Gas leakage monitoring and alerting system for industries

PROJECT NAME	**GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES**
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BRANCH	**COMPUTER SCIENCE AND ENGINEERING**

1.INTRODUCTION

1.1 PROJECT OVERVIEW

Internet of Things (IoT) is the networking of 'things' by which physical things can communicate with the help of sensors, electronics, software, and connectivity. These systems do not require any human interaction. Internet of Things aim towards making life simpler by automating every small task around us. As much is IoT helping in automating tasks, the benefits of IoT can also be extended for enhancing the existing safety standards.Safety plays a major role in today's world and it is necessary that good safety systems are to be implemented in places of

education and work. This work modifies the existing safety model installed in industries and this system can also be used in homes and offices. The traditional Gas Leakage Detector Systems though have great precision, fail to acknowledge a few factors in the field of alerting the people about the leakage. Therefore we have used the IoT technology to make a Gas Leakage Detector for society which having Smart Alerting techniques involving sending text message to the concerned authority and an ability performing data analytics on sensor readings.

1.2 PURPOSE

The Internet of Things is an emerging topic of technical, social, and economic significance. Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025. The Internet of Things (IoT) is an important topic in technology industry, policy, and engineering circles. This technology is embodied in a wide spectrum of networked products, systems, and sensors, which take advantage of advancements in computing power, electronics miniaturization, and network interconnections to offer new capabilities. The large-scale implementation of IoT devices promises to transform many aspects of the way we live. For consumers, new IoT products like Internet-enabled appliances, home automation components, energy management devices are moving us toward a vision of the “smart home’’, offering more security and energy efficiency. IoT systems like networked vehicles, intelligent traffic systems, and sensors embedded in roads

and bridges move us closer to the idea of “smart cities’’, which help minimize congestion and energy consumption. IoT technology offers the possibility to transform agriculture, industry, and energy production and distribution by increasing the availability of information along the value chain of production using networkedsensors.

2.LITERATURE SURVEY

2.1 EXISTING PROBLEM

In the existing method, different gas sensing technology is used. The LPG gas leakage is detected by the semiconductor sensor. Nowadays LPG accidents occur very common. The main reason of these accidents is due to the leakage of LPG. This leakage of LPG starts when we forget to close the main regulator valve. This is the basis of these kinds of accidents. Already there are some sorts of remedial measures such as when the leakage is detected, alert message is sent to the fire station and the owner.

2.2 REFERENCES

A number of reviews on the subject of gas leakage detection techniques were done in the past either as part of research papers/technical reports on a certain leak detection method and other gas related subjects. A.Mahalingam, r. T. Naayagi, n. E. Mastorakis; they introduce design and implementation of an economic gas leakage detector. They gave the formulation of many problems in previous gas leakage detectors. They told that several standards have been formulated for the design of a gas leakage detection system such as IEEE, BS 5730, and IEC.For this work, the recommended UK safety standards have been adopted.

The proposed alarm system is mainly meant to detect LPG leakage, which is most commonly used in residential and commercial premises. The system detects not only the presence of gas (gas leak), but also the amount of leakage in the air, and accordingly raises an appropriate audio visual alarm. The objective of the system is to detect LPG gases such as propane and butane.The allowed UK level for butane is 600 ppm above which it is considered to be of high level and poses a danger. The proposed system ensures a continuous monitoring of the gas levels.If the gas level increases above the normal threshold level of 400 ppm butane (LPG), the system starts to issue early warning alarms at 100ms interval, which implies low level gas leakage. If the leakage level increases to 575 ppm of butane (LPG), the system activates high severity audio alarms at 50 ms intervals warning the occupants to run to safety.

Prof. M.Amsaveni, A.Anurupa, R.S.Anu Preetha, C.Malarvizhi, M.Gunasekaran; they told in their research paper on “GSM based LPG leakage detection and controlling system”the leakage of LPG gas is detected by the MQ-6 gas sensor. Its analog output is given to the microcontroller. It consists of predefined instruction set. Based on this, the exhaust fan is switched on. So, the concentration of gas inside the room gets decreased. Then, the stepper motor is rotated thus closing the knob of the cylinder. Because of this process, the leakage of gas is stopped. The relay is switched to off the power supply of the house. buzzer produces an alarm to indicate the gas leakage. Then, the user is alerted by SMS through the GSM module. They proposed their methodology that the system takes an automatic control action after the detection of 0.001% of LPG leakage. This automatic control action provides a mechanical handle for closing the valve. We are increasing the security for human by means of a relay which will shut

down the electric power to the house. Also by using GSM, we are sending an alert message to the users and a buzzer is provided for alerting the neighbors about the leakage.

B.B.Didpaye, Prof.S. K. Nanda;told about their research on leakagedetection and review of“Automated unified system for LPG using microcontroller and GSMmodule”. Their paper proposed an advance and innovative approach for LPG leakage detection,prevention and automatic booking for refill. In advance, the system provides the automatic controlling of LPG regulator also if leakage is detected the system will automatically turn off the main switch of power supply. Hence it helps to avoid the explosion

and blast.

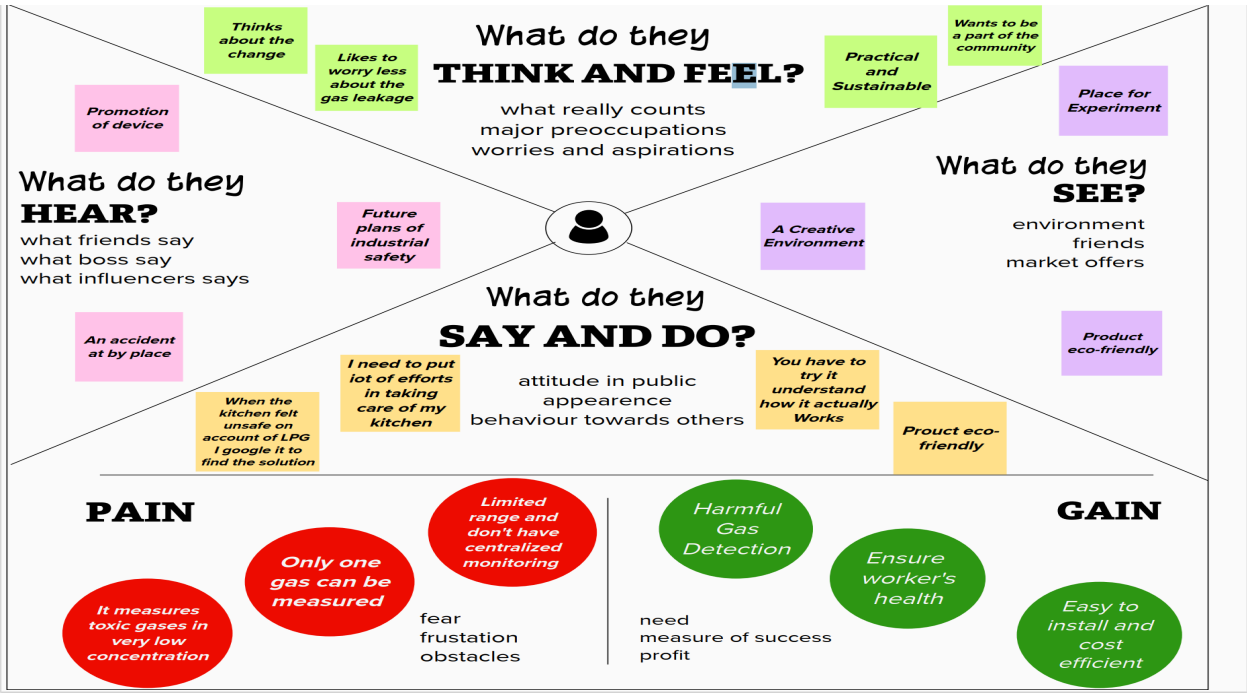
Srinivasan, Leela, Jeya bharathi, Kirthik,Rajasree; in this research paper they told about gas leakage detection and control. In this paper, the gas leakage resulting into fatal inferno has become a serious problem in household and other areas where household gas is handled and used. It alerts the subscriber through the alarm and the status display besides turning off the gas supply valve as a primary safety measure.

2.3 PROBLEM STATEMENT DEFINITION

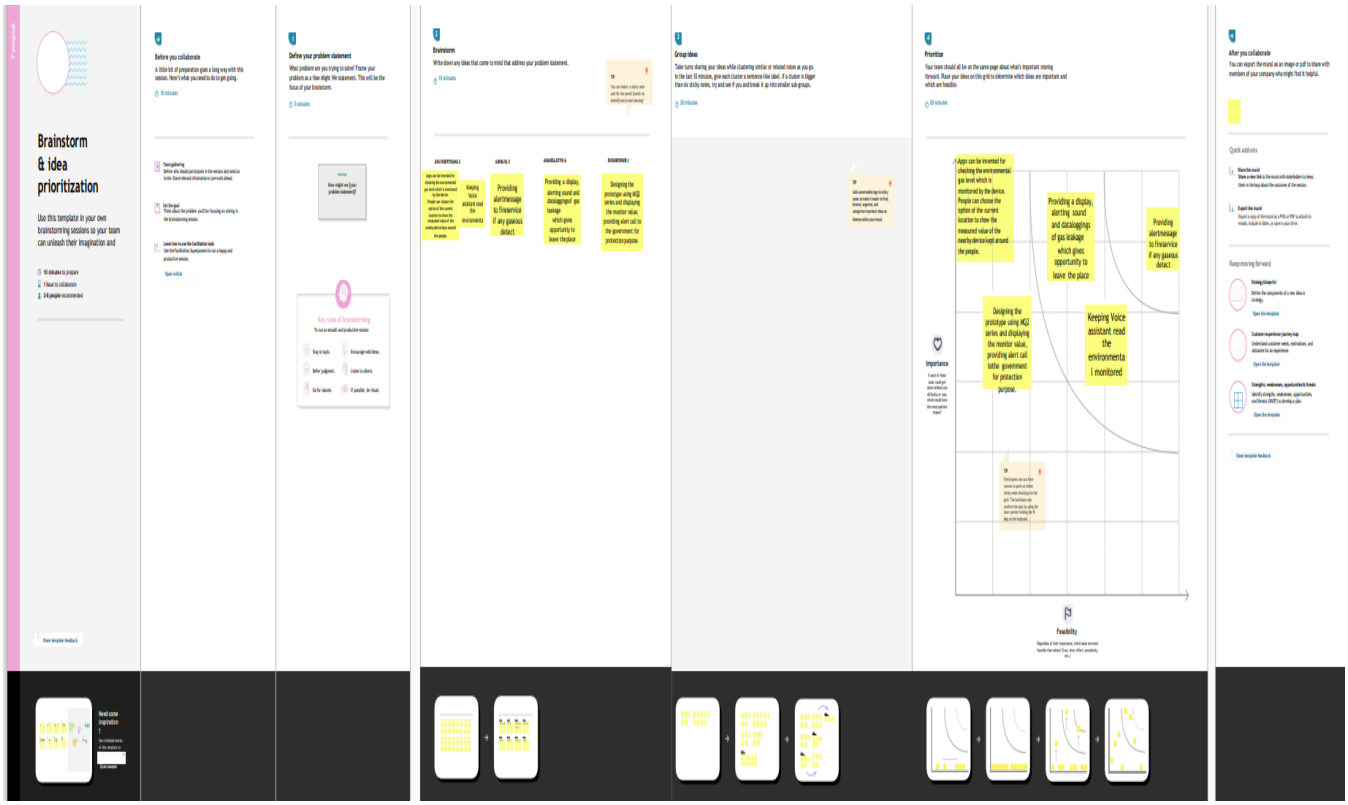
The design of a sensor-based automatic gas leakage detector with an alert and control system has been proposed. This is an affordable, less power using, lightweight, portable, safe, user friendly, efficient, multi featured and simple system device for detecting gas. Gas leakage detection will not only provide us with significance in the health department but it will also lead to raise our economy, because when gas leaks it not only contaminates the atmosphere, but also wastage of gases will hurt our economy. The need for ensuring safety in workplaces is expected to be the key driving force for the market over the coming years.

3.IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



3.2 IDEATION AND BRAINSTORMING

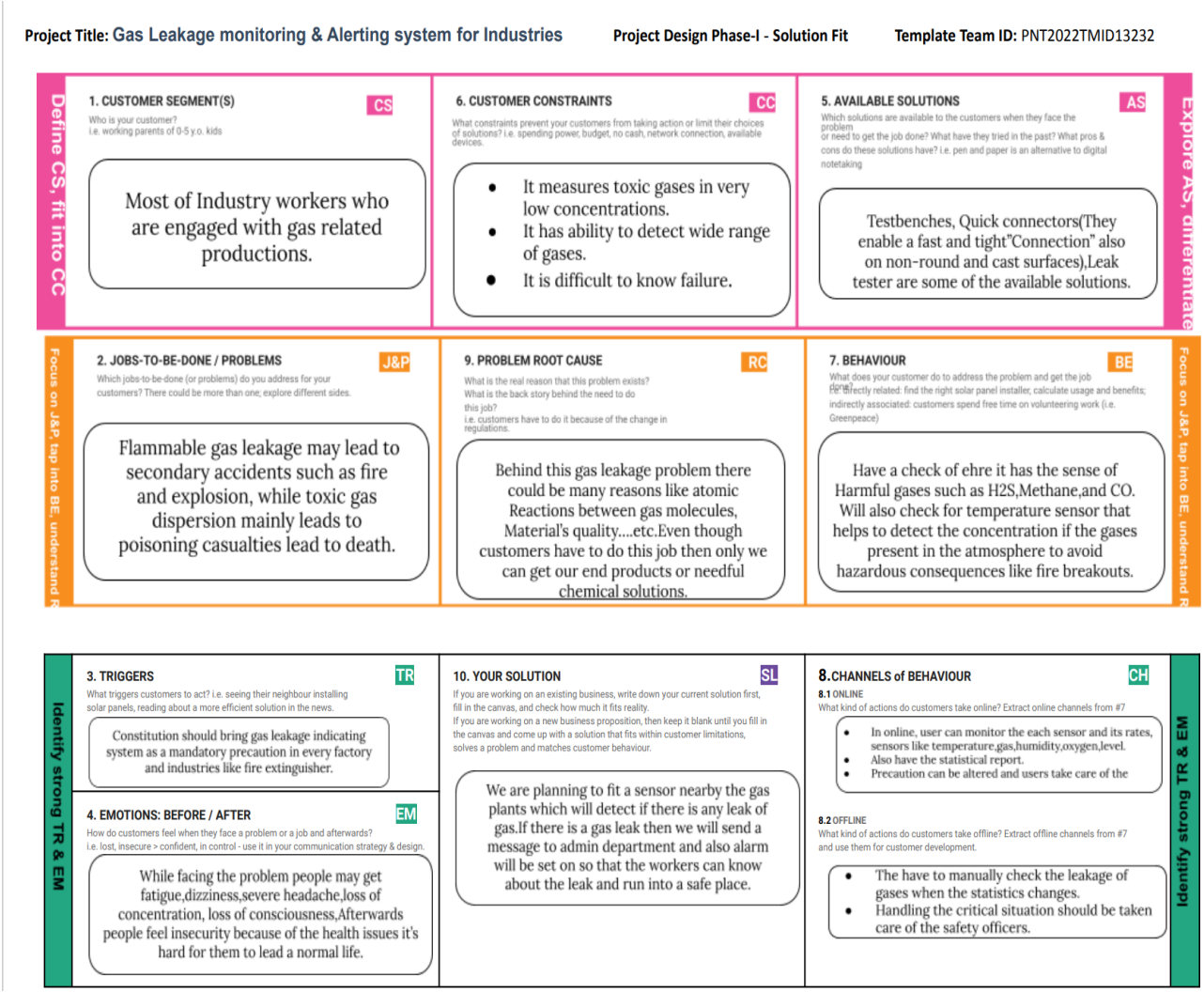


3.3 PROPOSED SOLUTION

The proposed system takes an automatic control action after the detection of 0.001% of LPG leakage.This automatic control action provides a mechanical handle driven by stepper motor for closing the valve. The closing of the cylinder knob stops the flow of gas and prevents fire outbreak. We are increasing the security for human by using the combination of a relay and the stepper motor which will shutdown the electric power of the house.

Also by using a GSM module, we are sending an alert message i.e SMS (Short messaging services) to warn the users about the LPG leakage and a buzzer is provided for alerting the neighbors in case of the absence of the users about the LPG leakage. The aim of this system is to reduce the probability of explosion due to gas leakage. The main advantage of this system overthe manual method is that, it does all the process automatically and has a quick response time.

3.4 PROBLEM SOLUTION FIT



4.REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

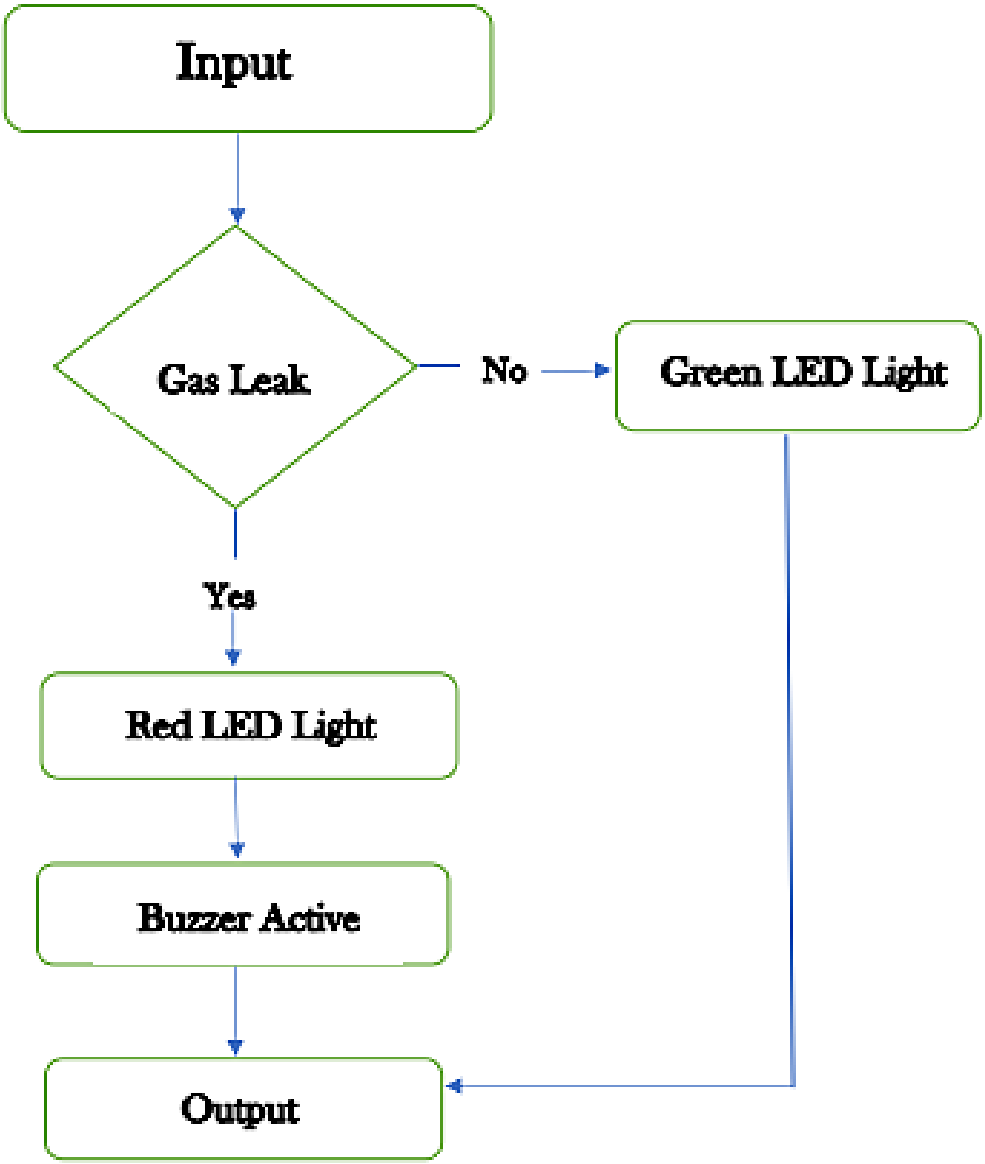
To ensure the system works well, it has to support the following business requirements: The user shall be able to receive warning message as quickly as possible.The user shall be able to turn off the electricity.The user shall be able to turn on the airrefreshing device.The user shall be able to view information of fire station.The user shall be able to view nearest fire station. The user shall be able to navigate to nearest fire station.The user shall be able to make call to 998.The user shall be able to share his/her location.

4.2 NON FUNCTIONAL REQUIREMENTS

The system should response immediately to any leakage situation.The system should update the local database in real time.The system should make decision within 5 seconds.The Arduino response time should be fast.The gas detector should be from anywhere at any time.The homeowner information should be modified easily.The communication between the Arduino and the GLDS should be secure by encryption.The system should not display the homeowner personal information to anyone.

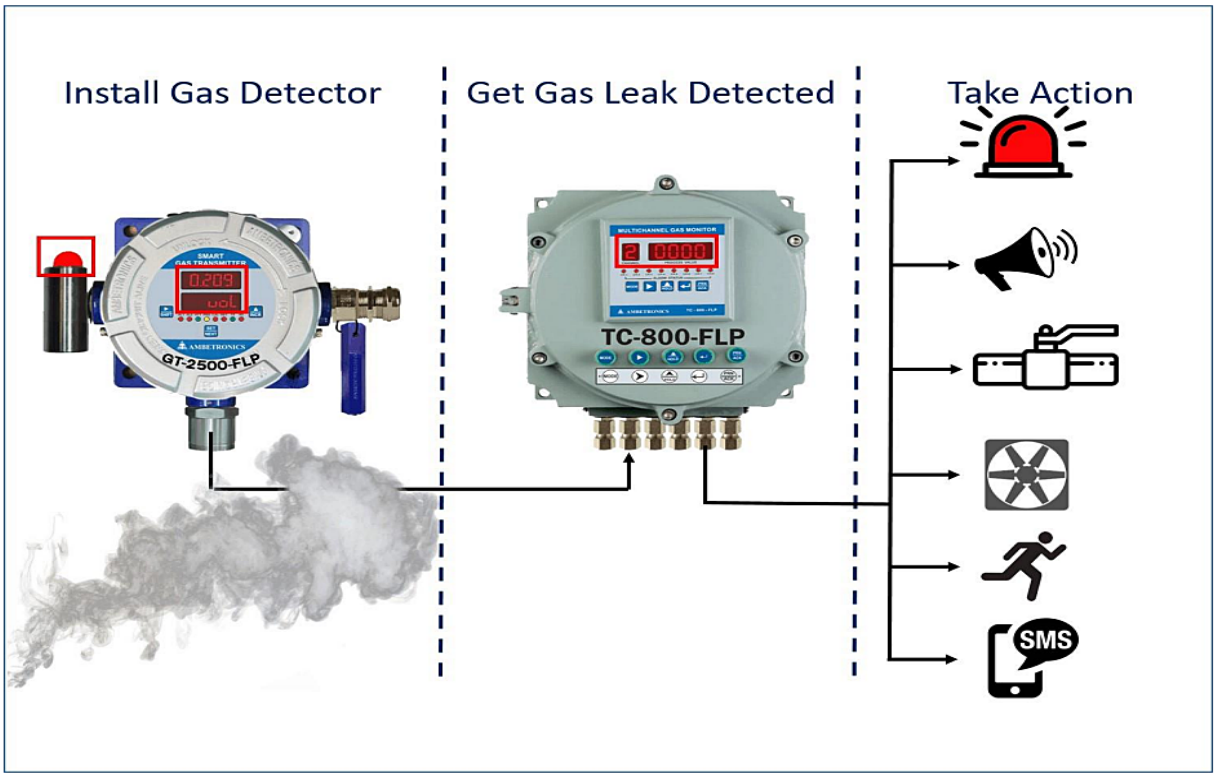
5.PROJECT DESIGN

5.1 DATA FLOW DIAGRAM



5.2 SOLUTION AND TECHNICAL ARCHITECTURE

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 datas are continuously transferred to the local server. The accuracy of MQ sensors are not upto 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.



5.3 USER STORIES

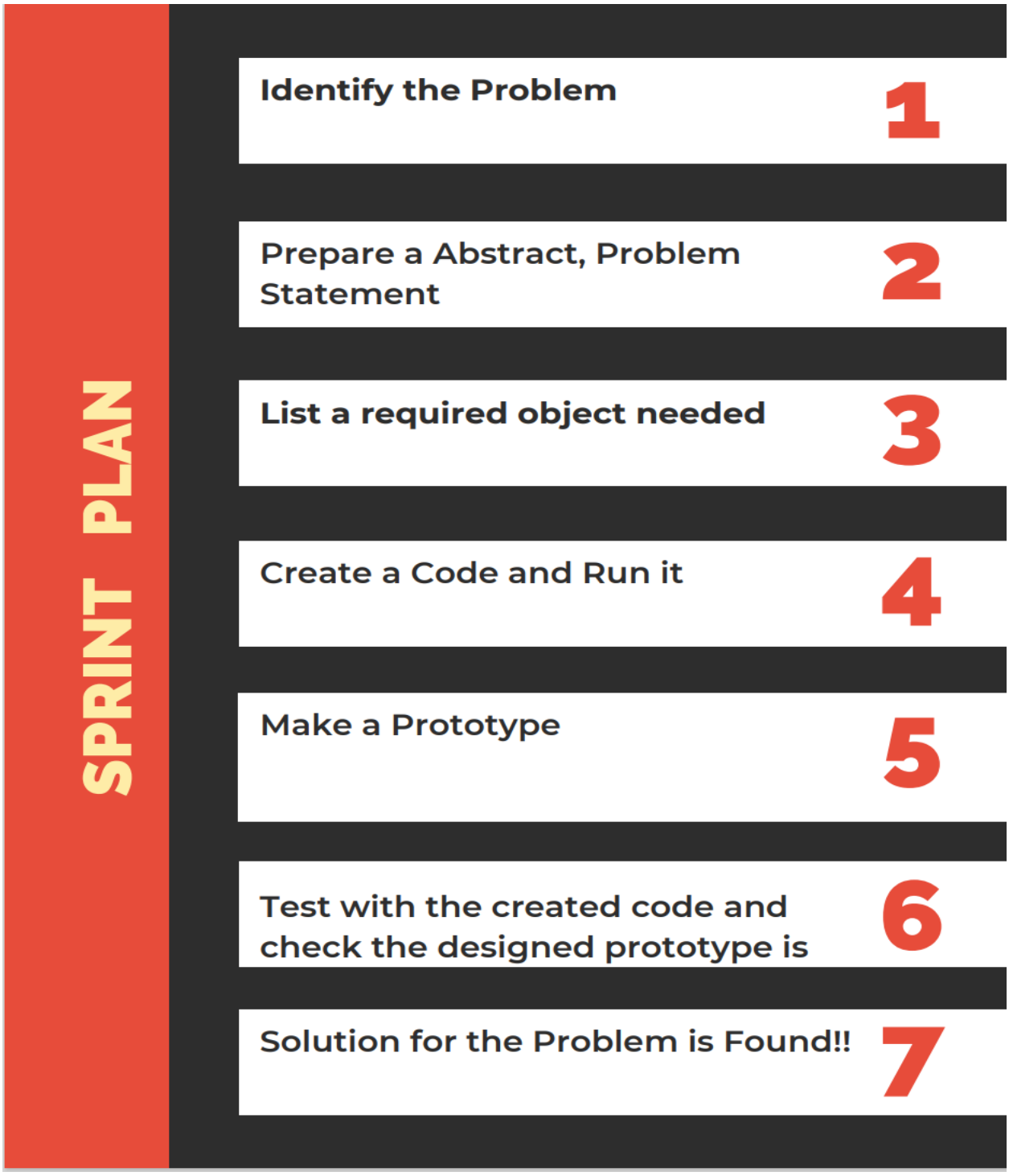
Gas leakage is nothing but the leak of any gaseous molecule from a stove,or a pipeline, or cylinder etc. This can occur either purposefully or even unintendedly. As we are aware that these kinds of leaks are dangerous to our health, and when it becomes explosive it could cause great danger to the people, home, workplace, industry and the environment.

Few of the major incidents took place due to gas leakage include the Bhopal Disaster and the Vizag Gas leak. The Bhopal disaster is known to be the worst industrial accident ever. Approximately 45 tons of Methyl Isocyanate was leaked from this insecticide plant. Methyl Isocyanate is an organic compound and a chemical that could come from the carbamate pesticides. This colorless, poisonous and flammable liquid is something that human beings have to be away from.

Vizag Gas leak was a resultant of the escape of styrene that were unattended for a long period. This colorless oily liquid can spread in fumes. So, a detector must be made in such a way that could detect any kind of gas, fume, leak, smoke etc. However harmful and dangerous it can be, the detector could be attached with certain parameters that could help to prevent the issue.

6.PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION



6.2 SPRINT DELIVERY SCHEDULE

Arduino will be active with 5 volts‟ power supply. The sensor will detect gas leakage once the system is launched, if there is no gas leakage, it will display "Normal Condition Air Cleaning" on the display. If the gas is leaked otherwise, the following three steps will follow

Step 1: A signal from the microcontroller will go to the display and show gas leakage message there.

Step 2: The signal from Buzzer will signal when the first step is completed.

Step 3: Lastly, through GSM, there will be a signal message that the gas has been leaked to a specific number or multiple.

LIST OF COMPONENTS

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

7.CODING AND SOLUTIONING

7.1 FEATURE 1

- PESO/CCOE tested Flameproof Enclosures;
- It has a loop of single wired series connection of detectors;
- Alarm indication is through a localized Relay Module connection within the series loop;
- Optional provision of Automatic Shut-off of incoming gas flow through main pipeline, in case of gas leak alert.
- Range of LPG/PNG Gas leak detection is 0 to 100% LEL.
- Optional monitoring from remote location through wireless devices and cloud platform
- These detectors are suitable in hazardous areas, specifically designed for detection of LPG/PNG group of gases.

```
#include<LiquidCrystal>
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);
  }
}
```

7.2 FEATURE 2

• One USB port can be used as debugging and firmware upgrading.
• Audio channels which include a microphone input and a receiver output.
• Programmable general-purpose input and output.
• One SIM card interface.
• Support Bluetooth function.
• Support one PWM.
• PCM/SPI/SD card interface, only one function can be accessed synchronously.
• Power supply 3.4V ~ 4.4V
• Typical power consumption in sleep mode is 1.2mA
• Frequency bands GPRS multi-slot class 12
• Support SIM card: 1.8V, 3V
• Serial Port: Can be used for AT commands for data stream

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

int redled = 2;
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    lcd.clear();
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    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);
   }
}
```

8.TESTING

8.1 TEST CASES

- Leak tightness checks on gas pipes (leak tightness check and load test according to TRGI 2018 and DVGW G 5952)
- Serviceability checks according to TRGI 2018 on gas pipes
- Pressure tests on water pipes (drinking water according to ZVSHK EN 806-4, waste water according to DIN EN 1610)
- Leak tightness checks on liquid gas pipes according to TRF 2021
- Gas pressure regulator inspections

- Pipe volume measurements
- Further applications including temperature measurements at radiators and pressure measurements at burners (die pressure, gas flow pressure…)

8.2 USER ACCEPTANCE TESTING

The preferred and primary method for leak detection is a direct reading instrument with a sensor that uses thermal conductivity different from that of the ambient air for detection, such as the Matheson LeakHunter Plus Model 8066 or its equivalent. This type of detector is highly sensitive and can locate leaks too small to bubble quickly with a liquid solution leak detector.

Gases and vapors with thermal conductivity different from air can be detected with this method, and some are listed in the table below.An alternate method, if the primary method cannot be used, is liquid solution leak detection such as the Matheson Detect-A-Leak™ or equivalent that meets or exceeds MIL-L-25567D Type I and II specifications.

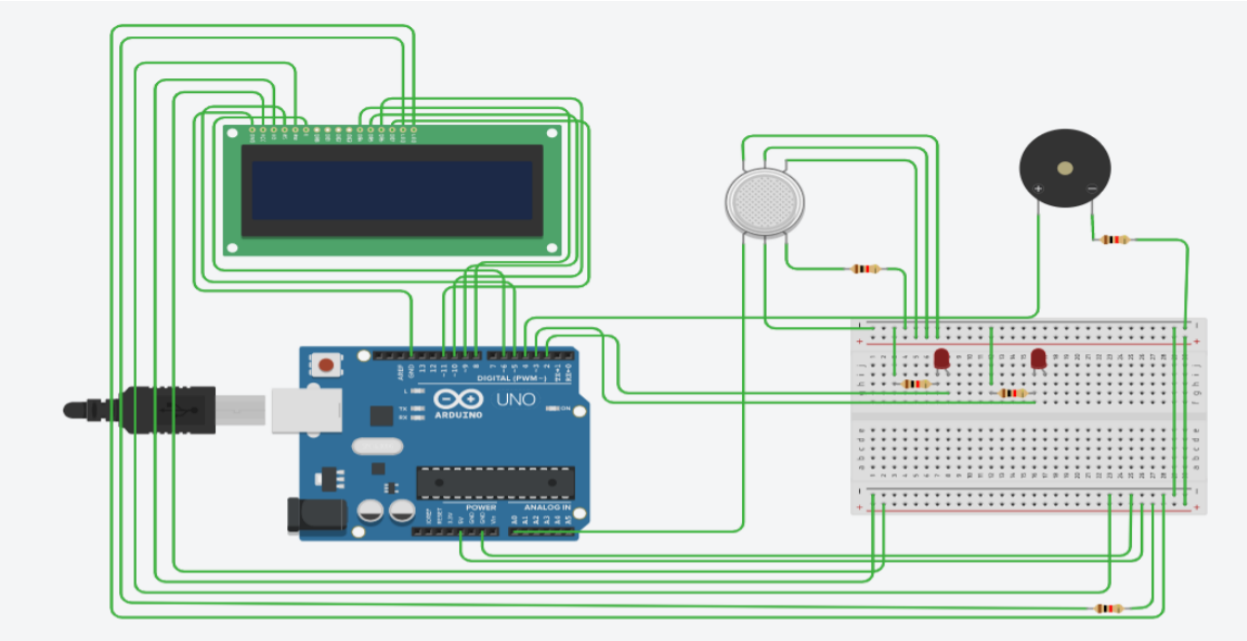
At Stanford University, all toxic gas cylinders will be tested for leaks prior to removing cylinders from the delivery vehicle, if possible. Also, non-toxic gas cylinders such as flammables should be tested for leaks before acceptance. Leaking gas cylinders will not be accepted. The Principal Investigator (PI) who ordered the gas cylinder is responsible for ensuring that the cylinder is leak tested. Similarly, all compressed gas experimental apparatus should be leak tested periodically per the applicable experimental protocol. Only individuals trained in the use of leak detection methods should perform this leak test procedure.

9.RESULTS

9.1 PERFORMANCE METRICS

Safety plays a serious role in today's world and it's necessary that smart safety systems are to be enforced in places of education and work. The LPG or gas that is combustible mixture of organic compound gases utilized in use as fuel in abundant application like homes, hostels, industries, automobiles' vehicles attributable to its fascinating properties that embrace high hot price, that manufacture the less smoke, produces less soot and doesn't cause abundant hurt to the setting. Each cases burns to provide clean energy, but there's a significant drawback concerning their outpouring within the air. The gases being heavier than air don't disperse simply could and should and will} cause suffocation once indrawn conjointly once gas outpouring into the air may cause explosion' thanks to the explosion of LPG gas the no of deaths has been inflated in recent years. Thusthis device are often used to avoid these issues by sleuthing and conjointly preventing outpouring of LPG. Gas leak discovering is that the method of characteristic doubtless venturesome gas leaks by means that of varied sensors 'The advantage of this automated detection And alerting system over the manual technique is that it offers fast latency And correct detection of an emergency and successively leading quicker diffusion of the vital situation' r The gas detection an alter system that we've designed could be a terribly value effective system to detect outpouring of any gas. It

is not solely detects outpouring of gas it conjointly alerts U.S. by manufacturing appears like alarm etc. It has its applications in numerous fields like faculty, colleges, universities, homes and industries.



10.ADVANTAGES AND DISADVANTAGES

ADVANTAGES

1. Low cost
2. Low power consumption
3. High accuracy
4. It also detects alcohol so it is used as liquor tester.
5. The sensor has excellent sensitivity combined with a quick response time

DISADVANTAGES

1. No prevention of fires possible with kit.
2. Applicable only as an indicator/alarming device.
3. It works only when at 5V power supply is given.

4. Its sensitivity depends on Humidity and temperature.
5. It is a little sensitive to smoke

11.CONCLUSION

Gas leakage leads to severe accidents resulting in material losses and human injuries. Gas leakage occurs mainly due to poor maintenance of equipments and inadequate awareness of the people. Hence, LPG leakage detection is essential to prevent accidents and to save human lives. This paper presented LPG leakage detection and alert system. This system triggers LED and buzzer to alert people when LPG leakage is detected. This system is very simple yet reliable.

After this project performance, can conclude that detection of the LPG gas leakage is incredible in the project system. Applicable usefully in the industrial and domestic purpose. In danger situations we are able to save the life by using this system. An alert is indicated by the GSM module. A sensor node senses gas like CO2, oxygen, propane. The estimated range of transmission and consumption of power is obtained. The simple procedures and Arduino UNO Micro controller area used to build the sensor.

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>

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);
  }
}
```

GITHUB AND PROJECT DEMO LINK

https://github.com/IBM-EPBL/IBM-Project-22584-1659854559

https://www.loom.com/share/0d259639bdcf45d29b865fd4512885ec