Hindusthan College of Engineering and Technology
Approved by AICTE, New Delhi, accredited with 'A' Grade by NAAC
(An Autonomous Institution, Affiliated to Anna University, Chennai) Valley Campus, Pollachi Highway, Coimbatore – 641 032

PROJECT NAME: IOT - Gas Leakage Monitoring and Alerting System.

TEAM ID: PNT2022TMID10014

TEAM MEMBERS:

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3. Namachivayam S (720719104109)
4. Nandhakumar G (720719104110) – Team Leader.

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Coimbatore - 641 032.

INDUSTRY MENTOR:

KUMAR JULURI

ABSTRACT

IoT is an expanding network of physical devices that are linked with different types of sensors and with the help of connectivity to the internet, they are able to exchange data. Through IoT, internet has now extended its roots to almost every possible things present around us and is no more limited to our personal computers and mobile phones. Safety, the elementary concern of any project, has not been left untouched by IoT. Gas Leakages in open or closed areas can prove to be dangerous and lethal. 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 having Smart Alerting techniques involving an alarm system and sending an e-mail to the concerned authority and an ability to predict hazardous situation so that people could be made aware in advance by performing data analytics on sensor readings.

1.INTRODUCTION

Internet of Things aim towards making life simpler by automating every small task around us. Safety has always been an important criterion while designing home, buildings, industries as well as cities. The increased concentration of certain gases in the atmosphere can prove to be extremely dangerous. As much is IoT helping in automating tasks, the benefits of IoT can also be extended for enhancing the existing safety standards.

The increased concentration of certain gases in the atmosphere can prove to be extremely dangerous. These gases might be flammable at certain temperature and humidity conditions, toxic after exceeding the specified concentrations limits or even a contributing factor in the air pollution of an area leading to problems such as smog and reduced visibility which can in turn cause severe accidents and also have adverse effect on the health of people.

This project helps the industries in monitoring the emission of harmful gases. In several areas, the gas sensors will be integrated to monitor the gas leakage. If in any area gas leakage is detected the alarm will be triggered automatically and the admins will be notified along with the location through email. In the web application, admins can view the sensor parameters and can toggle the state of the alarm. This system is not only capable of detecting the leakages and hence presence of excess amounts of harmful gases and alerting through audible alarms but also, with the help of IoT, alerting the concerned authority about the condition before any accident takes place through an e-mail about the details of the area using smtp mailing services. A web UI will be developed to continuously monitor the sensor data using Node Red application.

2.OBJECTIVES

The main objective of this project is to detect the leakage of toxic gas and to trigger an alert system to activate the safety precautions using IoT devices and cloud services.

The system comprises of sensors for detecting gas leak interfaced to microcontroller that will give an alert to user whenever there is a gas leakage with exact location details. It also allows the user to monitor the gas levels continuously using the web UI dashboard.

This project also aims at triggering an alarm system automatically using IOT devices to alert the labours about the gas leakage. This alarm will go off automatically once the gas levels are reduced. It can also be turned off by the admins using the Web application dashboard.

3.IDEATION PHASE

3.1 LITERATURE SURVEY

[1]

TITLE: Gas Leakage Detection System using IoT with integrated notifications using Pushbullet-A Review.

AUTHOR: M Athish Subramanian, Naveen Selvam, Rajkumar S, R Mahalakshmi, and J Ramprabhakar

This paper reviews the previous state of art and also have proposed a gas leakage detection system using MQ5 gas sensor and Arduino Uno controller is incorporated with a cloud storage for data collection and also used for storing and analysing data. Gas leaked is converted from Parts per Million (PPM) to volts through the Arduino IDE and results in notifying the user when the threshold limit is crossed. The user is alerted via an application for quick notification through the internet and also through a buzzer /LED for physical notification. The prime novelty of the proposal may be claimed as the usage of cloud storage for detection and notification. The system, though is simple and straight forward, can be very efficiently used for domestic purpose.

[2]

TITLE: Gas Leakage Detection Based on IOT

AUTHOR: Suma V, Ramya R Shekar, and Akshay Kumar A

The main idea of this paper is to carry out the literature review on IoT based gas detection techniques and to ensure the safety of people and surroundings. By presenting a simple yet reliable system, gas leakage detection system using MQ5 gas sensor and Arduino uno controller is incorporated with a cloud storage for data collection and also used for storing and analysing data. Gas leaked is converted from Parts Per Million (PPM) to volts through the Arduino IDE and results in notifying the user when the threshold limit is crossed. The user is alerted via an application for quick notification through the internet and also through a buzzer /LED for physical notification.

[3]

TITLE: LPG Gas Leakage Detection Using IOT

AUTHOR: Arun Manhas, Neeraj Chambyal, Manish Raina, Dr. Simmi Dutta

This paper provides a brand new approach to discover LPG discharge supported microcontroller based Node MCU. To alert on Liquefied rock oil Gas (LPG) leakage and preventing any unwanted incident, we need to apply some cautions to discover the discharge. This paper aims to provide a solution to this problem by building a device which will do the area monitoring continuously. The gas sensor provides data to Node MCU, and then the results are displayed as a warning to the user via an Android-based smart-phone device. Other than LPG gas, Air conditioner and refrigerator leaked gases are also harmful in home. Using this device users will be able to prevent accidents that occur due to harmful gas leaks so that accidents can be avoided

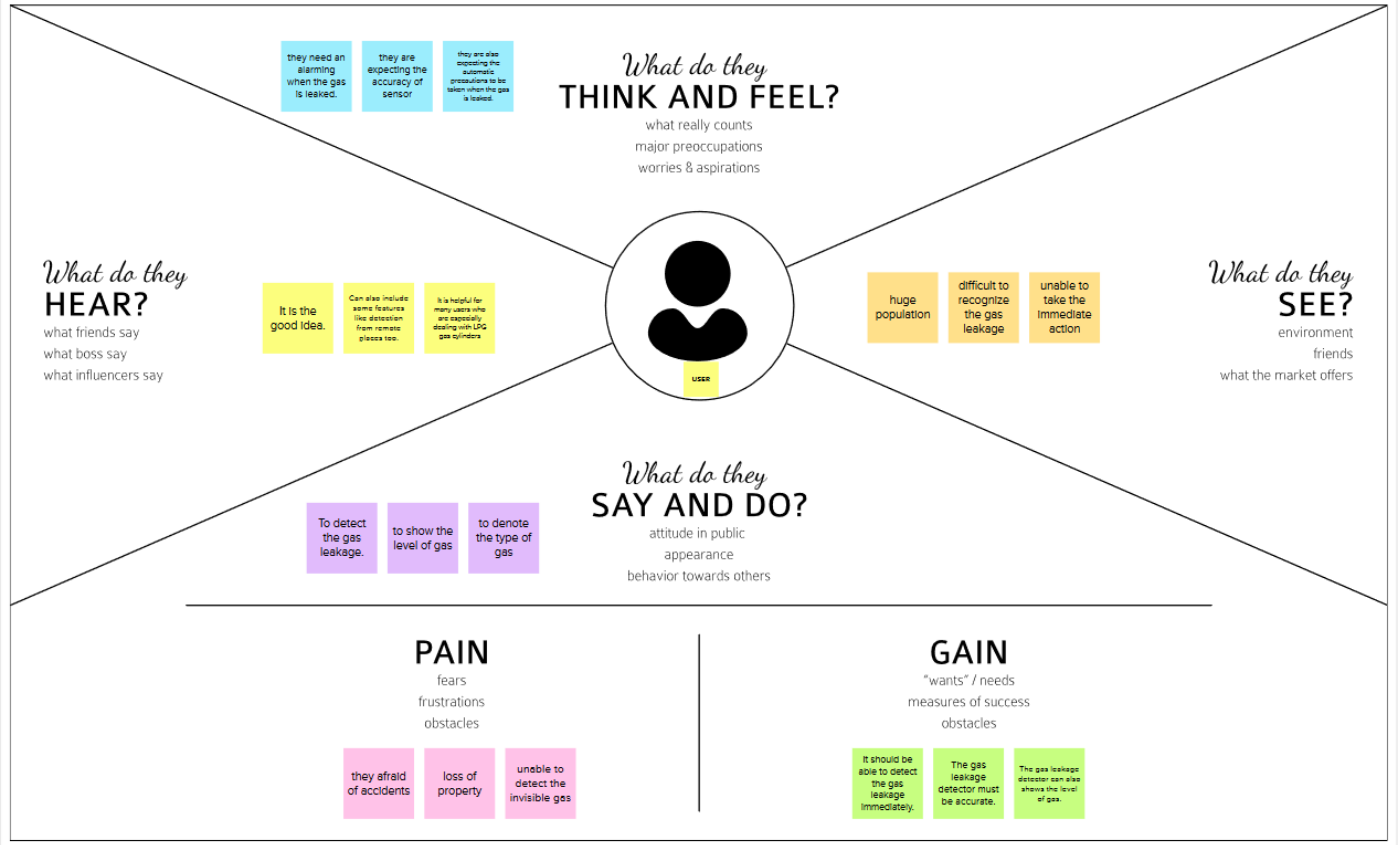
[4]

TITLE: Internet of Things (IOT) Based Gas Leakage Monitoring and Alerting System with MQ-2 Sensor

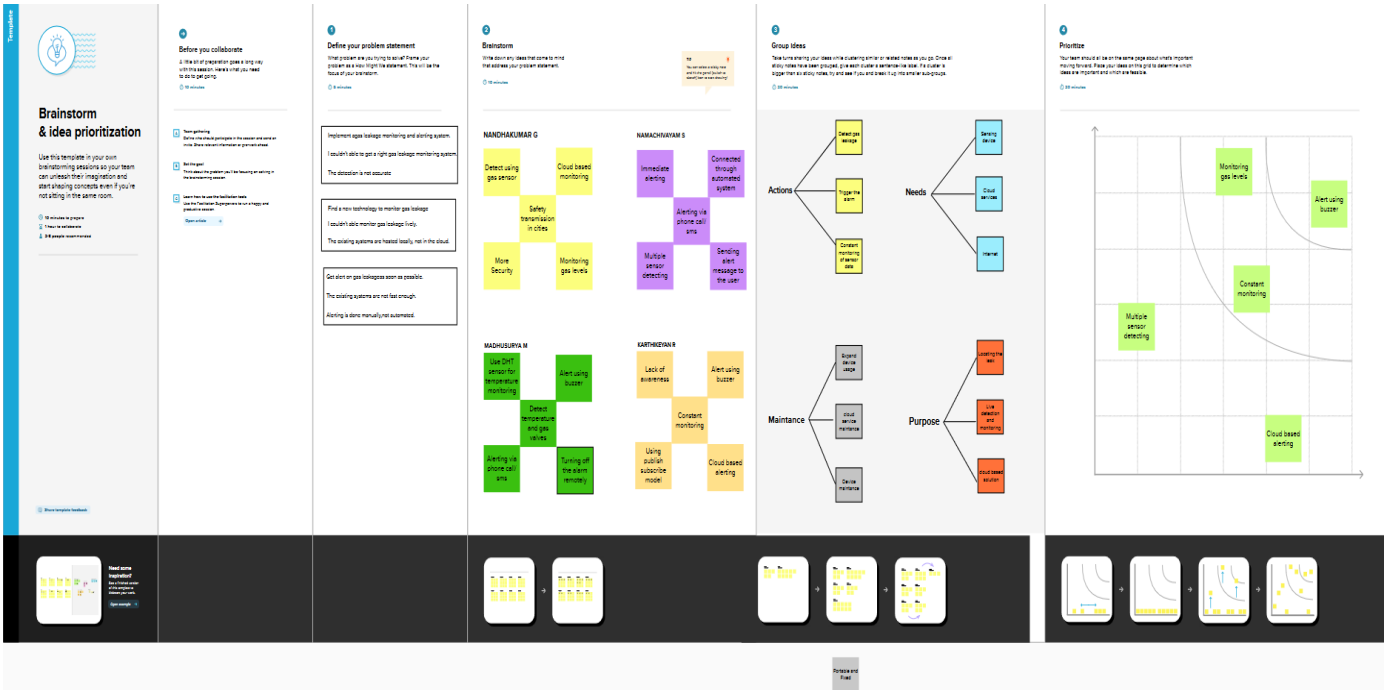
AUTHOR: Rohan Chandra Pandey, Manish Verma, Lumesh Kumar Sahu

This work modifies the existing safety model installed in industries and this system also be used in homes and offices. The main objective of the work is designing microcontroller based toxic gas detecting and alerting system. The hazardous gases like LPG and propane were sensed and displayed and notify each and every second in the LCD display. If these gases exceed the normal level, then an alarm is generated immediately and also an alert message (Email) is sent to the authorized person through the INTERNET and used ARM development board. The advantage of this automated detection and alerting system over the manual method is that it offers quick response time and accurate detection of an emergency and in turn leading faster diffusion of the critical situation.

3.2 EMPATHY MAP



3.3 IDEATION


Brainstorm
& idea prioritization
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.
Before you collaborate
Define your problem statement
Brainstorm
Group Ideas
Prioritize
NANDHAKUMAR G
Detect using gas sensor
Cloud based monitoring
Safety transmission in cities
More Security
Monitoring gas levels
NAMACHIVAYAM S
Immediate alerting
Connected through automated system
Alerting via phone call sms
Multiple sensor detecting
Sending alert message to the user
MADHUSURYA M
Use DHT sensor for temperature monitoring
Alert using buzzer
Detect temperature and gas valves
Alerting via phone call sms
Turning off the alarm remotely
KARTHIKEYAN R
Lack of awareness
Alert using buzzer
Constant monitoring
Using publish subscribe model
Cloud based alerting
Actions
Needs
Maintance
Purpose
Monitoring gas levels
Alert using buzzer
Constant monitoring
Multiple sensor detecting
Cloud based alerting

3.4 PROBLEM STATEMENT

Problem Statement	I am (Customer)	I'm Trying to	But	Because	Which makes me feel
PS - 1	Industrial labour.	Implement a gas leakage monitoring and alerting system.	I couldn't able to get a right gas leakage monitoring system.	The detection is not accurate.	Unsecure.
PS – 2	Industrial labour.	Find a new technology to monitor gas leakage	I couldn't able to monitorgas leakage lively.	The existing systems are hosted locally, not in the cloud.	Unsafe.
PS – 3	Industrial labour.	Get alert on gas leakage as soon as possible.	The existing systems are not fast enough.	Alerting is done manually, not automated.	Nervous.

4. PROJECT DESIGN PHASE 1

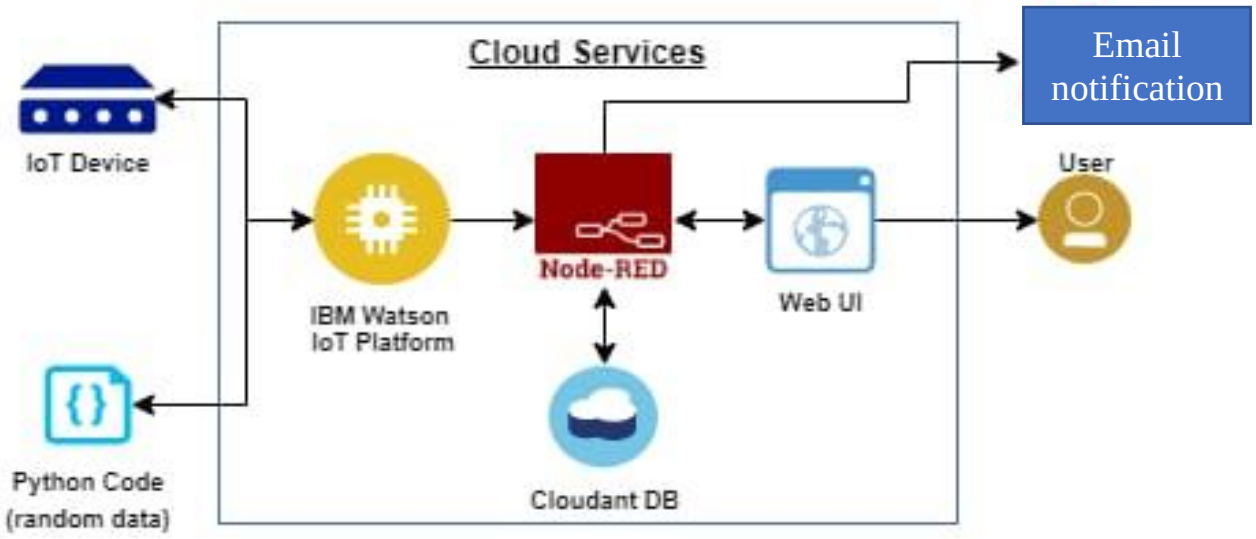
4.1 PROPOSED SOLUTION

S. No	Parameter	Description
1.	Problem Statement	▪ Develop an efficient system & application that can monitor and alert the users. ▪ If there is any leakage of gas in their surroundings so that they can work efficiently on major crises rather than worrying about monitoring the leakage of gas, this will indeed reduce the manpower of the industry and create a peaceful environment.
2.	Idea / Solution Description	▪ This system helps the industries in monitoring the emission of harmful gases. ▪ In Several areas, the gas sensors will be integrated to monitor the gas leakage. ▪ If it any large gas leakage is detected the admins will be notified along with the location. ▪ In the web application admins can view the sensor parameters.
3.	Novelty / Uniqueness	▪ Fastest alerts to the workers. ▪ User Friendly ▪ Cloud based application solution.

4.	Social Impact / Customer Satisfaction	▪ Cost Efficient ▪ Easy installation and provide efficient results. ▪ Can work with irrespective of fear.
5.	Business Model (Revenue Model)	▪ This system is advertised all over the platforms. Since it is economical, even helps small scale industries from disasters. ▪ As the product usage can be understood by everyone, it is easy for them to use in properly for their safest organization
6.	Scalability of the Solution	▪ Since the product is efficient, it can be placed in many places of the industries. ▪ Even when gas leakage is more, the product sense the accurate values and alerts the workers effectively. ▪ Our solution can be integrated for further future use because the solution we have provided will be lay on the basic or initial stage of any upgraded version.

4.2 PROBLEM SOLUTION FIT:

4.3 SOLUTION ARCHITECTURE



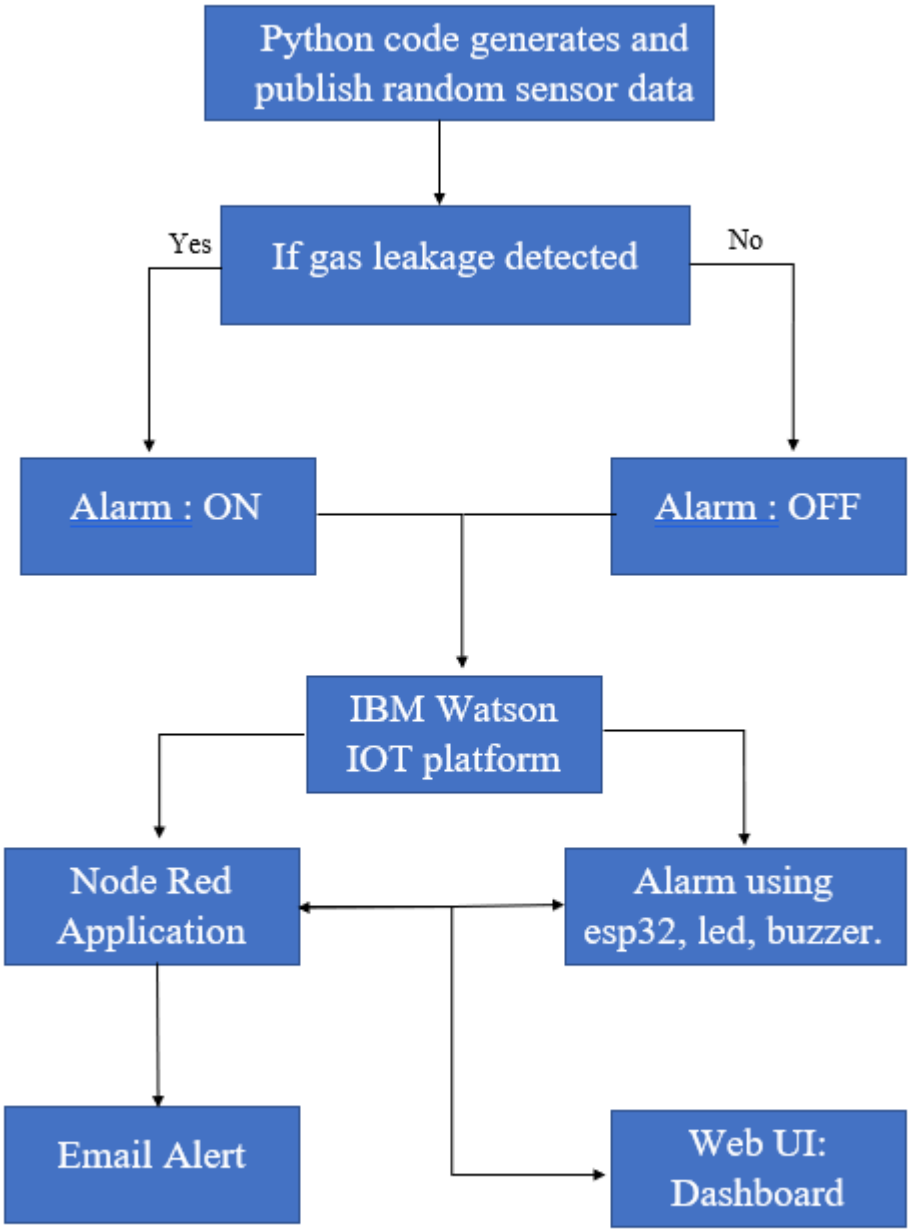
5. PROJECT DESIGN PHASE 2

5.1 CUSTOMER JOURNEY MAP

5.2 SOLUTION REQUIREMENTS

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Monitoring	Level of gas is monitored using sensor and if there is any leakage, alert can be sent through messages and with a buzzer sound.
FR-2	User Reception	The data like the level of gas can be send through messages
FR-3	User Understanding	The user can monitor the level of gas with the help of the data. If there is an increase in gas level then the alert will be given by message or buzzer sound.
FR-4	User Performance	When the user gets notified, they could take precaution steps like turning the gas off, turn on the exhaust fan/sprinkler and avoid serious accidents.

5.3 DATA FLOW DIAGRAMS



5.4 TECHNOLOGY STACK

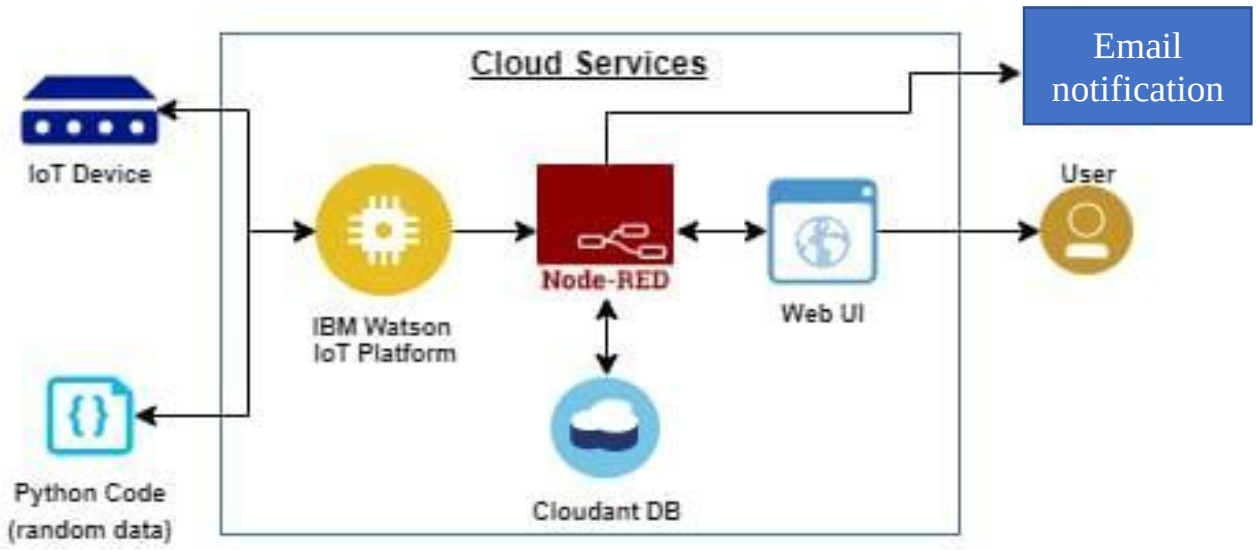


Table-1: Components & Technologies:

S. No	Component	Description	Technology
1.	ESP 32	ESP32 is a series of low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth.	ESP 32 is a series of low-cost, low-power system on chip microcontroller with integrated WIFI and dual-mode Bluetooth. The ESP32 series employ microprocessor in both dual-core and single-core variations.

2.	Gas Sensors	The Grove - Gas Sensor (MQ5) module is useful for gas leakage detection and for monitoring the air quality.	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.
3.	Web App	An application that is used to the see the gas level, GPS location and see the total overview of the system.	An app is a type of software that allows you to perform specific tasks. Applications for desktop or laptop computers are sometimes called desktop applications, while those for mobile devices are called mobile apps. When you open an application, it runs inside the operating system until you close it.
4.	IBM cloud	The IBM Cloud platform combines platform as a service (PaaS) with infrastructure as a service (IaaS) to provide an integrated experience. The platform scales and supports both small development teams and organizations, and large enterprise businesses.	Platform as a Service (PaaS) is a cloud computing solution that provides developers with an easy-to-use platform to create their own software, web applications, or other programming projects.

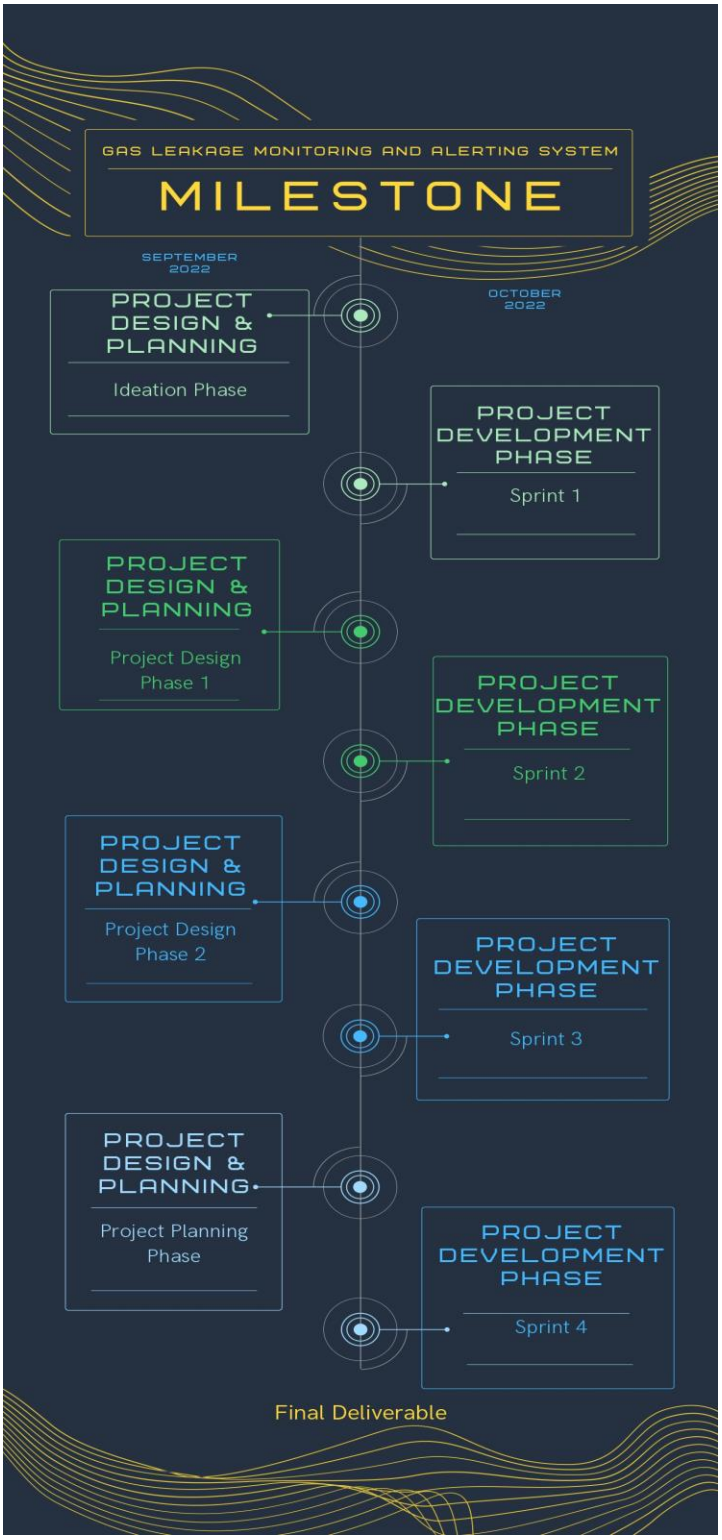
5.	E-MAIL	An Email system allows computer user on a network to send text, links, graphics, sounds and animated images to other users. On most networks, data can be simultaneously sent to a selected group or individual. Network users typically have an email box that receives, stores, and manages their correspondence.	When you send an E-MAIL, the message gets transmitted from the sending device to the receiver's devices over the internet. Here we have used Gmail services to send alert notification along with the dashboard UI link to monitor and control the system.
6.	Buzzer	A buzzer is a loud noise-making or an audio signalling device, which may be mechanical, electromechanical or piezoelectric.	Typical uses of buzzers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke.

Table-2: Application Characteristics:

S. No	Characteristics	Description	Technology
1.	Open-Source Frameworks	MQ5 gas sensor, Wi-Fi, Esp32, processor chips.	Internet of Things.
2.	Security Implementations	MQ5 gas sensor, alerting device which consists of Buzzer and a LED.	Internet of Things.
3.	Scalable Architecture	Detecting room temperature, if the temperature is above the specified temperature, it will alert workers.	Python.
4.	Availability	Use of Wi-Fi IP address.	Internet of Things.
5.	Performance	Performance is efficient.	Internet of Things.

6. PROJECT PLANNING PHASE

6.1 PREPARE MILESTONE AND ACTIVITY LIST



Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	10	04 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	13 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.2 SPRINT DELIVERY PLAN

SPRINT 1:

In this sprint we are going to develop a python code to generate random sensor data and publish that data to the IBM internet of things platform using a python package called ibmiotf. These data will be published to the respected device in that platform.

SPRINT 2:

In this sprint we will be creating IBM Watson internet of things platform cloud services and 2 devices, one for publishing sensor data another one for subscribing to alert system. Here the random sensor data will be successfully published in the json format from the python code that we would have developed during the previous sprint.

SPRINT 3:

In this sprint we are going to create and configure the node red services and develope a Web UI dashboard for the users to monitor the sensor data and to toggle the state of the alarm. The data from the IBM Watson IOT platform will be sent to this node red application and an email will be sent to the admins every 5 minutes with the node red UI dashboard link if the gas leakage is detected and the alarm will be automatically triggered. Using that link the admin can monitor the gas levels and can toggle the alarm switch from any device using the internet.

SPRINT 4:

In this sprint we will be developing an alarm system simulation using a led, buzzer and ESP32 microcontroller. The subscribe model device named Alert_System in IBM Watson IOT platform will be connected to this simulation using device credentials. Thus, the alarm gets toggles ON automatically when a gas leakage is detected. However, this alarm can be toggled manually from the Node Red Web Application dashboard by the admins.

7. PROJECT DEVELOPMENT PHASE

7.1 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 1

SPRINT 1:

In this sprint we have developed a python code to generate random sensor data and publish that data to the IBM internet of things platform using a python package called ibmiotf. These data will be published to the respected device in that platform.

PYTHON CODE:

```
import time
import sys
import random
import ibmiotf.application
import ibmiotf.device

# IBM Watson Device Credentials
organization = "hfj0vp"  # Organization ID
deviceType = "IOT_Device"  # Device type
deviceId = "Gas_Leakage_Detector"  # Device id
authMethod = "token"
authToken = " "  # Authentication token should be given here. It is not provided here since it is a demo and for security reasons.

try:
   deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod,
                    "auth-token": authToken}
```

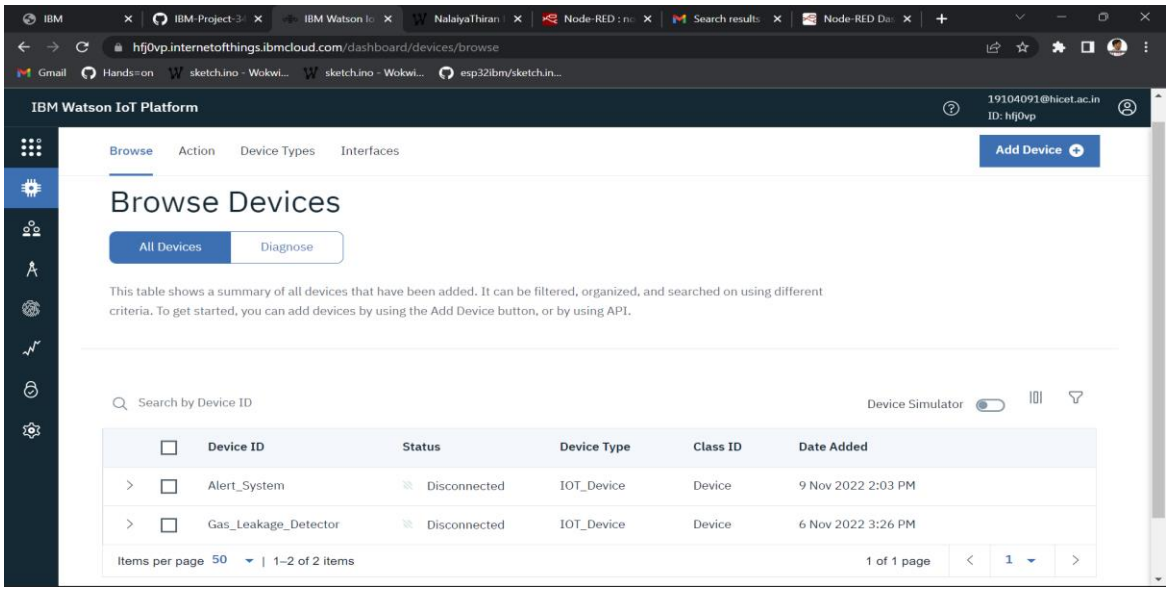
```
    deviceCli = ibmiotf.device.Client(deviceOptions)
# ..........................................

except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

deviceCli.connect()

while True:
    # Ransom sensor data generation
    T = random.randint(-40, 80)
    H = random.randint(0, 100)
    G = random.randint(100, 10000)
    A = "OFF"  # Alert flag

    if G >= 1000:  # We can add as many conditions here to check other sensor data
        A = "ON"

    else:
        A = "OFF"

    # Send sensor data to IBM Watson
    data = {'temperature': T, 'humidity': H, 'gas': G, 'alert': A}

    # print data
    def myOnPublishCallback():
```

```
        print("Published Temperature = %s C" % T, "Humidity = %s %%" % H, "Gas level =
%s ppm" % G, "to IBM Watson")



    success = deviceCli.publishEvent("event", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoTF")
    time.sleep(5)


# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

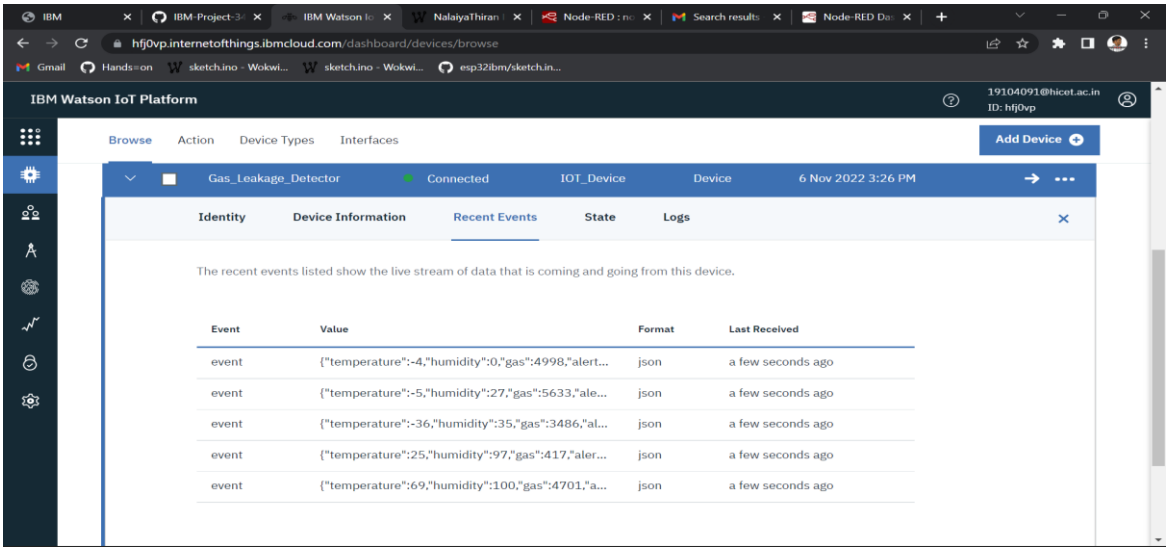
7.2 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 2

SPRINT 2:

In this sprint we have created IBM Watson internet of things platform cloud services and 2 devices, one for publishing sensor data another one for subscribing to alert system.



Here the random sensor data are successfully published in the json format from the python code that we have developed during the previous sprint.



7.3 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 3

SPRINT 3:

In this sprint we have created and configured the node red services and developed a Web UI dashboard for the users to monitor the sensor and to toggle the state of the alarm. The data from the IBM Watson IOT platform are sent to this node red application and an email is sent to the admins every 5 minutes with the node red UI dashboard link if the gas leakage is detected and the alarm is automatically triggered. Using that link the admin can monitor the gas levels and can toggle the alarm switch from any device using the internet.

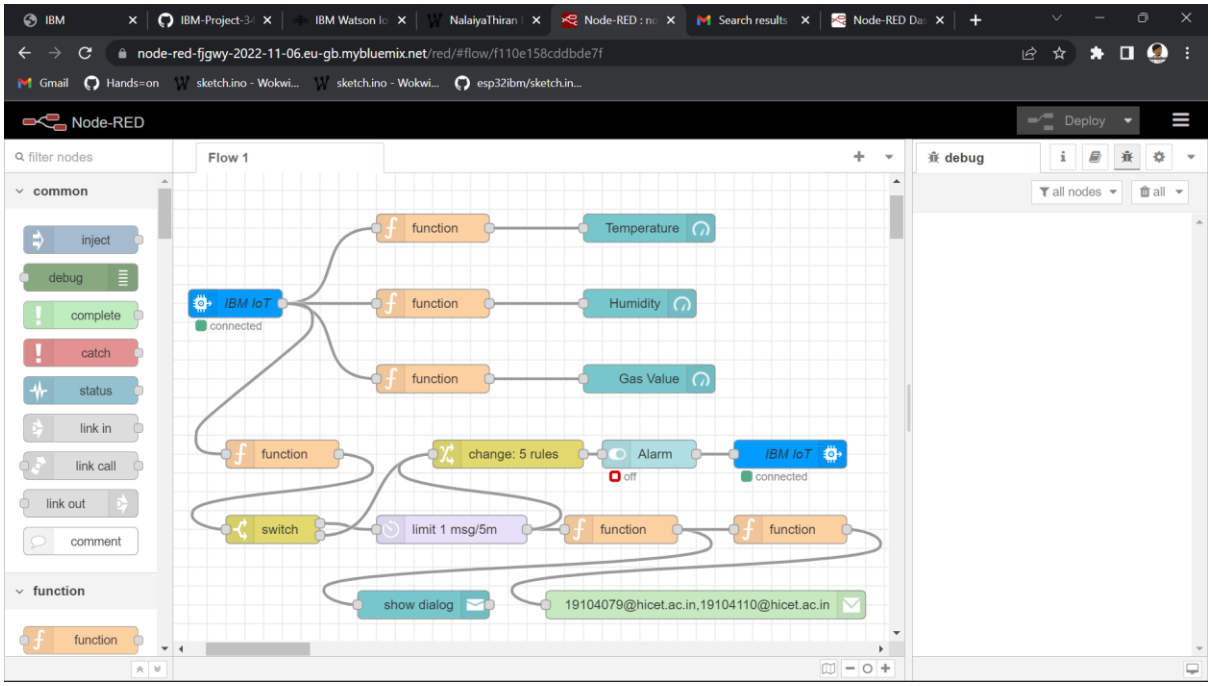
NODE RED FLOW LINK:

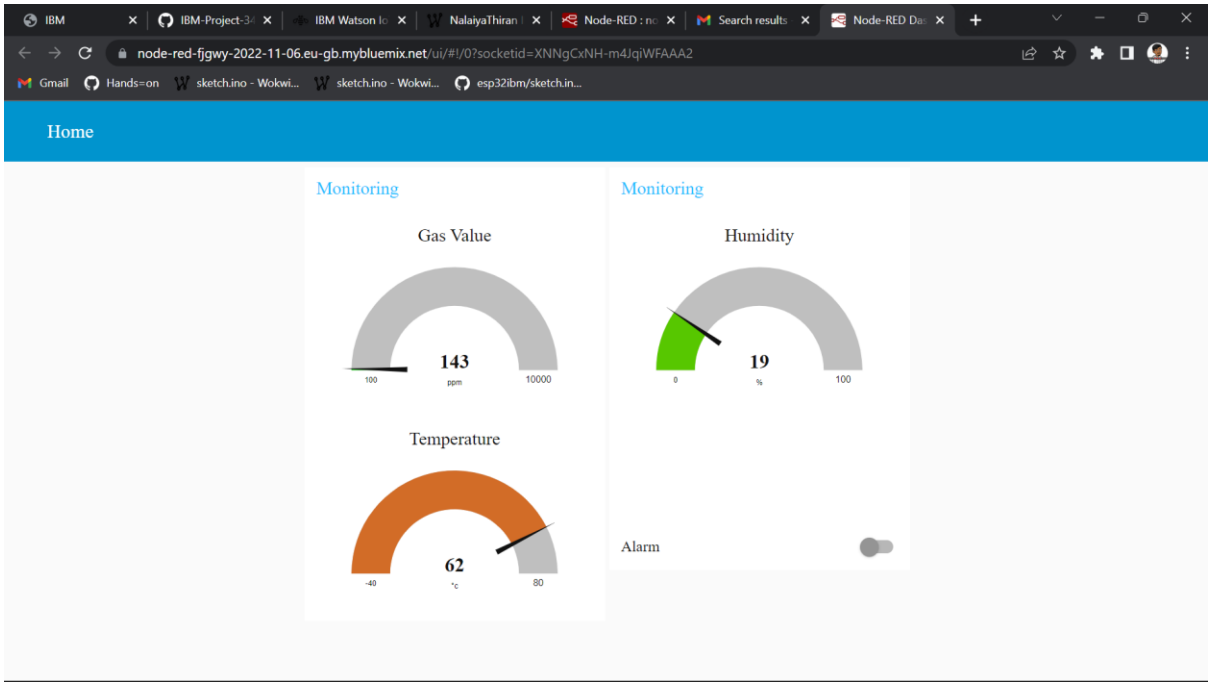
https://node-red-fjgwy-2022-11-06.eu-gb.mybluemix.net/red/#flow/f110e158cddbde7f

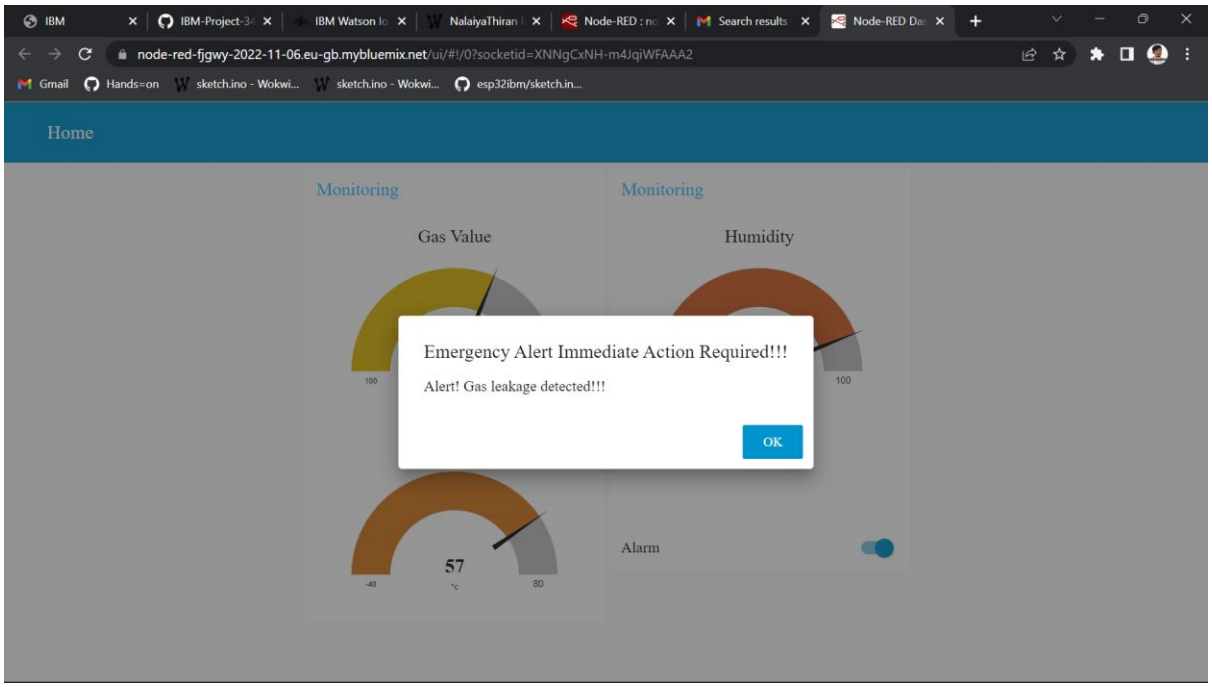
NODE RED UI DASHBOARD LINK:

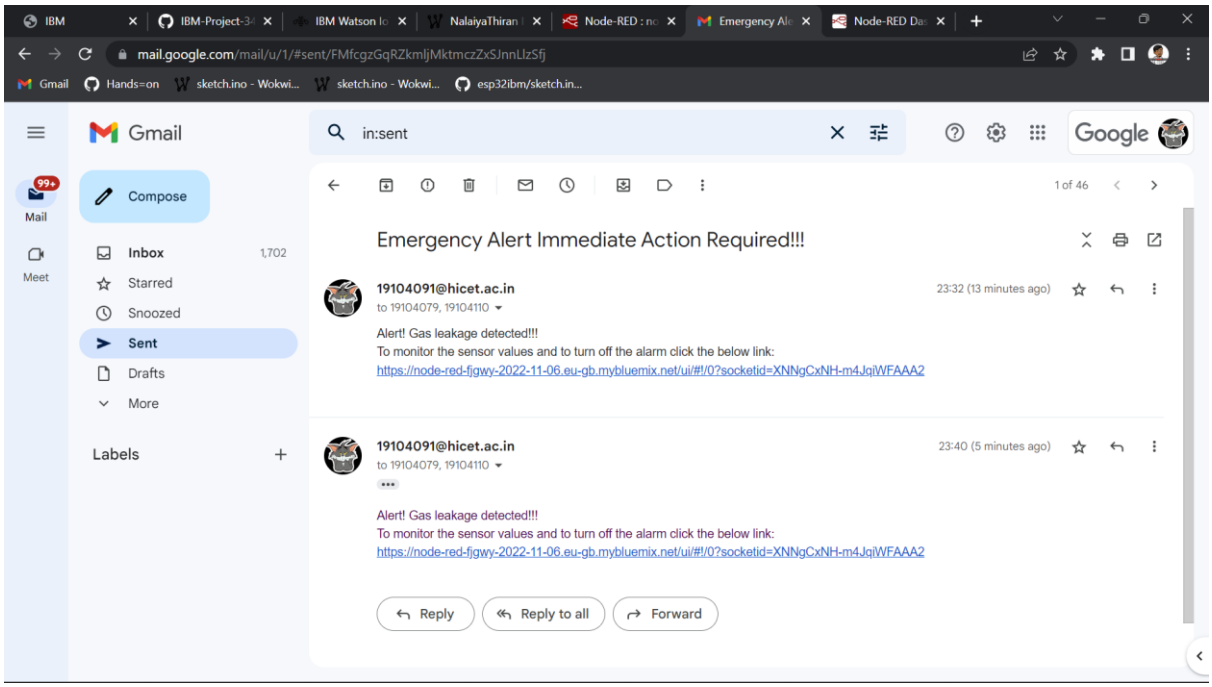
https://node-red-fjgwy-2022-11-06.eu-gb.mybluemix.net/ui/#!/0?socketid=XNNgCxNH-m4JqiWFAAA2

SCREENSHOTS:




node-red-fjgwy-2022-11-06.eu-gb.mybluemix.net/ui/#!/0?socketid=XNNgCxNH-m4JqiWFAAA2
Home
Monitoring
Gas Value
143
ppm
100
10000
Temperature
62
°c
-40
80
Monitoring
Humidity
19
%
0
100
Alarm


node-red-fjgwy-2022-11-06.eu-gb.mybluemix.net/ui/#!/0?socketid=XNNgCxNH-m4JqiWFAAA2
Home
Monitoring
Gas Value
Monitoring
Humidity
Emergency Alert Immediate Action Required!!!
Alert! Gas leakage detected!!!
OK
57
°c
-40
80
100
Alarm


mail.google.com/mail/u/1/#sent/FMfcgzGqRZkmljMktmczZxSJnnLlzSfj
Gmail
in:sent
Compose
Inbox 1,702
Starred
Snoozed
Sent
Drafts
More
Labels
Emergency Alert Immediate Action Required!!!
19104091@hicet.ac.in
to 19104079, 19104110
23:32 (13 minutes ago)
Alert! Gas leakage detected!!!
To monitor the sensor values and to turn off the alarm click the below link:
https://node-red-fjgwy-2022-11-06.eu-gb.mybluemix.net/ui/#!/0?socketid=XNNgCxNH-m4JqiWFAAA2
19104091@hicet.ac.in
to 19104079, 19104110
23:40 (5 minutes ago)
Alert! Gas leakage detected!!!
To monitor the sensor values and to turn off the alarm click the below link:
https://node-red-fjgwy-2022-11-06.eu-gb.mybluemix.net/ui/#!/0?socketid=XNNgCxNH-m4JqiWFAAA2
Reply
Reply to all
Forward

7.4 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 4

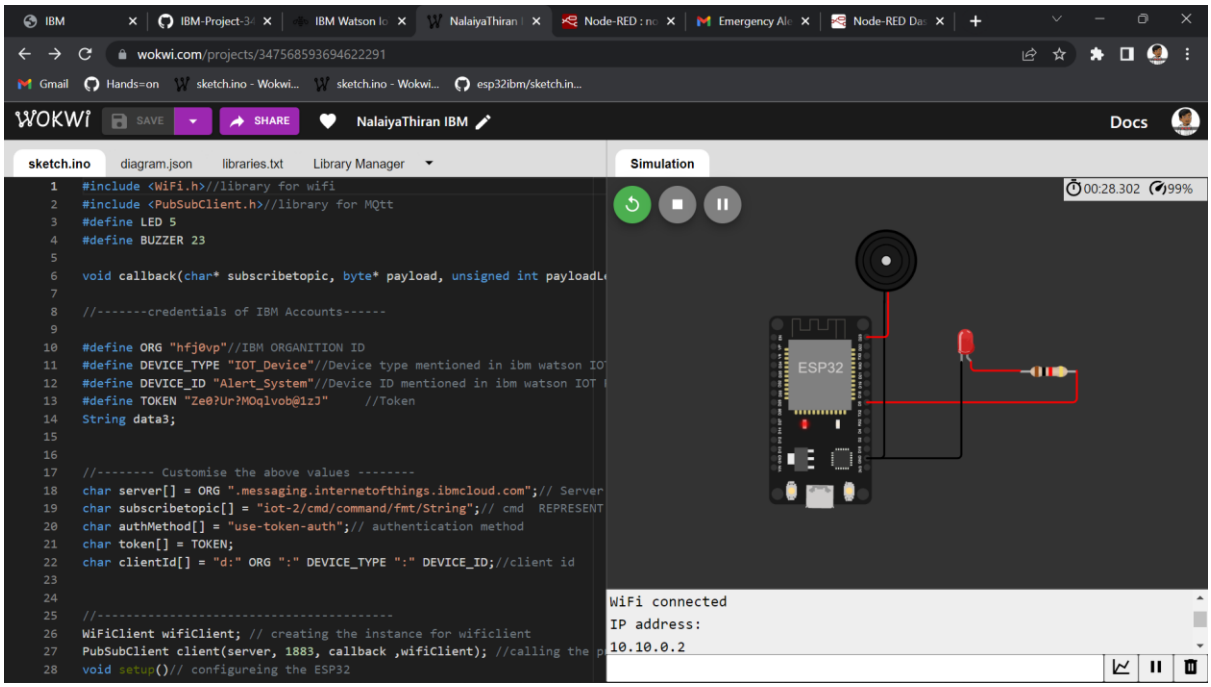
SPRINT 4:

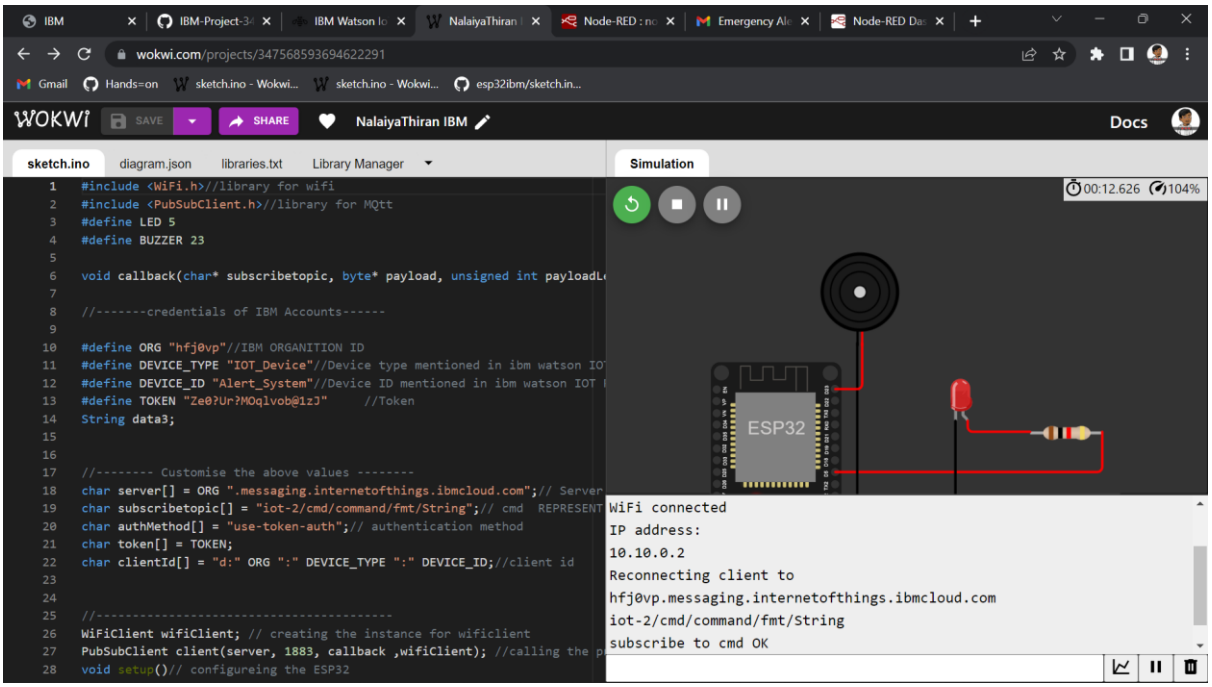
In this sprint we have developed an alarm system simulation using a led, buzzer and ESP32 microcontroller. The subscribe model device named Alert_System in IBM Watson IOT platform is connected to this simulation using device credentials. Thus the alarm gets toggles ON automatically when a gas leakage is detected. However, this alarm can be toggled ON and OFF manually from the Node Red Web Application dashboard by the admins.

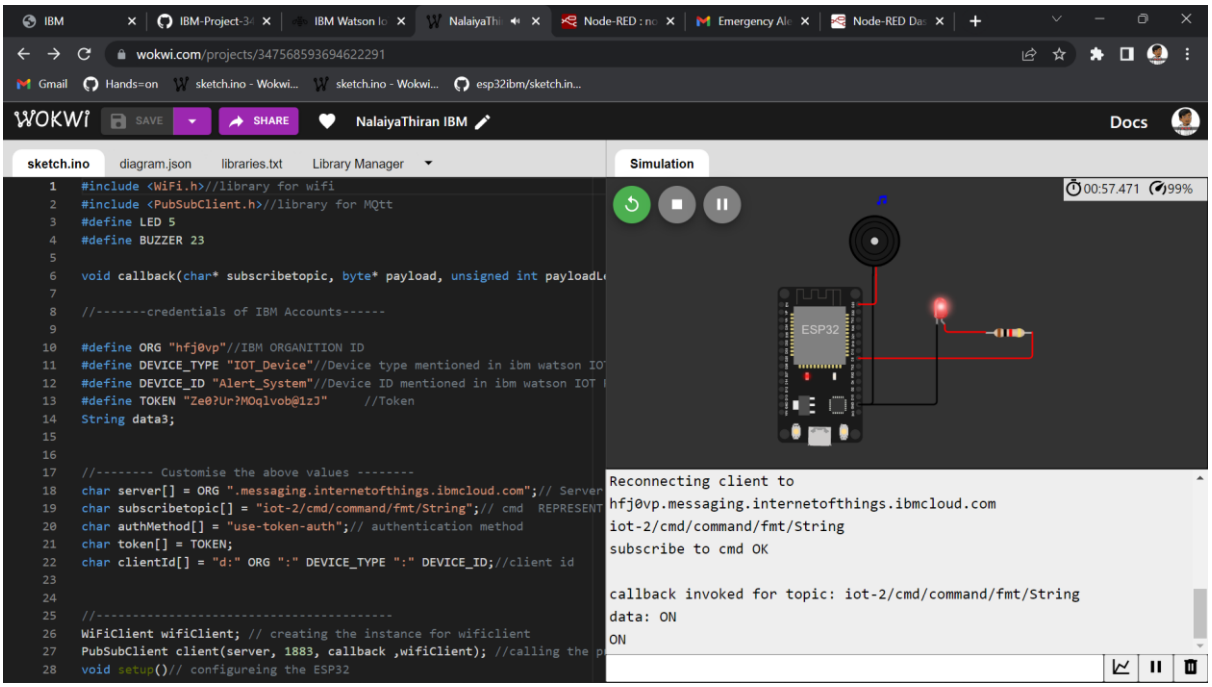
WOKWI WEBSITE LINK:

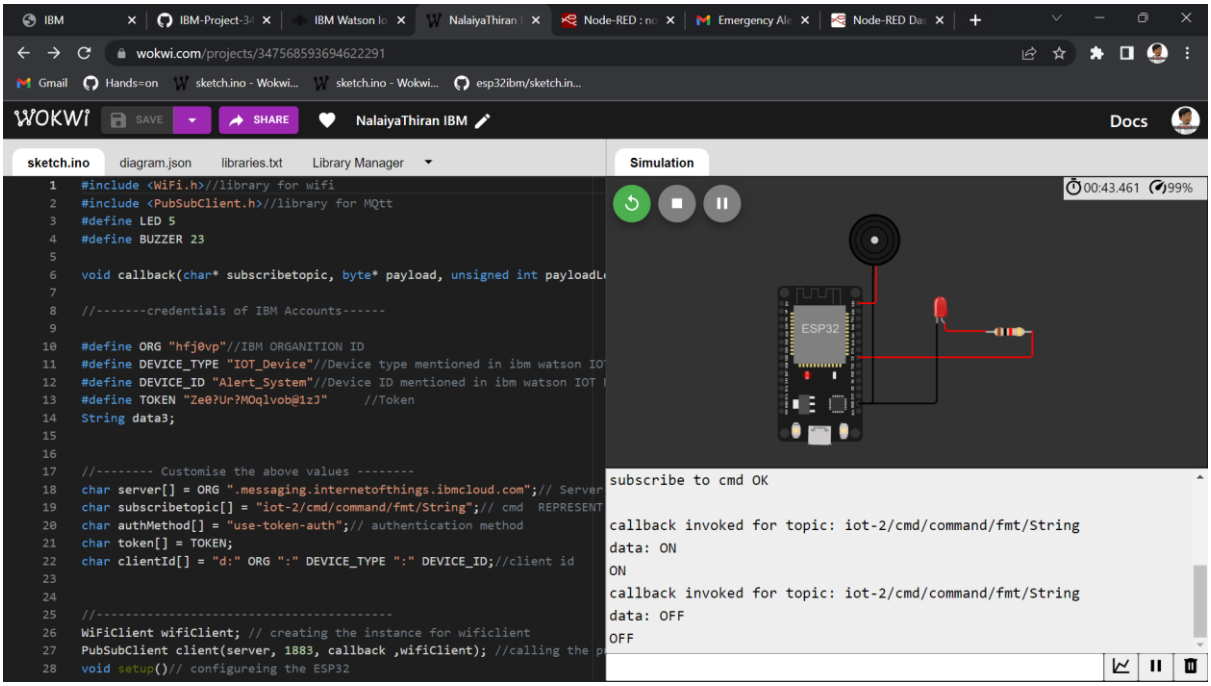
https://wokwi.com/projects/347568593694622291

SCREENSHOTS:






wokwi.com/projects/347568593694622291
WOKWI
SAVE
SHARE
NalaiyaThiran IBM
Docs
sketch.ino
diagram.json
libraries.txt
Library Manager
Simulation
00:57.471
99%
ESP32
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#define LED 5
#define BUZZER 23
void callback(char* subscribetopic, byte* payload, unsigned int payloadL
//-------credentials of IBM Accounts------
#define ORG "hfj0vp"//IBM ORGANITION ID
#define DEVICE_TYPE "IOT_Device"//Device type mentioned in ibm watson IO
#define DEVICE_ID "Alert_System"//Device ID mentioned in ibm watson IOT
#define TOKEN "Ze0?Ur?MOqlvob@1zJ" //Token
String data3;
//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server
char subscribetopic[] = "iot-2/cmd/command/fmt/String";// cmd REPRESENT
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id
//---
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient); //calling the p
void setup()// configureing the ESP32
Reconnecting client to
hfj0vp.messaging.internetofthings.ibmcloud.com
iot-2/cmd/command/fmt/String
subscribe to cmd OK
callback invoked for topic: iot-2/cmd/command/fmt/String
data: ON
ON


wokwi.com/projects/347568593694622291
WOKWI
SAVE
SHARE
NalaiyaThiran IBM
Docs
sketch.ino
diagram.json
libraries.txt
Library Manager
Simulation
00:43.461
99%
ESP32
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#define LED 5
#define BUZZER 23
void callback(char* subscribetopic, byte* payload, unsigned int payloadL
//-------credentials of IBM Accounts------
#define ORG "hfj0vp"//IBM ORGANITION ID
#define DEVICE_TYPE "IOT_Device"//Device type mentioned in ibm watson IO
#define DEVICE_ID "Alert_System"//Device ID mentioned in ibm watson IOT
#define TOKEN "Ze0?Ur?MOqlvob@1zJ" //Token
String data3;
//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server
char subscribetopic[] = "iot-2/cmd/command/fmt/String";// cmd REPRESENT
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id
//---
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient); //calling the p
void setup()// configureing the ESP32
subscribe to cmd OK
callback invoked for topic: iot-2/cmd/command/fmt/String
data: ON
ON
callback invoked for topic: iot-2/cmd/command/fmt/String
data: OFF
OFF

8. CONCLUSION

Gas leakage leads to severe accidents resulting in material losses and human injuries. Gas leakage occurs mainly due to poor maintenance of equipment and inadequate awareness of the people. Hence, gas leakage detection is essential to prevent accidents and to save human lives. The proposed gas leakage detector is promising in the field of safety. The attempt while making this prototype has been to bring a revolution in the field of safety against the leakage of harmful and toxic gases to minimize and hence nullify any major or minor hazard being caused due to them.

This paper presented gas leakage detection and alert system. This system triggers LED and buzzer to alert people when gas leakage is detected and by sending emails to the admins over the internet using an SMTP mailing services. This system is very simple yet reliable. Thus, the proposed system works well in monitoring the continuous sensor data using the node red web application dashboard and the automatic alarm system works precisely. This system facilitates the admin to monitor the gas levels and to control the alarm system from any part of the world, using any device, with the help of internet, using the web application dashboard.

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