

PROJECT REPORT

PROJECT TITLE: *Industry Specific Intelligent Fire
Management System*

TEAM ID: PNT2022TMID35665.

TEAM MEMBERS: Jagadish K (TEAM LEAD)

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Abinash V

1.INTRODUCTION 1.1 PROJECT OVERVIEW

Fire, explosion and toxic release are the three major hazards in the process industry, while fire is the most common one. Increasing number of fire incidents coupled with loss of property has enhanced the demand for automatic intelligent fire alarm systems in residential and commercial buildings. An intelligent fire alarm system is specifically designed to provide advantages such as identification of the fire location, locate any fault in the alarm system wiring, and ensure easier maintenance. This system includes a Gas sensor, Flame sensor and temperature sensors to detect any changes in the environment. Based on the temperature readings and if any Gases are present the exhaust fans are powered ON. If any flame is detected the sprinklers will be switched on automatically. Emergency alerts are notified to the authorities and Fire station. Moreover, these modern intelligent fire alarm systems are more sensitive as compared to the classic models and are competent to detect false alarms.

1.2 PURPOSE

The primary purpose of fire alarm system is to provide an early warning of fire so that people can be evacuated & immediate action can be taken to stop or eliminate the fire effect as soon as possible.

2.LITERATURE SURVEY 2.1 EXISTING PROBLEM

Fire monitoring systems have usually been based on a single sensor such as smoke or flame. These single sensor systems have been unable to distinguish between true and false presence of fire . Consuming energy all day long and being dependent on one sensor that might end with false alert is not efficient and environmentally friendly. We need a system that is efficient not only in sensing fire accurately, but we also need a solution which is smart. In order to improve upon the results of existing single sensor systems , the smart fire management system includes a Gas sensor, Flame sensor and a temperature sensor . This system also requires a proper network with individual smart devices connected to various panels .

2.2 REFERENCES

- [1] S.Sri Vidhya , Suresh Samkaranarayan “IoT–Fog Enabled Framework for Forest Fire Management System” 2020 World Conference on Smart Trends in Systems, Security and Sustainability **DOI:** 10.1109/WorldS450073.2020.9210328
- [2] Noorinder; Jaspreet Singh; Ekambir Sidhu “Raspberry pi based smart fire management system employing sensor based automatic water sprinkler” 2017 International Conference on Power and Embedded Drive Control (ICPEDC) **DOI:** 10.1109/ICPEDC.2017.8081068
- [3] Rafat Shams,Shafkat Hossain,Shaoni Priyom,Nusrat Fatema “An automated fire fighting system” 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD) **DOI:** 10.1109/FSKD.2015.7382316

[4] Ebubekir Erdem,Sercan Vançin,Karwan Muheden “Design and implementation of the mobile fire alarm system using wireless sensor networks” 2016 IEEE 17th International Symposium on Computational Intelligence and Informatics (CINTI) **DOI:** 10.1109/CINTI.2016.7846411

[5] Francis F. Balahadia,Ace C. Lagman,Shirley D. Moraga “Development of Fire Report Management Portal with Mapping of Fire Hotspot, Data Mining, and Prescriptions of Fire Prevention Activities” 2019 International Symposium on Multimedia and Communication Technology (ISMAC) **DOI:** 10.1109/ISMAC.2019.8836151

[6] Md Saiam,Md. Sarower Jahan,Md. Shoab Akther “A Microcontroller-based Fire Protection System for the Safety of Industries in Bangladesh” 2021 International Conference on Information and Communication Technology for Sustainable Development **DOI:** 10.1109/ICICT4SD50815.2021.9396964

[7] B Prabha “An IoT Based Efficient Fire Supervision Monitoring and Alerting System” 2019 Third International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) **DOI:** 10.1109/I-SMAC47947.2019.9032530

[8] Asma Mahgoub ,Nourhan Tarrad ,Rana Elsherif ,Abdulla Al-Ali “IoT-Based Fire Alarm System” 2019 Third World Conference on Smart Trends in Systems Security and Sustainability (WorldS4) **DOI:** 10.1109/WorldS4.2019.8904001

2.3 PROBLEM STATEMENT

Definition Industry Specific Intelligent fire management system are designed to Prevent fire accidents due to Gas leakage and flame in industry.


3.IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS






3.2 Ideation & Brainstorming

Template




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.


 10 minutes to prepare
 1 hour to collaborate
 2-8 people recommended


[Share template feedback](#)





Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.


 10 minutes

**Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

**Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.


**Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

[Open article](#) →




Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

 5 minutes


PROBLEM


Fire accidents have become a major hazard to the industries and to many other domestic areas. The Fire should be extinguished as soon as it started





Key rules of brainstorming


To run an smooth and productive session


 Stay in topic.

 Encourage wild ideas.

 Defer judgment.

 Listen to others.

 Go for volume.

 If possible, be visual.



Need some inspiration?

See a finished version of this template to kickstart your work.

[Open example](#) →

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

Be creative and think outside the box. Your ideas don't need to be perfect.

Sakthi Desai

- App to monitor the industry or get notified as a fire starts
- Temperature sensor to identify the rapid increase in temperature
- Send alert messages to the authorized persons in case of fire
- Turn on water sprinkler as soon as fire is detected

Jagadish

- Flame sensor to instantly detect the fire
- IBM cloud services to make the system efficient
- SMS alert to the people for awareness of fire incident
- Automatically on the fans when gas is detected

Niranjana

- Gas sensor for detection of gas leakage
- Water level sensor on the sprinklers
- Set manual threshold values for each sensor
- User must be able to monitor the location remotely

Abinash

- Humidity sensor to check humidity
- Automatically detect defect in the sprinklers and report to authorized person
- Set manual threshold type for different region of industrial
- Usage of system and adjusting value according to the location of industry

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

20 minutes

Apps Related

- App to monitor all sensor values from any where in the world
- Set manual threshold values for each sensor
- Set manual threshold values for each sensor
- Send alert messages to the authorized persons in case of fire
- Users must be able to remotely turn off the system whenever needed

Fire and Industry Related

- Detection of fire using flame sensor
- Turn on sprinkler on detection of fire
- Detection of fire using flame sensor
- Monitoring of temperature rise in case of fire
- Alert - Monitoring of humidity according to the location

Set up and Expansion

- The first temperature sensor and be connected to the gateway through internet
- The set up working of the application must be adjusted to the location of the industry
- Send alert messages to the people for awareness of fire incident

Other Sensor

- Temperature sensor for detection of temperature rise
- Flame sensor based on IR light to detect the flame
- Gas sensor to detect the explosion gases
- Humidity sensor to adjust the value according to the location of the industry

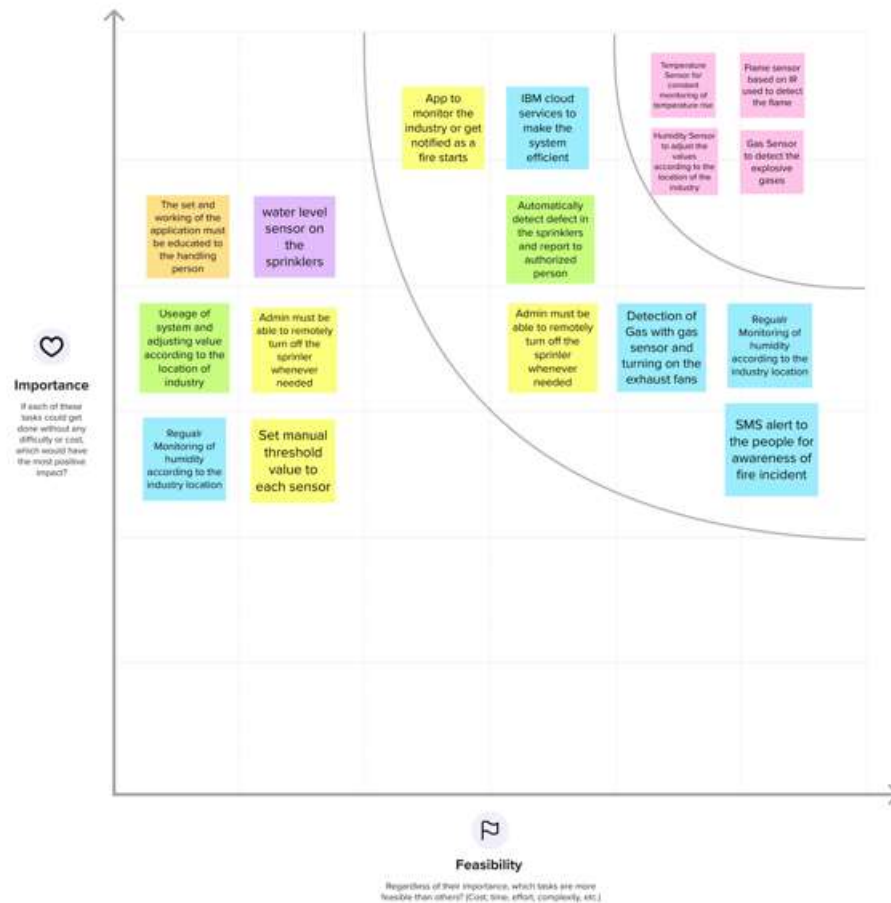


4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes



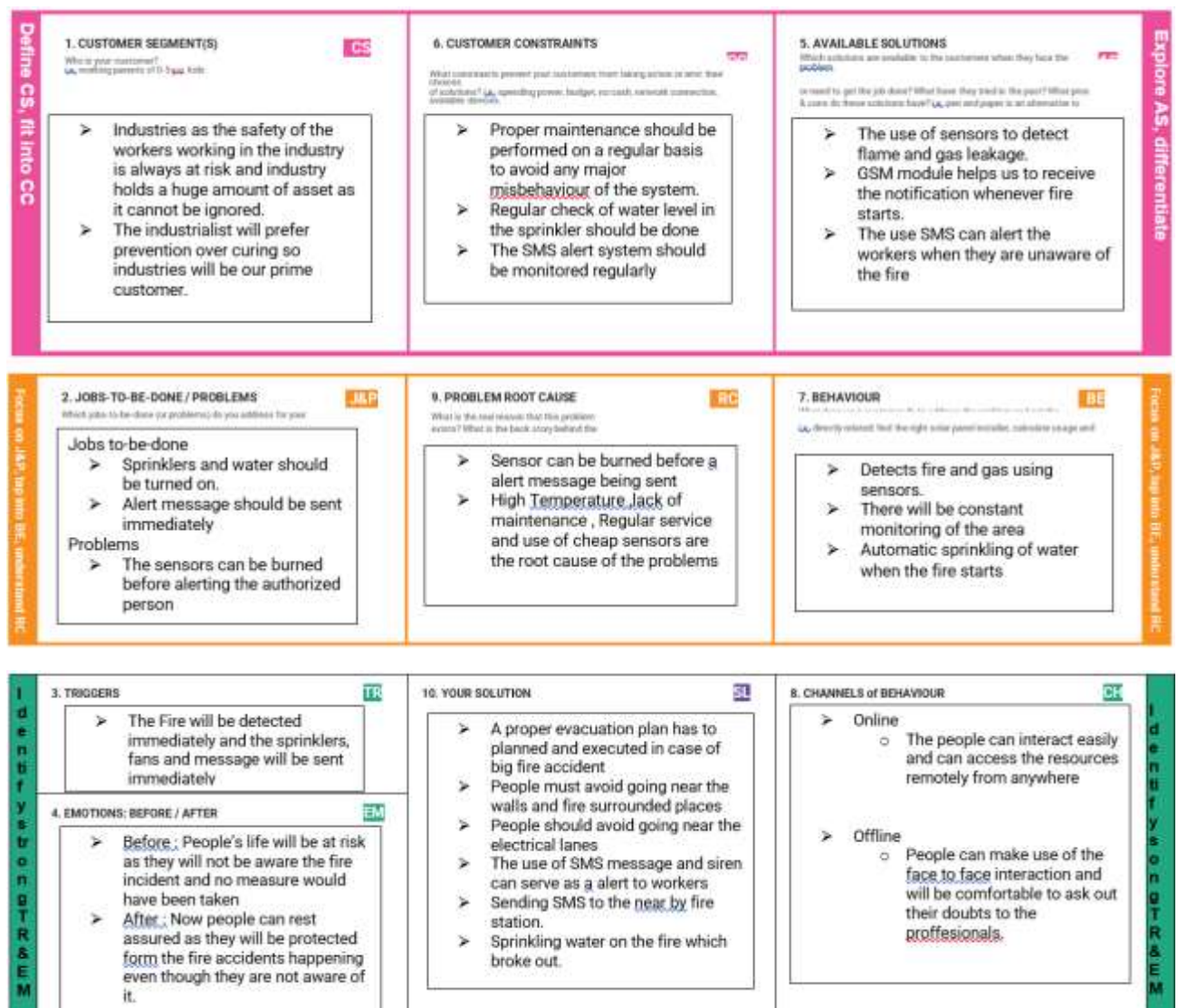
3.3 PROPOSED SOLUTION

| S.No. | Parameter | Description |
|-------|---|---|
| 1. | Problem Statement(Problem to be Solved) | <p>✂ The problem is to ensure the safety of the industries from fires accident before any serious accident happens. This Fire management system should ensure that the fire should be extinguished as well as the</p> |

| | | |
|----|---------------------------------------|--|
| | | authorized person is alerted about the fire incident. |
| 2. | Idea / Solution description | <ul style="list-style-type: none"> ✕ The main idea of this Fire management system is to make sure no fire is spread and to prevent any major fire accidents. This is done by employing a number of sensors as Flame sensor, Temperature sensor, Humidity Sensor and Gas sensor. The readings from these sensors are fed to a Node MCU which in turn will turn on the sprinkler and fans which control the fire. |
| 3. | Novelty / Uniqueness | <ul style="list-style-type: none"> ✕ This Fire management system is a integrated system of sensors and MCU. This has the unique feature of alerting the authorized Person through SMS or mail. The fire is also control through water sprinklers and exhaust fans ✕ Through the IBM cloud our management system not only notifies the industry person but also nearby fire stations. ✕ Low latencies which makes sure that the authorized persons are notified immediately which make the system more efficient. ✕ If a gas leak occurs within the industry or in a residential area, the fans are turned on to expel the gas. |
| 4. | Social Impact / Customer Satisfaction | <ul style="list-style-type: none"> ✕ Prevention is better than curing in that way our Fire management system prevents any major fire accidents. Which in turn would make sure that every person in the building is safe ✕ This Fire Management System will be extremely beneficial to the worker and the communities that are associated with the near industries. ✕ This solution will help many people's life and save a lot of assets from being engulfed in fire. ✕ This makes sure all the workers and employers can rest assured knowing no fire accidents can occur in the industries being the industry is monitored 24/7 by our Fire management system. |

| | | |
|----|--------------------------------|---|
| 5. | Business Model (Revenue Model) | <ul style="list-style-type: none"> ✧ Being deployed in the industries which are the major fire prone zones. The industry ownerships can be assured the safety and can be assured that they can minimize the loss in case of accident will make a way for our Fire Management system. ✧ The Agenda of this Fire management system will be to save people from big fire accidents. Since people are concerned about their life and assets deploying a Fire management system in industry will be a beneficial Business model. |
| 6. | Scalability of the solution | <ul style="list-style-type: none"> ✧ Since the primary concern of the model is reduction of loss and safety of people the scalability of the model is not limited. ✧ Every industry will prefers to have a Fire management system than to face the loss. ✧ So the scalability of the model is huge where it serves a demanding role in each industry. |

3.4 PROBLEM SOLUTION FIT



4.REQUIREMENT ANALYSIS 4.1FUNCTIONAL REQUIREMENT

Following are the functional requirements of the proposed solution.

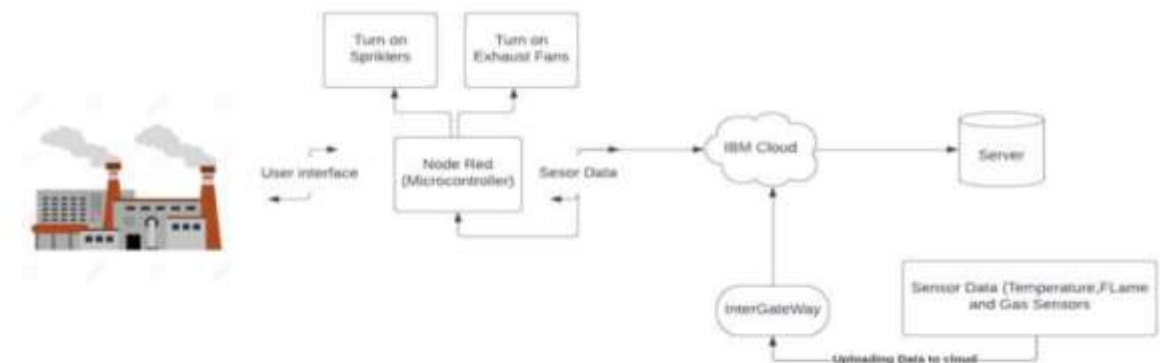
| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|--------|-------------------------------|--|
| FR-1 | User Registration | Registration through website or application Registration through Social medias Registration through LinkedIn |
| FR-2 | User Confirmation | Verification via Email or OTP |
| FR-3 | User Login | Login through website or App using the respective username and password |
| FR-4 | User Access | Access the app requirements |

| | | |
|------|----------------|--|
| FR-5 | User Upload | User should be able to upload the data |
| FR-6 | User Solution | Data report should be generated and delivered to user for every 24 hours |
| FR-7 | User Data Sync | API interface to increase to invoice system |

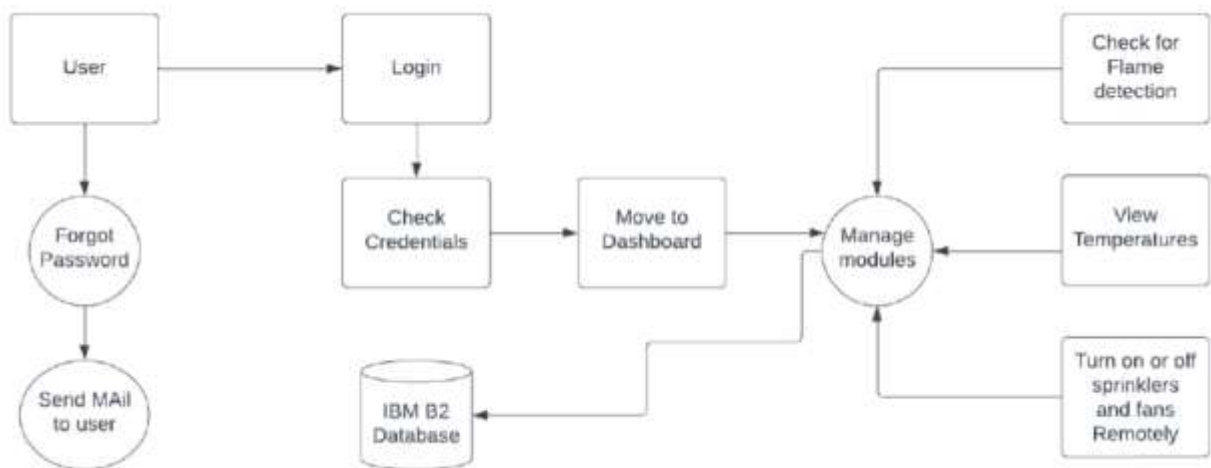
4.2 NON-FUNCTIONAL REQUIREMENT

| FR No. | Non-Functional Requirement | Description |
|---------------|-----------------------------------|---|
| NFR-1 | Usability | Usability requirements includes language barriers and localization tasks. Usability can be assessed by Efficiency of use. |
| NFR-2 | Security | Access permissions for the particular system information may only be changed by the system's data administrator. |
| NFR-3 | Reliability | The database update process must roll back all related updates when any update fails. |
| NFR-4 | Performance | The front-page load time must be no more than 2 seconds for users that access the website using an VoLTE mobile connection. |
| NFR-5 | Availability | New module deployment must not impact front page, product pages, and check out pages availability and mustn't take longer than one hour. |
| NFR-6 | Scalability | We can increase scalability by adding memory, servers, or disk space. On the other hand, we can compress data, use optimizing algorithms. |

5.PROJECT DESIGN 5.1 DATA FLOW DIAGRAM



5.2 SOLUTION ARCHITECTURE



5.3 USER STORIES

| User Type | Functional requirement | User story number | User story/task | Acceptance criteria | Priority | Release |
|---|------------------------|-------------------|--|------------------------------------|----------|----------|
| Customer (Mobile user, Web user, Care executive, Administrator) | Registration | USN-1 | As a user, I can register for the application by entering my mail, password, and | I can access my account/ dashboard | High | Sprint-1 |

| | | | | | | |
|--|-----------|-------|---|--|------|----------|
| | | | confirming my password | | | |
| | | USN-2 | As a user, I will receive confirmation email once I have registered for the application | I can receive confirmation email & click confirm | High | Sprint-1 |
| | Dashboard | USN-3 | As a user, I can register for the | I can register & access the dashboard | Low | Sprint-2 |

| | | | | | | |
|--|-----------|-------|--|---|--------|----------|
| | | | application through internet | with Internet login | | |
| | | USN-4 | As a user, I can register for the application through Gmail | I can confirm the registration in Gmail | Medium | Sprint-1 |
| | Logi n | USN-5 | As a user, I can log into the application by entering email & password | I can login with my id and password | High | Sprint-1 |

6.PROJECT PLANNING &SCHEDULING

6.1 Sprint Planning & Estimation

| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---------|---|-------------------|---|--------------|----------|---|
| Sprint1 | Sensing | USN-1 | Sensing the environment using the sensors. | 3 | High | Pelluru Manasa Polu Tejaswini M Deepika RC Chandhana |
| | Operating | USN-2 | Turning on the exhaust fan as well as the fire sprinkler system in cause of fire and gas leakage. | 3 | Medium | Pelluru Manasa Polu Tejaswini M Deepika RC Chandhana |
| Sprint2 | Sending collected data to the IBM Watson platform | USN-3 | Sending the data of the Sensors to the IBM Watson. | 3 | High | Pelluru Manasa Polu Tejaswini M Deepika RC Chandhana |

.CODING & SOLUTIONING

.1 Feature 1

IoT device

IBM Watson Platform

Node red

Cloudant DB

Web UI

MIT App Inventor

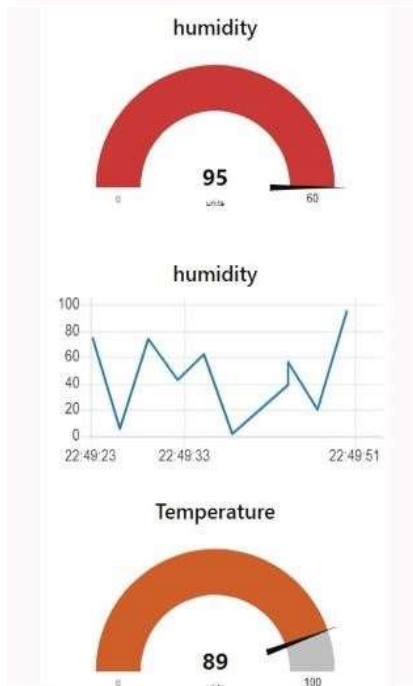
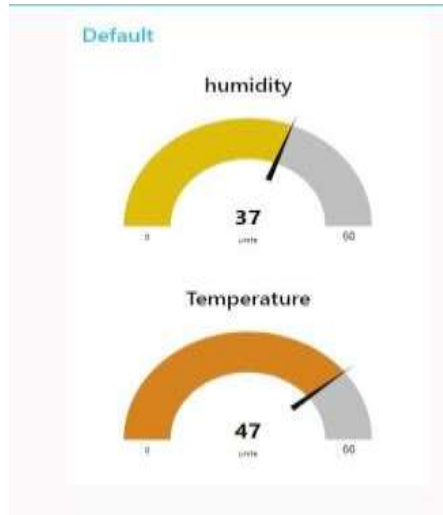
Python code

7.2 FEATURE 2

LOGIN

Wokwi

8.TESTING AND RESULTS 8.1 TEST CASES



9.ADVANTAGES

Reduced installation cost.

They monitor 24/7.

Improved security in homes, industries and Offices.

It pin points location of the fire.

10.DISADVANTAGES

Heat detectors are not considered as life saving devices because they are sensitive only to heat.

High battery or current consumption will need for these detectors.

Control pannel may need to be replaced if it becomes damaged.

11.CONCLUSION

This gas leakage system can be applied for household safety and many other applications in the industry . Gas leakages and fire outbreaks in industries as well as houses have lead to wide destruction and losses in the past. Gas leakages and fire outbreaks both spread widely and lead to even greater loss of life and property if proper action is not taken on time. So here we proposed a system that detects gas as well as fire outbreaks and alert us accordingly so that proper action may be taken to control it.

12.FUTURE SCOPE

Smoke detectors and alarms are migrating from just the detection of smoke, to combination detectors and multicriteria detector. The future will be with multicriteria detection in which the detector will be more of a sensor,with the detection more for the products of combustion, such as carbon monoxide, carbon dioxide ,sulfur dioxide ,nitrogen dioxide in addition to heat and particulate matter. Within the next decade, video image detection (VID) will become more mainstream in which, through analytics, the image of either smoke or flame will be able to be isolated and detected from within a room or space. The VID system would also be able to detect if an individual is within the space and through the integration with the notification appliances, provide a path of exit.

13.APPENDIX

13.1 Source Code:

```

import pandas as pd
import ipywidgets as widgets
import plotly.express as px

while True:
    try:
        amb_temp = float(input('Enter ambient room temperature (°C): '))
        rad_distance = float(input('Enter the horizontal distance between the fire and sprinkler head (m): '))
        height_above_fire = float(input('Enter the vertical distance between the fire and sprinkler head (m): '))
        RTI = float(input('Enter RTI value of the sprinkler head: '))
        c = float(input('Enter conduction value of the sprinkler head: '))
        activation = float(input('Enter sprinkler activation temperature (°C): '))
        break
    except ValueError as e:
        print('Error: Enter a valid number')

t_sq_list = ["slow", "medium", "fast", "ultra-fast"]
t_sq = None
while t_sq not in t_sq_list:
    t_sq = input('Enter fire t² growth rate. Select from the list [slow, medium, fast, ultra-fast]: ').lower().strip()
    if t_sq == 'slow':
        growth = 0.00293
    elif t_sq == 'medium':
        growth = 0.01172
    elif t_sq == 'fast':
        growth = 0.0469
    else:
        growth = 0.1876

index = pd.RangeIndex(0, 1308, 1) # a slow t² fire will take 1307 seconds

```

```

to reach 5 MW
columns = ['Time', 'HRR', 'Gas Temp 1', 'Gas Temp 2', 'Gas Vel 1', 'Gas Vel 2',
'Gas Temp', 'Temp Sprinkler']
df = pd.DataFrame(index=index,
columns=columns) df = df.fillna(0) # with 0s
rather than NaNs

df['Time'] = df.index
df['HRR'] = df['Time']*df['Time']*growth
if rad_distance/height_above_fire >
0.18:
    df['Gas Temp 1'] =
(5.38*(df['HRR']/rad_distance)**(2/3))/(height_above_fire)
df['Gas Temp'] = df['Gas Temp 1'] + amb_temp      a = 'one'
else:
    df['Gas Temp 2'] = (16.9*(df['HRR'])**(1/3))/height_above_fire**(5/3)
df['Gas Temp'] = df['Gas Temp 2'] + amb_temp      a = 'two'
if rad_distance/height_above_fire >
0.15:
    df['Gas Vel 1'] =
(0.2*df['HRR']**(1/3)*height_above_fire**(1/2))/(rad_distance**(5/6))
b = 'one' else:
    df['Gas Vel 2'] = 0.95*((df['HRR']/height_above_fire)**(1/3))
b= 'two'
x =
2

# initialise row 0
df.loc[0, 'Temp Sprinkler'] = amb_temp if
(a == 'one') & (b == 'one'):
    # initialise row 1
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
1']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
1']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
    # initialise remaining rows
while x < 1308:
    df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-
amb_temp)((1+(c/df.loc[x-1, 'Gas Vel 1']**0.5)))*(df.loc[x-1, 'Temp
Sprinkler']amb_temp))      x = x+1 elif (a == 'one') & (b == 'two'):
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
2']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
2']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
while x < 1308:
    df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-
amb_temp)((1+(c/df.loc[x-1, 'Gas Vel 2']**0.5)))*(df.loc[x-1, 'Temp
Sprinkler']amb_temp))      x = x+1 elif (a == 'two') & (b == 'one'):
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
1']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
1']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
while x < 1308:
    df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] + ((df.loc[x-
1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-amb_temp)-

```

```

((1+(c/df.loc[x-1, 'Gas Vel 1']**0.5)))*(df.loc[x-1, 'Temp
Sprinkler']amb_temp))      x = x+1 else:
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1, 'Gas Vel
2']**0.5)/RTI)*((df.loc[1, 'Gas Temp']-amb_temp)-((1+(c/df.loc[1, 'Gas Vel
2']**0.5)))*(df.loc[0, 'Temp Sprinkler']-amb_temp))
while x < 1308:
    df.loc[x, 'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-
amb_temp)((1+(c/df.loc[x-1, 'Gas Vel 2']**0.5)))*(df.loc[x-1, 'Temp
Sprinkler']amb_temp))      x = x+1      try:
    act_time = df.loc[df['Temp Sprinkler']>activation, 'Time'].iloc[0]
except:
    print('The sprinkler does not activate')

try:
    act_hrr = round(df.loc[df['Temp Sprinkler'] > activation,
'HRR'].iloc[0],1)
except:
    print('The sprinkler does not activate')

act_time_text = 'Sprinkler activates at ' + str(act_time) + ' s.' + '\n' + '
Fire size: ' + str(act_hrr) + ' kW'
act_temp_text = 'Activation temperature: ' + str(activation) + ' °C'

fig = px.line(df, x="Time", y="Temp Sprinkler", title="Sprinkler Activation
Time (" + t_sq + ' t² fire)', template = 'none')

fig.update_layout(
    autosize=False,
    width=600,
    height=500,
    yaxis=dict(
        title_text="Temperature (°C)",
        titlefont=dict(size=12),
    ),
    xaxis=dict(
        title_text="Time (s)",
        titlefont=dict(size=12),
    )
)

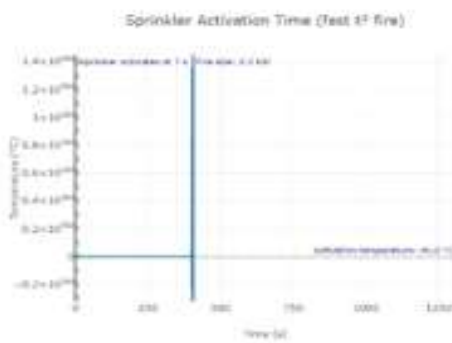
fig.update_layout(
    title={
        'y':0.9,
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'})

fig.update_layout(
    xaxis = dict(
        tickmode =
'linear',          tick0 =
0,          dtick = 250
    )
)

```



OUTPUT:

[illegible]

GitHub Link :- <https://github.com/IBM-EPBL/IBM-Project-5288-1658755720>