GAS LEAKAGE MONITORING AND ALERTING SYSTEM FOR INDUSTRIES

PROJECT REPORT

TEAM ID:
PNT2022TMID18424
ROJECT NAME:
GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES

TEAM MEMBERS:
HARIVIGNESH A
SIVA AKASH K
MATHESH J
MANOJ KUMAR S

BRANCH:
ELECTRONICS AND COMMUNICATION ENGINEERING

1. INTRODUCTION

1.1 Project Overview

Gas Detectors have been in the market for a very long time and have been vastly used. They have wide range of applications and can be found in industrial plants, refineries, pharmaceutical manufacturing, paper pulp mills, aircraft and ship-building facilities, wastewater treatment facilities, vehicles, indoor air quality testing and homes. There are a lot of ways in which the Gas Detectors could be characterized. They are categorized on the basis of what type of gas they detect, what is the technology behind the making of the sensor and sometimes even the components which are used that affect their operation mechanism (semiconductors, oxidation, catalytic, photoionization, infrared, etc.). Gas Detectors are also widely characterized as fixed or portable detectors. They are characterized on the basis of which category of risk they fall in, Ex-Ox-Tox, the three categories of risk - Ex – Risk of explosion by flammable gases - Ox – Oxygen Risk of asphyxiation by oxygen displacement Risk of increase of flammability by oxygen enrichment - Tox – Risk of poisoning by toxic gases, the list of categorization goes on. As a result we cannot have a single system or a group of systems which we can call the best but instead there is a plethora of devices available for matching the varying user requirements.

1.2 Purpose

● Solve complex problems in a way that fits the state of your customers.

● Succeed faster and increase your solution adoption by tapping into existing medium and channels of behaviour.

● Sharpen your communication and marketing strategy with the right triggers and messaging

● Increase touch-points with your company by finding the right problem-behaviour fit and building trust by solving frequent annoyances, or urgent or costly problems.

● Understand the existing situation in order to improve it for your target group.

2. LITERATURE SURVEY

2.1 Existing problem

In industries, the existing Problem in gas monitoring is that there is no efficient system for monitoring the gas leakage, the good system is of high cost and also the installation process is too complicated. Then the affordable of the system is high and the systems are sometimes making disasters and the number of sensors is unpredictable and the positioning of equipment is improper.

2.2 References

1) Bing Han, Qiang Fu, Hanfang How, 'Methane Leakage Monitoring Technology For Natural Gas Stations And Its Application', IEEE 5th International Conference on Computer and Communications,2001.

2) Shruthi Unnikrishnan,1 Mohammed Razil, Joshua Benny, Shelvin Varghese and C.V. Hari, 'LPG Monitoring And Leakage Detection System', Department of Applied Electronics and Instrumentation Engineering, Rajagiri School of Engineering and Technology, Rajagiri Valley, Kakkanad, Kochi, India.

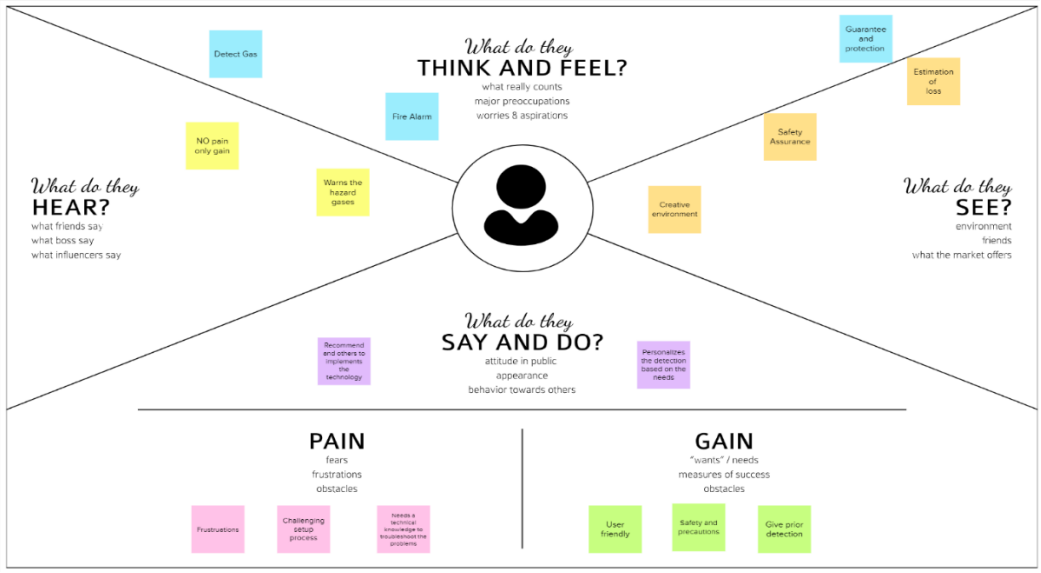
2.3 Problem Statement Definition

The presence of the hazardous gas leakage in work place of industries also store gases contains gas which exhibits ideal characteristics is used. The sensors Arduino UNO are widely used to detect the essence of the gas in the atmosphere of the industries.

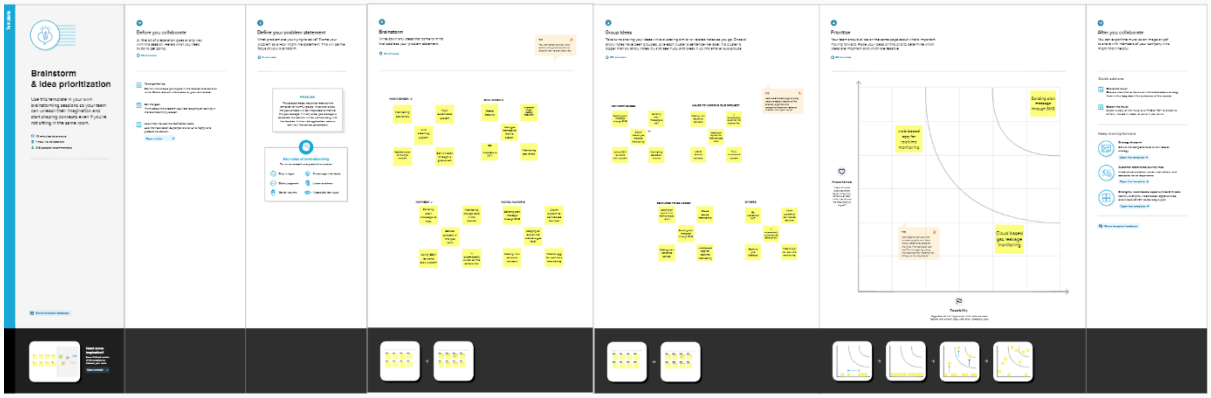
The usage of the gas brings great problem in industries which is excessively used in industries causes destructible impact to the lives and as well as to the heritage of the people.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming



3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Monitoring and Detecting the gas leakage in industries at unmanned zone.

2.	Idea / Solution description	Sensor which is used along with Arduino UNO detect the essence of gas in atmosphere of the industries and audible alarm sound is switched on and automatically turn off the gas supply at the source when the gas detected and our solution also monitor the data and upload to the cloud regularly.
3.	Novelty / Uniqueness	We use sensor called Gas Sensor.
4.	Social Impact / Customer Satisfaction	• Lost revenue and impact on finances • Brand value and reputation • Operational downtime
5.	Business Model (Revenue Model)	Gas leakage monitoring and alerting system is the most efficient and cost effective technology for producing large quantities of gas in the industries and it helps them to increase the business growth.
6.	Scalability of the Solution	Our system is a reliable one and the installation is ease and the connectivity is well planned. It has extraordinary functionality .

3.4 Problem Solution fit

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioural patterns and recognize what would work and why.

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Gas detection design coverage T	The gas detection function shall provide reliable and fast detection of flammable and toxic leaks before a gas cloud reaches a concentration and size which could cause risk to personnel and installation.

FR-2	Leak detection	Flammable gas detection shall be provided in all areaswhere flammable gas leakages could occur. In these areas the smallest gas cloud that has the potential to cause unacceptable damage shall be specified as the minimum cloud size for confirmed gas detection.
FR-3	Gas detection location	Detectors should be positioned in different levels in an area or module.
FR-4	Gas detection actions	The alarm starts ringing when the gas gets leaked, Doors will be opened automatically and the data's will be stored in cloud and alert message will be displayed on the LCD display.
FR-5	Gas detection calibration	Gas detectors shall be individually identifiable with a self test function. It shall ensure the presence of gasconcentration and amount of gas leakage
FR-6	Gas detection level	• Low alarm limit for IR open path detector is maximum 1 LELm . • High alarm limit for IR open path detector is maximum 2 LELm .

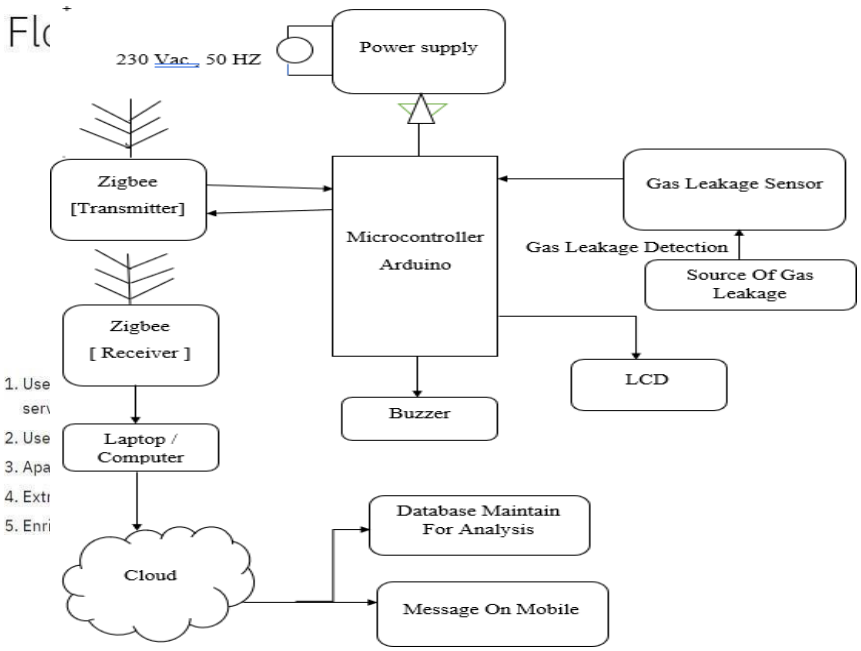
4.2 Non-Functional requirements

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Used to avoid accidents in industries and save life.
NFR-2	**Security**	To Protect Sensitive Data which is being monitored and stored in cloud for future needs.
NFR-3	**Reliability**	This system can perform consistently well in all Circumstances.
NFR-4	**Performance**	it performs Speedy operation and it send response faster.
NFR-5	**Availability**	This device detects sensitive gases even to minor gas leaks.
NFR-6	**Scalability**	Any Sensors can be added depending upon the geographical region.

5. PROJECT DESIGN

5.1 Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



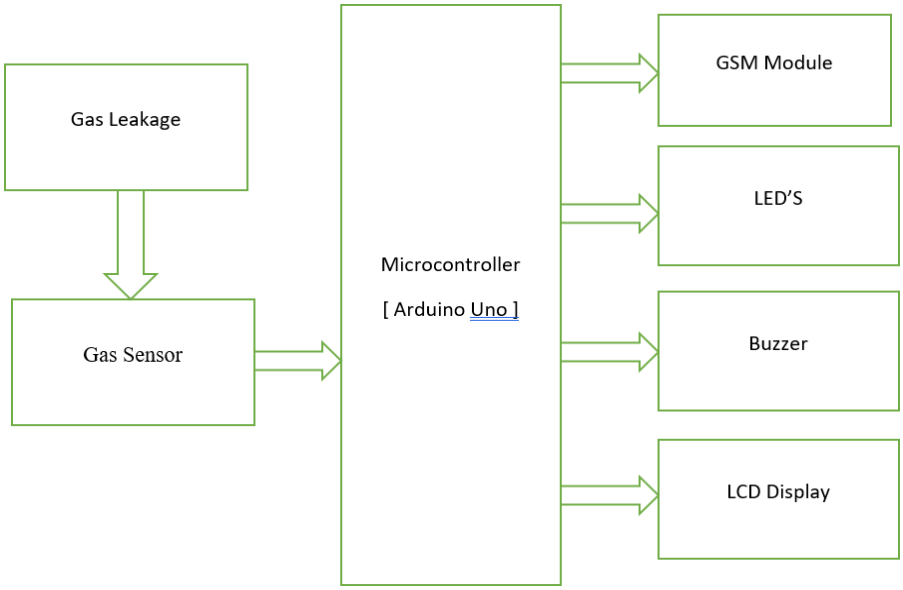
5.2 Solution & Technical Architecture

SOLUTION ARCHITECTURE

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 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 id defined, managed, and delivered.

SOLUTION ARCHITECTURE DIAGRAM



TECHNICAL ARCHITECTURE

The deliverable shall include the architectural diagram sa below and the information as per the table1 and table2.

Table-1 : Components & Technologies:

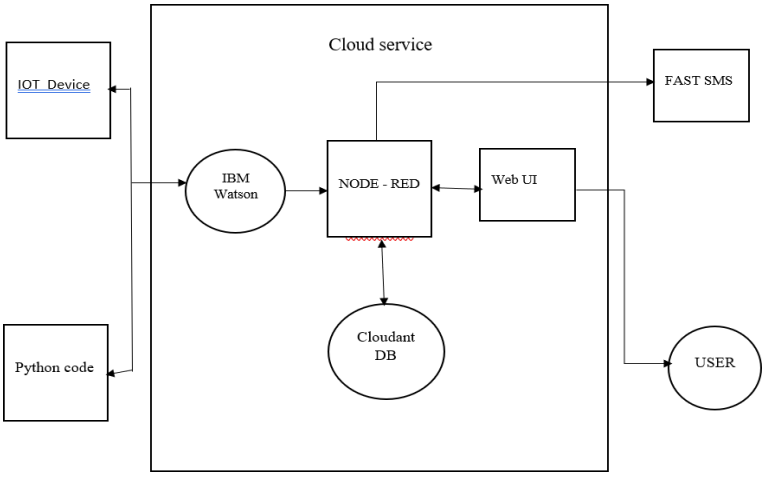
S. No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot	Node-Red
2.	Application Logic-1	Logic for a process in the application	Python
3.	Application Logic-2	Logic for a process in the application	IBM Watson Assistant
4.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Technology of Opensource framework

2.	Security Implementations	List all the security / access controls implemented, use of firewalls etc.	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro services)	Technology used
4.	Availability	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Technology used
5.	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache,use of CDN's) etc.	Technology used

TECHNICAL ARCHITECTURE DIAGRAM



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Worker in industry	Gas detection design coverage	USN-1	Area Coverage for Gas Detectors Like smoke detectors, a gas detector is capable of providing up to 75SQM area coverage based on a 5M radius of operation.	Design coverage measures the percentage of test cases coverage against the	High	Sprint-1

				number of requirements		
Owner in industry	Leak detection	USN-2	In industrial settings leak detection is a routine procedure that is necessary for monitoring product movement.	To detect leaks in fluid system such as piping network and pressure vessels	High	Sprint-1
Owner in industry	Gas detection actions	USN-3	A gas detection system is usually connected with an alarm system, so as soon as the potentially dangerous gas is detected, the alarm is set to ON automatically, which warns the workers in time to safely evacuate.	Gas detection systems are used to monitor and either alarm or be part of processing control	Low	Sprint-2
Worker in industry	Gas detection location	USN-4	A gas detection sensors should be located near the floor for gases or vapors three or four times heavier than air. They should be installed near the ceiling or roof to detect lighter-than-air gases.	To detect install your natural gas detectors in locations close to sources of natural gas.	Medium	Sprint-1
Worker in industry	Gas detection levels	USN-5	A gas detection levels programmed, typically 10-20% LEL for a first alarm (warning) and 20-40% LEL for a second stage alarm to evacuate or take furtheraction	Gas detection level shows the percentage within a safety range of 0-10% of the Lower Explosive Limit (LEL) and, ideally, should read 0%	High	Sprint-1
Worker in industry	Gas detection calibration	USN-6	A gas detection calibration must be traceable to a national or international standard in order to be considered accurate for calibration.	Calibration is recommended annually or if bump testing indicates an out of spec sensor	High	Sprint-1

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

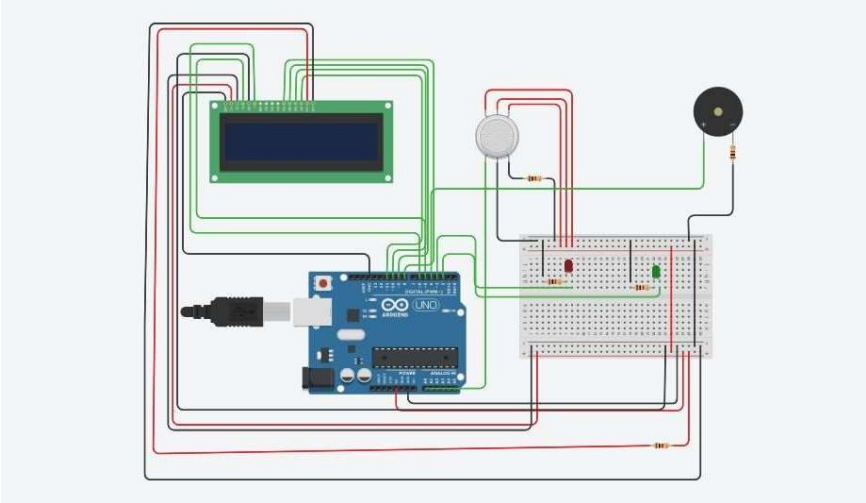
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Analyzing the gas leakage	USN-1	The owner who wants to save his employees or a person who wants to savetheir family from explosion takes necessary actions	2	High	Harivignesh A Mathesh J Siva Akash K Manoj Kumar S
Sprint-1	Preventing from explosion	USN-2	The fire officers worries about any explosions due to gas leakage which may cause many death	1	High	Harivignesh A Mathesh J Siva Akash K Manoj Kumar S
Sprint-2	To detect the gas leakage	USN-3	The owner can take necessary steps by deploying gas detectors intheir surroundings	2	Low	Harivignesh A Mathesh J Siva Akash K Manoj Kumar S
Sprint-3	Testing and training of the model device	USN-4	The programmer can design an gas leakage detection model by trainingthe dataset	2	Medium	Harivignesh A Mathesh J Siva Akash K Manoj Kumar S
Sprint-4	Notification	USN-5	The gas leakage detected by the model can be notified using SMS or alarming system	1	High	Harivignesh A Mathesh J Siva Akash K Manoj Kumar S

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint StartDate	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	05 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

7. SCHEMATIC DIAGRAM OF PROJECT & COMPONENTS:

7.1 Circuit Diagram:



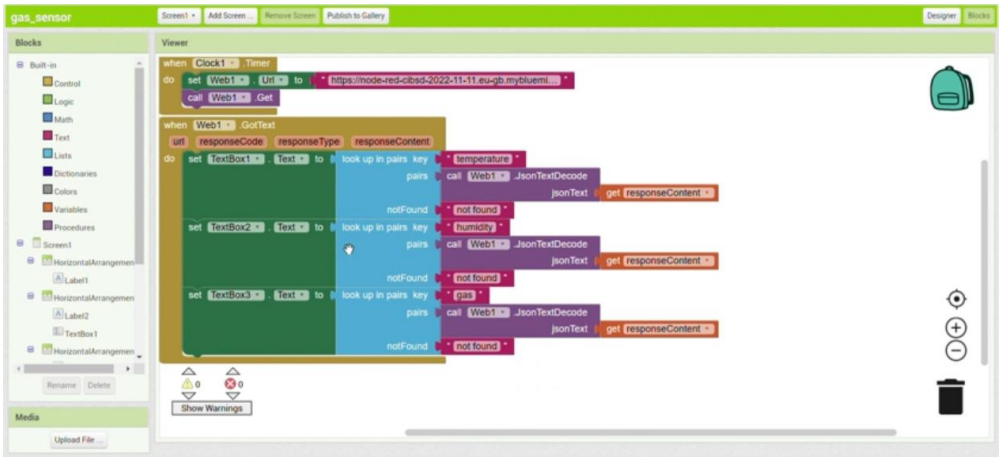
7.2 Components:

The design of a sensor-based automatic gas leakage detector with an alert and control system. The components are

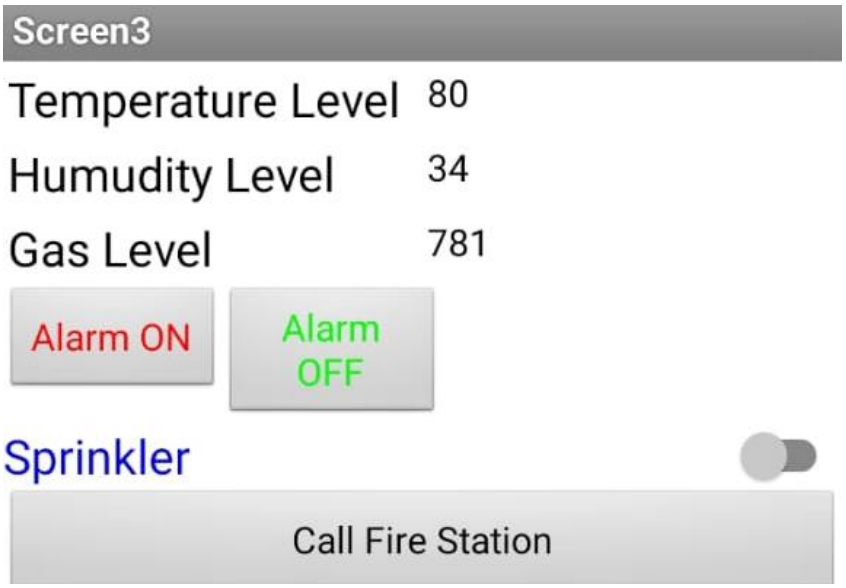
S.No	Name of the component	Quantity
1	Arduino UNO R3	1
2	Breadboard	1
3	LED	2
4	Resistor	5
5	Piezo	1
6	Gas Sensor	1
7	LCD(16*2)	1

0

8. TESTING



9. RESULTS



10. ADVANTAGES & DISADVANTAGES

ADVANTAGES

- 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

DISADVANTAGES

- Poor stability and greater environmental impact.
- The output parameters cannot be determined.
- It could not be used in places where accurate measurement is required.
- Non-selective in the flammable gas range.
- Under fire, there is a danger of igniting an explosion.
- Most elemental organic vapours are toxic to the sensor.

11. CONCLUSION

The advantage of this simple gas leak detector is its simplicity and its ability to warn about the leakage of the LPG gas. This system uses GSM technique to send alert massage to

respective person if no one is there in the house and then gas leaks occurs, GSM module is there to send immediate messages to the respective person regarding the gas leak. The main advantage of this system is that it off the regulator knob of the cylinder automatically when gas leakage detected.

12. FUTURE SCOPE

Major cities of India are pushing Smart Home application, gas monitoring system is a part of Smart Home application. Enhancing Industrial Safety using IoT. IoT turns drone into gas detection sensor. Another major future scope could be including a Automatic Shut-off device which will turn off the gas supply whenever it will detect any gas leakage. This system can be implemented in Industries, Hotels and wherever the LPG cylinders are used. This system can be used in industries involving applications such as Furnace, Boilers, Gas welding, Gas cutting, Steel Plants, Metallurgical industries, Food processing Industries, Glass Industries, Plastic industries, Pharmaceuticals, Aerosol manufacturing. As hospitals require to provide maximum possible safety to patients, this system can be used to keep track of all the cylinders used in it. Some of the cylinders used are Oxygen cylinder, Carbon dioxide cylinder, Nitrous oxide cylinder. As many students are naïve the risk of causing accidents is high. Hence, our system can also be used in schools, colleges. Many colleges have well established labs including chemistry lab and pharmaceutical labs where gas burners are used. Plenty of medical equipment requires gas cylinders.

13. APPENDIX

Source Code

```
#include
<LiquidCrystal.h>

                    LiquidCrystal lcd(6, 7, 8, 9, 10, 11);
                    float gasPin = A0;
                    float gasLevel;
                    int ledPin = 2;
                    int buttonPin = 3;
                    int buzzPin = 4;
                    int buttonState;
                    int fan = 5;

                    void setup(){
                      pinMode(ledPin, OUTPUT);
                      pinMode(buttonPin, INPUT);
                      pinMode(gasPin,INPUT);
                      pinMode(fan,OUTPUT);
```

```
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.setCursor(0,0);
  lcd.print(" Welcome");
  lcd.setCursor(0,2);
  lcd.print(" Youtube");
  delay(500);
  lcd.clear();
}

void loop(){
  // Read the value from gas sensor and button
  gasLevel = analogRead(gasPin);
  buttonState = digitalRead(buttonPin);

  // call the function for gas detection and button work
  gasDetected(gasLevel);
  buzzer(gasLevel);
  exhaustFanOn(buttonState);
}

// Gas Leakage Detection & Automatic Alarm and Fan ON
void gasDetected(float gasLevel){
  if(gasLevel >= 300){
   digitalWrite(buzzPin,HIGH);
    digitalWrite(ledPin,HIGH);
    digitalWrite(fan,HIGH);
    lcd.setCursor(0,0);
   lcd.print("GAS:");
    lcd.print(gasLevel);
   lcd.setCursor(0,2);
   lcd.print("FAN ON");
   delay(1000);
   lcd.clear();
  }else{
   digitalWrite(ledPin,LOW);
    digitalWrite(buzzPin,LOW);
    digitalWrite(fan,LOW);
    lcd.setCursor(0,0);
   lcd.print("GAS:");
    lcd.print(gasLevel);
   lcd.setCursor(0,2);
   lcd.print("FAN OFF");
   delay(1000);
   lcd.clear();
  }
```

```
}
//BUZZER
void buzzer(float gasLevel){
if(gasLevel>=300)
  {
  for(int i=0; i<=30; i=i+10)
  {
  tone(4,i);
  delay(400);
  noTone(4);
  delay(400);
  }
  }
}
// Manually Exhaust FAN ON
void exhaustFanOn(int buttonState){
  if(buttonState == HIGH){
    digitalWrite(fan,HIGH);
    lcd.setCursor(0,0);
   lcd.print("Button State:");
    lcd.print(buttonState);
    lcd.setCursor(0,2);
    lcd.print("FAN ON");
    delay(10000);
    lcd.clear();
  }
}
```

GitHub & Project Demo Link

GitHub link:

https://github.com/IBM-EPBL/IBM-Project-4794-1658740341

Project Demo Link: