PROJECT REPORT

ADHIYAMAAN COLLEGE OF ENGINEERING - HOSUR

Hazardous area monitoring for industrial plant powered by IoT

TEAM ID- PNT2022TMID08189

TEAM MEMBERS:

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5. **SAKTHI T**

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

The proposed system aims at reducing the risk of fires and explosions, thus increasing the safety of workers engaged in maintenance or inspection of gas storages.

The monitoring system is based on compact battery-powered wearable sensor nodes containing sensors for LPG flammable compounds, toxic gases, and oxygen.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

The existing detection systems are available to sense only a particular gas and they use GSM technology to indicate the critical situations.The drawback is that the detection system can send a message to only one person.

2.2 REFERENCES

[1] Nivit Yadav, “CPCB **Real time Hazardous area Monitoring**", Report: Center for Science and Environment, 2012.

[2] Fraiwan L., Lweesy K., Bani-Salma A., Mani N., "A wireless home safety **gas leakage detection system**", 2011 1st Middle East Conference on Biomedical Engineering, 2011, pp. 11-14, d: 10.1109/MECBME.2011.5752053.

[3] Quio Tie-Zhn, Song Le, “The Design of Multi-parameter On line **Monitoring System of Hazardous area** based on GPRS”, Report:Advanced Transducers and intelligent Control System Lab, Taiyuan Technical University, Taiyuan, China, 2010.

[4] Abrardo A., Fort A., Landi E., Mugnaini M., Panzardi E., Pozzebon A., “Black Powder Flow Monitoring in Pipelines by Means of Multi-Hop LoRa Networks”, 2019 IEEE International Workshop on Metrology for Industry 4.0 and IoT.

2.3 PROBLEM STATEMENT DEFINITION

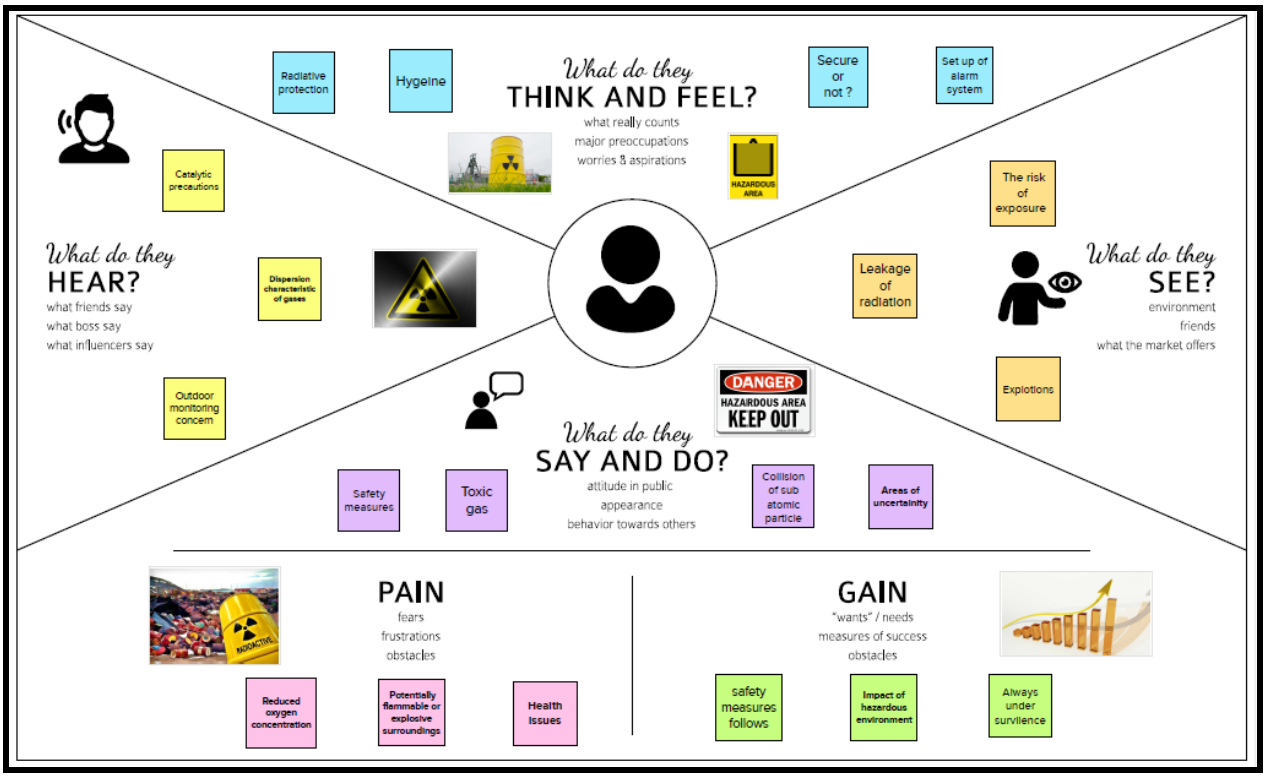
In industry, changes in the chemical reaction and environment affects the machines and causes some explosions. Due to this hazardous problem the industry will meet a million of losses and also loss the lives of the workers and nearby people.

3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user’sbehaviours and attitudes. It is a useful tool to helps teams better understandtheirusers.Creating an effective solution requires understanding the true problemand the personwho is experiencing it. The

exercise of creating the map helps participants consider thingsfrom the user's perspective along with his or her goals and challenges.



3.2 IDEATION & BRAINSTORMING

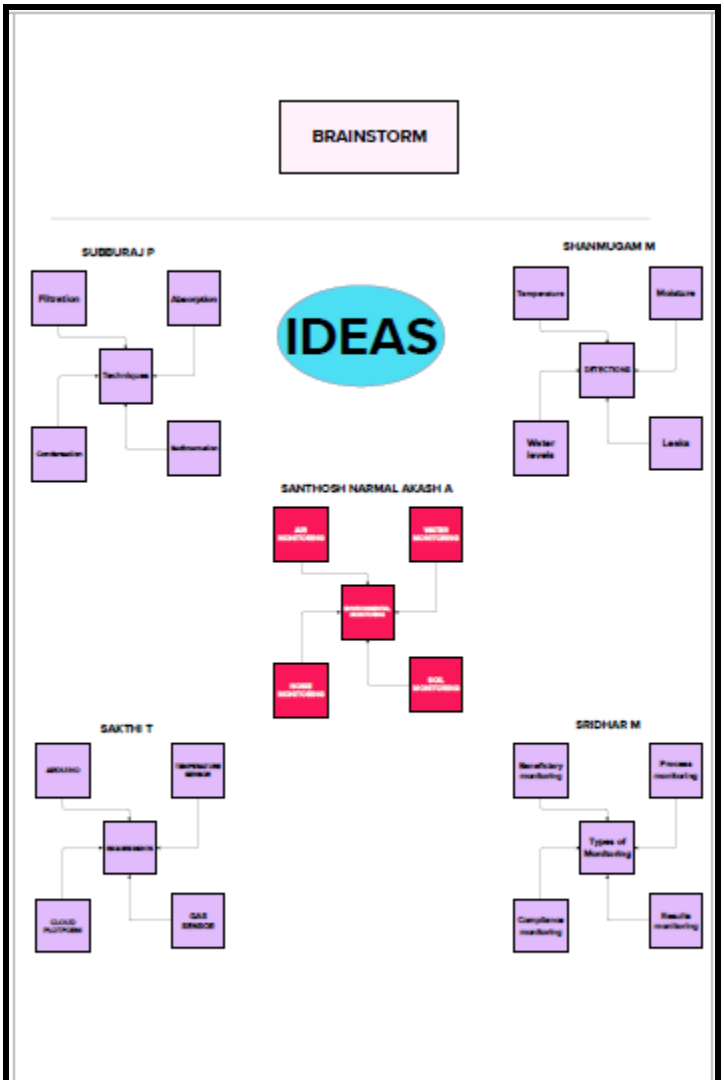
Brainstorming provides a free and open environment that encourages everyone withinateamto participate in the creative thinking process that leads to problemsolving. Prioritizingvolume over value, out-of-the-box ideas are welcome and built upon, and all participants areencouraged to collaborate, helping each other develop a rich amount of creative solutions. Use this template in your own brainstorming sessions so your teamcan unleashtheirimagination and start shaping concepts even if you're not sitting in the same room.

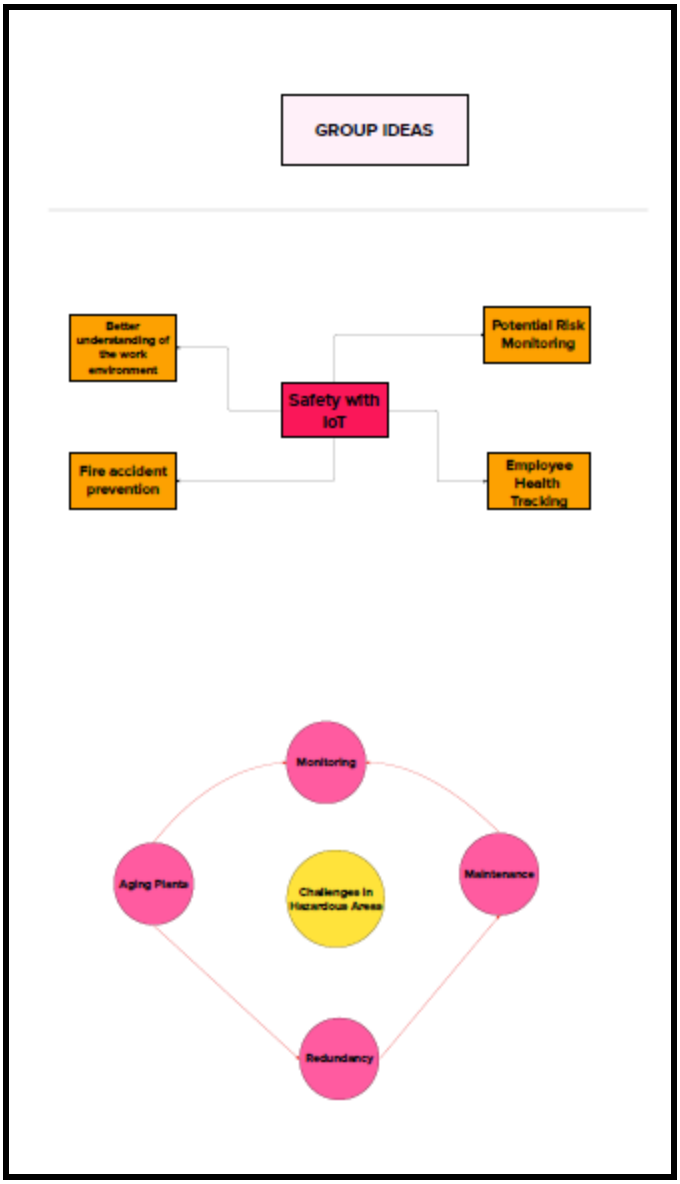
PROBLEM

HAZARDOUS AREA MONITORING FOR INDUSRIAL PLANT POWERED BY IOT.

Hazard monitoring is a common term that describes the equipment and process of monitoring grain handling equipment and facilities for proper operation and the conditions that can lead to the creation of a heat source that can initiate an explosion.

BRAINSTORM

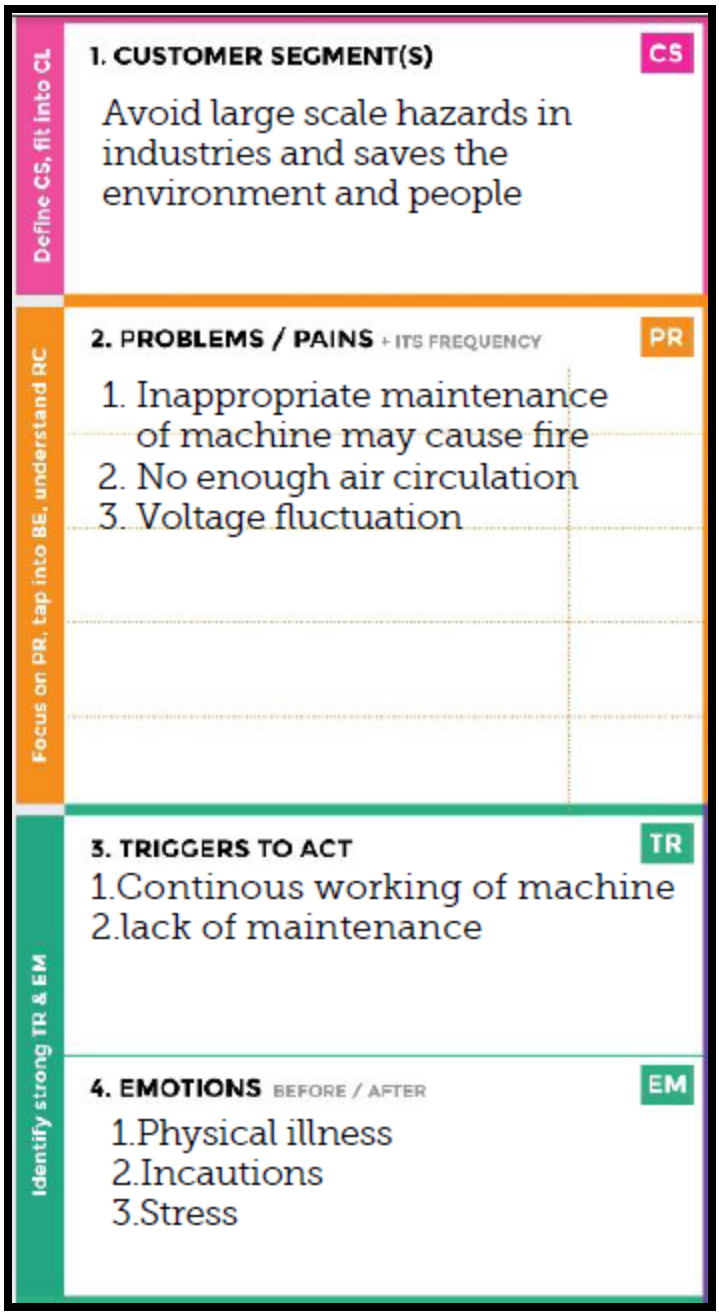



GROUP IDEAS
Better understanding of the work environment
Potential Risk Monitoring
Safety with IoT
Fire accident prevention
Employee Health Tracking
Monitoring
Aging Plants
Challenges in Hazardous Areas
Maintenance
Redundancy

3.3 PROPOSED SOLUTION

S.NO	PARAMETER	DESCRIPTION
1	Problem statement (problem to be solved)	Continuous monitoring of Hazardous Area
2	Idea / Solution description	Not only monitoring, it includes real intimation to authorised one and some self-protection system.
3	Novelty / Uniqueness	solve the problem at the beginning by using some external sensors.
4	Social Impact / Customer Satisfaction	Avoid large scale hazards in industries and saves the environment and people.
5	Business Model (financial Benefit)	We can bring this device for continuous monitoring and work as a defender to the problem.
6	Scalability of Solution	The technology can automatically monitor fire, toxic gas. This method is very adaptable.This system may be used to monitor any hazardous or natural disaster.

3.4 PROBLEM SOLUTION



6. CUSTOMER LIMITATIONS EG. BUDGET, DEVICES CL

Devices-Arduino uno, fire Sensor, temperature and humidity Sensor and gas sensor

9. PROBLEM ROOT / CAUSE RC

1. Continuous monitoring of the industry encironment
2. Quick response to relay control unit

10. YOUR SOLUTION SL

This system are continuous monitoring of the industry environment and knowning
when the sensors detect values over the threshold and act as a defender without human support.

5. AVAILABLE SOLUTIONS PLUSES & MINUSES

AS

Pluse : Automation and quick response

Minuse : Need maintenance for storage unit

Explore AS, differentiate

7. BEHAVIOR + ITS INTENSITY

BE

Happens due to any voltage Fluctuation and improper maintenance of machine.

Focus on PR, tap into BE, understand RC

8. CHANNELS of BEHAVIOR

CH

ONLINE

Updating of sensors value continuously, Indication through Android & web, when the sensors exceeds the threshold value

OFFLINE

Automatic activation of relay unit without any Human help

Extract online & offline CH of BE

4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Data Gathering	The smart beacon must be able to detect and the temperature of a particular area in real.
FR-2	Location Detection	The smart beacon must be able to detect when a wearable device has entered an area near it.
FR-3	Beacon Data Syncing	The smart beacon must be able to share its stored data with both the wearable device and admin dashboard through the cloud.
FR-4	Wearable Device Display	The wearable device must be able to display the temperature of the area where the worker is currently present.
FR-5	SMS Notification	If the temperature of the area is found to above of threshold value, the worker should be informed via SMS to their phone instructing them to leave the area.
FR-6	Admin Dashboard	If the temperature of the area is found to above of threshold value, the admin is informed via the dashboard and must take the necessary precautions.

4.2 NON-FUNCTIONAL REQUIREMENT

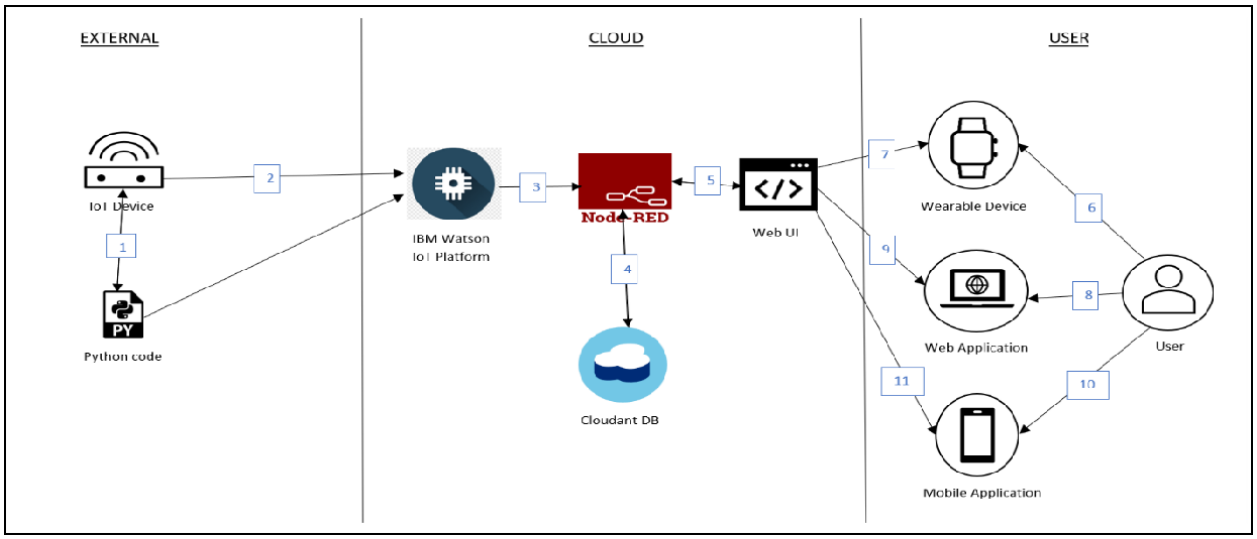
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The wearable device should be slim and not annoy or disturb the workers who are wearing that. It should also be clear display without large delays and notifications should be clear in cases of any danger.
NFR-2	**Security**	The connection of the beacons to the cloud and wearable devices should be secure. The security of the database housing all the temperature data should also be bolstered.
NFR-3	**Reliability**	The wearable device should be able to function without any faults even at High temperatures. If a fault is detected it should notify the user and the admin to be immediately make it repaired and

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 COMPONENTS & TECHNOLOGIES

S. NO	COMPONENT	DESCRIPTION	TECHNOLOGY
1.	User Interface	User can interact through mobile app application	HTML, CSS / Angular Js / React Js etc.
2.	Application Logic-1	Used to measure the environmental parameters like temperature and humidity etc...	Python.
3.	Application Logic-2	It is used to build a communication interfaces between two different	IBM Watson Assistant

		applications	
4.	Database	Used to show the collected data in the tabular form.	Python.
5.	Cloud Database	Cloudant is a non-relational, distributed data base service, which handles software and hardware provisioning, management and scaling, and support.	IBM DB2, IBM Cloudant etc.
6.	File Storage	Using IBM block storage, the collected data's are stored permanently.	IBM Block Storage or Other Storage Service or Local Filesystem
7.	External API-1	The purpose of this API is to collect the required data from the cloud.	IBM Weather API, etc.

APPLICATION CHARACTERISTICS

S. NO	CHARACTERISTICS	DESCRIPTION	TECHNOLOGY
1	Open-Source Frameworks	KAA IoT, ZETTA, GE PREDIX, Thing speak	KAA IoT
2	Security Implementations	Mandatory access control, Discretionary access control, Role-based access control, Rule-based access control.	e.g., SHA-256, Encryptions, IAM Controls, OWASP etc.

3	Scalable Architecture	It refers to a system, network or process that is designed to handle a workload that may change in scope.	Kubernetes, elastic storage, load balancers.
4	Availability	Equipment availability is a metric used to measure the percentage of time a machine can be used.	Technology used
5	Performance	Need to simulate devices from different locations with required network technologies.	Machine learning algorithms

5.3 USER STORIES

USER TYPE	FUNCTIONAL REQUIREMENT (EPIC)	USER STORY NUMBER	USER STORY/ TASK	ACCEPTANCE CRITERIA	PRIORITY	RELEASE
Technician	Installation	USN-1	The technician mustinstall the smartbeacons at points to ensurethe entire area ofthe plant iscovered.	A beacon can be found in every areaof the plant.	High	Sprint-1
	Data Gathering	USN-2	The beacons obtainthe temperature of theirrespective area using sensors.	The temperature of areas within the plant is obtained.	High	Sprint-1
	Data Sync	USN-3	The beacons sendtheir data to thecloud in thereal time which is in turn sent to nearby wearable devices and the administrators dashboard.	Data is sent to the cloud successfully and synced with other devices.	High	Sprint-1

Worker	Wearable devicedisplay	USN-4	The wearable devices shoulddisplay the datasent by beacons withinthe area.	The user can seethe temperature of the area ontheir device.	High	Sprint-1
	Wearable device adjustments	USN-5	The user can adjust the size of the wearable device to better suit them.	The user can make adjustments to the deviceto make working with it more comfortable.	Low	Sprint-2
	Wearable display customization	USN-6	The user can adjust the device display to suit theirneeds on the device itself.	The user can modify thedisplay of the device to increase readability.	Medium	Sprint-2
	SMS Notifications	USN-7	The user is sent a notification to their phone from the wearable devicethrough an API whenthe area theyare in reaches dangerous temperatures.	The user is informed of potential danger via SMS as soon as it is detected by the beacons.	High	Sprint-1
Administrator	Admin Dashboard	USN-8	The beacons send thedata through the cloudtoa dashboard which is run by the administrator.	The data of all the beaconscan be viewed by the administrator of the plant.	High	Sprint-1
	Dashboard Customization	USN-9	The dashboard can becustomized by the admin to suit theirpersonal requirements andpriorities.	The admin can customize theUI for theirdashboard.	Medium	Sprint-2

6. PROJECT PLANNING AND SCHEDULING

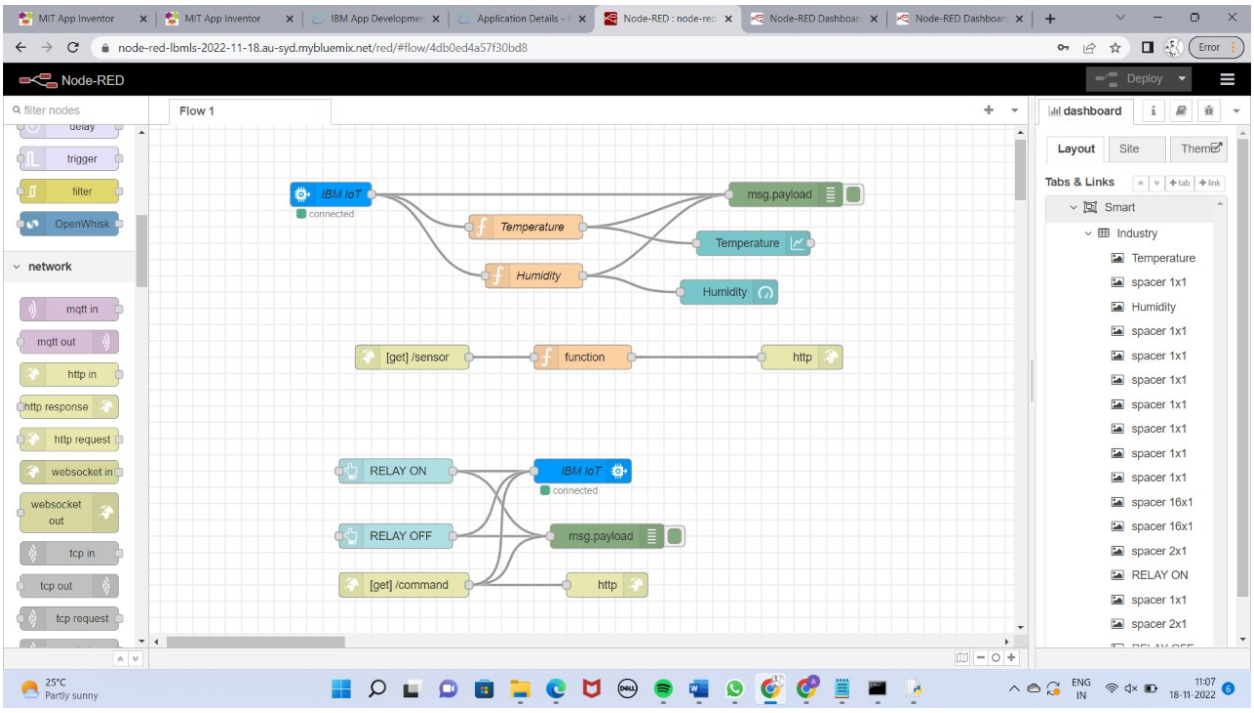
6.1 SPRINT PLANNING AND ESTIMATION

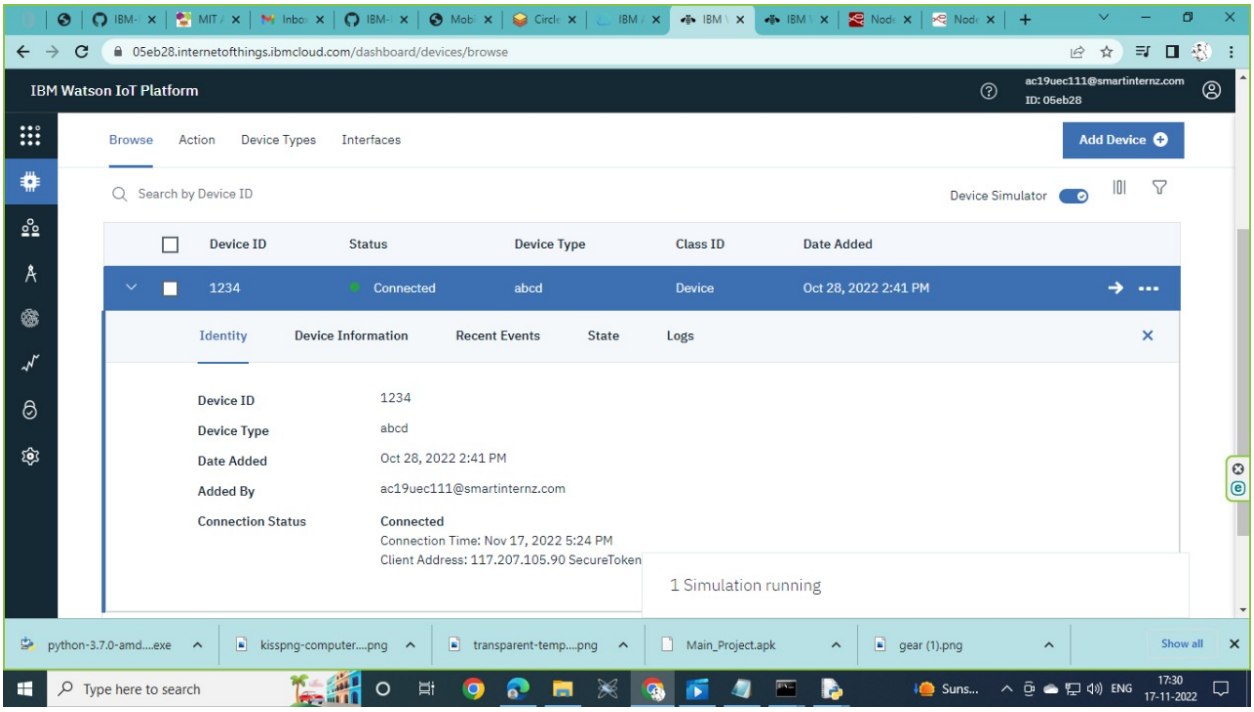
TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publications etc.	10 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	10 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	17 SEPTEMBER 2022
Proposed solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	24 SEPTEMBER 2022
Problem solution fit	Prepare problem - Solution Fit document	1 OCTOBER 2022
Solution Architecture	Prepare solution architecture document.	1 OCTOBER 2022
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	8 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	16 OCTOBER 2022

Data Flow Diagrams	Draw the data flow diagrams and submit for review	16 OCTOBER 2022
Technology Architecture	Prepare the technology architecture diagram	18 OCTOBER 2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	22 OCTOBER 2022
Project Development -- Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	2 NOVEMBER 2022

7. CODING AND SOLUTIONS

7.1 NODE RED SERVICE ASSOCIATED WITH IBM CLOUD





8. RESULTS

8.1 PERFORMANCE METRICS

PARAMETER	PERFORMANCE	DESCRIPTION
ADMIN TESTING	95%-100%	THE TESTING DONE BEFORE IT IS DEPLOYED AS AN APP
CUSTOMER SATISFACTION	75-85%	THE CUSTOMER NEED TO BE SATISFIED WITH THE MOBILE APPLICATION
USER INTERFACE	65-85%	THE APP CAN USED BY ANYONE.(EASE OF ACCESS)
SEVER RESPONSE	50-75%	url - response
DATA VALIDATION WITH NO. OF TEST CASE	60-80% (15-30 TESTCASE)	VALID DATA FROM THE APP
ERROR	3-5%	REAL-TIME DELAY MAY OCCUR

9. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Minimize human effort
- Save time
- Improved security
- Useful for safety concerns

DIS ADVANTAGES:

- Increased unemploymen
- High dependency on the internet
- The complexity of the system
- Complex system for maintenance

10. CONCLUSION

The worker should be warned through SMS to their phone that they need to leave the location if it is determined that the temperature has reached unsafe levels.

11. FUTURE SCOPE

The sensor has been integrated with IoT framework which has efficiently been used to measure and monitor the pollutants in real time. The datas are automatically stored in the database; this information can be used by the authorities to take prompt actions. It also helps the normal people to know about the amount of pollutants in their area. It also notifies the user through SMS if the gas concentration is more than normal condition it also shut off the valve when concentration reaches to dangerous level without further damage. It is able to successfully detect temperature and humidity which can be used for further study.

12.APPENDIX

12.1 SOURCE CODE

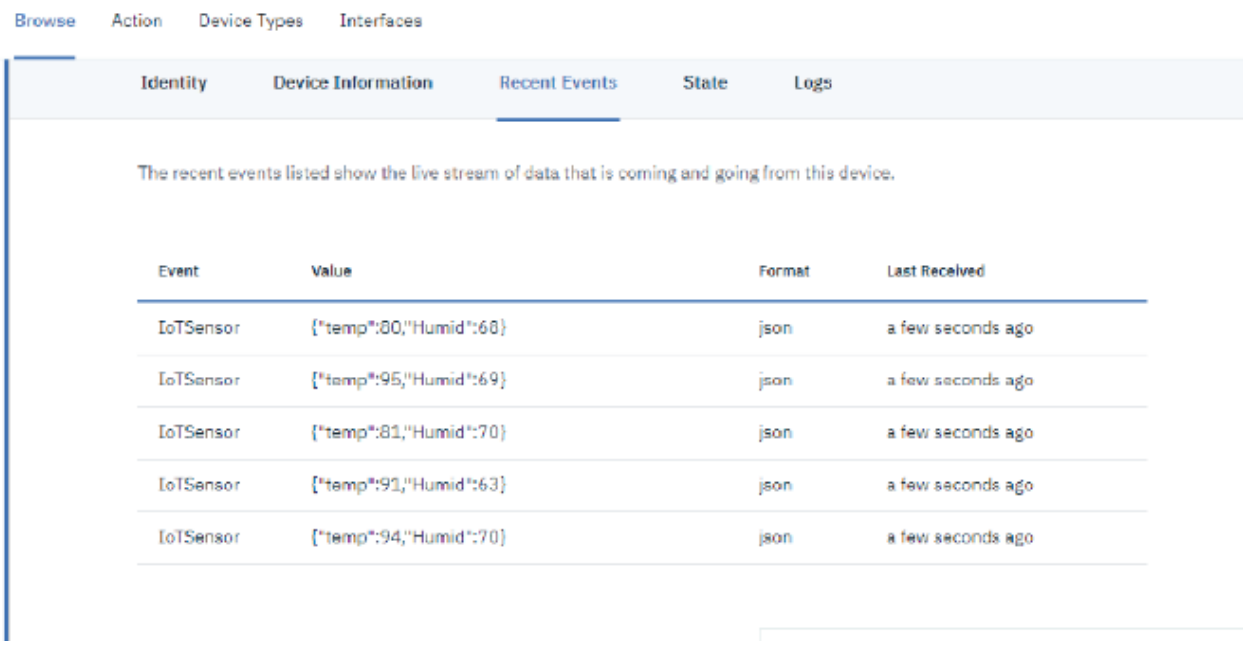
PYTHON CODE TO PUBLISH DATA

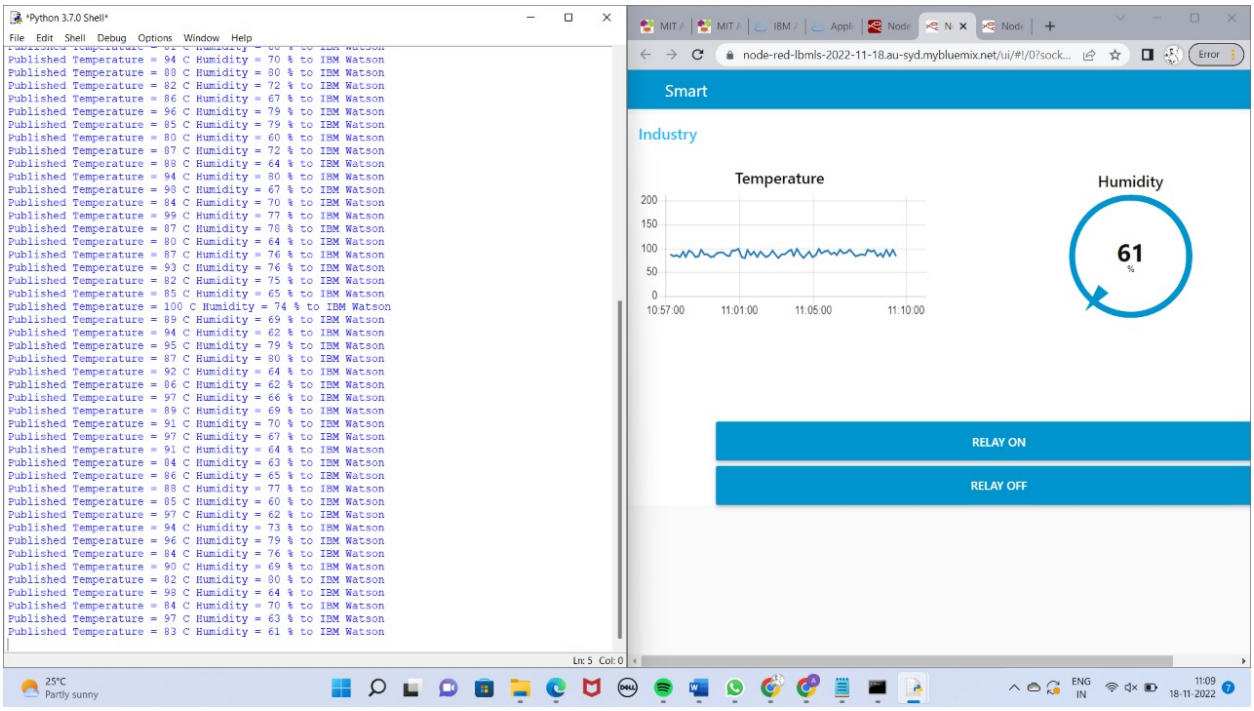
```
import time
import symbol
import sys
import ibmiotf.application
import ibmiotf.device
import random


#Provide your IBM Watson Device Credentials
organization = "05eb28"
deviceType = "abcd"
deviceId = "1234"
authMethod = "token"
authToken = "12345678"

# Initialize GPIO
```

```
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="Relayon":
        print ("Relay is on")
    elif status=="Relayoff":
        print ("Relay is off")


    #print(cmd)




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()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of
type "greeting" 10 times
deviceCli.connect()

while True:
        #Get Sensor Data from DHT11

        temp=random.randint(80,100)
        Humid=random.randint(60,80)

        data = { 'temp' : temp, 'Humid': Humid }
        #print data
```

```
        def myOnPublishCallback():
            print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % Humid,
"to IBM Watson")

        success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
        if not success:
            print("Not connected to IoTF")
        time.sleep(10)

        deviceCli.commandCallback = myCommandCallback

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

OUTPUT




Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
Published Temperature = 94 C Humidity = 70 % to IBM Watson
Published Temperature = 88 C Humidity = 80 % to IBM Watson
Published Temperature = 82 C Humidity = 72 % to IBM Watson
Published Temperature = 86 C Humidity = 67 % to IBM Watson
Published Temperature = 96 C Humidity = 79 % to IBM Watson
Published Temperature = 85 C Humidity = 79 % to IBM Watson
Published Temperature = 80 C Humidity = 60 % to IBM Watson
Published Temperature = 87 C Humidity = 72 % to IBM Watson
Published Temperature = 88 C Humidity = 64 % to IBM Watson
Published Temperature = 94 C Humidity = 80 % to IBM Watson
Published Temperature = 90 C Humidity = 67 % to IBM Watson
Published Temperature = 84 C Humidity = 70 % to IBM Watson
Published Temperature = 99 C Humidity = 77 % to IBM Watson
Published Temperature = 87 C Humidity = 78 % to IBM Watson
Published Temperature = 80 C Humidity = 64 % to IBM Watson
Published Temperature = 87 C Humidity = 76 % to IBM Watson
Published Temperature = 93 C Humidity = 76 % to IBM Watson
Published Temperature = 82 C Humidity = 75 % to IBM Watson
Published Temperature = 85 C Humidity = 65 % to IBM Watson
Published Temperature = 100 C Humidity = 74 % to IBM Watson
Published Temperature = 89 C Humidity = 69 % to IBM Watson
Published Temperature = 94 C Humidity = 62 % to IBM Watson
Published Temperature = 95 C Humidity = 79 % to IBM Watson
Published Temperature = 87 C Humidity = 80 % to IBM Watson
Published Temperature = 92 C Humidity = 64 % to IBM Watson
Published Temperature = 86 C Humidity = 62 % to IBM Watson
Published Temperature = 97 C Humidity = 66 % to IBM Watson
Published Temperature = 89 C Humidity = 69 % to IBM Watson
Published Temperature = 91 C Humidity = 70 % to IBM Watson
Published Temperature = 97 C Humidity = 67 % to IBM Watson
Published Temperature = 91 C Humidity = 64 % to IBM Watson
Published Temperature = 84 C Humidity = 63 % to IBM Watson
Published Temperature = 86 C Humidity = 65 % to IBM Watson
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Published Temperature = 85 C Humidity = 60 % to IBM Watson
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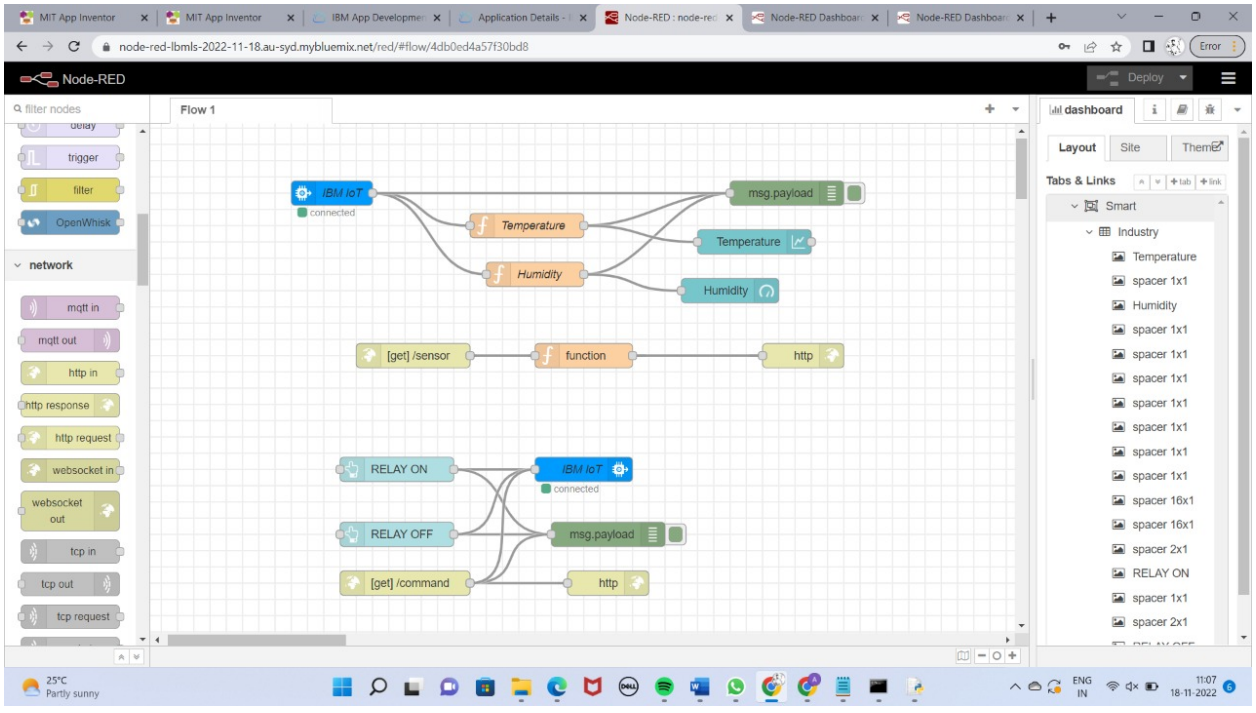
Published Temperature = 84 C Humidity = 70 % to IBM Watson
Published Temperature = 97 C Humidity = 63 % to IBM Watson
Published Temperature = 83 C Humidity = 61 % to IBM Watson
Ln: 5 Col: 0
node-red-lbmls-2022-11-18.au-syd.mybluemix.net/ui/#!/0?sock...
Smart
Industry
Temperature
200
150
100
50
0
10:57:00
11:01:00
11:05:00
11:10:00
Humidity
61
%
RELAY ON
RELAY OFF
25°C
Partly sunny
ENG
IN
11:09
18-11-2022


node-red-lbmls-2022-11-18.au-syd.mybluemix.net/red/#flow/4db0ed4a57f30bd8
Node-RED
Deploy
filter nodes
Flow 1
trigger
filter
OpenWhisk
network
mqtt in
mqtt out
http in
http response
http request
websocket in
websocket out
tcp in
tcp out
tcp request
IBM IoT
connected
Temperature
Humidity
msg.payload
Temperature
Humidity
[get] /sensor
function
http
RELAY ON
RELAY OFF
[get] /command
dashboard
Layout
Site
Theme
Tabs & Links
Smart
Industry
Temperature
spacer 1x1
Humidity
spacer 16x1
spacer 2x1
RELAY ON
25°C
Partly sunny
ENG
IN
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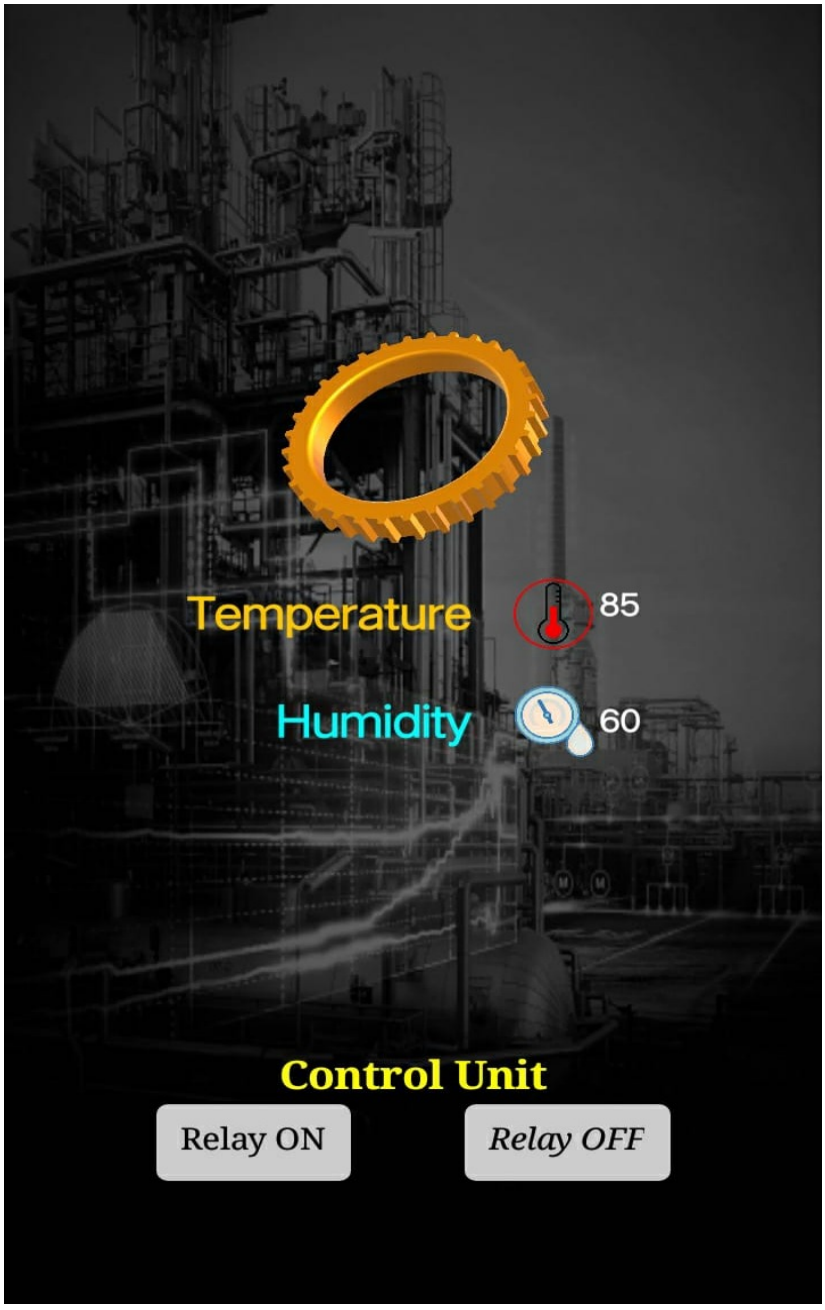
18-11-2022



12.2 GIT-HUB LINK

https://github.com/IBM-EPBL/IBM-Project-17724-1659675521/tree/main/IBM

PROJECT DEMO LINK

https://youtu.be/sAYv1Kmwzx4