Smart-Sensor Based Fire & Gas Avoider System

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Abstract: Now-a-days Fire and gas leakage incidents pose serious threats to life, environment, and property. Conventional detection systems often lack from precision, resulting in false alarms and delayed response. Our project proposes a Smart sensor based fire and gas avoider system, which utilizes the multiple environmental sensors that includes flame, gas, smoke, and temperature sensors. Proposed system use Machine Learning algorithms for advance detection and action, which are trained to differentiate between true threats and non-hazardous fluctuations by reducing false positives. This system sends real-time notifications to cloud platforms that are connected for remote monitoring and automatically sounds alerts using adaptive buzzer.

Keywords: IoT, machine learning, intelligent sensors, fire and gas leak detection, and adaptive buzzers.

1. INTRODUCTION

In today's world, safety has become a top priority, especially in places like homes, factories, and laboratories where fire and gas accidents can happen suddenly. Traditional approaches to detecting these hazards are often limited; they may use only one type of sensor and sometimes generate false alarms. This may cause misunderstandings and needless. The system employs fundamental machine learning techniques to comprehend and categorize various threat levels in order to decrease false alarms and enhance decision-making. It employs real-time data processing to activate alarms, such as buzzers and LEDs, when danger is detected. This project presents a Smart Sensor-Based Fire and Gas Avoider System that detects using a range of sensors to detect temperature changes, smoke, flames, and gas leaks.

This project aims to develop a scalable, cost-effective, and dependable safety system that can be applied in a variety of settings. Combining machine learning (ML) algorithms, adaptive alert systems, and Internet of Things (IoT) technology, the goal of the project is to create a reliable, affordable, and scalable safety system that can be used in a range of situations, reducing the risk of injury or death.

2. RELATED WORKS

The limitations of these traditional systems in dynamic or complex environments, where a fixed-threshold approach can result in errors, have been highlighted by (NFPA, 2013). Chen et al. (2016) demonstrated that integrating multiple sensors, such as gas (MQ series), flame, temperature, and humidity sensors can significantly improve detection accuracy. By gathering a variety of environmental data, these systems offer a more comprehensive view of the situation.

Using an ESP8266 module, Rani et al. (2019) created an Internet of Things-enabled gas and fire detection system that allowed for remote monitoring and response by sending users real-time alerts via the internet. However, such systems still struggled with false positives and lacked intelligent decision-making capabilities. Kumar and Sharma (2020) used supervised learning algorithms such as Decision Trees and Support Vector Machines (SVM) to classify threats more effectively based on sensor input patterns. These techniques eventually reduced the false alarm rate and improved the system's adaptability. Mehta and Mehta (2021) explored the use of computer vision and deep learning, particularly Convolutional Neural Networks (CNNs), for flame and smoke recognition, although such methods were limited to camera-based systems and required high computational power. Tiwari et al. (2022) involved adaptive alert mechanisms, where the alarm system adjusts its intensity based on the severity of the threat. This dynamic alerting reduces unnecessary panic during minor events while ensuring urgent action during critical situations.

3. EXISTING SYSTEM

A few gas and fire avoidance systems are currently in place. To detect fire, the first existing system usually uses heat sensors, flame sensors, or smoke detectors. Smoke detectors identify the presence of smoke particles in the air, whereas flame detectors detect infrared radiation from flames. Despite their accuracy in identifying fire, these systems are susceptible to false positives, especially in settings with high levels of dust, humidity, or other elements that could skew sensor readings.

Drawbacks in Existing system:

- False Alarms
- Lack of Intelligence
- High Maintenance and Calibration Requirements
- Scalability Issues

4. PROPOSED SYSTEM

Our project aims to address the limitations of traditional fire and gas detection systems by integrating advanced technologies such as IoT, Artificial Intelligence and Machine Learning to provide a more reliable, adaptive, and efficient solution for detecting and responding to fire and gas hazards. The proposed system will feature several key components and functionalities designed to enhance detection accuracy, reduce false alarms, and provide real-time notifications to users. The core features of the proposed system are Multi-Sensor Integration Artificial Intelligence and Machine Learning Dynamic Alert System Real-Time Monitoring and Remote Notifications.

5. METHODOLOGY

A. Data Collection and Sensor Setup

This includes: Flame Sensor for detecting fire presence. DHT11 or DHT22 for measuring temperature and humidity.

Smoke Sensor (MQ-135) for monitoring air quality and detecting early signs of combustion.

B. Data Pre-processing and Thresholding

Each sensor output is filtered to remove noise using basic signal smoothing techniques like moving averages. Initial calibration is done by exposing sensors to controlled conditions (e.g., with a candle or gas source) to define safe and dangerous thresholds. Sensor values are compared against these thresholds to identify abnormal conditions. In more advanced implementations, labelled data collected over time is used to train simple machine learning models to classify situations more intelligently.

C. Decision Making and Output Control

Once the data is processed, the system checks whether any sensor value exceeds its safe limit. If a threat is detected:

The buzzer is triggered with varying intensity (controlled by PWM) based on the severity. LEDs indicate the status: green for safe, yellow for warning, and red for danger. An LCD display shows real-time sensor readings and alert messages.

D. Machine Learning Integration

For intelligent decision-making, simple machine learning models can be trained using collected sensor data under different conditions (safe, smoke only, gas leak only, actual fire, etc.). The system continuously gathers environmental data using a number of sensors. Features such as temperature, smoke level, gas concentration, and flame presence are employed. Lightweight models that are appropriate for microcontroller-based deployment, such as KNN or Decision Trees, are selected. Lightweight models that are appropriate for microcontroller-based deployment, such as KNN or Decision Trees, are selected. Lightweight models that are appropriate for microcontroller-based deployment, such as KNN or Decision Trees, are selected. Lightweight models that are appropriate for microcontroller-based deployment, such as KNN or Decision Trees are chosen.

6. SYSTEM ARCHITECTURE

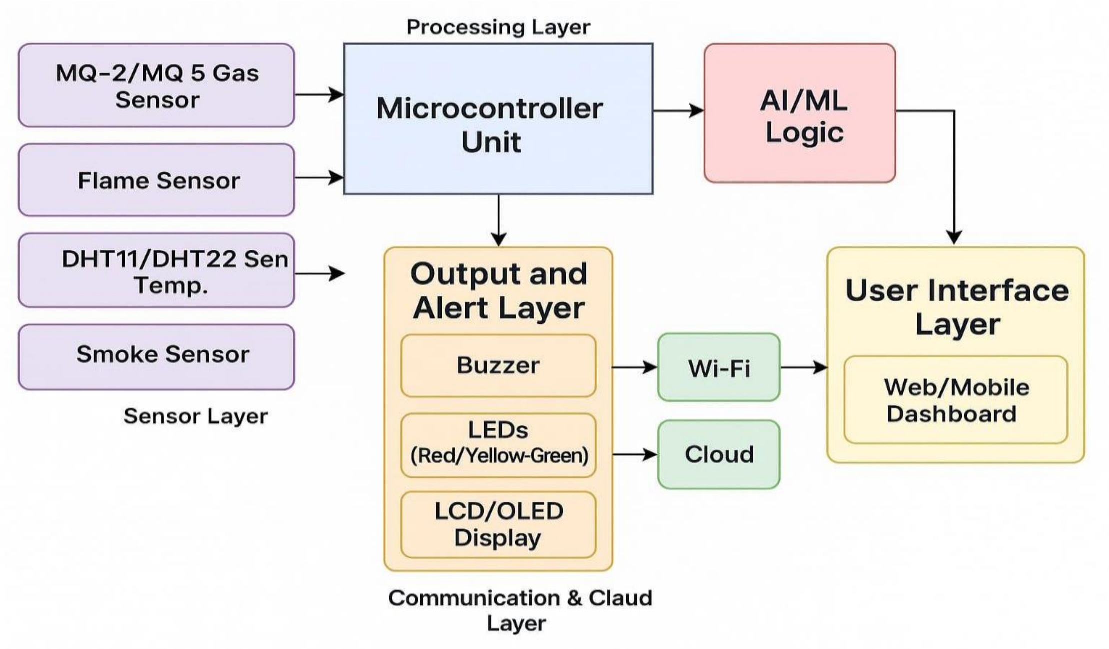

Fig: Architecture of smart sensor based fire and gas avoider system

1. Sensor Layer

All of the physical sensors in charge of gathering environmental data are included in this layer.

MQ-2 / MQ-5 Gas Sensors: Detect flammable gases like LPG, methane, etc.

Flame Sensor: Detects the presence of fire via IR radiation.

2. Processing Layer

This is the brain of the system, where all sensor data is processed.

Micro controller: Arduino Uno

Reads analog /digital sensor inputs.

Applies logic or ML model to classify conditions.

Controls actuators like buzzer, LEDs, display.

Sends data to cloud or app via Wi-Fi in ESP32.

3. Intelligence Layer

Pre-trained ML Model

Trained using historical sensor data to detect real vs. false fire/gas threats.

Predicts severity level: Safe, Warning, or Critical.

4. Output and Alert Layer

Buzzer: Varies tone/intensity depending on severity.

LCD/OLED Display: Shows real-time sensor data and messages.

Mobile Notifications: Sent via cloud services

5. Communication layer

Responsible for remote monitoring and data storage.

Sends sensor data to cloud servers or IoT platforms.

IFTTT/Twilio integration for SMS/email alerts.

Protocols: MQTT or HTTP used for data transmission.

6. User Interface Layer

Web/Mobile Dashboard:

Displays current sensor readings, system status, and historical data.

Allows remote monitoring and configuration.

Receives notifications in case of danger.

7. IMPLEMENTATIONDETAILS

The implementation of the Smart Sensor-Based Fire and Gas Avoider System involves both hardware and software integration to ensure real-time, intelligent detection and response to fire and gas hazards. Cloud connectivity, software development, hardware configuration, and machine learning integration are the stages of the project's development. First, connect the Arduino to the laptop using a USB cable. Next, write the code based on the Arduino's sensor configuration. Install the following libraries in Visual Studio Code: cv2, numpy, smtplib, threading, operating system, pygame, and time. User should also install an alarm's audio so that a buzzer will sound when a fire is detected.

8. ALGORITHM

Step1: Turn on the system and set up every part.

Initialize Arduino.

Initialize sensors (Gas, Smoke, Flame, and Temperature).

Initialize output devices (LEDs, Buzzer, and LCD).

Connect to Wi-Fi network.

Step2: Continuously read sensor data.

Read analog value from MQ-2/MQ-5 Gas Sensor.

Read analog value from MQ-135 Smoke Sensor.

Read digital value from Flame Sensor.

Read temperature and humidity from DHT11/DHT22.

Step3: Machine Learning Integration

Passing sensor data into a trained model.

Use model output to determine threat classification.

Step4: Check for any hazard detected.

Proceed to Step 5 if any of the warnings are accurate.

Else display normal status, keep green LED ON, buzzer OFF.

Step5: Determine severity level.

If multiple alerts = True, set severity = HIGH.

If only one alert = True, set severity = MEDIUM.

If sensor values are just near threshold, set severity = LOW.

Step6: Trigger local alerts.

Control buzzer using PWM based on severity.

Activate the corresponding LED (yellow for medium, red for high).

Display sensor values and alert on LCD.

Step7: Send data and alert to cloud.

Upload sensor values to Firebase/Thing Speak.

If hazard is detected, send SMS/Email via IFTTT or Twilio.

Step8: Wait for delay (5seconds) and repeat from Step 2.

Step9: Stop (only if system is powered off).

9. CONCLUSION

The Smart Sensor-Based Fire and Gas Avoider System effectively address the limitations of conventional fire and gas detection systems by incorporating a multi-sensor approach, real-time monitoring, and intelligent decision-making. By integrating sensors for gas, smoke, flame, and temperature with an ESP32 microcontroller, the system ensures continuous environmental monitoring and immediate hazard detection. By reducing false alarms and enhancing accuracy, machine learning algorithms In addition to offering local alerts through adaptive buzzers, LEDs, and displays, the system enables remote monitoring and notifications through IoT platforms. Because of this, it is a very dependable and expandable safety solution for homes, offices, labs, and public areas. Its value in contemporary smart environments is highlighted by its low cost, simplicity of deployment, and real-time responsiveness.

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