Hazardous Area Monitoring for Industrial Plant powered by IoT

Team ID : PNT2022TMID48099

A Project report

Submitted by

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SHANMUGANATHAN ENGINEERING COLLEGE

INTRODUCTION

1.1 PROJECT OVERVIEW

By the end of this project :

- Gain knowledge of WatsonIoT Platform.
- Connecting IoT devices to the Watson IoT platform and exchanging the sensor data.
- Gain knowledge on Cloudant DB
- Creating a Web Application through which the user interacts with the device.

Project Flow:

- Sending random Humidity and Temperature values will be sent to the IBM IoT platform
- Sensors values can be viewed in the Web Application
- Notifies the admin the random values cross the threshold value

To accomplish this, we have to complete all the activities and tasks listed below:

- Create and configure IBM Cloud Services
    - Create IBM Watson IoT Platform
    - Create a device & configure the IBM IoT Platform
    - Create Node-RED service
    - Create a database in Cloudant DB to store location data
- Develop a web Application using Node-RED Service.
    - Develop the web application using Node-RED
- Develop a python script to publish the sensor data to the IBM IoT platform

1.2 PURPOSE

- Through this, we can monitor the temperature parameters of the hazardous areas in industrial plants.
- The area is integrated with smart beacon devices which will be broadcasting the temperature of that particular area.
- Every person working in those areas will be given smart wearable devices which will be acting as beacon scanners.

LITERATURE SURVEY

2.1 EXISTING PROBLEM

In this project industrial safety is one of the major issues in hazardous environment, specially industries like fireworks, chemical, foundry and manufacturing etc. In hazardous environment, safety is a very important factor. To avoid any types of unwanted phenomena all hazardous area follows some basic preventative measure and phenomena. Communication is the factor for any industry today to monitor different parameters and take necessary actions accordingly to avoid any type of hazards. To avoid health injury and material loss, protection system as well as faithful communication system is necessary inside and outside the industry. To increase both safety and productivity, a reliable communication must be established between workers and a fixed base station. The wired communication system is not effective. The reliability and long life of conventional communications systems in harsh hazardous environments has always been a problem. Inside the industry due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. It is very difficult to install the wired communication system it again inside industry after a landslide or damage due to some reason. Due to maintenance activity, if by any means some workers trapped, to maintain the continuity of the communication system is very much important to know the actual position and condition of the trapped workers. To monitor multi parameters during this condition it is very much necessary to maintain the communication system as usual. Accordingly, development of safety monitoring system to accurately detect temperature, radiation, flammable and poisonous gas and fire and smoke on real-time has significant meaning to safety and rescue of disaster.

2.2REFERENCES

[1] QingyuanZhu,ChengluWen,WenyiXie"GeneralEnvironmentIntegratedMonitoringandData ManagementSystemBasedonVirtual Instrument ",Advances in Information Technology andIndustry Applications,2012,Volume136, pp 163-168 .

[2] K.P.Vinay,P.Naresh,J.V.S.SManoj,M.PranayKumar"VirtualInstrumentationBasedSurveill anceSysteminIndustry",International JournalofEngineeringResearch andApplications(IJERA),Jul-Aug2013,Vol.3,Issue4,pp.903-907.

[3] GangZhao"WirelessSensorNetworksforIndustrialProcessMonitoringandControl:ASur vey",NetworkProtocolsandAlgorithms,2011, Vol.3,No.1,pp.46-63.

[4] Kumarsagar.M.Dange,Prof.R.T.Patil"DesignofMonitoringSystemforCoalMineSafetyBase donMSP430",InternationalJournalof Engineering ScienceInvention,July.2013,Volume2Issue 7,PP.14-19.

[5] LKBandyopadhyay,SKChaulya,PKMishra,AChoure,BMBaveja"Wirelessinformationands afetysystemformines",journalof scientificand industrialResearch2009, Vol.68 February,pp.107-117

[6] G.AhalyaP.SureshBabu,P.PrabhakarRao"DevelopmentOfCoalMineSafetySystemUsingWi relessSensorNetworks",International JournalofEngineeringScience&AdvancedTechnology,2013,Volume-3,Issue-3,74-78

[7] Achonu O. Adejo , adeiza J , Onumanyi, Jane M. Anyanya , Stephen O. Oyewobi "Oil and gas process monitoring through wirelesssensor networks:asurvey",OzeanJournalofAppliedSciences,2013,issue 6(2),2013,pp.39-43

[8] P.V. ManS.Shaikh"MicrocontrollerPic18f4550 BasedWirelessSensorNodetoMonitor.

2.3 Define the Problem Statements

Today there is a great challenge in the development of industrial hazardous safety monitoring for the application of gas leaks, fire, smoke,radiation etc. In all related fields of investigation, a key matter is the need flexible and practical virtual instruments, a way to easily expose the multi-sensors to the hazardous levels in risk concentration. The implementation of wireless sensor network provides an alternative solution by deploying alarger number of disposable sensor nodes. The Sensor data may consist of industrial environmental parameters like critical temperature, gas leakage,radiation, fire, smoke and the dynamic variations of these physical quantities. This software platform is in the terms of virtual instruments developedunder PYTHONprogrammingenvironmentandintegratedwithcomputercontrolledsystem.

Customer Problem Statement Template:

I am	Trying to Avoid Industrial hazardous accidents.
I'm trying to	Control and monitoring the hazardous area.
But	Many industry are not following the proper maintenance and services.
Because	Of maintenance cost high and awareness less of some industry.
Which makes me feel	We losses more employees life, industrial materials and industrial surrounding areas were polluted.

Reference: https://miro.com/templates/customer-problem-statement/

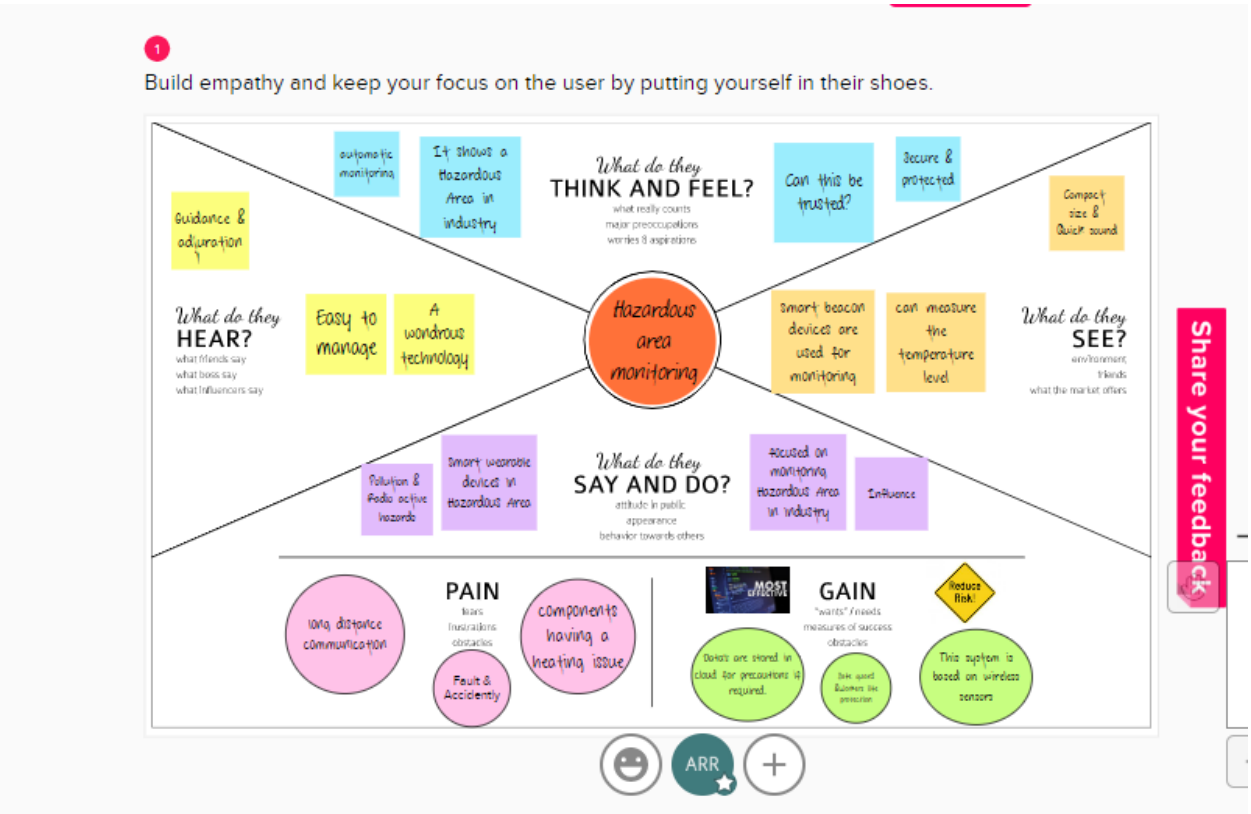
PROBLEM STATEMENTS

Problem Statement (PS)	**Iam (Customer)**	**I'm trying to**	**But**	**Because**	**Which makes me feel**
PS-1	We think that to avoid industria-l acciden-t	Prevent Industrial hazardou-s accident	Rules are not followed by industr-y	Of less awareness	To avoid pollution
PS-2	To avoid pollution	To avoid the human Dead's in industry	Not proper mainte-nenace	Careless ness	We lose our industrial employees life

IDEATION& PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An Empathy Map is **a collaborative tool teams can use to gain a deeper insight into their customers**. Much like a user persona, an empathy map can represent a group of users, such as a customer segment.



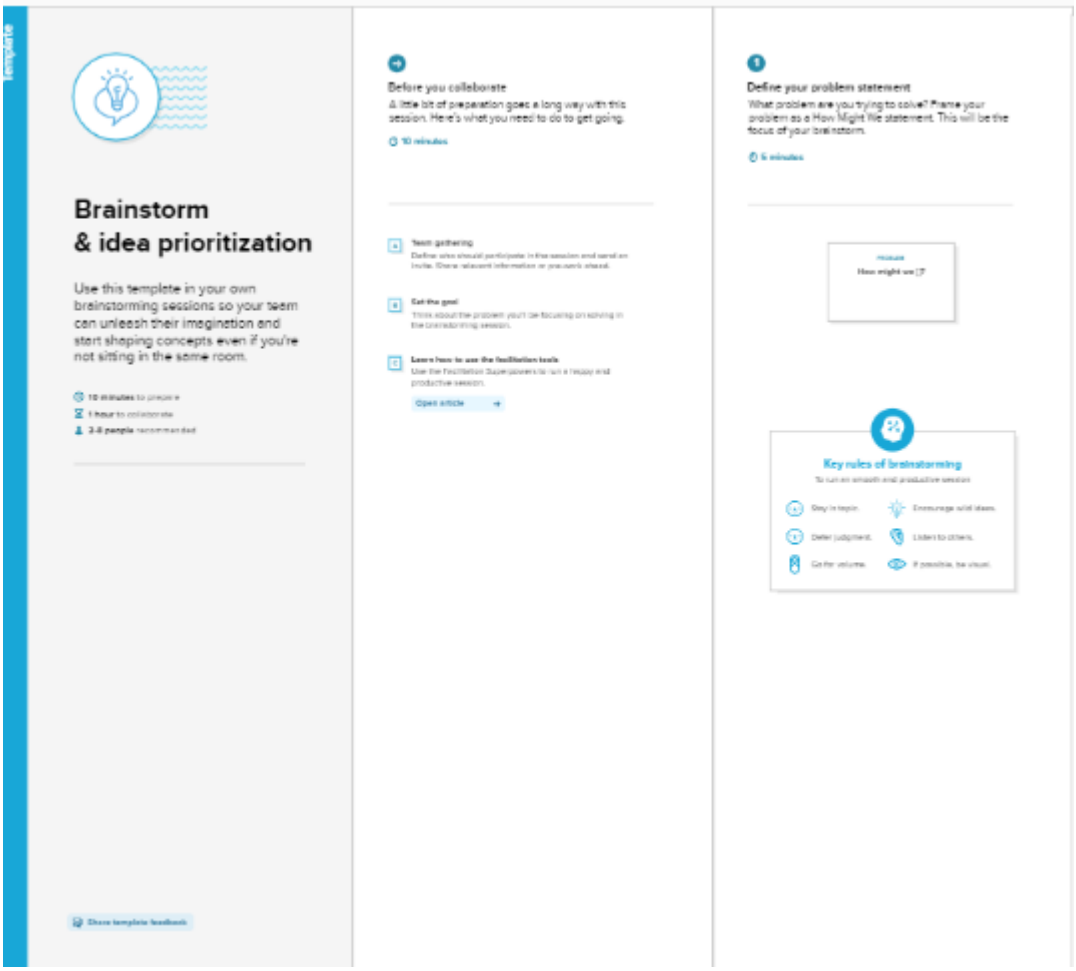
REFERENCE LINK:

https://app.mural.co/invitation/mural/iotmakers7542/1662826043578?sender=u254a533787913ed14aa43587&key=d37b87bf-d759-4a68-9a2e-e7b25f1fb9da

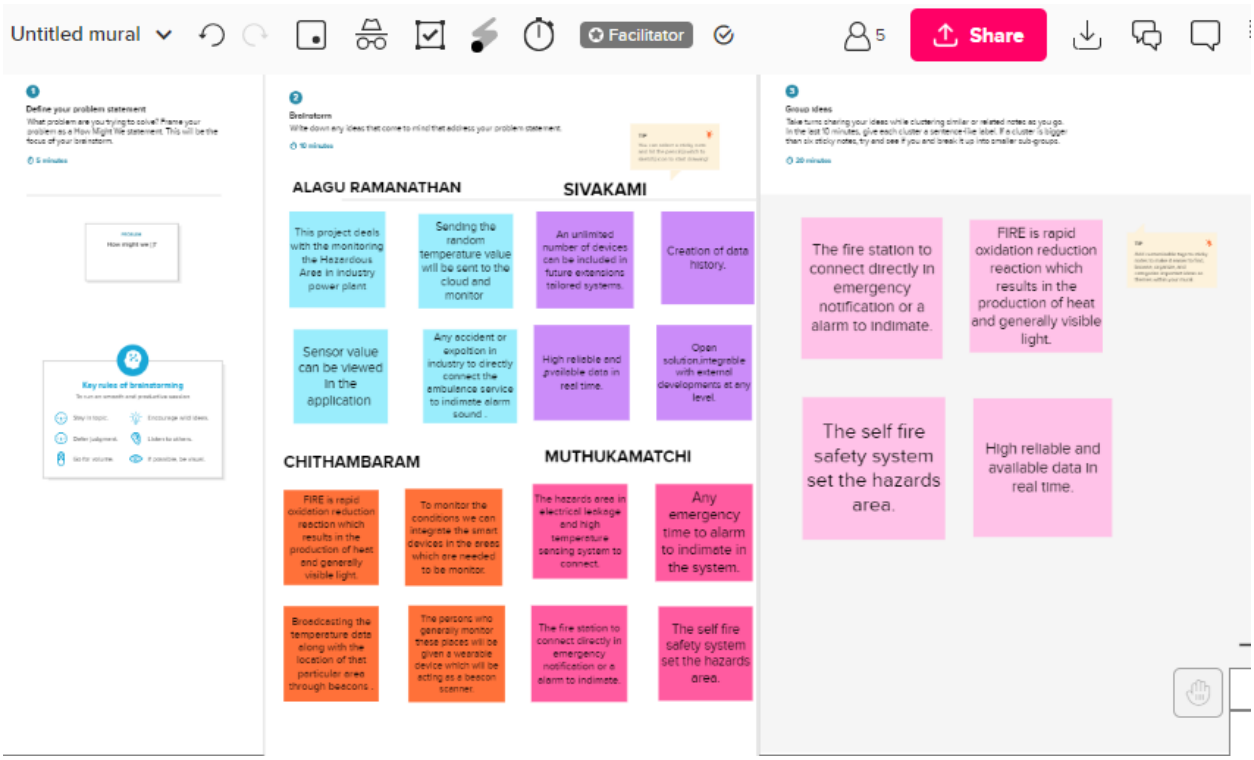
3.2 IDEATION&BRAINSTROMING

To solve a problem or make a decision by thinking of as many ideas as possible in a short time.

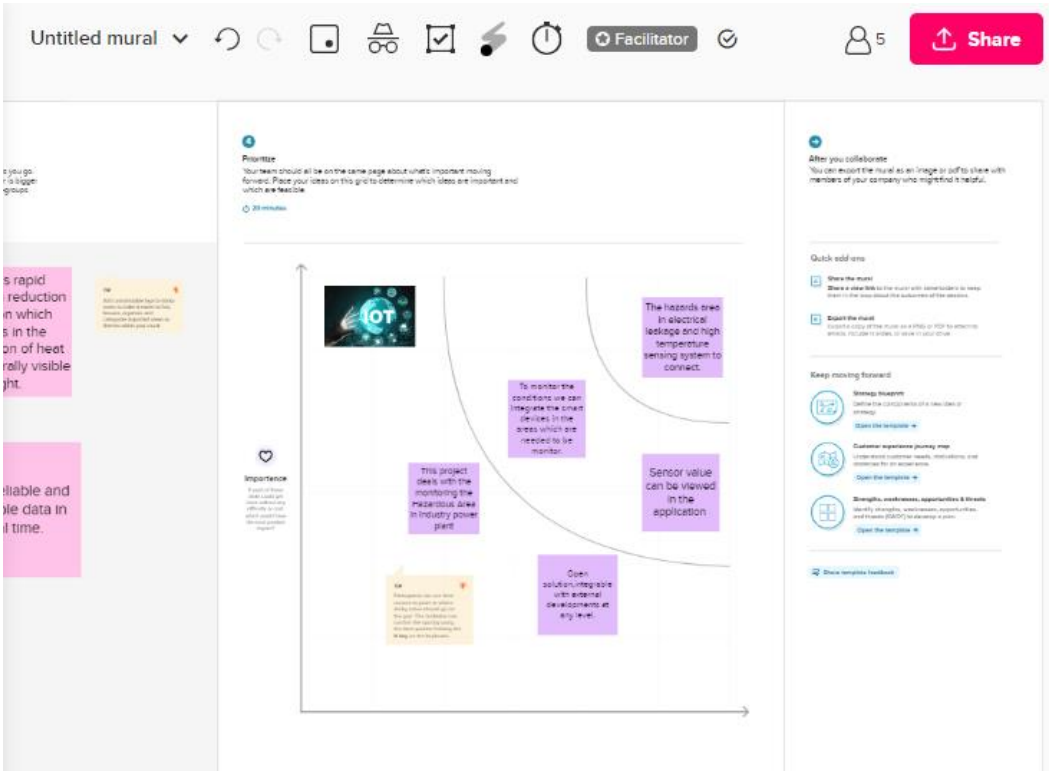
Brainstorm & Idea Prioritization Template



STEP1: Team gathering,, collaboration & select the problem statement



Step2:Brain stroming,idea listingand grouping



Step3 idea prioritization

REFERENCE
LINK:*https://app.mural.co/invitation/mural/iotmakers7542/1663648369943?sender=u254a533787913ed14aa43587&key=c087dd12-0b36-46a8-bc55-4ec174b37f58*

3.3 PROPOSED SOLUTION

Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

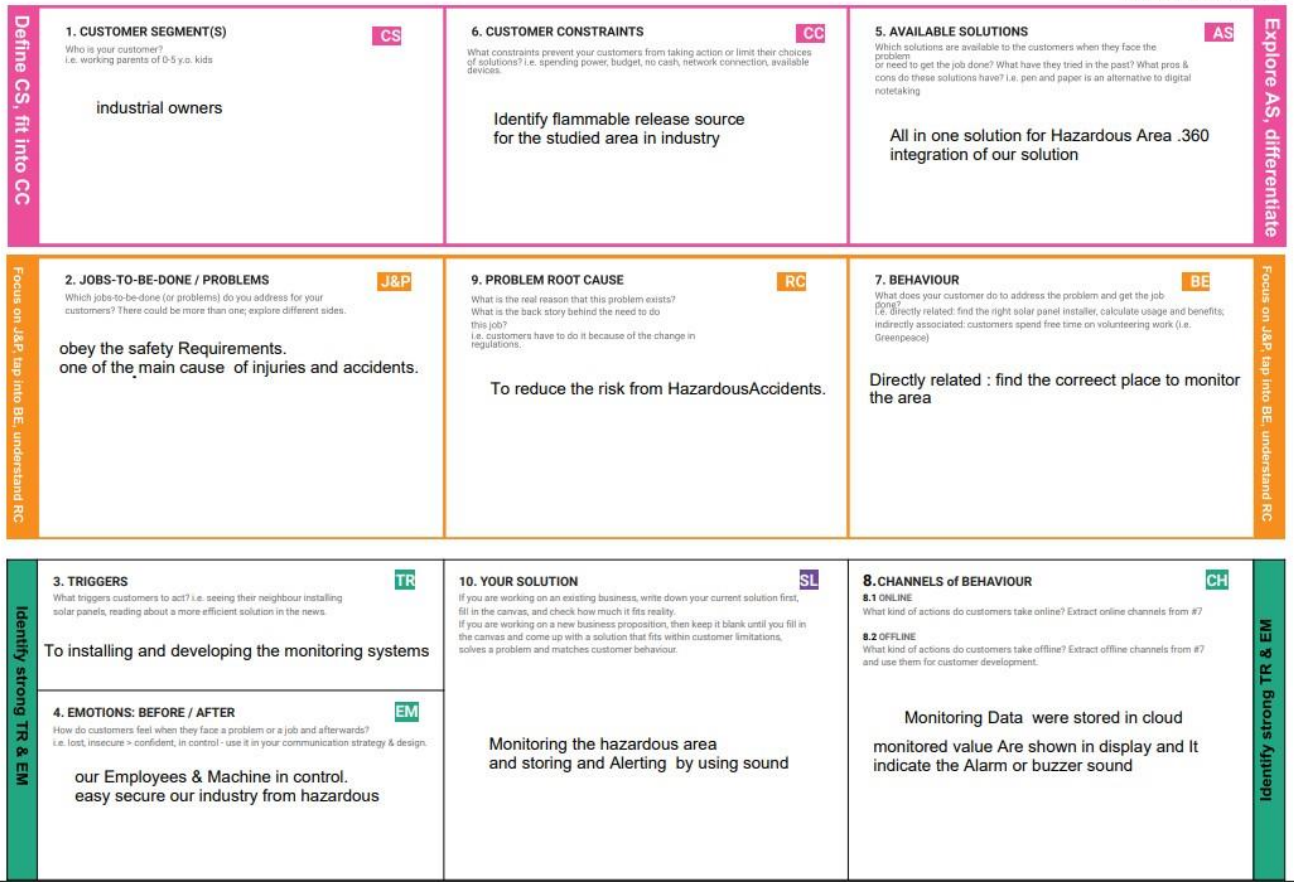
S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Traditional safety system can be effectively replaced by the wireless sensor network and virtual instrumentation system proposed in the project
2.	Idea / Solution description	it implements a long-range communication protocol that, at the same time, allows to transmit data in a range able to cover the area of typical Oil & gas or chemical plants (1-2 km depending on area morphology) and save battery energy.
3.	Novelty / Uniqueness	It constantly monitors the levels of ammonia and carbon monoxide emitted in order to keep the air pollution levels in check
4.	Social Impact / Customer Satisfaction	A larger industrial area and more hazardous area are now can be covered and potential accidents can be controlled efficiently
5.	Business Model (Revenue Model)	A smart reconfigurable assembling asset is improved with internet intelligence, giving nearby control to the physical assembling asset, plug – and – play capacity, and high computational strength.
6.	Scalability of the Solution	The information about the present condition of the industry is intimated to the concerned official as SMS to their mobile. The SMS is only sent when any abnormality is detected or if any safety issues arrived

3.4 PROBLEM SOLUTION-FIT

Project Title:

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMIDxxxxxx
PNT2022TMID48099



REQUIREMENT ANALYSIS

4.1 FunctionalRequirements

Followingarethefunctionalrequirementsoftheproposedsolution.

FR No.	Functional Requirement(Epic)	SubRequirement(Story/Sub-Task)
FR-1	UserRegistration	Registration through FormRegistrationthroughG mail
FR-2	UserConfirmation	ConfirmationviaEmailConfirmation via OTP
FR-3	User approval	Approvalthroughphonecall
FR-4	Usertransaction	TransactionthroughonlinemodeTransactionthroughdebit card
FR-5	Testing	TestingthroughcomponentTestingvia APIandUI
FR-6	Endresult	Endresultthroughproductfeatures

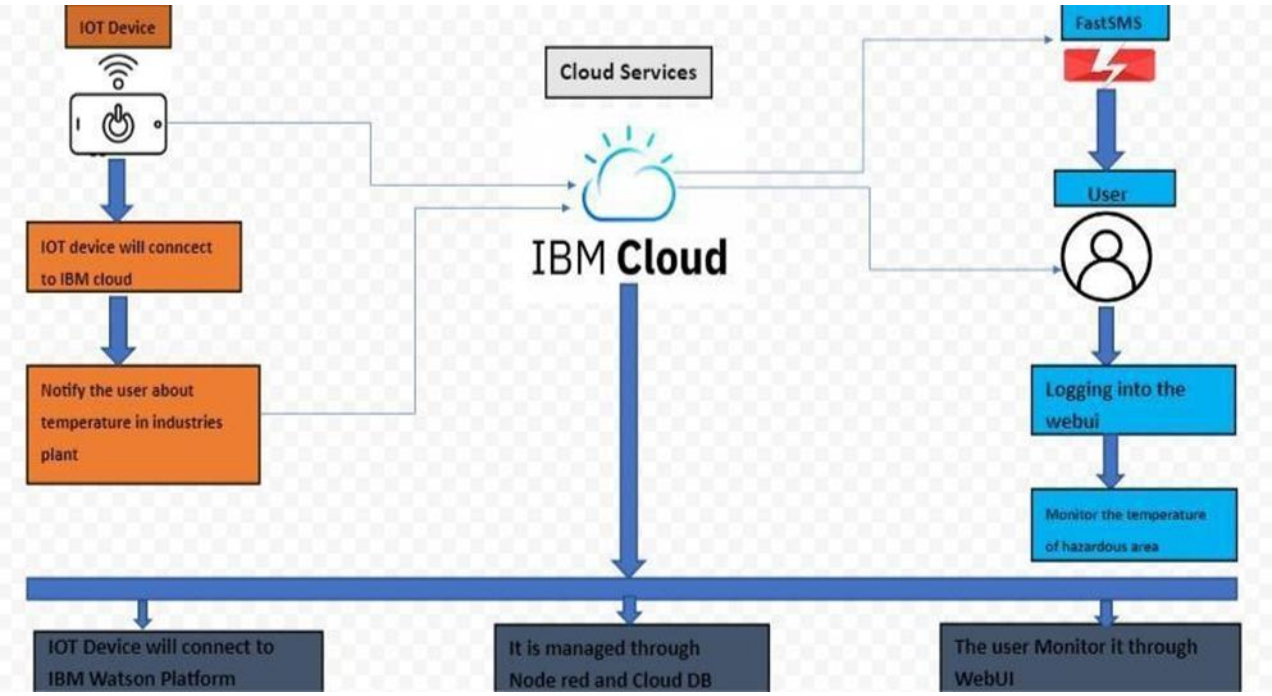
4.2 NonfunctionalRequirements

FR No.	Non-FunctionalRequirement	Description
NFR-1	**Usability**	Itreferstotheaveragetimeittakestoaccomplishauser'sgoals.
NFR-2	**Security**	To ensuretheuserthat thesoftwareisprotectedfromunauthorizedaccesstothe System and its stored data.
NFR-3	**Reliability**	It describes how likely it is for the software to work without failure for a given period time.
NFR-4	Performance	Qualityattributethatdescribestheresponsiveness ofthesystemtovarioususerinteractionswithitforusersefficiency.
NFR-5	Availability	It is the period of time that the system'sfunctionalityandservicesareavailableforusewithalloperations.

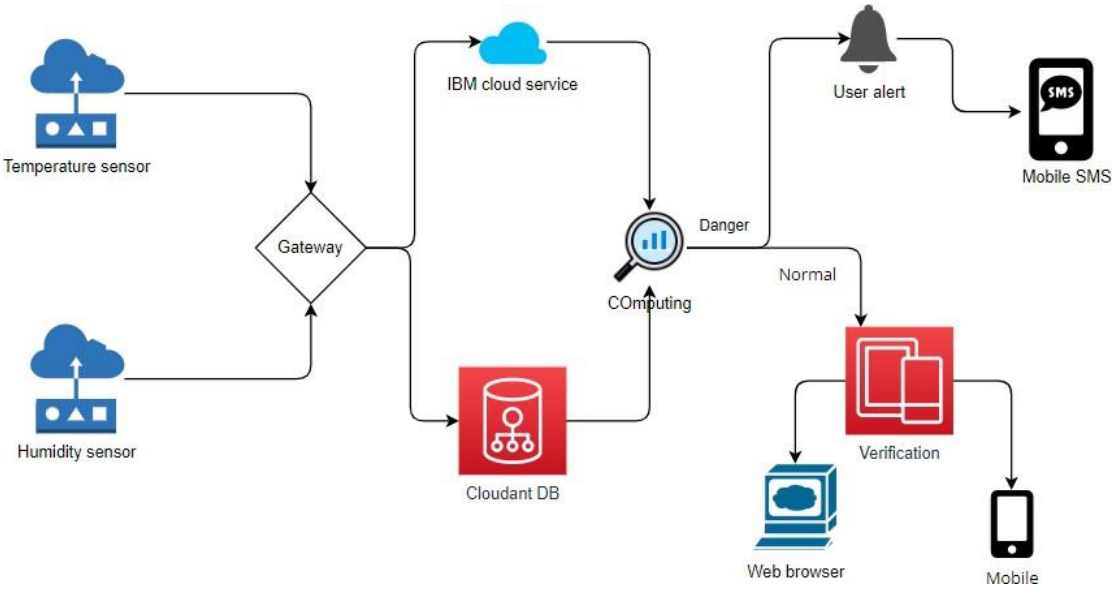
]]PROJECT DESIGN

5.1 DataFlowDiagrams

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 ofthe systemrequirementgraphically.Itshowshowdataentersandleavesthesystem,whatchangestheinformation, andwheredata isstored.



5.2 SOLUTION &TECHNICAL ARCHITECTURE



5.3 USER STORIES

Usethebelowtemplatetolistalltheuserstoriesfortheproduct.

Customer (Industrial Worker)	Registration	USN-1	AsanIndustrialWorker,Icanregister intotheapplicationbyenteringemail &password	Icanaccess my account /dashboard	High	Sprint-1
	DataModules	USN-2	AsanIndustrialWorker,Icanget messageaboutthetemperatureand humidity	Icanreceive confirmationemail & clickconfirm	High	Sprint-1
	Login	USN-3	AsanindustrialOwner,Icanlogini nto myaccountthroughemailand Password	Icanaccess my account	Medium	Sprint-2
	Dashboard	USN-4	AsanIndustrialOwner,Icanget alert hightemperature	Icanaccessthe dashboard with individualLogin id/password	High	Sprint-1

PROJECT PLANNING &SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	FunctionalRequirement	UserStoryNumber	UserStory/Task	TaskPoint	Priority	TeamMembers
Sprint-1	InstallationofBeacons	USN-1	FirsttheAdminUserwillbeinstallingsmartbeaconsatnecessaryplaces.	15	High	AlaguramanathanRChithambaramSMuthukamatchi LSivakamiR
Sprint-2	Beacondevices	USN-2	TheAdminshouldprovidewearabledevicestoeveryoneintheindustry.	5	Medium	AlaguramanathanRChithambaramSMuthukamatchi LSivakamiR
Sprint-3	CloudSetup	USN-3	The Smart Beacons will be connected to the IBM cloudservices where we can get the realtime monitoring datafromthewearablegadget.	20	High	AlaguramanathanRChithambaramSMuthukamatchi LSivakamiR
Sprint-4	OnlineMonitoringviaWeb	USN-4	Websitesshouldbecreatedandconnected withIBMcloud which helps in viewing the realtime data fromwearable device in GUI and storing the logs in thedatabase.	20	High	AlaguramanathanRChithambaramSMuthukamatchi LSivakamiR
Sprint-5	MonitoringviaMobile	USN-5	Toalerttheabnormality,MobileApplicationsandMailservicesarecreatedto receivethe alert notification.	20	High	AlaguramanathanRChithambaramSMuthukamatchi LSivakamiR

6.2SPRINT DELIVERY SCHEDULE

ProjectTracker,Velocity&Burndown

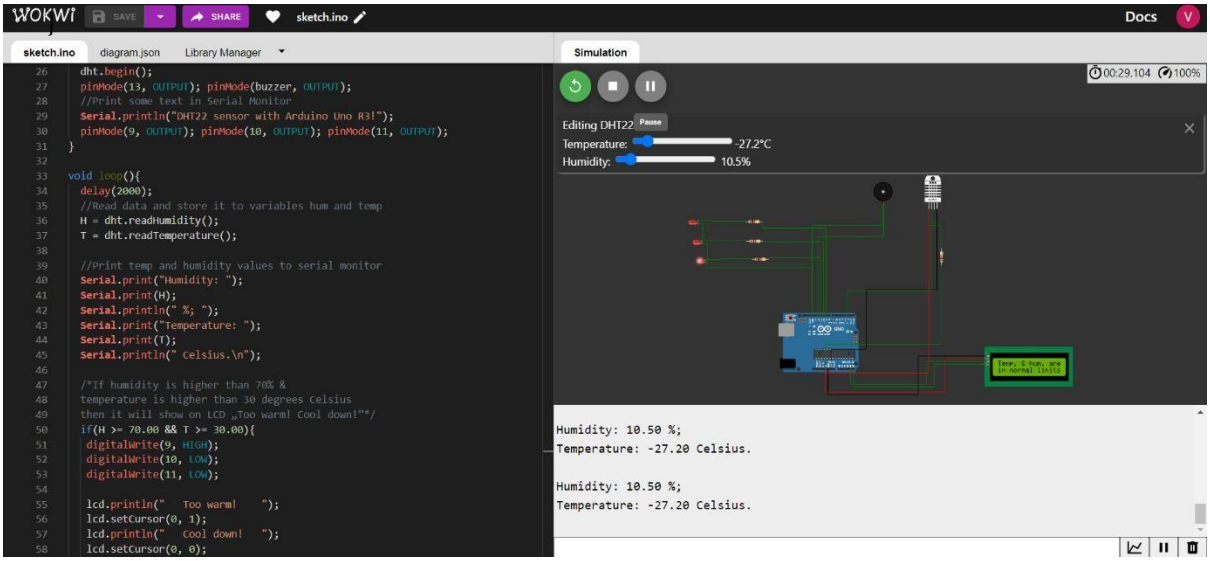
Sprint	Total Story Points	Duration	SprintStartDate	SprintEndDate(Planned)	Story PointsCompleted(ason PlannedEndDate)	SprintReleaseDate(Actual)
Sprint-1	20	3Days	06Nov2022	08Nov2022	20	08Nov2022
Sprint-2	20	3Days	09Nov2022	11Nov2022	20	11Nov2022
Sprint-3	20	4Days	12Nov2022	15Nov2022	20	15Nov2022
Sprint-4	20	4Days	16Nov2022	19Nov2022	20	19Nov2022

CODING &SOLUTION

7.1 FEATURE-1

```
#include<stdio.h>
  //LCDI2Clibrary:
  #include<LiquidCrystal_I2C.h>
  //DHT22sensorlibrary:
  #include<DHT.h>;

  //LCD I2C address 0x27, 20 column and 4
  rows!LiquidCrystal_I2Clcd(0x27, 16,2);

  //Constants:
  #defineDHTPIN2          //what pin we're connected
  to#defineDHTTYPEDHT22 //DHT22(AM2302)
  DHTdht(DHTPIN,DHTTYPE);//Initialize DHTsensorfornormal16mhzArduino

  //Variables:
  intchk;
  float H; //Humidity
  valuefloat T; //Temperature
  valueintbuzzer =12;

  voidsetup(){
lcd.init();lcd.backlight();
    //Serial Communication is starting with 9600 of baudrate
    speedSerial.begin(115200);
    dht.begin();
    pinMode(13,OUTPUT);pinMode(buzzer,OUTPUT);
```

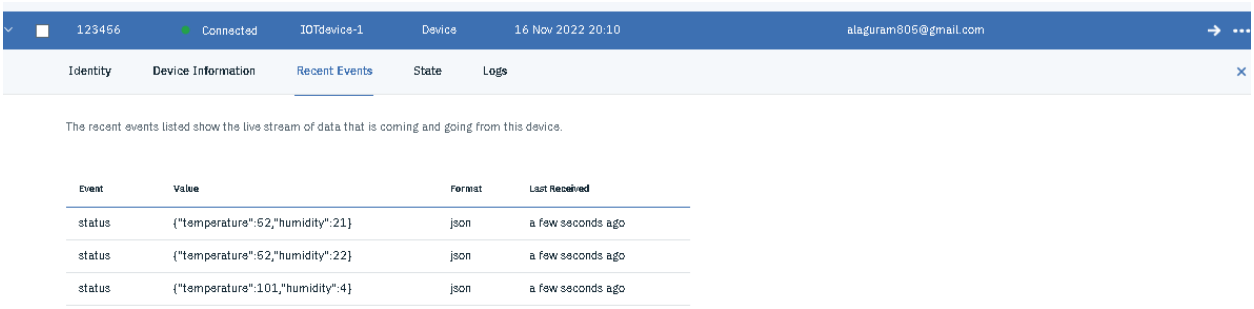
```
  MonitorSerial.println("DHT22sensorwithArduinoUn
  oR3!");
  pinMode(9,OUTPUT);pinMode(10,OUTPUT);pinMode(11,OUTPUT);
}
```



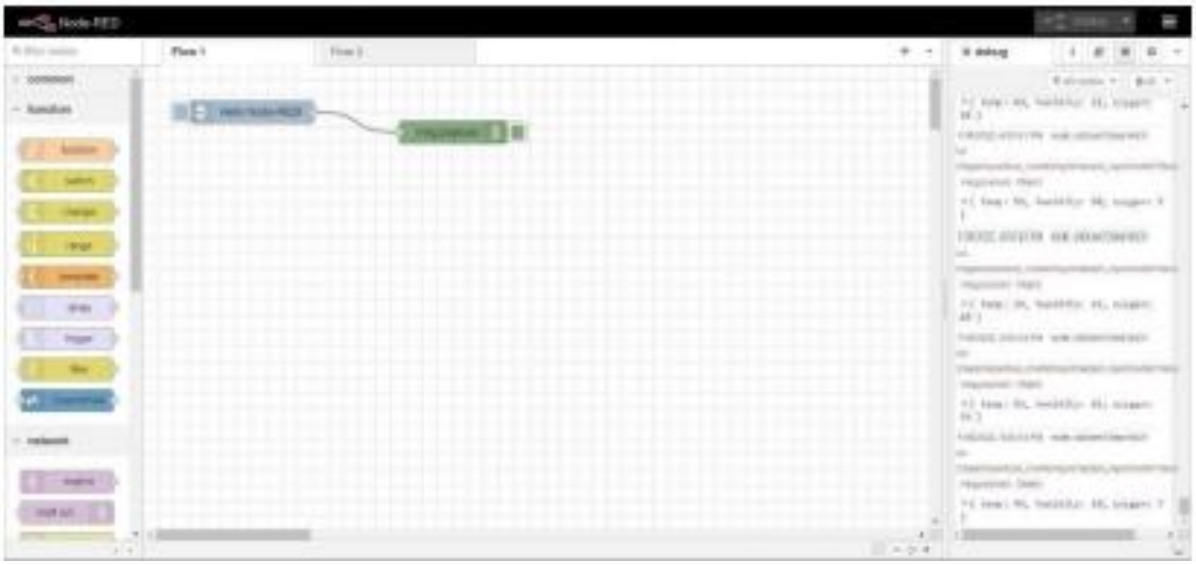
Output:

7.2 FEATURE-2

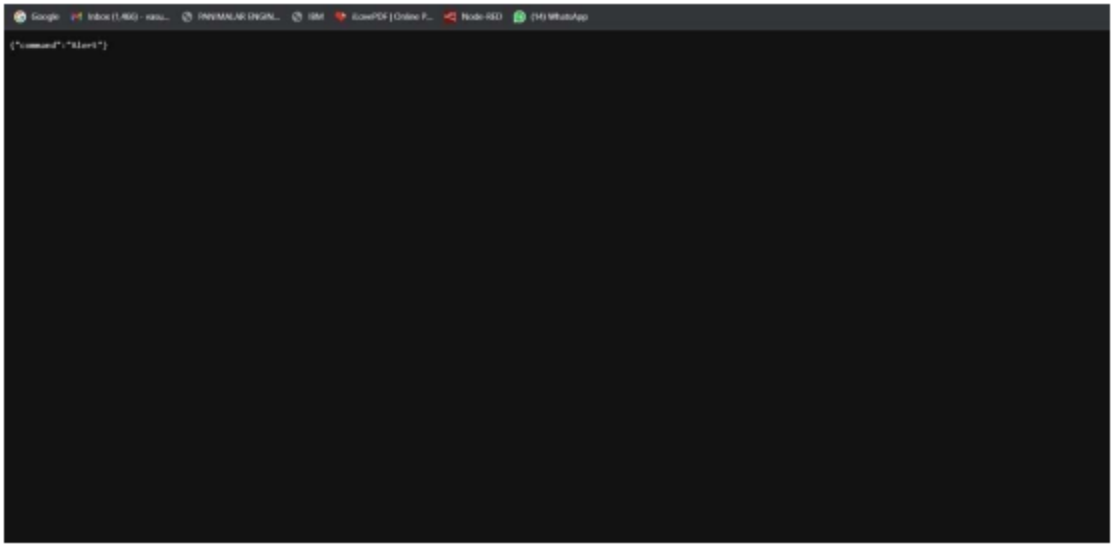
1.Device Creation using IoT Watson platform with credentials: • IBM Watson IoTplatformacts as the mediator to connect the web application to the IoT device, so create the IBM Watson IoT platform. • In order to connect the IoT device to the IBM cloud, we need to create a device in the IBM Watson IoT platform and get the device credentials. • To configure the connection security and create API keys that are used in the Node-RED service for accessing the IBM IoT Platform.

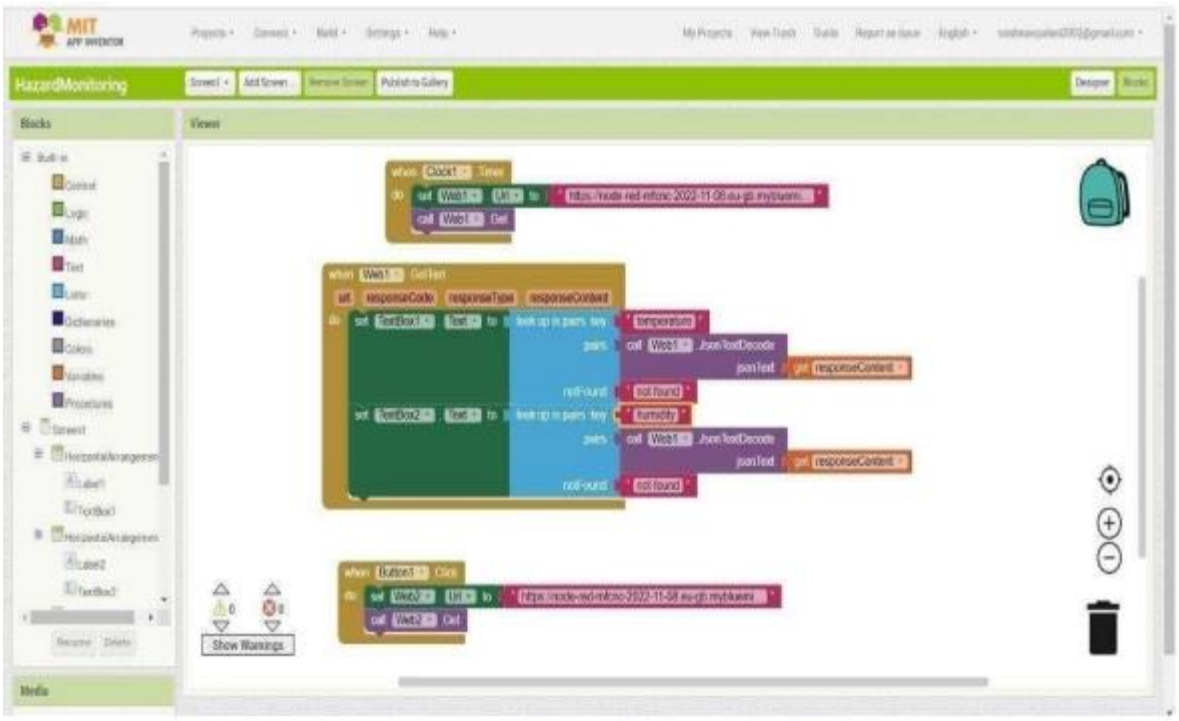


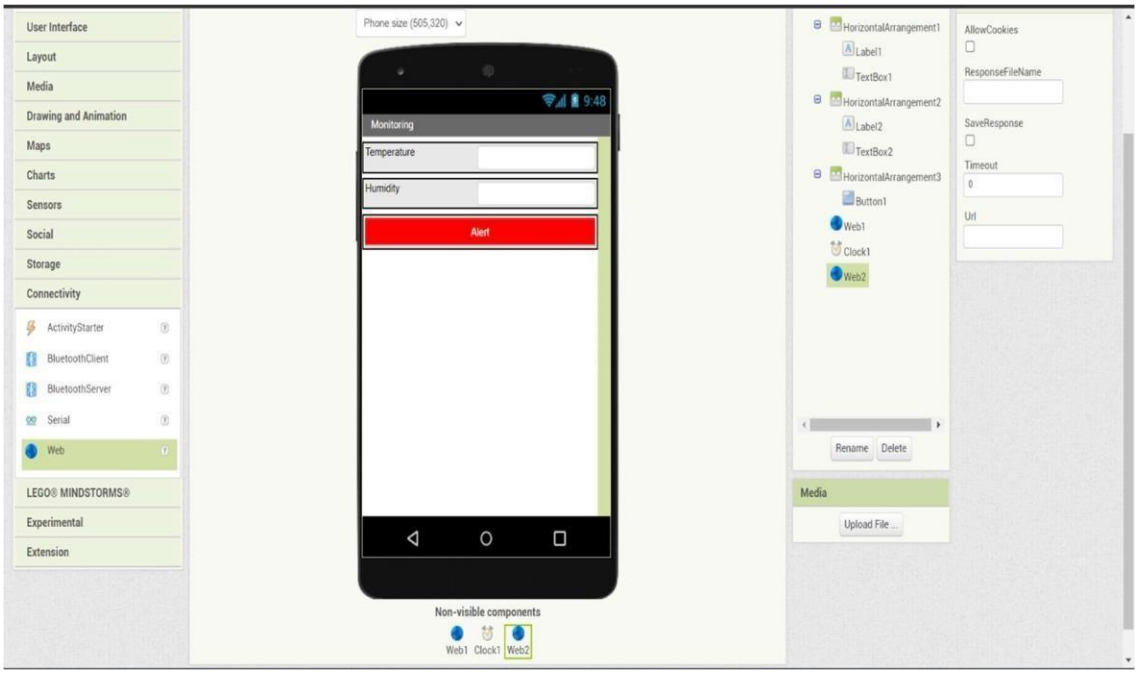
Required Performance of device using Local Node-Red Platform



ALERT WINDOW:




MIT
HazardMonitoring
Blocks
Viewer
Show Warnings
Media

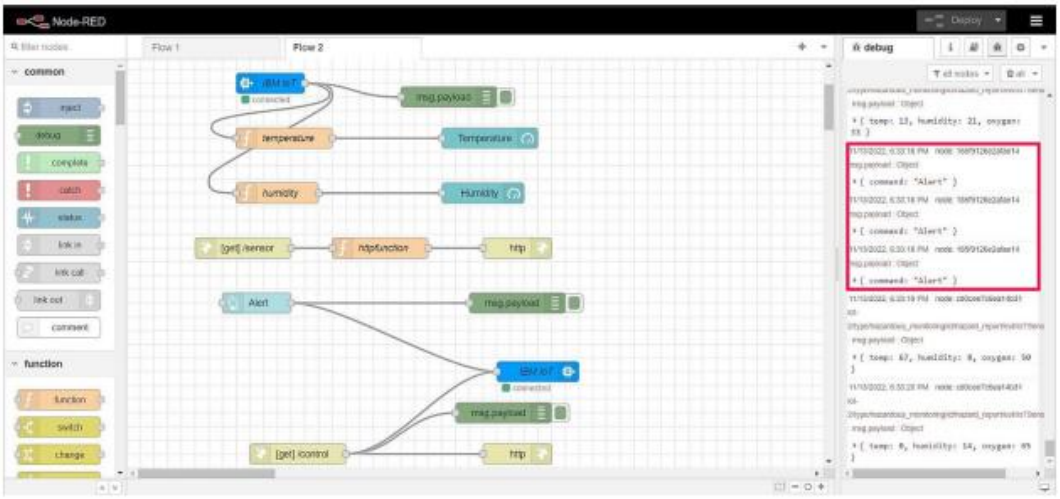

User Interface
Layout
Media
Drawing and Animation
Maps
Charts
Sensors
Social
Storage
Connectivity
ActivityStarter
BluetoothClient
BluetoothServer
Serial
Web
LEGO® MINDSTORMS®
Experimental
Extension
Phone size (505,320)
9:48
Monitoring
Temperature
Humidity
Alert
Non-visible components
Web1
Clock1
Web2
HorizontalArrangement1
Label1
TextBox1
HorizontalArrangement2
Label2
TextBox2
HorizontalArrangement3
Button1
Web1
Clock1
Web2
Rename
Delete
Media
Upload File ...
AllowCookies
ResponseFileName
SaveResponse
Timeout
0
Url

TESTING

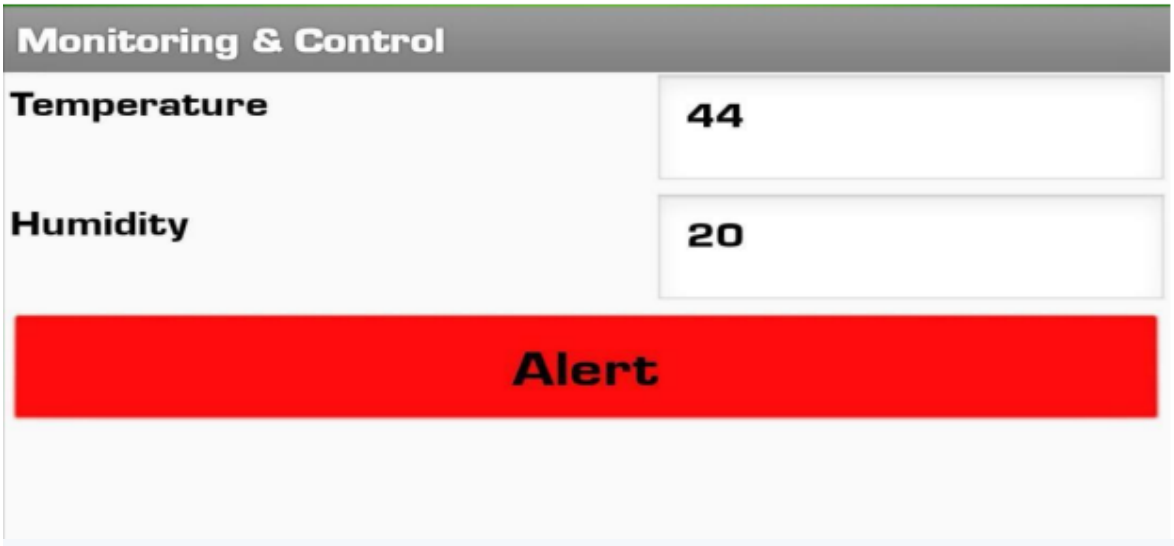
8.1 TEST CASE

8.2 USER ACCEPTANCE TEST

The purpose of the document is to briefly explain the test coverage and issues of the Hazardous Area Monitoring for Industrial Plant powered by IoT.at the time of the release to (UAT)


Node-RED
Deploy
Flow 1
Flow 2
debug
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
temperature
Temperature
humidity
Humidity
[get] /sensor
ndpfunction
http
Alert
msg.payload
[get] /control
http

RESULT



123456 Connected IOTdevice-1 Device 16 Nov 2022 20:10 alaguram806@gmail.com

Identity Device Information Recent Events State Logs

The recent events listed show the live stream of data that is coming and going from this device.

Event	Value	Format	Last Received
status	{"temperature":52,"humidity":21}	json	a few seconds ago
status	{"temperature":52,"humidity":22}	json	a few seconds ago
status	{"temperature":101,"humidity":4}	json	a few seconds ago

ADVANTAGES &DISADVANTAGES

ADVANTAGES

- This choice allows for low power consumption and a transmission range able to cover a standard plant area.
- In this way, it is possible to view and analyse the receive data.
- which can further exploited , with further processing.
- To generate safety commands in case of hazardous alarm information from the sensor node.

DISADVANTAGES

- Devices must be protected from physical tampering.
- Internet based software attacks ,network based attacks and hardware based attacks
- Data privacy is another concern, especially because IoT devicesare bring used in more sensitive industries, such as healthcare and finance.

CONCLUSION

The Internet of Things has a broad perspective in shaping tomorrow's world. Even though the IoT system has some demerits, its merits like saving consumer's time and money outstand its cons. It is predicted that soon IoT applications will be installed and used equally in both domestic and industrial areas. Companies are working hard to shoot back IoT disadvantages and making this futuristic technology more beneficial for the betterment of humanity.The number of industrial disasters due to accidents or mere negligence is steadily rising every year. The past has numerous accounts of industrial accidents that have caused the death of many human beings. This shows that one small human error could cause the lives of many innocent people and also cause distress in the lives of people who survive by causing them permanent disability. Thus, this project focuses mainly on eliminating the possibility of human errors in the industrial site which could reduce the probability of an accident. It focuses on monitoring the ideal temperature and humidity conditions in order to keep the equipment in its optimum condition for working. It constantly monitors the levels of ammonia and carbon monoxide emitted in order to keep the air pollution levels in check. Flammable gases such as hydrogen, propane, butane, and LPG are also checked which are the main causes of an explosion.

FUTURE SCOPE

- Laboratories contain many chemicals, in that many are retractable to high temperatures or heat. So, every lab must contain this detection of high level temperature so that vigorous reaction of chemicals with fire can be avoided.

- Refrigeration plants use CFC gases which highly react able with fire, so it is necessary to have this system in the plants.

- It is also used in various others industries like beverage manufacturing, biogas industry.

- A smart reconfigurable assembling asset is improved with internet intelligence, giving nearby control to the physical assembling asset, plug – and – play capacity, and high computational strength.

APPENDIX

SOURCE CODE

Python code for the Temperature Alert and Humidity check

```
import time import sys
import
ibmiotf.application
import ibmiotf.device
import random
# Initialize GPIO


#Provide your IBM Watson Device
Credentials organization = "0vbvyp"
deviceType =
"hazardous_monitoring" deviceId = "
123456" authMethod ="token"
authToken =
"CNCJXKF5f&WYESGhdt"


def myCommandCallback(cmd):
                                    print("Command
received: %s" % cmd.data['command'])
Status=cmd.data['command']   if Status=="Alert":
print("Alert")
 #print(cmd)


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.connec

t()while True:

    #Get Sensor Data from

DHT11temp

=random.randint(0,100) humid

=random.randint(0,100) oxygen

=random.randint(0,100)


    data = { 'temp' : temp, 'humidity': humid ,'oxygen': oxygen}

data1 = { 'High temperature' : temp>60}

    #print data

                        d

ef

myOnPublishCallbac

k():

        print ("Published Temperature = %s C" % temp, "humidity = %s %%" % humid,"alert",
"toIBM Watson")

     success = deviceCli.publishEvent("IoTSensor", "json", data,
qos=0,on_publish=myOnPublishCallback)


 if not success:

                        print("N

ot connected to IoTF")

time.sleep(1)
```

```
        deviceCli.commandCallback = myCommandCallback


    # Disconnect the device and application from the

    clouddeviceCli.disconnect()
```

GITHUB LINK

https://github.com/IBM-EPBL/IBM-Project-1515-1658393722