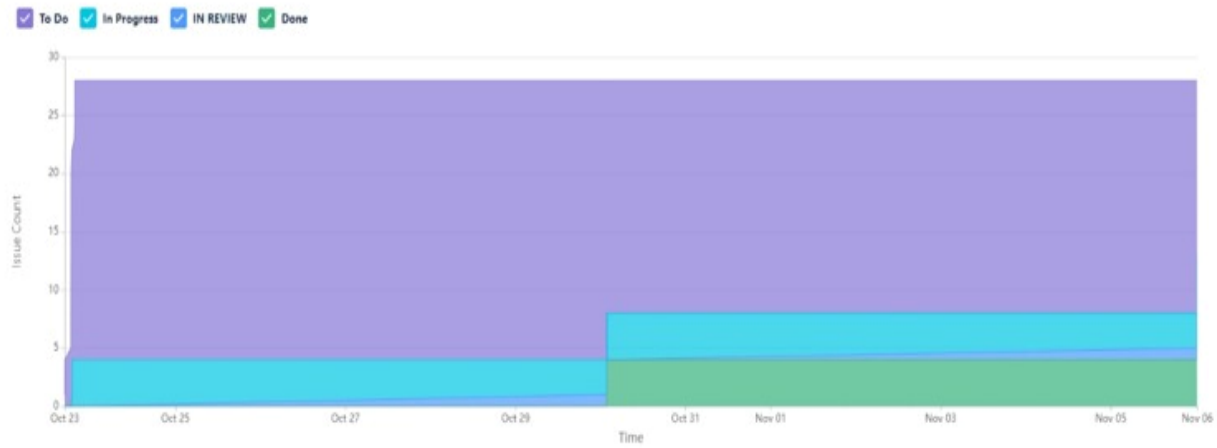
Velocity report

› How to read this report



Sprint	Commitment	Completed
GLMAS Sprint 1	20	20
GLMAS Sprint 2	20	20

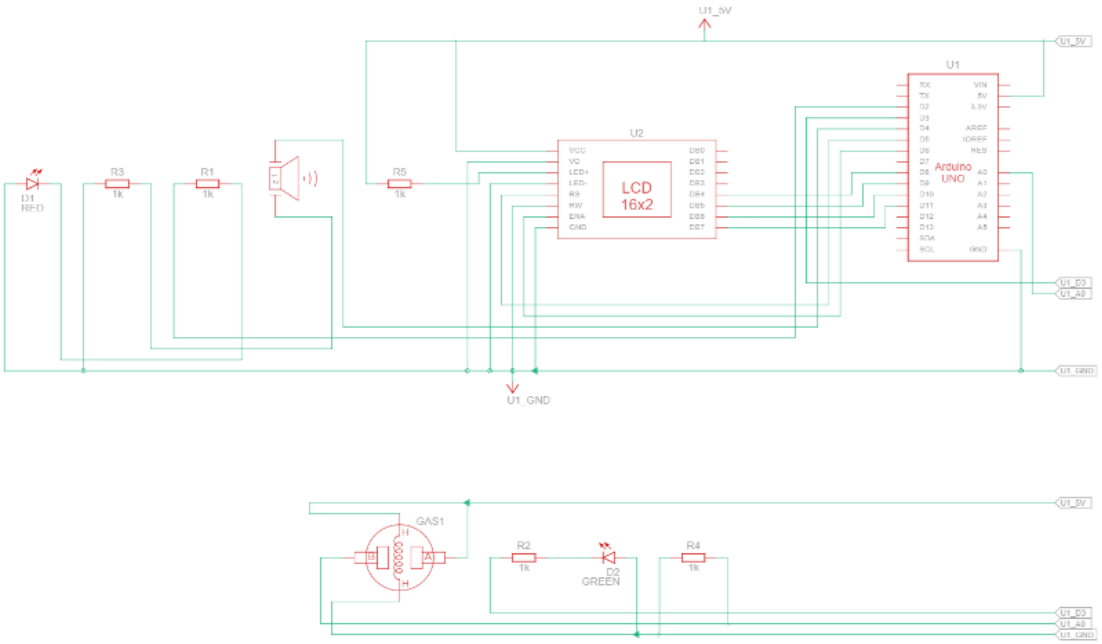
Cumulative flow diagram



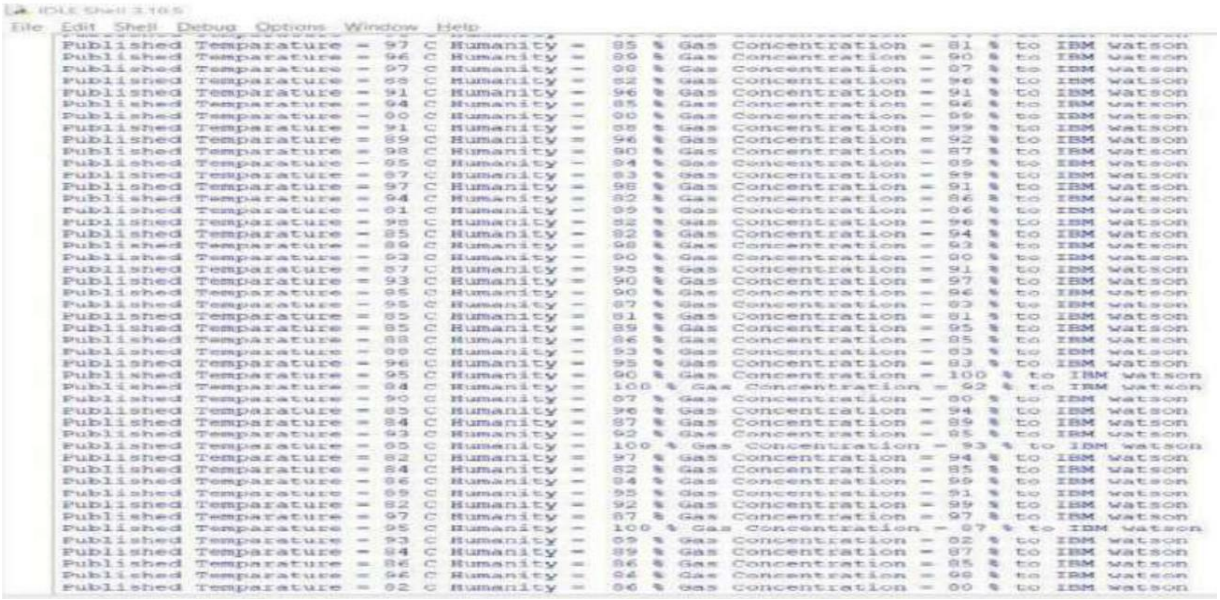
CHAPTER 7

CODING & SOLUTIONING

7.1 Feature 1



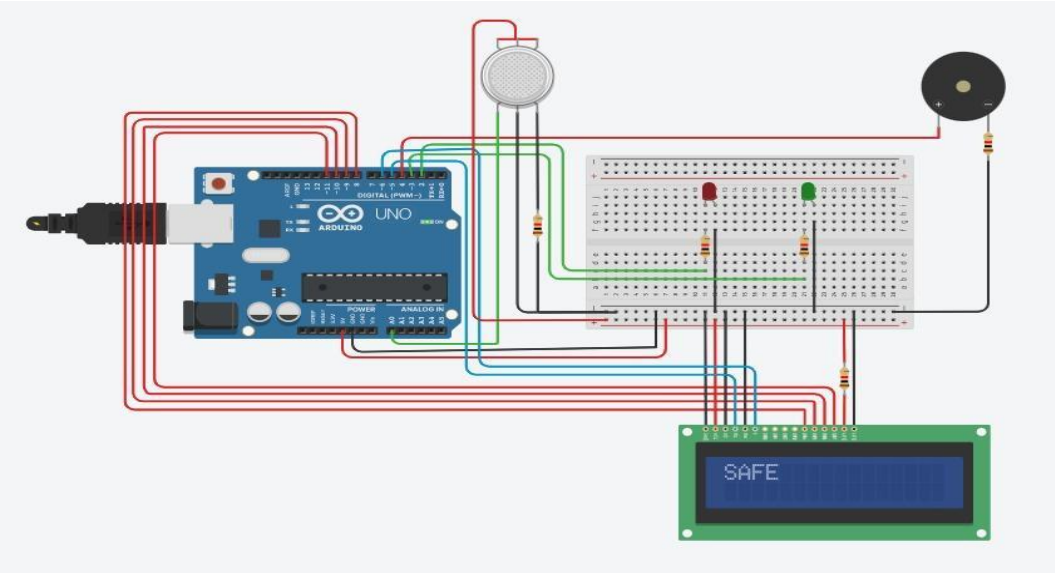
7.2 Feature 2



CHAPTER 8
TESTING

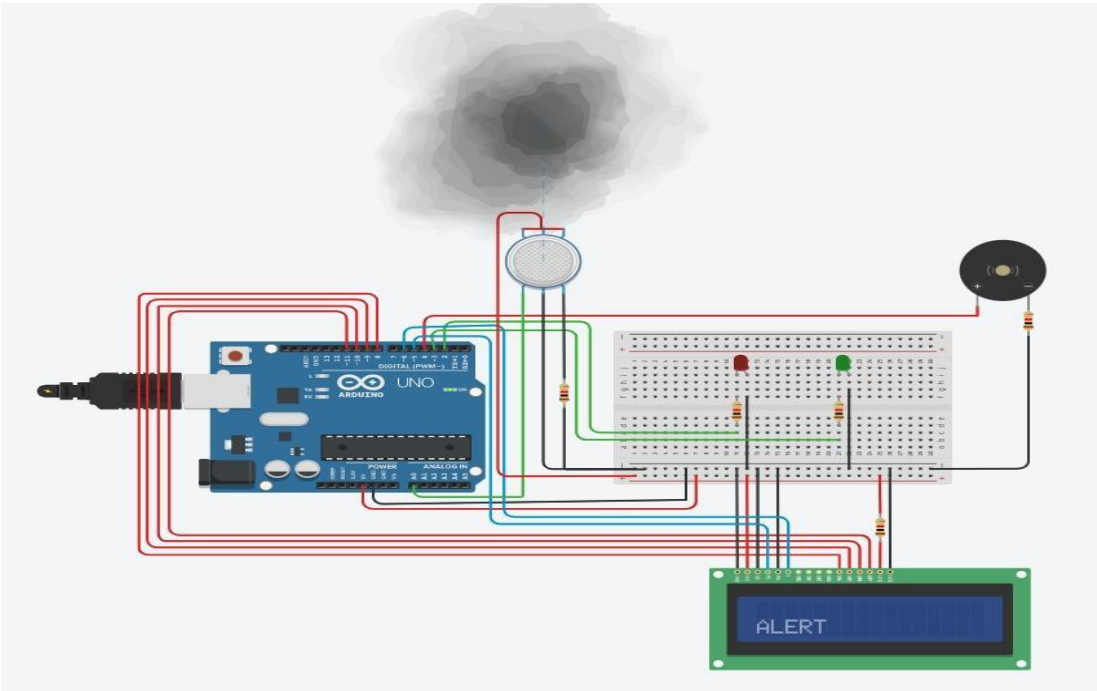
8.1 Test Cases

Test case 1



Industries at normal temperature, it is not alerted

Test case 2



Due to gas leakage in industries, this circuit model is alerting the worker through their mobile phone. It will be monitor and rectify by workers in industries.

Name	Quantity	Component
GAS1	1	Gas sensor
PIEZO1	1	Piezo
M1	1	DC motor
S2	1	Push button
D1	1	Red LED
Rpot2	1	250 kΩ potentiometer
R1,R3	2	1kΩ resistor
R2	1	330Ω resistor
U2	1	LCD 16X2
U3	1	Arduino Uno R3

Arduino Uno R3

One type of ATmega328P-based microcontroller board is the Arduino Uno R3. It comes with everything needed to support the microcontroller; all you need to do is use a USB cable to connect it to a computer and provide power using an AC-DC adapter or a battery to get things going. The name Uno, which in the language of "Italian" means "one," was chosen to commemorate the launch of the Arduino IDE 1.0 software. The third and most recent version of the Arduino Uno is called the R3. The reference versions of Arduino are the board and the IDE software, both of which have recently undergone updates.

Bread Board

A breadboard is a common tool for circuit design and testing. Using a bread board eliminates the necessity for soldering wires and components together to form a circuit. Component mounting and reuse is simpler. Components are not soldered together, allowing for easy circuit design changes at any time.

LED

An optoelectronic LED (Light Emitting Diode) operates on the electro-luminance principle. The ability of a substance to transform electrical energy into light energy and then emit that light energy is known as electro-luminance. The semiconductor in an LED operates similarly, emitting light when an electric field is present.

Resistor

A passive electrical device having two terminals that controls or limits the flow of electricity in electrical circuits.

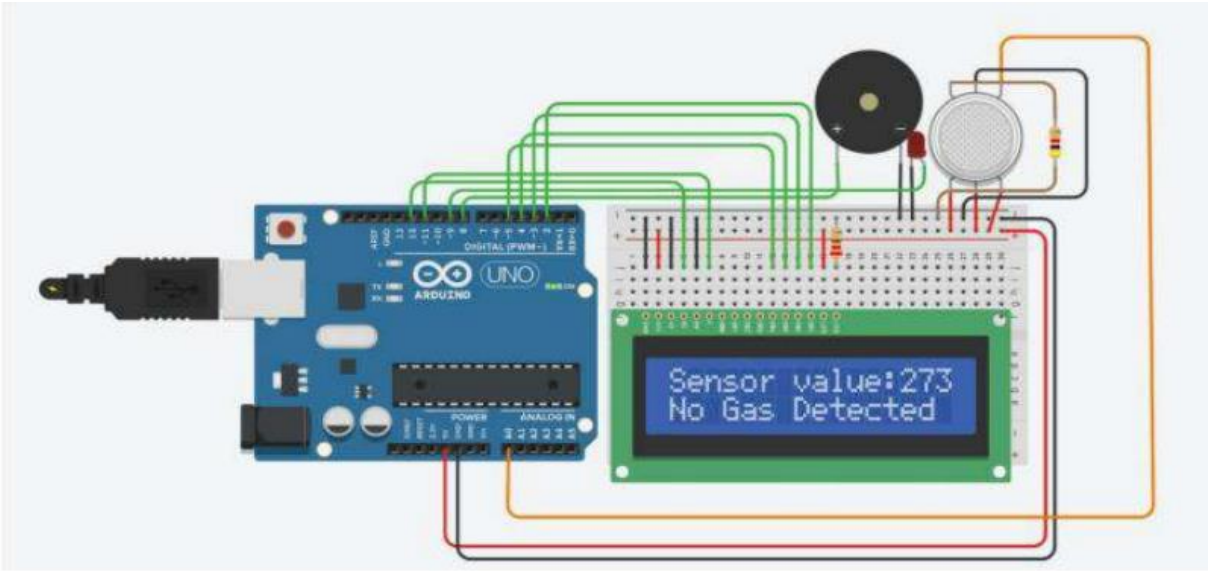
Gas Sensor

A device that detects the presence or concentration of gases in the atmosphere is called a gas sensor. The sensor generates a corresponding potential difference based on the gas concentration by altering the material's resistance, which may be observed as output voltage. The type and concentration of the gas can be inferred from this voltage value.

LCD 16*2

One type of electronic gadget utilised to display the message and data is a 162 LCD. Liquid Crystal Display is the term's full name. Because it has 16 Columns and 2 Rows, the display is known as a 162 LCD. It can display a total of (16 + 2) 32 characters, each of which is composed of 5 x 8 pixels.

CIRCUIT DIAGRAM



8.2 User Acceptance Testing

Purpose of Document

Accidents caused by gas leaks can cause both material loss and human injuries. Based on their physical characteristics, such as toxicity, flammability, etc., the risk of explosion, fire, and asphyxia exists. In recent years, there have been an increasing number of fatalities brought on by gascylinder explosions. Testing this project results in a dependable performance and identifies both its strengths and weaknesses. The document's goal is to do an accurate analysis by taking into account each parameter and providing a value.

Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved.

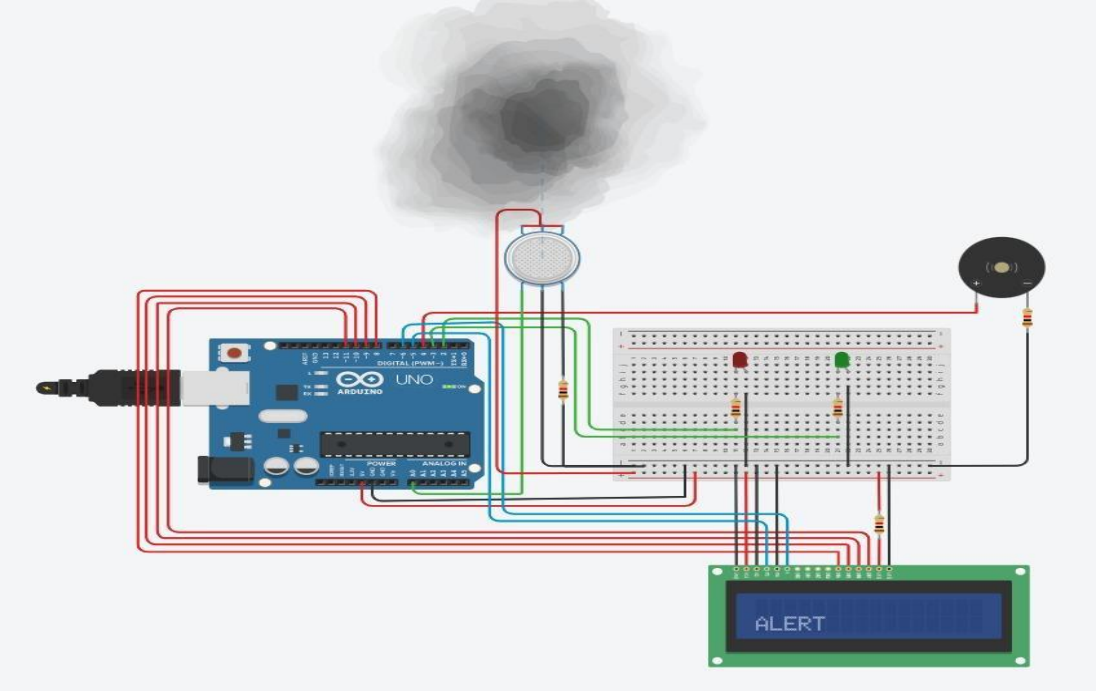
Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By design	3	3	4	4	14
Duplicate	1	0	2	0	3
External	8	2	2	0	12
Fixed	10	3	1	24	38
Not reproduced	0	0	2	0	2
Skipped	0	1	1	2	4
Won’t Fix	0	4	1	2	4
Total	22	13	13	32	78

Test Case Analysis:

Section	Total cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	2	0	0	2
Exception Reporting	7	0	0	7
Final Report Output	6	0	0	6
Version Control	1	0	0	1

CHAPTER 9
RESULTS

9.1 Performance Metrics



The performance of the circuit is analyzed by the buzzer sound, LED warning and warning message in the display.

CHAPTER 10
ADVANTAGES AND DISADVANTAGES

Advantages

- This project is useful for finding gas leaks in industrial settings.
- Equipment and Components are more effective.
- Low power usage, and trustworthy.
- Finding LPG gas leaks in the home is another use for it.

Disadvantages

- Since there are numerous locations that house gas cylinders, the exact location of the leak cannot be determined.
- Temperature and relative humidity both affect how sensitive it is.
- Setup won't operate and function without the Internet.
- Installation of the setup is challenging.

CHAPTER 11
CONCLUSION

We can infer from the project's performance that the system's detection of LPG gas leakage is remarkable and useful for both residential and commercial purposes. We can use this technique to save lives in dangerous situations. The GSM module indicates an alert, Propane, CO2, and other gases are detected by a sensor node. Power usage and transmission range estimates are made. The sensor was constructed using straight forward techniques and an Arduino UNO Micro controller.

CHAPTER 12

FUTURE WORKS

- This technology can be further developed and can be implemented in a way that it can turn off the whole gas supply in that industry.
- The proposed system can be extended to a mine safety artificial intelligence-based platform for people's safety applications.

CHAPTER 13
APPENDIX

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(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,HIGH);
    digitalWrite(greenled,LOW);
    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,HIGH);
    digitalWrite(redled,LOW);
    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);
  }
}
```