

PROJECT REPORT

Gas Leakage Monitoring and Alerting System

(Department of Electronics and Communication Engineering)

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ABSTRACT :

Leakage of any kind of gas has been a concern in recent years, whether it is in a residential setting, a business, a cafe, or a canteen. In this paper development of an IoT based gas wastage monitoring, leakage detecting and alerting system is proposed. This paper elaborates design such an intelligentsystem that will help save gas and smartly prevent accidents. The system needs to be integrated with the cooker. The technology includes ultrasonic sensors that determine if the cooker is being utilized for cooking purposes or not. If it is discovered that the cooker is not in use, the system uses an automatic switching off mechanism to cut off the gas supply. The moment gasleakage will probably be recognized, users will be informed via SMS through GSM, and so that user can solve the issue as soon as possible. The system will monitor flame and fire through flame sensor. When a fire is detected, the buzzer begins to sound. Aside from that, the system also has a cloud storage capability. The usage of gas for each user each day may be tracked with the aid of this cloud storage solution. At the end of the day, this procedure will assist in detecting per user natural gas usage. The system has been tested and it is able to monitor gas wastage, leakage and send a SMS to the user. The resulting performance indicated its effectiveness toward saving a significant portion of the wasted gas in domestic.

INTRODUCTION :

Now a days the home safety detection system plays the important role for the security of people. Since all the people from the home goes to work on daily bases, it makes impossible to check on the appliances available at home specially LPG gas cylinder, wired circuits, Etc. Since last three years there is a tremendous hike in the demands of liquefied petroleum gas (LPG) and natural gas. To meet this access amount of demand for energy and replace oil or coal due to their environmental disadvantage, LPG and natural gas are preferred. These gases are mostly used on large scale in industry, heating, home appliances and motor fuel. So as to track this leakage gas, the system includes MQ6 gas sensor. This sensor senses the amount of leak gas present in the surrounding atmosphere. Through this, explosion or getting affected by the leakage of gas could be avoided.

OBJECTIVE :

The design of a sensor-based automatic gasleakage 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.

PROBLEM FORMULATION :

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 that took place due to gas leakage include the Bhopal Disaster and the Vizag Gasleak. 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.

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

Arduino UNO R3 :

Arduino Uno R3 is one kind of ATmega328P based microcontroller board. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC

adapter or a battery to get started. The term Uno means “one” in the language of “Italian” and was selected for marking the release of Arduino’s IDE 1.0 software. The R3 Arduino Uno is the 3rd as well as most recent modification of the Arduino Uno.

Arduino board and IDE software are the reference versions of Arduino and currently progressed to new releases. The Uno-board is the primary in a sequence of USB-Arduino Board, & the reference model designed for the Arduino platform.



Breadboard :

A breadboard is a widely used tool to design and test circuit. You do not need to solder wires and components to make a circuit while using a bread board. It is easier to mount components & reuse them. Since, components are not soldered you can change your circuit design at any point without any hassle. It consist of an array of conductive metal clips encased in a box made of white ABS plastic, where each clip is insulated with another clips. There are a number of holes on the plastic box, arranged in a particular fashion. A typical bread board layout consists of two types of region also called strips. Bus strips and socket strips. Bus strips are usually used to provide power supply to the circuit. It consists of two columns, one for power voltage and other for ground. Socket strips are used to hold most of the components in a circuit. Generally it consists of two sections each with 5 rows and 64 columns. Every column is electrically connected from inside.

LED :

LED (Light Emitting Diode) is an optoelectronic device which works on the principle of electro-luminance. Electro-luminance is the property of the material to convert electrical energy into light energy and later it radiates this light energy. In the same way, the semiconductor in LED emits light under the influence of electric field. The symbol of LED is formed by merging the symbol of P-N Junction diode and outward arrows.



These outward arrows symbolise the light radiated by the light emitting diode.

Resistor :

A passive electrical component with two terminals that are used for either limiting or regulating the flow of electric current in electrical circuits.

Piezo :

A piezo is a device that generates a voltage when force is applied or becomes deformed when voltage is supplied.

Gas

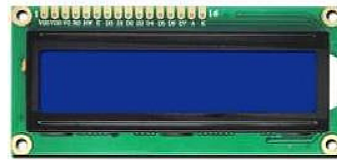
Sensor :

A gas sensor is a device which detects



the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which can be measured as output voltage. Based on this voltage value the type and concentration of the gas can be estimated.

LCD 16*2 :



16×2 LCD is one kind of electronic device used to display the message and data. The term LCD full form is Liquid Crystal Display. The display is named 16×2 LCD because it has 16 Columns and 2 Rows. it can be displayed ($16 \times 2 = 32$) 32 characters in total and each character will be made of 5×8 Pixel Dots. These displays are mainly based on multi-segment light emitting diodes. There are a lot of combinations of display available in the market like 8×1, 8×2, 10×2, 16×1, etc. but the 16×2 LCD is widely used. These LCD modules are low cost, and programmer-friendly, therefore, is used in various DIY circuits, devices, and embedded projects.

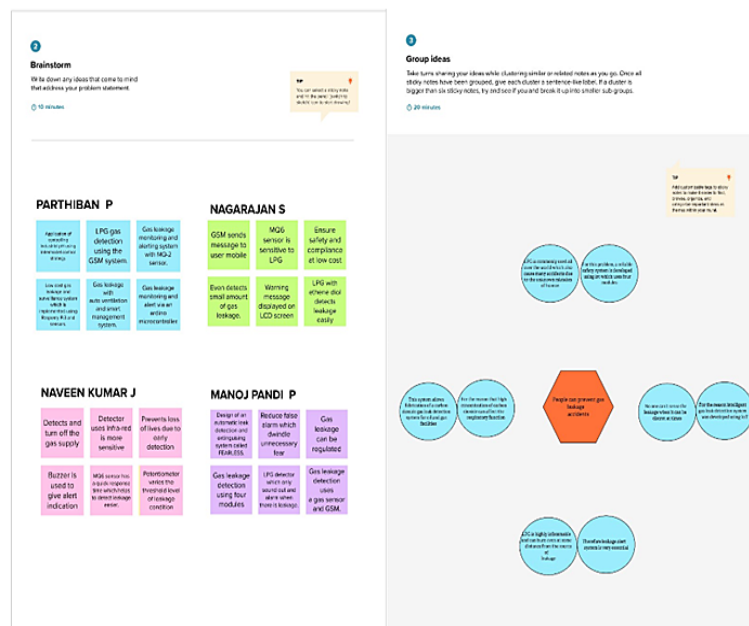
PROJECT DESIGN & PLANNING :

★ Ideation Phase :

★ Brainstrom & Idea Prioritization:

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even **if you're not sitting in the same room**.



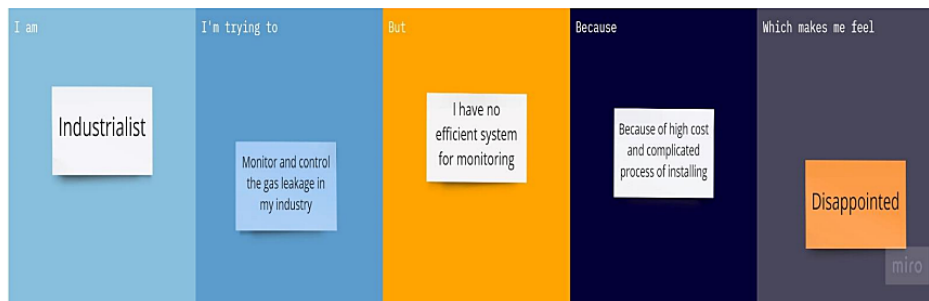
★ Literature Survey:

Design and Fabrication of a Carbon Dioxide Gas Leak Detection System for Oil and Gas Facilities

Chibuzor Amaobichukwu (2021) presented design and fabrication of a carbon dioxide gas leak detection system for oil and gas facilities. This is developed because of the reason that high concentration of carbon dioxide can affect the respiratory function and the central nervous system. This prompted the development of this carbon dioxide gas leakage detection system as a safety measure to reduce this risk. This carbon dioxide gas leakage detection is developed with an Arduino microcontroller which is programmed using embedded C++

language and an MQ-135 sensor for a highly accurate and fast response system. The gas leakage detection is not only highly accurate but cheap and portable and can be used for industrial and domestic safety.

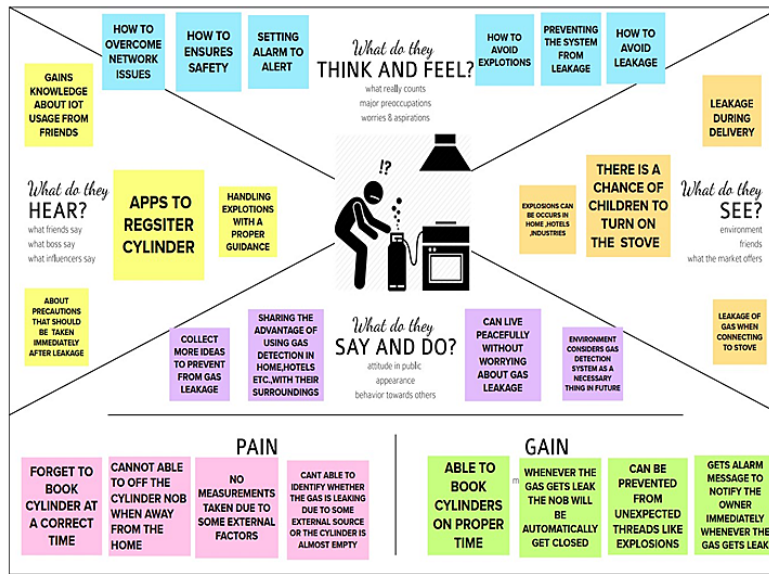
★ Problem Statement :



Domestically we use natural gas and it is very useful for burning purposes. If this gas is leaked in our kitchens, offices or factories and not sensed in time, it may lead to a fatal disaster, and may cause human loss. For this purpose, we came forward with an idea of making such an electronic device to sense that leakage and alarm the respective persons to solve that leakage problem and save assets and human lives. It also down our economical rate.

★ Empathy Map :

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



★ Project Design Phase I:

★ Proposed Solution:

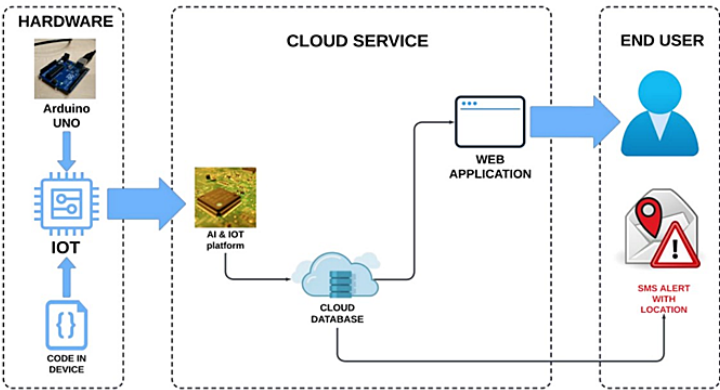
S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	➤ Develop an efficient system & an application that can monitor and alert the users(workers)
2.	Idea / Solution description	<ol style="list-style-type: none"> 1. This product helps the industries in monitoring the emission of harmful gases 2. In several areas, the gas sensors will be integrated to monitor the gas leakage 3. If in any area gas leakage is detected the admins will be notified along with the location 4. In the web application, admins can view the sensor parameters.
3.	Novelty / Uniqueness	<ol style="list-style-type: none"> 1. Fastest alerts to the workers 2. User friendly
4.	Social Impact / Customer Satisfaction	<ol style="list-style-type: none"> 1. Cost efficient 2. Easy installation and provide efficient results 3. Can work with irrespective of fear

5.	Business Model (Revenue Model)	<ol style="list-style-type: none"> 1. The product is advertised all over the platforms. Since it is economical, even helps small scale industries from disasters. 2. As the product usage can be understood by everyone, it is easy for them to use it properly for their safest organization.
6.	Scalability of the Solution	<ol style="list-style-type: none"> 1. Since the product is cost efficient, it can be placed in many places in the industries. 2. Even when the gas leakage is more, the product sense the accurate values and alerts the workers effectively.

★Proposed Solution Fit:

Define CS, fit into CL	1. CUSTOMER SEGMENT(S) CS The industrialists who use gases for their manufacturing.	6. CUSTOMER LIMITATIONS <small>EG. BUDGET, DEVICES</small> CL High budget in installing other products make them to move far from modern technologies.	5. AVAILABLE SOLUTIONS <small>PLUSSES & MINUSES</small> AS The monitoring and controlling of the leakage could be done by the manpower. Even though man power could reduce electricity cost and monitor properly, it may cause high risk for their life. There is also a cause of some errors due to manpower.
	2. PROBLEMS / PAINS <small>ITS FREQUENCY</small> PR <ul style="list-style-type: none">• Suffering from many losses due to gas leakage.• Having no proper system for controlling or monitoring the leakage.• Facing heavy budget problems in buying and installing a system for monitoring and controlling.	9. PROBLEM ROOT / CAUSE RC When the workers failed to monitor properly, the gas can cause high risk to their health or the properties of the industry.	7. BEHAVIOR <small>ITS INTENSITY</small> BE <ul style="list-style-type: none">• Using manpower as the source of monitoring the leakage causes high hazards.• If the gas leaked is heavily toxic, there is a chance of causing hereditary health issues too.
Focus on PR, tap into BE, understand RC	3. TRIGGERS TO ACT TR The heavy damages or higher health issues due to the toxic gases urges them to find out a solution as soon as they could possible.	10. YOUR SOLUTION SL Develop an efficient system & an application that can monitor and alert the workers.	8. CHANNELS OF BEHAVIOR CH Promoting through social media. With the help of social media entrepreneurs/influencer.
	4. EMOTIONS <small>BEFORE / AFTER</small> EM Before: The heavy losses due to the leakages made them feel of guilt due to reduced reputation of their products. After: Increased the level of confidence and feel secured		<small>OFFLINE</small> Through newspaper advertisements.
Identify strong TR & EM			

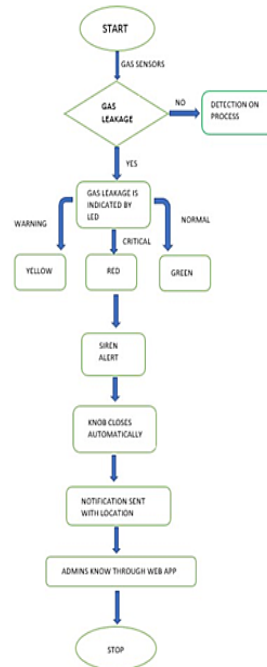
★Solution Architecture:



★Project Design Phase II :
★Customer Journey:

CUSTOMER JOURNEY.....									
Journey Steps Which step of the experience are you describing?	DISCOVERY Why do they even start the journey?		REGISTRATION Why would they trust us?		ONBOARDING & FIRST USE How can they feel successful?			SHARING Why would they invite others?	
Actions What does the customer do? What information do they look for? What is their context?	Leakage of the gas is detected	Type of the gas leaked is detected	To share their contact details to reach them out!	To prioritise delivery	Check for well-functioning and faulty devices	Ensure all specifications are met	Testing the whole system before actual deployment	Check for authenticity	Test device before sharing
Needs and Pains What does the customer want to achieve or avoid?	Quick action after the gas detected	To prevent future disaster	To make them know how terrible these machines are for the safety of their industries	To get to know completely about the device they're going to purchase	Experts seamless working experience	Achieve maintenance and long life of devices		Promote business	A way of helping the society
	Network Failure	Human Errors	Delivering unverified product	Not being customer-friendly		Lacks down on expensive and frequent reparations		Efforts going unrecognized	
Touchpoint What part of the service do they interact with?	Through their IOT-connected devices, such as mobile phones and systems	Website	Website	App	Expos	A guided manual	Edutext hardware and software	Database management	Warnings and buzzers
Customer Feeling What is the customer feeling on this product?	Secured feeling	Happy about this discovery	Non-complex	Easy Process	Trustable	Confident equipment handling		Save people's lives	Generate good revenue

★Data Flow Diagram:



★Functional Requirements:

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Online Payment for the service
FR-2	User Access	Access the details using web browser Access the details using mobile application
FR-3	User alert	Gets alert as an SMS message Gets alert alarm in the working area.

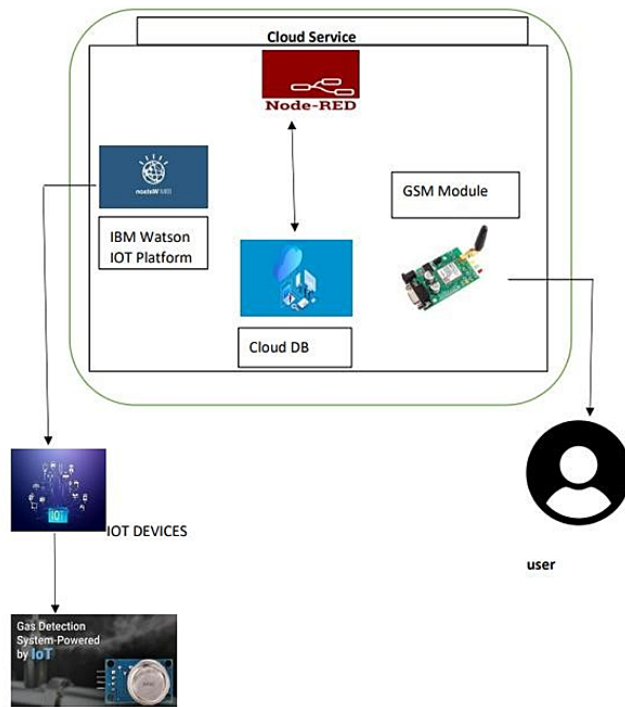
Non-Functional Requirements:

Following are the non-functional requirements of the proposed solution.

NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	The device must be usable by the customer anywhere
NFR-2	Security	Data from the sensors are stored securely and away from other data
NFR-3	Reliability	Data can be retrieved anytime and no data is discarded without customer knowledge
NFR-4	Performance	No performance delay in case of large number of data or more parameters
NFR-5	Availability	The device doesn't fail even under harsh conditions. Device continues to send parameters, even after an alert situation.
NFR-6	Scalability	Device must be capable of measuring conditions even in a larger industry

★Technology Stack:

Figure: Gas Leakage Monitoring and Alerting System



★Project Planning :

★ Milestone and Activity List:

GAS LEAKAGE MONITORING AND ALERTING SYSTEM

MILESTONE

SEPTEMBER
2022

PROJECT DESIGN & PLANNING

Ideation Phase

OCTOBER
2022

PROJECT DEVELOPMENT PHASE

Sprint 1

PROJECT DESIGN & PLANNING

Project Design
Phase 1

PROJECT DEVELOPMENT PHASE

Sprint 2

PROJECT DESIGN & PLANNING

Project Design
Phase 2

PROJECT DEVELOPMENT PHASE

Sprint 3

PROJECT DESIGN & PLANNING

Project Planning
Phase

PROJECT DEVELOPMENT PHASE

Sprint 4

Final Deliverable

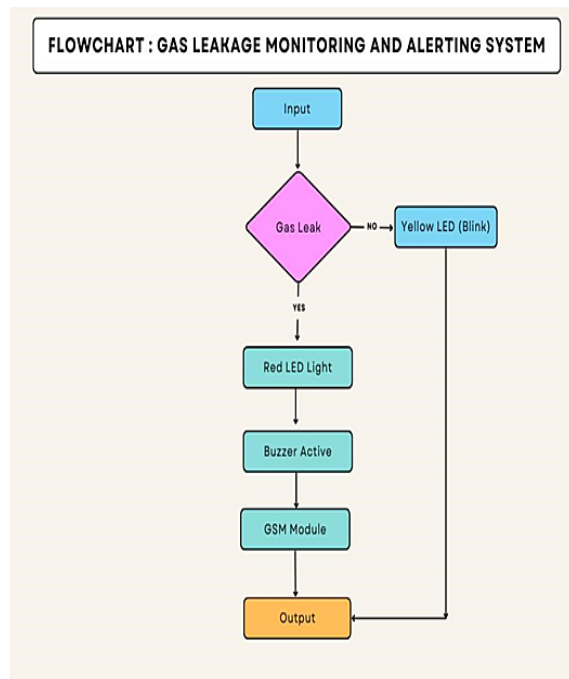
★Sprint Delivery Plan:

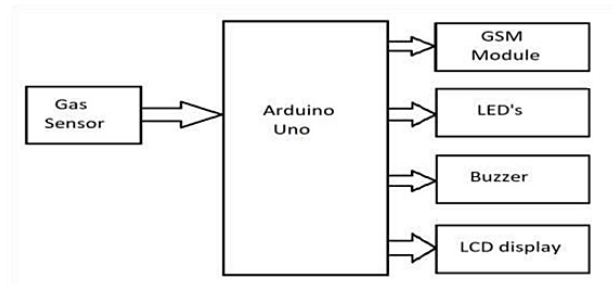


Proposed Method :

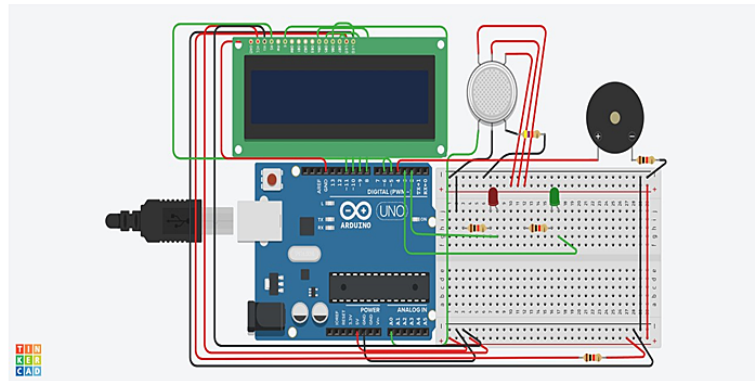
Arduino UNO (Atmega-328) is the main unit of the system which performs the following tasks. A signal conditioning of the

Arduino UNO is done by output signal of the sensor, provided input to Arduino. The detection results displayed on LCD. Indicates the people of danger in work place, factory, home. Buzzer activity with beep(siren) sound is made. Also send alert SMS to the in charge of the plant whose number is saved in SIM card by using GSM modem. The SMS received depends upon the leak of gas in the detection area of the sensor.





CIRCUIT DIAGRAM:



SOLUTION STATEMENT:

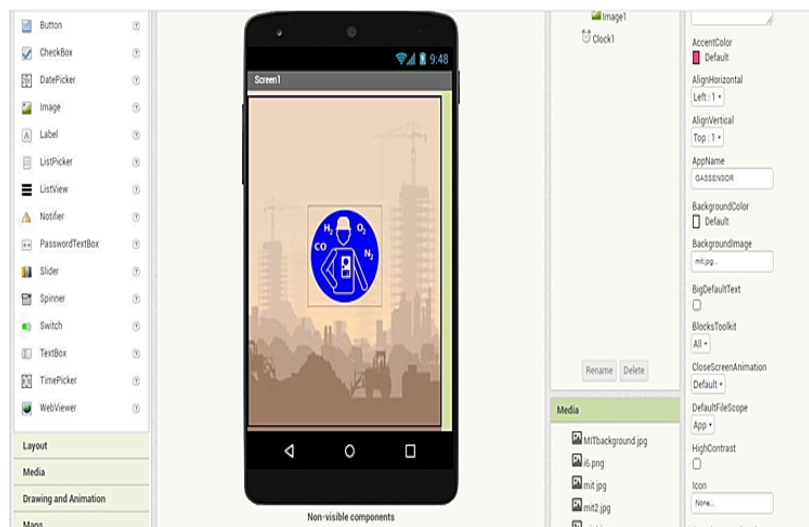
The system can be taken as a small attempt in connecting the existing primary gas detection methods to a mobile platform integrated with IoT platforms. The gases are sensed in an area of 1m radius of the rover and the sensor output datas are continuously transferred to the local server. The accuracy of 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.

PROJECT DEVELOPMENT PHASE:

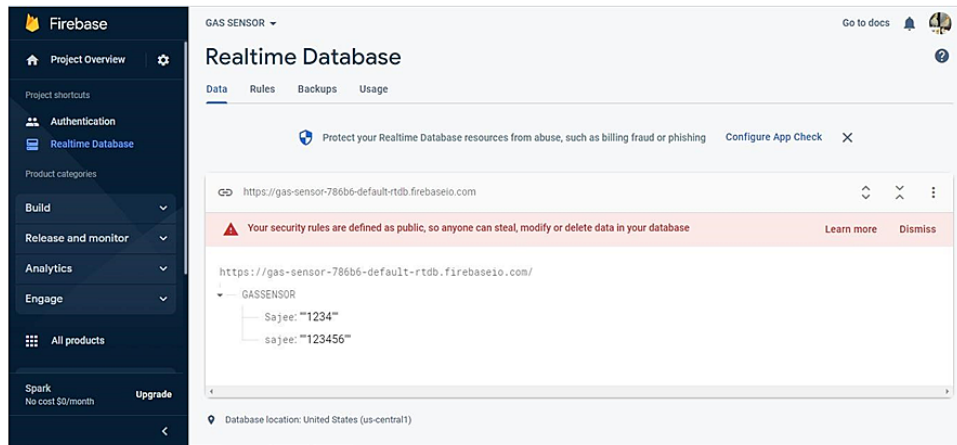
★Project Development -Delivery Of Sprint-1:

Registration and Login Credentials.



Realtime Database :

It is used to store the registered User name and Password.



★Project Development -Delivery Of Sprint-2:

Task:

Sensed data is brought to Node-RED and displayed in dashboard.

Source code:

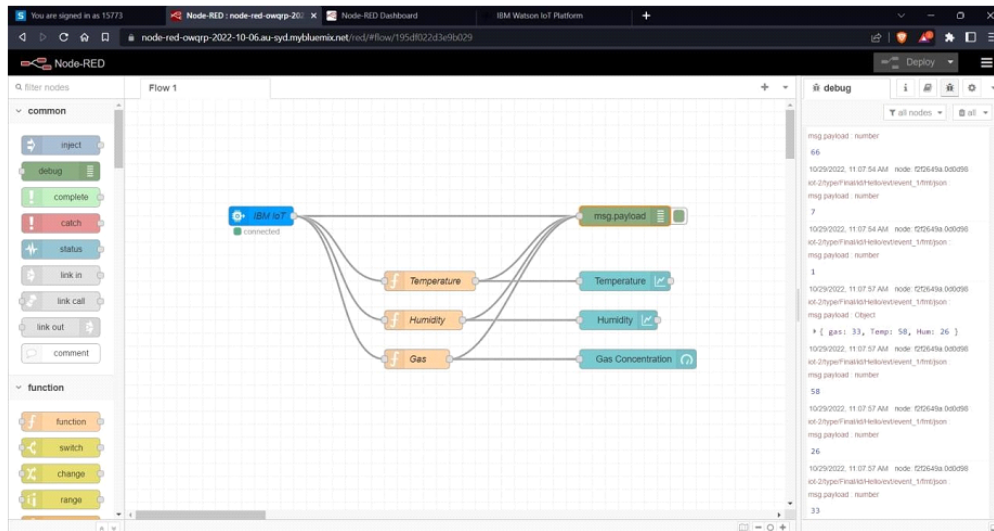
Temperature: `msg.payload = msg.payload.Temp;`
 `return msg;`

Humidity: `msg.payload = msg.payload.Hum;`
 `return msg;`

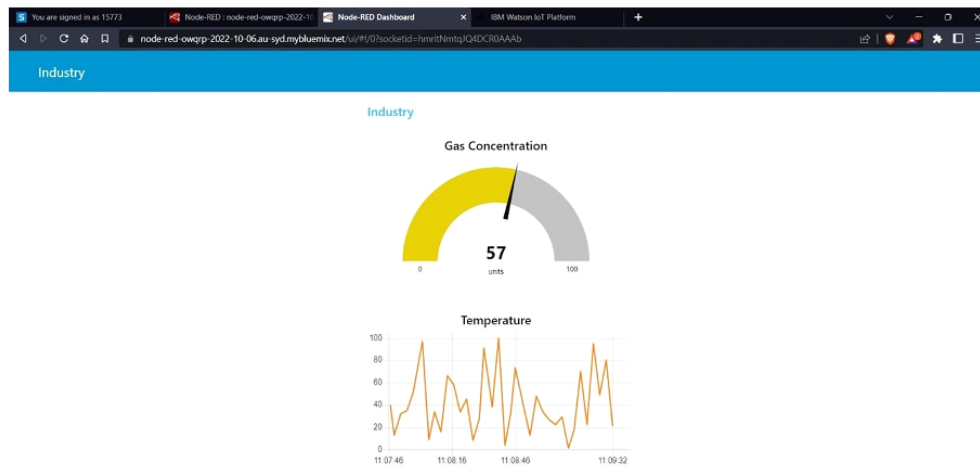
Concentration of Gas: `msg.payload = msg.payload.gas;`
`return msg;`

Output:

1. Data is brought to Node-RED



2. Data is displayed in Dashboard



★Project Development -Delivery Of Sprint-3:

Task:

A mobile application for monitoring the Environmental parameters around the region of sensor has been developed using MIT App Inventor.

Screens Information:

1. **Screen – 1:** It is the entry screen of the mobile application and will be displayed only for 3 seconds.
2. **Screen – 2:** It is the login page of the application. Each user has their own user id and password, which is known only to them. After validating the credential, User can access the data produced by their devices.
3. **Screen – 3:** Environmental parameters such as Temperature, Humidity & Gas Concentration are displayed in this page.

Screen – 1:



Screen – 2:



Screen – 3:



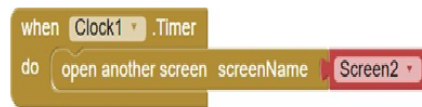
Blocks:

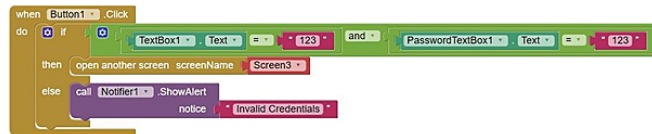
Images displayed in the Blocks section, displays the Back-End of the Mobile Application.

Only developers have access to view and modify it.

Proper working of the Application solely depends on the code developed in the Block section.

Screen - 1





★Project Development -Delivery Of Sprint-4:

FINAL CODE:

```
#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);  
  }  
}
```

Conclusion :

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 gaslike 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.