INDUSTRY-SPECIFIC INTELLIGENT FIRE MANAGEMENT SYSTEM.

(INTERNET of THINGS)

In fulfillment of project in IBM-NALAYATHIRAN 2022

SUBMITTED BY

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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]   N N Mahzan, N I M Enzai, N M Zin and K S S K M Noh," Design of an Arduino-based home fire alarm system with gSM module", 1st International conference on green and Sustainable computing (ICoGeS), 2017.

[2]   ZHANG Ying-Cong, YU Jing, "Study on the Fire IOT Development
Strategy", Shenyang Fire Research Institute --Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling, US: ANSI/FMRC, pp. FM32602004.

[3]   Public Security, Shenyang 110034, China Shenyang Institute of Engineering, Shenyang 110136, China, 2019. Liu Yunhong Qi Meini,"The Design of Building Fire Monitoring System Based on ZigBee-WiFi Networks", Eighth International
Conference on Measuring Technology and Mechatronics Automation, IEEE, 2016, pp-733-735

[4]   R.A. Sowah, A.R. Ofoli, S.N. Krakani, S.Y. Fiawoo, hardware Design and Web-Based Communication Modules of a Real-Time multisensor Fire Detection and Notification System Using Fuzzy Logic, IEEE Transactions on Industry Applications, 53 (2016) 559-566.

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

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

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.
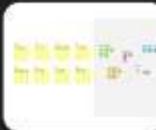
⏱ 8 minutes

Key rules of brainstorming
To run an smooth and productive session

- Stay in topic
- Defer judgment
- Go for volume
- Encourage wild ideas
- Listen to others
- If possible, be visual

Need some inspiration?

Open session →

2

Brainstorm

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

⏱ 10 minutes

JanEnJ	Lotha B	Dhanalakshmi M	Amani B	Poornima K

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 and break it up into smaller sub-groups.

⏱ 20 minutes

The reporting should be made on time

The fire should be sensed on time

The fire control should be proper at all the time

The IOT components should accomodate the step by step process without any kind of delay

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

Importance

The flame sensor, smoke sensor should operate

Modern technology along with Artificial Intelligence should be accessed

The reporting alarm should be done at proper time

The access should be easy

Feasibility

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template →

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To develop a safety management system for industries for protecting against the fire incidents in industries.
2.	Idea / Solution description	To implement the fire safety system in industries based on IOT using Arduino uno with fire detection and fire extinguisher system using sensors like gas sensor, Flame sensor, temperature sensor .
3.	Novelty / Uniqueness	The integrated system detects fire and gas in the atmosphere and extinguish it automatically. It also send alert via sms when gas and fire are detected.
4.	Social Impact / Customer Satisfaction	The system detects and senses the fire using sensors that we use and it helps the customers to access with the immediate notification and the timely access and helps in early prevention of fire accidents in industries.
5.	Business Model (Revenue Model)	This model is used to calculate the probability of the ignition and spread across a landscape of industries and help in rescuing people and machine from the fire accident.
6.	Scalability of the Solution	This is completely modular system makes it easily expandable and business efficient for the customized fire detection, with the significant cost , Easy operatability and management.

3.4 Problem Solution Fit

1. CUSTOMER SEGMENT(S) CS
- Oil, Gas, Polymer Industries
- Hospitals
- Safety Control Personals
- Mining

6. CUSTOMER CONSTRAINTS CC
- Network Connection
- Complexity in Installation
- High budget in installing other products make them to move far from modern technologies

5. AVAILABLE SOLUTIONS AS
- Upgrading to a premium networkplan.
- Availing network connection from a reliable Service provider.

2. JOBS-TO-BE-DONE / PROBLEMS
- Suffering from many losses due to gas leakage.
- Having no proper system for controlling or monitoring the leakage.
- Facing heavy budget problems in buying and installing a system for monitoring and controlling

9. PROBLEM ROOT CAUSE
- Quality of the material using which the device is made up of plays a vital role in the capability of the device to work in harsh environment.
- Location of the device installation and the network plan used by the user are the cause of Network issue.

7. BEHAVIOUR
- Harsh environment is prevailing only on certain industry; thus, the frequency of the said problem is low. In such a case the customer complaints multiple times to get the attention.
- Network issue is very common as most of the industries are located at the country side. Here the contact both the developers and the service providers

4.REQUIREMENT ANALYSIS

4.1Functional requirement

Functional Requirements:

Following are the functional requirements of the proposed solution.

| FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	• Registration through Form • Registration through Gmail • Registration through LinkedIn
FR-2	User Confirmation	• Confirmation via Email • Confirmation via OTP
FR-3	User Login with respective ID	• Login through website • 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 • Delivered to user for every 24 hours
FR-7	User Data Sync	• API interface to increase to invoice system
FR-8	User Guide	• Guides the basic steps of using the application

4.2 Non-Functional requirement

Non-functional Requirements:
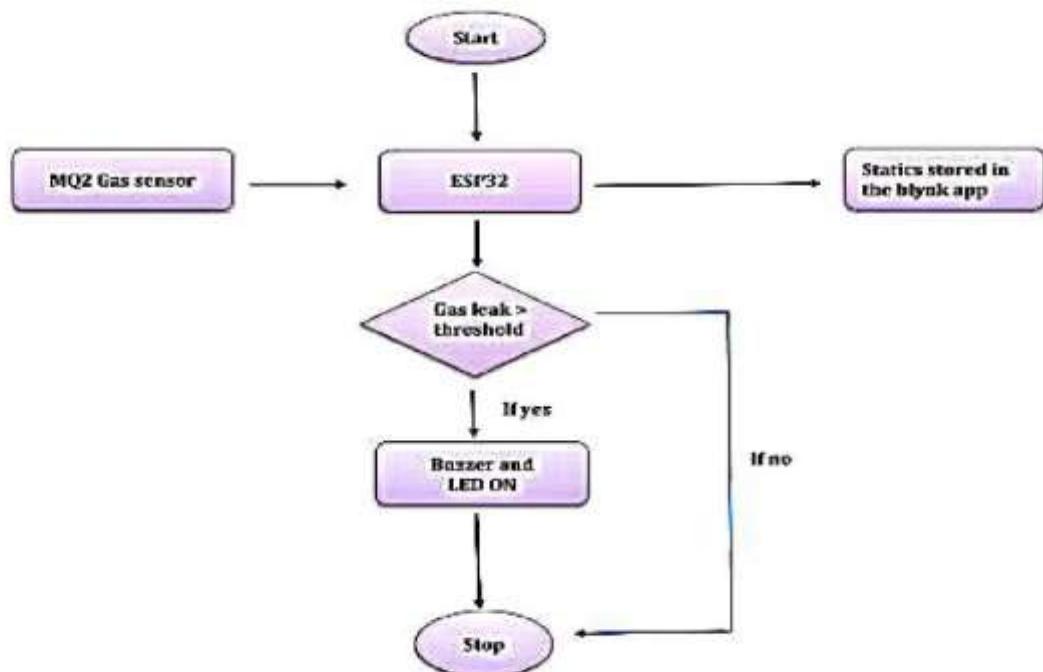
Following are the non-functional requirements of the proposed solution.

| FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	• Low perceived workload. • Easy and simple UI. • Usability requirements can consider language barriers and localization tasks. • Usability can be assessed from the below functions. • Efficiency of use.
NFR-2	**Security**	• Access permissions for the 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**	• The rest of the pages that may experience problems must display a notification with a timer showing when the system is going to be up again. • New module deployment mustn't 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. • The website attendance limit must be scalable enough to support 500,000 users at a time.
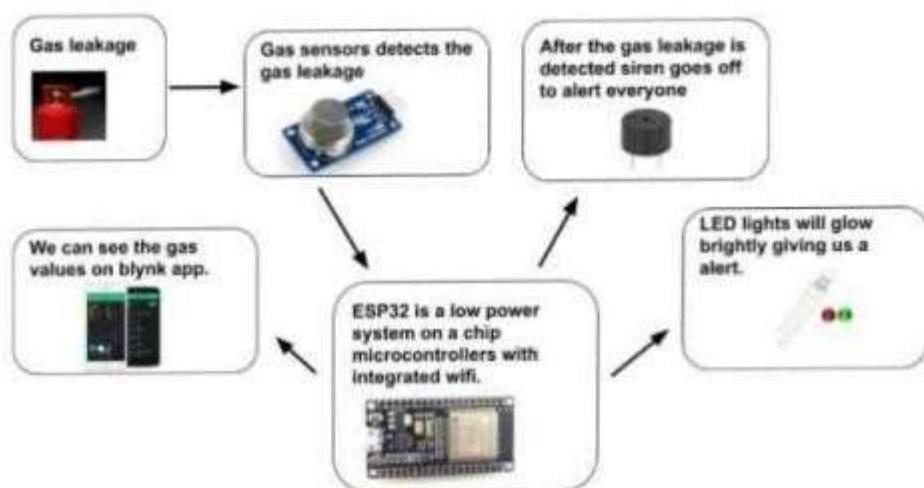
5.PROJECT DESIGN

5.1 Data Flow Diagram

Data Flow Diagram:

5.2 Solution Architecture

5.3 User Stories

User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
• Customer (Mobile user, Web user) • Customer Care Executive Administrator	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		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
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1

6.PROJECT PLANNING &SCHEDULING

6.1 Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story /Task	Story Points	Priority
Sprint-1	Simulation creation	USN-1	Connect Sensors and Arduino with python code	2	High
Sprint-2	Software	USN-2	Creating device in the IBM Watson IoT platform, workflow for IoT scenarios using Node-Red	2	High
Sprint-3	Dashboard	USN-3	Design the Modules and test the app	2	High
Sprint-4	Web UI	USN-4	To make the user to interact with software.	2	High

7.CODING & SOLUTIONING

7.1 Feature 1

- IoT device
- IBM Watson Platform
- Node red
- Cloud and DB
- Web UI
- MIT App Inventor

- Python code

7.2 Feature 2

- Login
- Wokwi

8.TESTING AND RESULTS

8.1 Test Cases
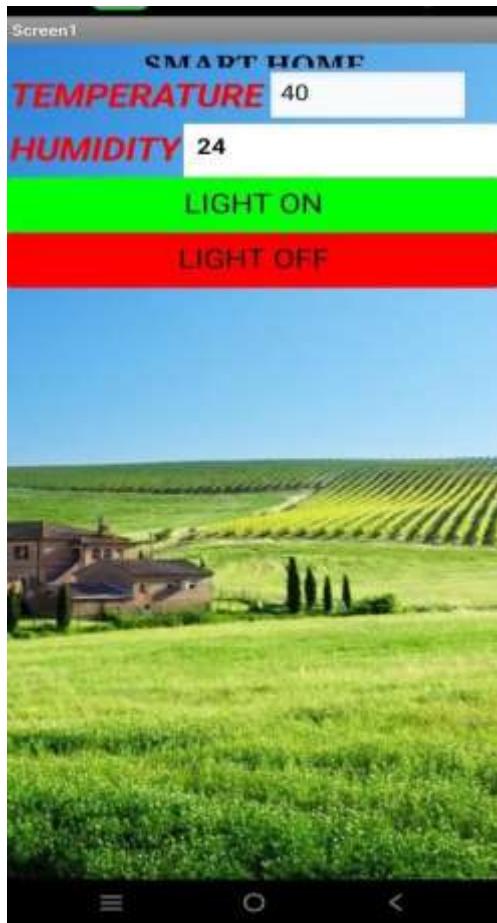
TEST CASE 1

TEST CASE 2

TEST CASE 3

9.ADVANTAGES

- Reduced installation cost.
- They monitor 24/7.
- Improved security in homes, industries and Offices.
- It points out the location of 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 panel 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 led 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, sulphur 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

```
#include <WiFi.h>//library for wifi

#include <PubSubClient.h>//library for MQtt

#include "DHT.h"// Library for dht11

#define DHTPIN 15    // what pin we're connected to

#define DHTTYPE DHT22   // define type of sensor DHT 11

#define LED 2


DHT dht (DHTPIN, DHTTYPE);// creating the instance by passing pin and typr of dht connected


void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);
```

```
//-------credentials of IBM Accounts------


#define ORG "i3869j"//IBM ORGANITION ID

#define DEVICE_TYPE "abcd"//Device type mentioned in ibm watson IOT
Platform

#define DEVICE_ID "1234"//Device ID mentioned in ibm watson IOT Platform

#define TOKEN "12345678"     //Token

String data3; float h, t;



//-------- Customise the above values --------

char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server
Name  char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type
of event

perform and format in which data to be send char subscribetopic[] =
"iot2/cmd/command/fmt/String";// cmd  REPRESENT command type AND
COMMAND IS TEST OF FORMAT STRING

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 predefined
client id by passing parameter like server id,portand wificredential



void setup()// configureing the ESP32

{
```

```cpp
  Serial.begin(115200);   dht.begin();
  pinMode(LED,OUTPUT);
  delay(10);   Serial.println();
wificonnect();
mqttconnect();
}


void loop()// Recursive Function
{

  h = dht.readHumidity();   t =
dht.readTemperature();
  Serial.print("temp:");
  Serial.println(t);
  Serial.print("Humid:");
  Serial.println(h);

  PublishData(t, h);
delay(1000);   if (!client.loop())
{
```

```
  }
   mqttconnect();


}



/................................retrieving to Cloud............................/


void PublishData(float temp, float humid) {
mqttconnect();//function call for connecting to ibm
  /*    creating the String in in form JSon to update the data to ibm cloud
  */
  String payload = "{\"temp\":";
payload += temp;   payload += ","
"\"Humid\":";   payload +=
humid;   payload += "}";



  Serial.print("Sending payload: ");
  Serial.println(payload);



  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish ok");// if it sucessfully upload data on the cloud then it
will print publish ok in Serial monitor or else it will print publish failed   } else
{
```

```
  }
    Serial.println("Publish failed");



}



void mqttconnect() {   if (!client.connected())
{
    Serial.print("Reconnecting client to ");
Serial.println(server);     while (!!!client.connect(clientId,
authMethod, token)) {      Serial.print(".");
delay(500);
    }
    initManagedDevice();
    Serial.println();
  } }
void wificonnect() //function defination for wificonnect
{
  Serial.println();
  Serial.print("Connecting to ");

  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish
the connection   while (WiFi.status() != WL_CONNECTED) {     delay(500);

    Serial.print(".");

  Serial.println("");
```

```cpp
  }
  Serial.println("WiFi connected");

  Serial.println("IP address: ");

  Serial.println(WiFi.localIP());

}


void initManagedDevice() {   if
(client.subscribe(subscribetopic)) {     Serial.println((subscribetopic));

    Serial.println("subscribe to cmd OK");

  } else {

    Serial.println("subscribe to cmd FAILED");

  }

}


void callback(char* subscribetopic, byte* payload, unsigned int payloadLength)
{


  Serial.print("callback invoked for topic: ");
Serial.println(subscribetopic);   for (int i =
0; i < payloadLength; i++) {
//Serial.print((char)payload[i]);     data3 +=
(char)payload[i];

  }
  Serial.println("data: "+ data3);
```

```
if(data3=="lighton")

 {

Serial.println(data3); digitalWrite(LED,HIGH);

 }   else

 {

Serial.println(data3); digitalWrite(LED,LOW);

 } data3="";

}
```

13.2 GitHub GitHub Link:

  https://github.com/IBM-EPBL/IBM-Project-52284-1660994263

 Demo Video Link:

https://drive.google.com/file/d/1-
BFJ49BkW_noYfb1RJTeP_sLzIUy8IXB/view?usp=drivesdk