PROJECT REPORT

Team ID	PNT2022TMID18996
Project Name	Industry Specific Intelligence Fire Management System

FACULTY MENTOR:

SURIYAKRISHNAAN K

TEAM MEMBERS:

NEWTON PRABU P

NIVEDHA S

KARTHIKEYAN M

BANUSHREE S

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1. INTRODUCTION

1.1 Project Overview

Fire and smoke kill more people every year than many other forces. While controlled fire serves us in so many instances, uncontrolled fire can be of harm, however, the rapid detection of fire and its control can save lives and property damage worth millions. Conventional and addressable are two main types of fire alarm systems, but unfortunately, these fire alarm systems often generate false alarms. The ratio of false alarm is higher in conventional alarm systems compared to addressable, but addressable alarm fire systems are more expensive.

The smart fire management system includes a gas, flame, and temperature sensor to detect any environmental changes. The exhaust fans are turned on based on the temperature readings and the presence of any gases. If a flame is detected, the sprinklers will automatically activate. Emergency alerts are sent to the authorities and the Fire Station.

1.2 Purpose

- ➤ To provide a detect the status of the room using IoT devices
- ➤ To turn on sprinkler and exhaust fan when there is an accident
- ➤ To detect the flow of water
- ➤ To send and store the temperature status in a cloud storage
- ➤ To provide an easy management system on dashboard
- ➤ To provide an overview of what is happening to the user

2. LITERATURE SURVEY

2.1 Existing problem

The situation is not ideal because fire management systems in homes and industries are not very reliable, efficient, or cost-effective, and lack advanced processing and features such as an automatic alert system for administrators and authorities. They are using older fire safety systems that cannot even activate the sprinkler system and do not communicate with one another properly to prevent false alarms. They also monitor the entire system using applications.

2.2 References

1)Title: Urban Fire Risk Evaluation Based on 2-tuple AHP—Taking the 8th Division with Shihezi City for Example

Author: Caihong Yin; Kaixuan Qi; Kunze Li; Qiangling Duan; Lijing Gao; Jinhua Sun

Published in : 2019

Abstract:
The evaluation of urban fire risk was an important gist of scientific and effective urban firefighting management, planned and constructed. This study, took the 8th division with Shihezi city (Shi-City) as an example, an evaluation index system of urban fire risk was first built through

analyzing the influential factors of fire risk in urban areas, which contained four first-class indexes and twenty-two second-class indexes. Then, to overcome the weaknesses of the analytic hierarchy process (AHP), 2-tuple fuzzy linguistic representation model was incorporated into AHP to calculate the weights of indexes. After that, an urban fire risk evaluation model was proposed. Finally, the developed model was applied into the fire risk evaluation of Shi-City and the fire risk rating of Shi-City was derived as slightly higher than medium, which offered significant guidance for fire control and safety management.

2)Title: Application of PHM Technology in the Design of Tank Fire Control System

Author: Jing Xu;Yang Lei; Bin Liu; Chao Ji; Lijun Nan

Published in : 2018

Abstract:
Combined with the process of Prognostics Health Management (PHM), the technology and application of armored vehicle fire control system PHM were discussed. The architecture of the health management system for tank fire control system was researched. According to the information characteristics of tank fire control system, the dual redundant bus transmission technology of FLEXRAY and CAN was applied, and the corresponding software and hardware systems were designed. Through the vehicle test, it was proved that the health management system will be effective for locating the fault, comparing the aim and assisting the soldier training. The data and video collected by this system were convenient for both maintenance and further study as the basic data.

3)Title: Fire Safety Management in Transportation of Municipal Wastes with the Use of Geographic Information System

Author: O.P. Savoshinsky; A.A. Zakharova; A.V. Pak

Published in : 2018

Abstract:
Fire safety management is one of the main tasks in the field of waste safety. The transportation of municipal waste was a complex management task that requires a highly skilled decision maker. The current management technique is based on the approach to the construction of systems based on the analysis, by assessing the set of initial factors, which does not allow to achieve the management goal. The proposed approach based on synthesis was devoid of this drawback. The application of the system was shown by the example of the use of geoinformation systems to the problem of fire safety in the transportation of municipal waste.

4)Title: Fire incidents Management System in the city of Manila through Geo-Mapping

Author: Maricor Y. Ingal; Ralph Louisse T. Tolentino; Mico J. Valencia; Francis F. Balahadia; Arlene R. Caballero

Published in : 2016

Abstract:
Fires had become a concern in recent years in the city of Manila, posing a threat to the entire community. Manila Fire District was facing problems in their internal transactions between different sub-stations. The study served as an automated fire incidents management system that can provide a chart and a summary based on the input data of each sub-station and can provide a map of all the fire incidents through geo-mapping in districts of Manila. This study, Manila Fire District implemented appropriate programs and lead awareness campaign to the community to help lessen fire incidents and mitigated its damages.

5)Title: Fire Safety Management Information System Design for Key Social Organizations

Author: Xu Fang; Zhang Di; Wang Jun

Published in : 2014

Abstract:
Aimed at the actual fire safety management needs of key social organizations and units, this paper introduced the design and implementation of the fire safety management information systems of the networked key organizations and units, provide information sharing and services on fire-fighting facilities' operating conditions, fire alarm information, and fire management information to the networked users, fire maintenance enterprises, and the fire supervision and administrative authorities so as to improve the fire safety management efficiency for these organizations and units, offered a scientific tool to the organizations to improve their fire safety management level, extended the functions of fire remote monitoring control system, and promoted fire prevention and controlled capability of the whole community.

6)Title: Discussion of Society Fire-Fighting Safety Management Internet of Things Technology System

Author: Wang Jun; Zhang Di; Liu Meng; Xu Fang; Sui Hu-Lin; Yang Shu-Feng

Published in : 2014

Abstract:

IOT is regarded as another information industry wave following computer, Internet and mobile communication network, and had become one of strategic dominant positions of new economic and technological development all over the world. The society fire-fighting safety management was an important application field of Internet of Things (IOT) technology. This paper combines application features of IOT technology according to firefighting business requirement to discuss the fire-fighting IOT systematic frame, plan society fire-fighting safety management IOT technology system, and proposed priority development points of society fire-fighting safety management IOT technology,

7)Title: Automatic fire alarm and fire control linkage system in intelligent buildings

Author: Wang Suli; Liu Ganlai

Published in : 2010

Abstract:
This paper described a comprehensive program of an office building intelligent systems Fire Control Linkage System subsystem design, At the same time, it described the following: the idea of the system design, the system components, selecting equipment, the linkage of alarming and controlling gas extinguishing, and the technical features. Projects under this program have been completed, can realize the intelligent prediction of fire, automatic fire alarm and linkage functions.

8)Title: A System design of the Tahe's forest -Fire -prevention Management System

Author: Xindan Gao; Nihong Wang; Jun Li **Published in :** 2010

Abstract:
This article paper aimed to introduces how a system was designed for Tahe's forest-fireprevention management in Northeast China after a brief introduction to the overall functional characteristics, the overall function flow chart and the operating environment of the forest -fire -prevention management system. firstly, and then This system design consists of seven function modules, which were geographic information system module, fire-risk each function module of the system in detail, including geographic information system module, fire forecast module, forest -fire -alarm receiving module, blazes fire-putout-aided decision-making module, forest-fire-put-out troops sending module, loss evaluation module, forest -fire -prevention office and information management module and as well as GPS real-time monitoring module. Among all modules, the geographic information system module was the core of those fire -prevention -management system, and other various modules were carried out various functions through links with the core module, based on its function, realized link. In conclusion, that this paper summarized the whole system design work done by this paper and as well as the advantages and disadvantages of this system.

9)Title: Building fire rescue with evacuation management information system and its application

Author: Xu Tao; Mao Guozhu; Li Xin; Zhao Lin

Published in : 2009

Abstract:
Building Fire Rescue with Evacuation Management Information System (BFREMIS) was established. And the evacuation model of BFREMIS was analyzed and presented in this paper. Based on the constructed network model, the evacuation of the teaching building in the university was analyzed by using the software EVACNET4. The analysis items included: the total evacuation time, the floor clear time, evacuation bottleneck, and the visual path of the evacuation on MAPGIS platform. BFREMIS was valuable in building safety assessment and building fire rescue.

10)Title: Forest Fire Management at Aggtelek National Park Integrated Vegetation Fire Management Program from Hungary

Author: Agoston Restas

Published in : 2006

Abstract:
Szendro Fire Department is located in the northeastern part of Hungary. The main task was to fight against wildfire and mitigate the impact of fire at the Aggtelek National Park - which belongs to the UNESCO World Heritage list. In 2004 the Fire Department started a project named Integrated Vegetation Fire Management (IVFM). The IVFM consist of two main parts: Peripheries and Modules. The Modules are: Tower based environment monitoring and fire detection system, Mobile command control unit and Static and dynamic decision support system. The Tower based environment monitoring and fire detection system addressed the Fire Department by hot information. The Static and dynamic decision supported system was based on robot reconnaissance aircraft (UAV-RRA)- dynamic parts; and the GIS - static parts. The data supplied by the robot reconnaissance aircraft was combined with the GIS based fuel model and other information to predict the fire activity. The environment monitoring and fire detection system and the Dynamic part (UAV-RRA) of Decision support system based on remote sensing.

2.3 Problem Statement Definition

Smart buildings/cities are among the most innovative solutions for engineers to ensure social and environmental responsibility and provide safe and secure environments for occupants.

Emerging technology when aligned together to complement each other that can deliver the promise of enhanced Fire safety and enabling the promise of smart buildings and cities that are safer.

Question	Description
Who does the problem affect?	Industries in manufacturing sectors are affected due to the fire
What are the boundaries of the problem?	Geographic and confined spaces.
What is issue?	Unexpected accidental fire in industries which could cause life and property damage .
When does the issue occur?	Negligence and Breaking the standard governmental norms.
Where is the issue occurring?	Large scale heavy manufacturing industries are affected during the fire accident.
Why is it important that we fix the problem?	To create a safe working conditions to Reduce the property losses.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

➤ An empathy map is a simple, easy-to-understand visual that captures knowledge about a user's behaviors and attitudes.

➤ It is a useful tool for assisting teams in better understanding their users.

➤ Creating an effective solution necessitates understanding the true problem and the person experiencing it.

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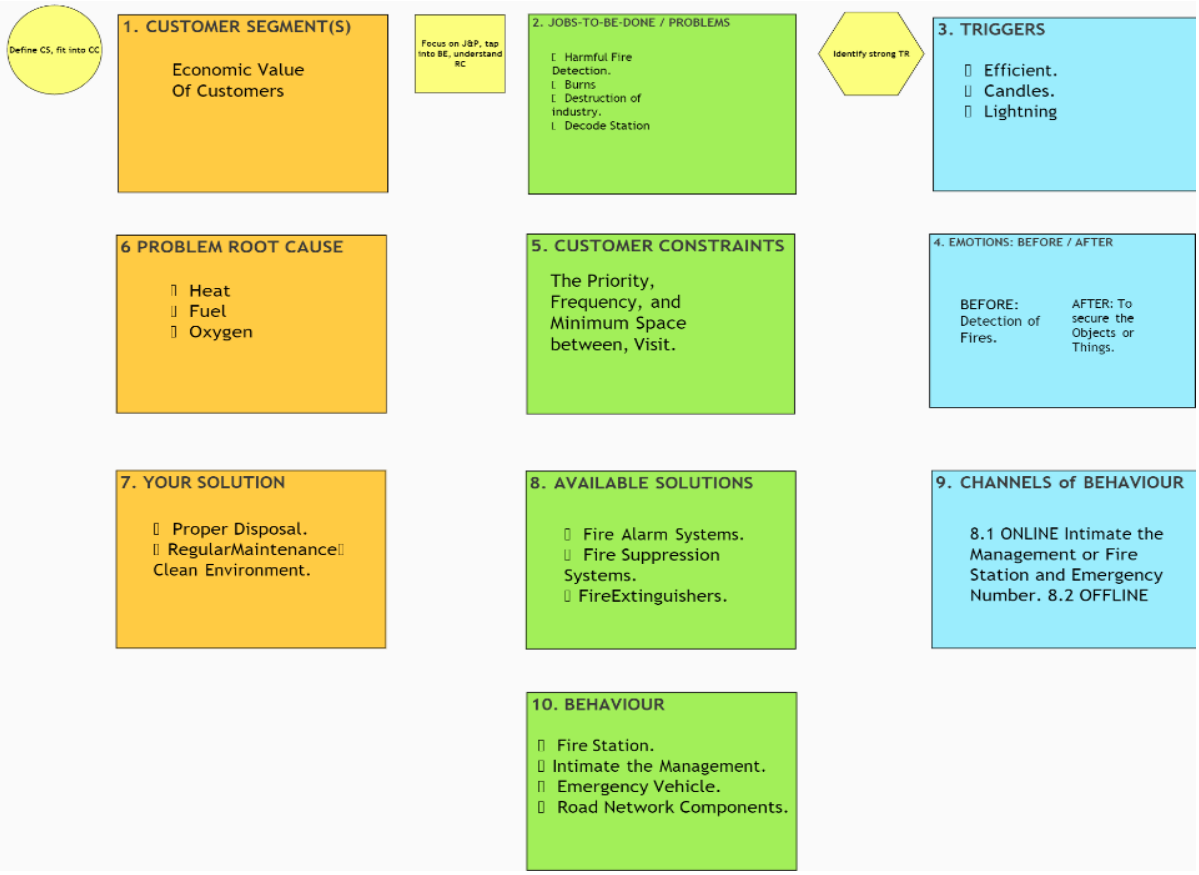
3.2 Ideation & Brainstorming

Basic protection describes the generally accepted and legally required measures like fire extinguisher, wall hydrants, manual alarm points, water supply, constructive fire protection etc. Additional and supplementary protection measures can be - Reduction of fire load - More stringent fire partition - Automatic fire detection system - Sensors for early warnings (smoke, heat, gas) - Semi-fixed extinguishing systems - Fixed extinguishing systems (sprinkler, water spray) - Fire brigade. The list defines menu items to choose from with respect to the potential (financial and social) impact. Especially sprinkler extinguishing systems fit the demands of the chemical industry due to short response time, design flexibility and robustness.

3.3 Proposed Solution

S.no	Parameter	Description
1.	Problem Statement (problem to be solved)	Industry Specific Fire Management System
2.	Idea/solution description	This Project helps the industries in monitoring the leakage of fire.in several locations , the sensors like flame/temperature sensors will be integrated to monitor the fire leakage.
3.	Novelty/uniquences	Fire Explotion /fire leakage location send to the management
4.	social impact/customer Satisfaction	The industrial admin /management can prevent before the accident through the fire leakage monitoring System
5.	Business Model (revenue Model	*Efficiency of cost *High security
6.	Scalability of the solution	High Scalability

3.4 Problem Solution fit



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

A functional requirement defines a system or component's function, where a function is

- ➤ Defined as a specification of behavior between inputs and outputs
- ➤ It defines "what the software system should do"
- ➤ Defined at the component level
- ➤ Usually simple to define
- ➤ Aids in testing the software's functionality

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detection	The fire is detected by a sensor which has a threshold value of temperature.If any gasses are present, it is also detected.
FR-2	Accuracy	A great accuracy in detection is maintained by proper and optimized code.
FR-3	Alerting	As soon as the fire is detected, the alarm rings and the water is sprinkled and it is notified to the personnels. .If any gasses are present,the exhaust fans are switched on .

4.2 Non-Functional requirements

- ➤ A non-functional requirement defines a software system's quality attribute.
- ➤ It limits "How should the software system fulfill the functional requirements?"
- ➤ It is not required Applied to the entire system
- ➤ Usually more difficult to define

- ➤ Aids in the verification of software performance

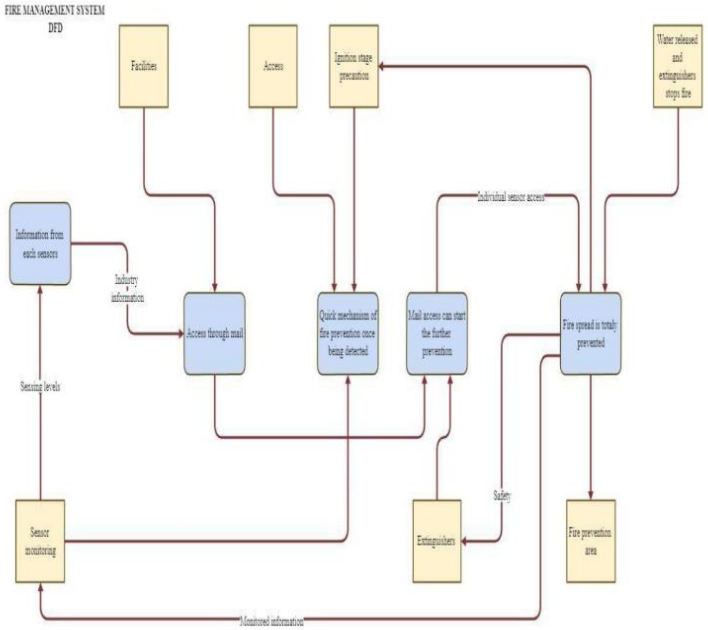
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	User friendly and easy to maintain and detect.
NFR-2	**Security**	There are no security issues in this system.
NFR-3	**Reliability**	This system is highly reliable because it can detect change in temperature accurately .
NFR-4	**Performance**	The performance of the system is measured in terms of accuracy and the accuracy of the system is about 95% and it alerts within a shorter period of time.
NFR-5	**Availability**	This system can be easily available and can be installed anywhere.
NFR-6	Scalability	This system is highly scalable and it detects accurately.

5. PROJECT DESIGN

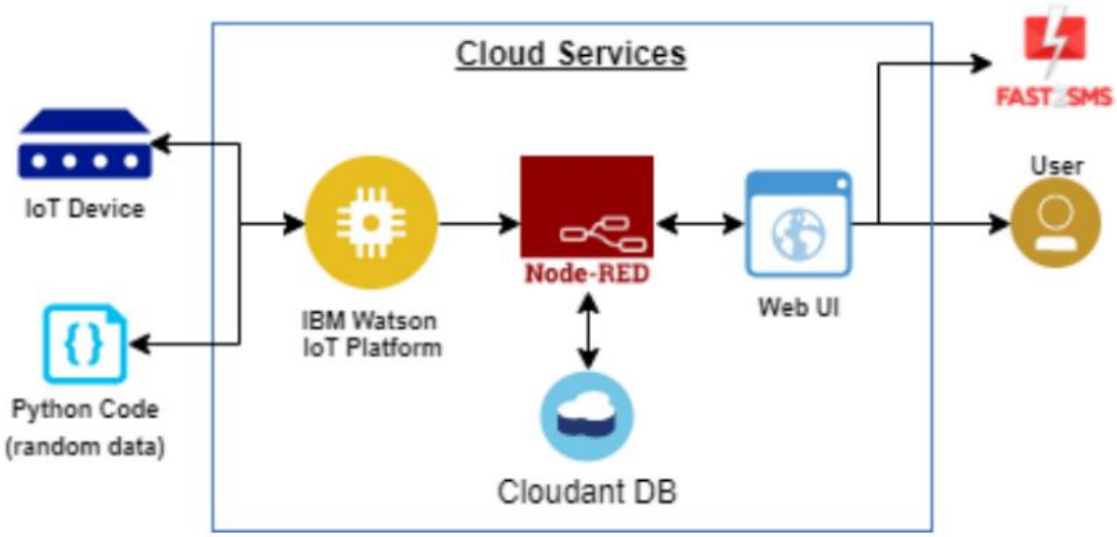
5.1 Data Flow Diagrams

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.

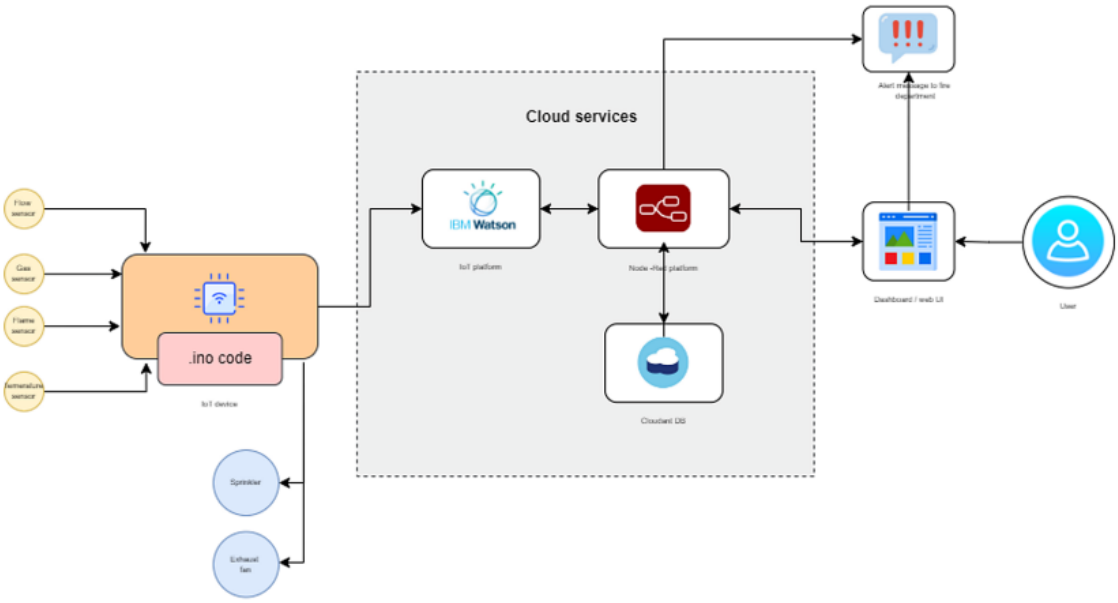


5.2 Solution & Technical Architecture

Solution Architecture



Technical 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 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
	Dashboard	USN-3	As a user, I can register for the application through internet	I can register & access the dashboard with Internet login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can confirm the registration in Gmail	Medium	Sprint-1
	Login	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

- ANALYZE THE PROBLEM
- PREPARE An ABSTRACT, PROBLEM STATEMENT
- LIST A REQUIRED OBJECT NEEDED
- CREATE A PROGRAM CODE AND RUN IT
- MAKE A PROTOTYPE TO IMPLEMENT
- TEST WITH THE CREATED CODE AND CHECK THE DESIGNED PROTOTYPE IS
- SOLUTION FOR THE PROBLEM IS FOUND

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a customer, I might ensure login credential through Gmail ease manner for the purpose of sending alert message to the owner.	2	High	Newton prabu P, Nivedha S, Karthikeyan M, Banushree S
Sprint-1	Registration	USN-2	As a user, I have to registered my details and tools details in a simple and easy manner in case of fire, this registered system sends notification to the industrialist.	2	High	Newton prabu P, Nivedha S, Karthikeyan M, Banushree S
Sprint-2	Dashboard	USN-3	As a user, in case of Fire in the industry I need the sprinkler to spray water on the existing fire automatically.	2	Low	Newton prabu P, Nivedha S, Karthikeyan M, Banushree S
Sprint-1	Dashboard	USN-4	As a user, I need to safeguard my properties as well as and it will be better to send alert message to the fire department.	2	Medium	Newton prabu P, Nivedha S, Karthikeyan M, Banushree S
Sprint-1	Dashboard	USN-5	As a user, its good to have a IOT based system to extinguish the fire without human presence.	2	High	Newton prabu P, Nivedha S, Karthikeyan M, Banushree S

6.2 Sprint Delivery Schedule

TITLE	DESCRIPTION	DATE
IDEATION PHASE		
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publications etc.	19 OCT 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements.	19 OCT 2022
Problem Statement	List of problem in the project.	19 OCT 2022
Brainstorm And Idea Prioritization	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	19 OCT 2022
Project Design Phase - I		
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	26 OCT 2022
Problem Solution Fit	Prepare problem - solution fit document.	26 OCT 2022
Solution Architecture	Prepare solution architecture document.	26 OCT 2022

TITLE	DESCRIPTION	DATE
Project Design Phase - II		
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	30 OCT 2022
Functional Requirement	Prepare the functional requirement document.	30 OCT 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	30 OCT 2022
Technology Architecture	Prepare the technology architecture diagram.	30 OCT 2022
Project Planning Phase		
Prepare Project Planning & Sprint Delivery Plan	Prepare the Product Backlog, Sprint Planning, Stories, and Story points.	8 NOV 2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	8 NOV 2022
Project Development Phase		
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	IN PROGRESS

7. CODING & SOLUTIONING (Explain the features added in the project along with code)

7.1 Feature 1

If any fire is detected by the sensor, it sends signal to the entire module and the Buzzer added in our system gives signal as an alarm sound to alert people in the place.

7.2 Feature 2

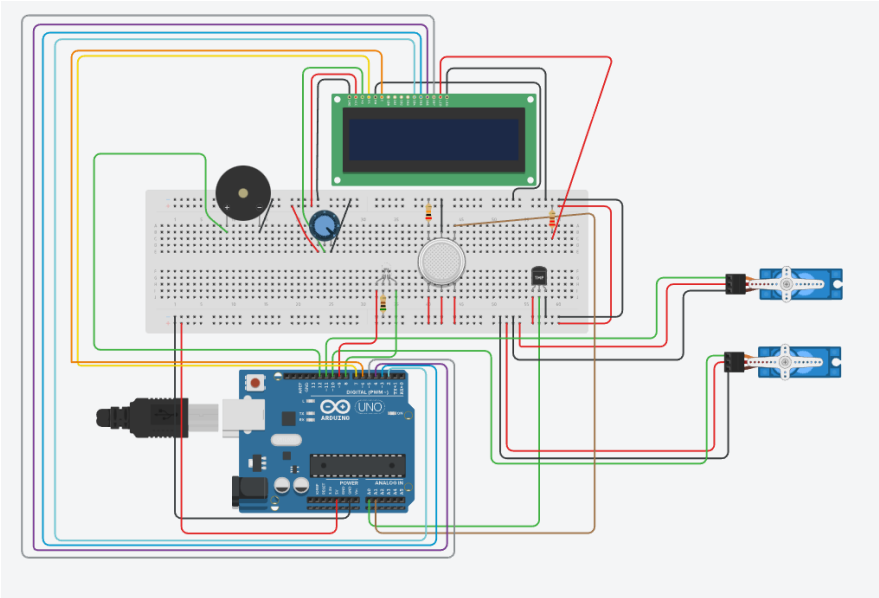
The data represented previously will be stored in the IBM cloud as entire database is connected with our app. We have created our device with these specification listed below:

Organization ID: lzfy5b
Device Type: Nodemcu
Device ID: 12345
Authentication Method: use-token-auth
Authentication Token: NKRyjd+IyhkMhS?3B-

8. TESTING

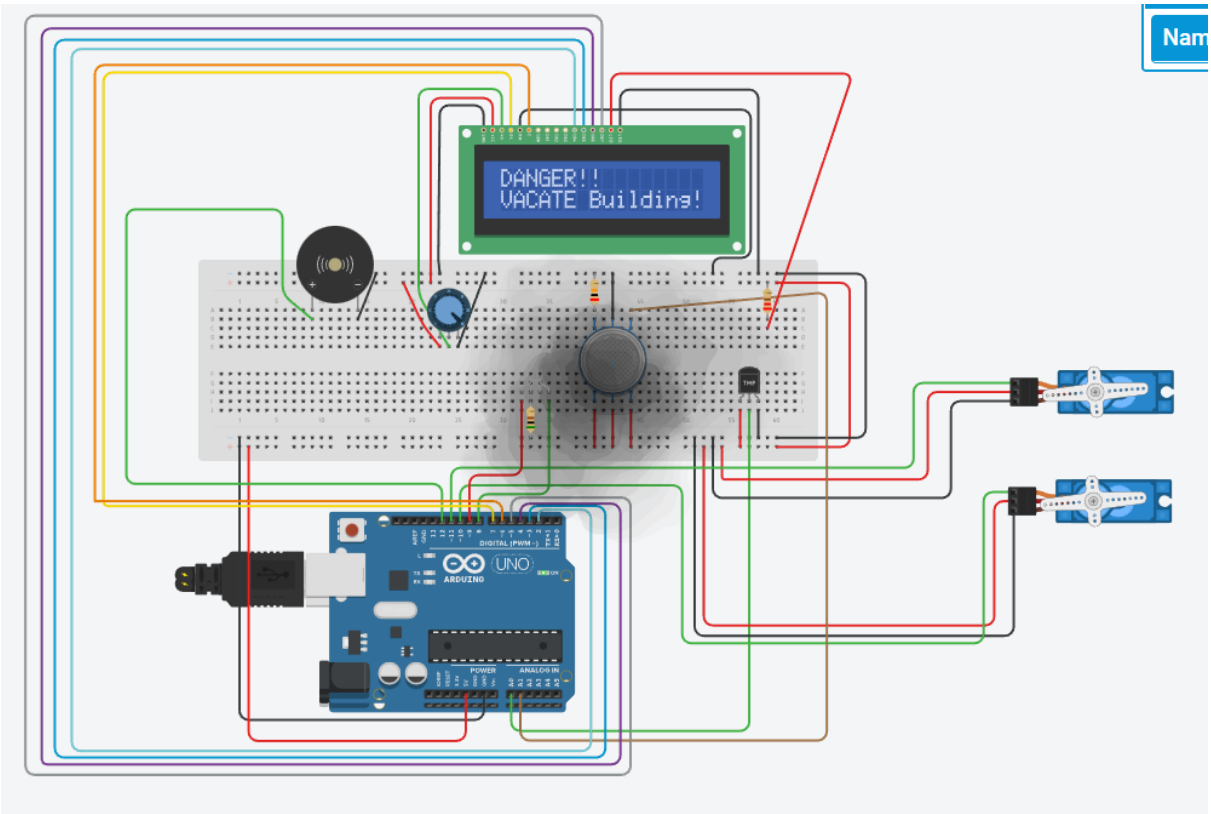
8.1 Test Cases

As every connections are made and verified, the entire module is simulated to check its working. The sensor keeps on detection if any fire is there. If there is no fire is happened no alert signals are sent



9. RESULTS

If any FIRE is detected the buzzer goes ON and alert signals are sent to the consent devices



9.1 Performance Metrics

CPU Usage:

The micro version of C++ makes the most efficient use of the CPU. The program runs in O(1) time for each loop, ignoring the network and communication. To improve communication with MQTT, the program sleeps every 1 second. Because the program runs in O(1) time and the compiler optimizes it during compilation, there is less CPU load per cycle. The following instructions are stored on the stack memory and can be popped after execution.

Memory Usage:

The sensor values and networking data are saved in the ESP32's sram. It's a lot of information because the ESP32 only has 520 KB of memory. To save memory and ensure optimal program execution, the exact addresses for each memory cycle are overwritten with new values.

Error Rates:

The error rates are very low because the backend and dashboard are handled with node red. Exceptions are handled properly so that the system's usability is not affected.

10. ADVANTAGES & DISADVANTAGES

Advantages:

➤ Active detection of gas leaks and fire outbreaks
➤ SMS alerting of administrators and fire authorities
➤ Turning on/off sprinklers and exhaust fans automatically
➤To manually turn on/off sprinklers and exhaust fans, as well as send SMS alerts, authe ntication is required
➤ It detects false fire outbreaks automatically, reducing unnecessary panic
➤ We can confirm that the sprinkler system is functioning properly by using flow sensors
➤ A dashboard can display the status of any device
➤ The dashboard can be viewed by users via a web application

Disadvantages:

➤ Always require an internet connection [only to send the SMS alert]
➤ If the physical device fails, the entire operation fails
➤ Because a large amount of data is stored in the cloud database every second, a large database is required

11. CONCLUSION

So we conclude that, our problem premise is solved using IoT devices by developing a smart management system that solves many inherent problems in traditional fire management systems, such as actively monitoring for fire breakouts and gas leakage and sending SMS alerts to administrators and fire authorities.

12. FUTURE SCOPE

The existing devices can be modified to work in various specialized environments, as well as scaled to house use to large labs [Because fire accidents can cause significant loss of human lives in homes to large industries], as well as used in public places and vehicles.

13. APPENDIX

13.1 Source Code

```
#include<Servo.h>//header file for servo

#include <LiquidCrystal.h>//header file for LCD



//first of all we will use the  TMP36 which is a temperature sensor that outputs

//a voltage that's proportional to the ambient temperature.
```

```
// We'll use analog input 0 to measure the temperature sensor's signal pin.
//Temparature Sensor
const int temperaturePin = 0; //The output of tmp36 is connected to A0 of arduino
const int buzzer = 12; //buzzer is connected to D12 on the arduino


//Gas Sensor
int gasSensorPin=A1;//Gas sensor output is connected to A1 of Arduino
int sensorval;//For storing the value sensed by gas sensor

//Doors
Servo servo1,servo2;
int servo1Pin=11;
int servo2Pin=10;

//RGB LED
int red_led=9;//Red terminal of RGB LED is connected to D9 of Arduino
int green_led=8;//Green terminal of RGB LED is connected to D8 of Arduino

//LCD
LiquidCrystal lcd(7, 6, 2, 3, 4, 5);//Sets the interfacing pins on Arduino that are connected to LCD
//7-Rs,6-E(Enable), 5,4,3,2 are the inputs->4 bit mode
```

```
void setup()
{
  pinMode(buzzer, OUTPUT);//set the pin connected to the buzzer as an output

  servo1.attach(servo1Pin);
  servo2.attach(servo2Pin);
  servo1.write(90);//Intially both doors are closed(i.e, 90 degrees)
  servo2.write(90);
  delay(2000);

  pinMode(red_led,OUTPUT);
  pinMode(green_led,OUTPUT);

  //Serial.begin(9600);

  lcd.begin(16,2);//initialisation of 16*2 LCD
}

void loop()
{
        //for buzzer and tmp36 temp sensor
```

```
    float voltage, degreesC;
    voltage = getVoltage(temperaturePin);
    degreesC = (voltage - 0.5) * 100.0;

    sensorval=analogRead(gasSensorPin);
    //Serial.print(sensorval);


    if(degreesC>37 || sensorval>700)
    {
digitalWrite(buzzer, LOW);
tone(buzzer, 800, 800);
delay(200);  //delay
tone(buzzer,600,800);
delay(200);

servo1.write(0);
servo2.write(0);
delay(1000);


digitalWrite(red_led,HIGH);
digitalWrite(green_led,LOW);
```

```
delay(1000);
digitalWrite(red_led,LOW);

lcd.clear();
lcd.setCursor(0,0);//row 0 column 0
      lcd.print("DANGER!!");
lcd.setCursor(0,1);//row 1 column 0
lcd.print("VACATE Building!");
    }
    else{
servo1.write(90);
servo2.write(90);
delay(1000);

digitalWrite(green_led,HIGH);
digitalWrite(red_led,LOW);

lcd.clear();
      lcd.setCursor(0,0);//column 0 row 0
      lcd.print("SAFE");
lcd.setCursor(6,0);//column 6 row 0
lcd.print(degreesC);
lcd.print("C");
```

```
      lcd.setCursor(0,1);
      lcd.print("Gas Conc.:");
      lcd.print(sensorval);
  }

}
float getVoltage(int pin)
{

  return (analogRead(pin) * 0.004882814);
}
```

13.2.GitHub & Project Demo Link

GitHub:https://github.com/IBM-EPBL/IBM-Project-22608-1659855001

Demo link: https://drive.google.com/file/d/1Uc0z-mM11zxz3VlF1vr6oTg5hOc0x9h5/view?usp=share_link