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ABSTRACT

Due to its importance in protecting people's lives and property, safety is seen as a high priority, particularly in high-risk industries including aviation, oil and gas, construction, transportation, steel manufacturing, and mining.Establishing and implementing a robust safety management system is crucial in mitigating the likelihood of irreversible incidents. To efficiently identify potential threats, avert mishaps, and reduce risks, the International Space Station (ISS) integrates a range of components, including sensors, data analytics, and real-time monitoring systems. Additionally, the system has a closed loop that functions similarly to a feedback system.

By using the Industrial Safety System, businesses may drastically lower the number of accidents, increase productivity, and give employees' well-being top priority. All of these benefits will eventually help to create a safe and productive work environment.In order to ensure a safe working environment, the system facilitates seamless communication and collaboration between management professionals and frontline workers through an intuitive interface.

This project makes use of servo motors, humidity sensors, fire sensors, light sensors, and an ESP 32 wifi module. The output will be displayed on the LCD screen and on the employee's mobile device on a regular basis. In the event of a harmful incidence, it is advantageous that the management is aware of it and takes the necessary action if they are not in the industry.

TABLE OF CONTENTS

1. Introduction

- Importance of industrial safety in preventing accidents and ensuring productivity. Overview of Industrial Safety System
- How proper safety systems could have prevented or mitigated these incidents.
- In this project We had use ESP-32 module ,humidity sensor , light sensor, smoke sensor ,motor etc

  .
- Worker Well-being: Industrial safety prioritizes the protection and health of employees, reducing the risk of injuries, illnesses, and fatalities in the workplace.
- Environmental Protection: By preventing industrial accidents, safety measures minimize the release of hazardous substances and pollutants, preserving ecosystems and public health.
- Financial Safeguarding: Industrial safety practices shield companies from significant financial losses caused by property damage, equipment failures, legal liabilities, and interruptions in operations.
- Operational Continuity: Ensuring a safe working environment helps maintain consistent production schedules and prevents disruptions, thereby supporting operational efficiency and reliability

2. Literature Survey

Industrial fire safety systems are essential for reducing hazards since fires in these environments can endanger people's lives, property, and business operations. First introduced during the Industrial Revolution, increased industrialization led to increased fire hazards, which in turn prompted the development of basic safety precautions such as appropriate material storage and fire-resistant building materials. More advanced detection and suppression systems, such as automatic sprinklers, smoke detectors, and fire alarms, were made possible by advancements.

The integration of modern technologies for improved detection and suppression is emphasized in recent studies. Artificial intelligence (AI) and machine learning-based intelligent systems use sensor data analysis to accurately identify hazards. Research also evaluate other types of suppressants, such as foam, gas-based systems, and water mist.

IoT and cloud-based solutions for remote system control and real-time monitoring are emerging trends. Drones are becoming more popular for surveillance and inspection purposes. They can also be integrated with firefighting robots to provide rapid reactions. Predictive analytics for proactive risk management and the integration of building automation systems with fire protection for increased efficiency could be the main topics of future research.

3. Specifications Of The Project

The project focuses on developing an industrial safety system aimed at safeguarding personnel during emergency situations, particularly fires. The system integrates various sensors and a microcontroller to detect and respond to potential hazards in real-time. Here's an elaboration on the project:

Objective: The primary goal of the project is to implement a safety product that enhances emergency response mechanisms, thereby minimizing damage and ensuring the safety of personnel in industrial settings.

Hardware Components:

ESP32: A powerful microcontroller that serves as the central processing unit of the safety system, responsible for data processing, decision-making, and communication.

Humidity Sensor (DHT-11): Detects changes in humidity levels, which can indicate the presence of smoke or fire.

Fire Sensor (IR FLAME/FIRE): Detects the infrared radiation emitted by flames, enabling early fire detection.

Temperature Sensor (NTC Thermistor): Monitors ambient temperature to identify abnormal increases indicative of fire.

Smoke Sensor (MQ-2): Detects smoke particles in the air, providing another layer of fire detection.

Light Sensor (LDR Module): Measures ambient light levels, which can help detect sudden changes associated with fires or power failures.

System Design:

The system operates in a closed-loop manner, continuously monitoring environmental conditions using the sensors.

If any sensor detects abnormal conditions indicative of a fire hazard, predefined protocols are triggered for mitigation.

Real-time system monitoring ensures rapid detection and response, with a latency of just 1 second.

A web server component allows remote monitoring of the system status from any location with internet access, enhancing situational awareness and enabling timely intervention.

Benefits:

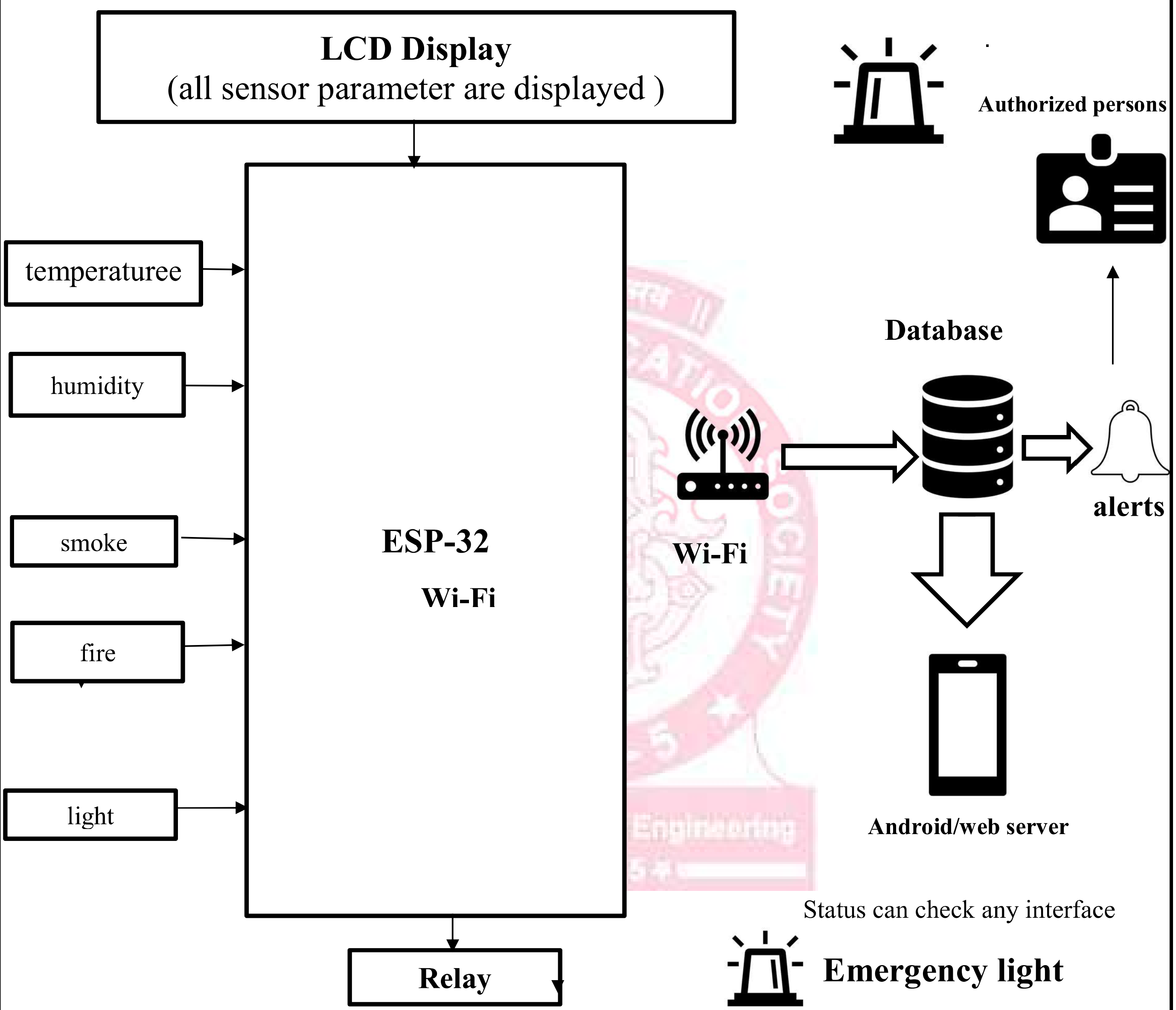
Enhanced Safety: The system provides early detection of fire hazards, allowing for prompt action to mitigate risks and protect personnel.

Remote Monitoring: The ability to monitor the system remotely ensures that responsible personnel can stay informed even when they are not physically present at the industrial site.

Efficient Response: By automating the response to emergencies, the system minimizes the time required to address hazards, reducing the potential for catastrophic events.

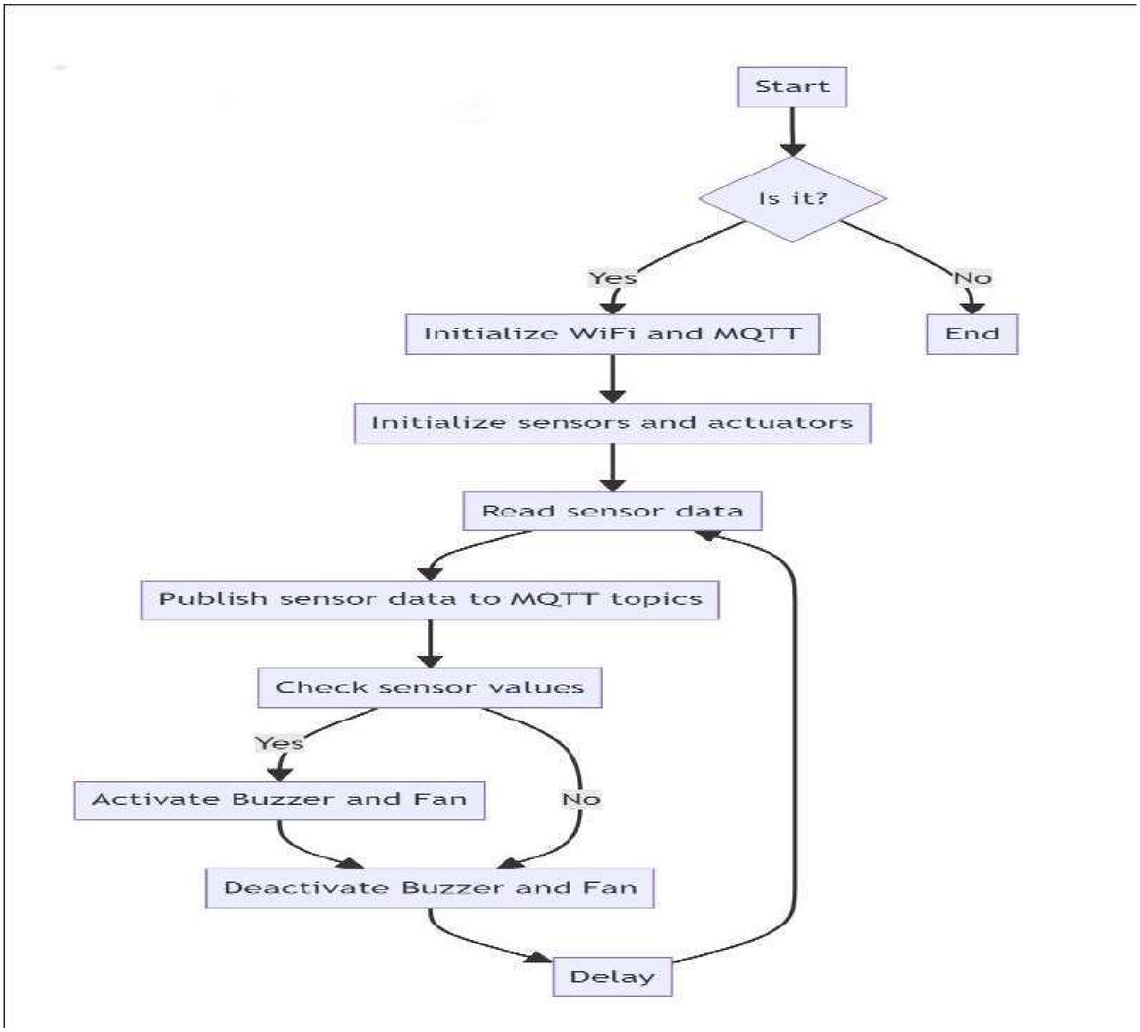
In summary, the industrial safety system combines advanced sensor technology with real-time monitoring and remote access capabilities to create a robust safety solution for industrial environments, ultimately saving lives and preventing damage to property.

4. Block Diagram and Description

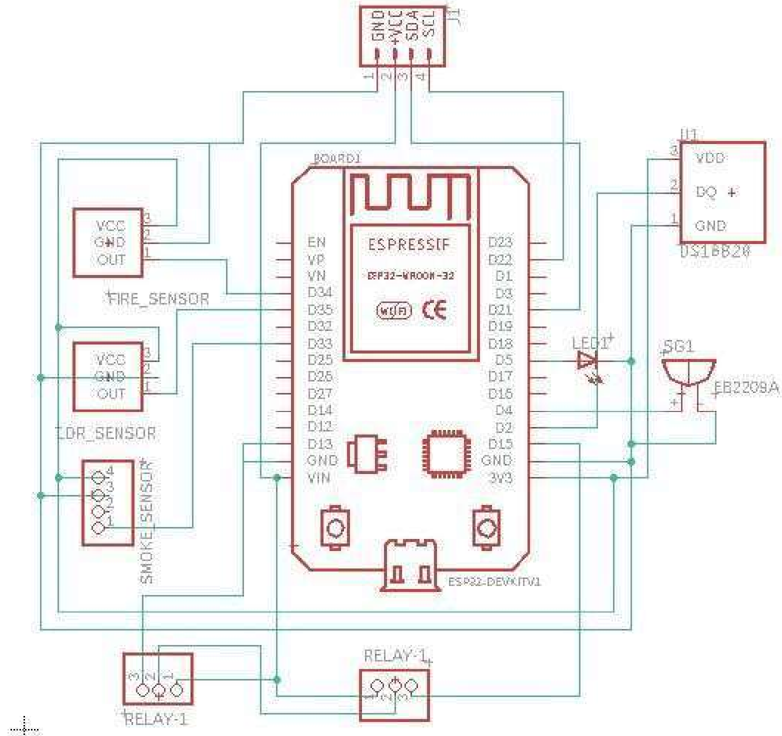


5. Software System Design

Flowchart: -



System Design :-



Code:-

```
#include <LiquidCrystal_I2C.h>
#include <WiFi.h>
#include <WebServer.h>
#include <Wire.h>
#include <DHT.h>

#define DHTPIN 2 // Pin where the DHT sensor is connected
#define DHTTYPE DHT11 // Type of DHT sensor
DHT dht(DHTPIN, DHTTYPE);

const int motor = 15;
const int smokeSensorPin = 33; // Pin where the smoke sensor is connected
const int fireSensorPin = 34; // Pin where the fire sensor is connected
const int buzzerPin = 4; // Pin where the buzzer is connected
const int ldrSensorPin = 35; // Pin where the LDR sensor is connected
const int LED = 5;

const char *ssid = "ESP32-Access-Point"; // SSID for ESP32 AP
const char *password = "123456789"; // Password for ESP32 AP
LiquidCrystal_I2C lcd(0x27, 16, 2); // I2C address, number of columns and rows on the LCD
WebServer server(80);

void handleRoot()
{
// Read sensor data
float humidity = dht.readHumidity();
float temperature = dht.readTemperature();
int smokeValue = analogRead(smokeSensorPin);
int fireStatus = digitalRead(fireSensorPin);
int ldrValue = digitalRead(ldrSensorPin);

// Convert LDR value to day-night indicator
String dayNight;
if (ldrValue,LOW)
{
dayNight = "Day";
}
else
{
dayNight = "Night";
}

// Prepare HTML response with JavaScript for reloading
String response = "<!DOCTYPE html><html lang=\"en\"><head><meta charset=\"UTF-8\"><meta
name=\"viewport\" content=\"width=device-width, initial-scale=1.0\"><title>Sensor Data</title>";
response += "<style>body { font-family: Arial, sans-serif; margin: 0; padding: 0; background-color:
#f4f4f4; }";
```

```
response += "header { background-color: #333; color: #fff; padding: 10px 0; text-align: center; }";
response += "h1 { margin-top: 20px; text-align: center; }";
response += "table { width: 50%; margin: 20px auto; border-collapse: collapse; }";
response += "th, td { padding: 10px; border: 1px solid #ddd; text-align: left; }";
response += "th { background-color: #333; color: #fff; }</style>";
response += "<script>setTimeout(function() { location.reload(); }, 1000);</script>"; // Reload the page every 1000 milliseconds
response += "</head><body><header><h1>Industrial Safety System</h1></header>";
response += "<table><tr><th>Parameter</th><th>Value</th></tr>";
response += "<tr><td>Temperature</td><td>" + String(temperature) + " &deg;C</td></tr>";
response += "<tr><td>Humidity</td><td>" + String(humidity) + " %</td></tr>";
response += "<tr><td>Smoke Value</td><td>" + String(smokeValue) + "</td></tr>";
response += "<tr><td>Fire Status</td><td>" + String(fireStatus == LOW ? "Fire Detected!" : "No Fire Detected") + "</td></tr>";
response += "<tr><td>Day/Night</td><td>" + dayNight + "</td></tr>"; // Display day-night indicator
response += "</table></body></html>";

// Send HTML response to client
server.send(200, "text/html", response);
}

void setup()
{
lcd.init(); // initialize the LCD
lcd.backlight(); // Turn on backlight
Serial.begin(9600);

// Initialize DHT sensor
dht.begin();

// Set pin modes
pinMode(buzzerPin, OUTPUT);
pinMode(fireSensorPin, INPUT);
pinMode(LED, OUTPUT);
pinMode(motor, OUTPUT);

// Start WiFi Access Point
WiFi.softAP(ssid, password);
IPAddress myIP = WiFi.softAPIP();
Serial.print("Access Point IP address: ");
Serial.println(myIP);

// Register handler for root URL
server.on("/", handleRoot);

// Start web server
server.begin();
Serial.println("HTTP server started")
}
```

```
void loop()
{
// Read sensor data
float humidity = dht.readHumidity();
float temperature = dht.readTemperature();
int smokeValue = analogRead(smokeSensorPin);
int fireStatus = digitalRead(fireSensorPin);
int ldrValue = digitalRead(ldrSensorPin);

// Display sensor data on LCD
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Smo: ");
lcd.print(smokeValue);
lcd.setCursor(0, 1);
lcd.print("Humidity: ");
lcd.print(humidity);
lcd.print("%");

// Print fire status for debugging
Serial.print("Fire status: ");
Serial.println(fireStatus);

// Control buzzer based on fire status
if (fireStatus == HIGH)
{
Serial.println("No fire detected. Buzzer OFF.");
digitalWrite(buzzerPin, LOW);
}
else
{
digitalWrite(buzzerPin, HIGH);
Serial.println("Fire detected! Buzzer ON.");
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Fire detected!");
}

// Control LED based on LDR value
if (ldrValue,LOW)
{
digitalWrite(LED, HIGH);
}
else
{
digitalWrite(LED, LOW);
}
// Control motor based on humidity level
if (humidity >= 40 && humidity <= 60)
{
```

```
Serial.println("Humidity is normal");
analogWrite(motor,255);
}
else
{
Serial.println("Humidity crossed its limit!!");

analogWrite(motor,0);
}

// Handle client requests
server.handleClient();

// Delay between readings
delay(2000);
}
```

6. Simulation Result and Performance Evaluation

The simulation contains the working of each component as well as the integrated system:-
1.Condition for a normal situation: -

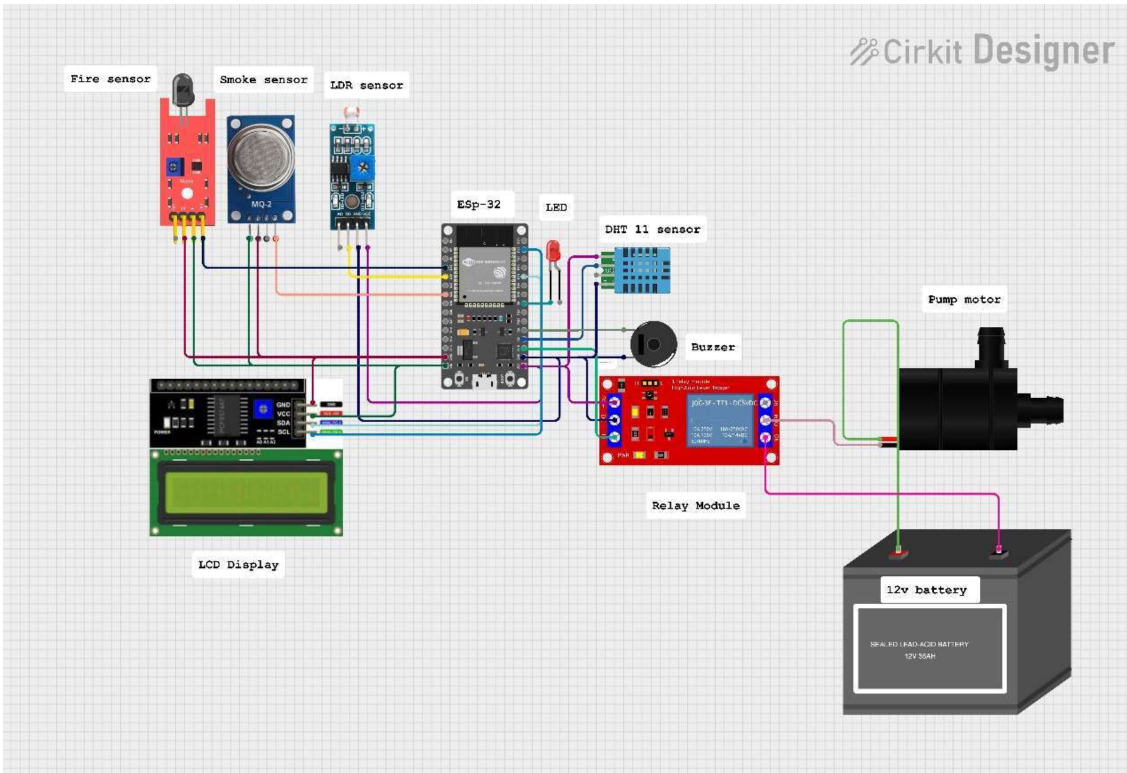


fig a: normal situation

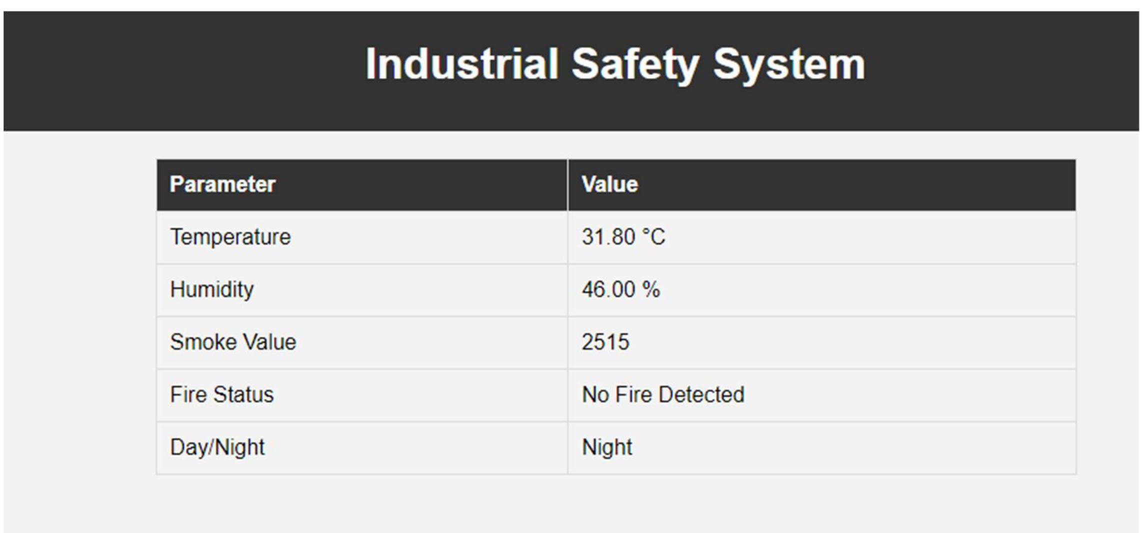
2.Condition for higher Humidity:-

fig b:higher Humidity

3.Fire Detection:-

fig c: Fire Detection

Web Server



Industrial Safety System

Parameter	Value
Temperature	31.80 °C
Humidity	46.00 %
Smoke Value	2515
Fire Status	No Fire Detected
Day/Night	Night

Fig : - Server data

7. Applications and Future Modifications

Application :-

- Industrial Safety Systems (ISS) applications involve a range of technologies and protocols aimed at ensuring the safety of industrial processes and personnel. These applications encompass various elements such as:
- Emergency Shutdown Systems (ESD): These systems are designed to quickly shut down industrial processes in case of emergencies to prevent accidents and protect equipment.
- Fire and Gas Detection Systems: These systems detect and respond to the presence of fire, smoke, or hazardous gases in industrial environments to minimize the risk of explosions or health hazards.
- Process Control Systems: While primarily focused on optimizing production processes, modern process control systems often inegrate safety features to ensure safe operation.
- Safety PLCs (Programmable Logic Controllers): These specialized PLCs are designed with redundant hardware and software to ensure reliable operation in safety-critical applications.
- Human-Machine Interface (HMI) Systems: Intuitive interfaces allow operators to monitor industrial processes and quickly respond to safety-critical events.
- Overall, ISS applications play a crucial role in safeguarding industrial operations, protecting personnel, and minimizing the risk of catastrophic incidents.

Future Modification :-

Future modifications of industrial safety systems could include advancements in sensor technology for real-time monitoring, implementation of artificial intelligence for predictive analytics and early hazard detection, integration of wearable devices for worker safety, and increased automation to minimize human error. Additionally, there might be improvements in communication systems for better coordination during emergencies and enhanced training programs utilizing virtual reality simulations.