FIRE DETECTION AND SAFETY MONITORING SYSTEM

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DATE: Dec 06, 2025

ABSTRACT

This project presents a low-cost Fire Detection and Safety Monitoring System using the MQ2 gas sensor and the DHT11 temperature–humidity sensor. The system detects early signs of fire through smoke concentration, rapid temperature changes, and abnormal humidity variations that may occur during combustion. When smoke levels exceed a predefined threshold, a light alarm activates to alert the user, providing an immediate local warning. The Arduino-based microcontroller continuously monitors environmental conditions, processes sensor data, and provides real-time readings through the Serial Monitor. The system's hardware design is simple, portable, and easy to implement without the need for complex circuitry. Experimental testing demonstrates that the system can reliably sense smoke, temperature rise, and environmental changes, allowing early detection of potential fire hazards. The design is suitable for homes, offices, kitchens, laboratories, and small industrial environments. With further enhancements such as IoT integration, flame sensors, and wireless alerts, this system can be developed into a more advanced and fully automated fire safety solution.

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1.INTRODUCTION:

One of the most important safety issues that must be considered both at home and in the business setting is fire accidents. They might have devastating effects on property, daily life and in worst scenarios, result in injuries or loss of life. These consequences should be prevented by promptly identifying fire hazards (smoke or spur of the moment increase in temperature). Although the traditional fire alarms are effective, they tend to be costly and also bulk and complex to install, thus making them not very accessible, particularly to small homes, laboratories, classrooms, and small businesses.

This project offers designing and deployment of an easy, cheap, and effective fire detection system that is capable of achieving simple deployment in diverse environments. The system can be used with the MQ2 gas sensor which can detect smoke, flammable gases and other elements that can be burned in the air and the DHT11 sensor that can measure the temperature and humidity. These two sensors will be used together by which the system will be able to detect the presence of smoke and the abnormal increase of temperature thus provide a more complete fire detection system.

As soon as a smoke concentration has surpassed a safe level that is predetermined, a led is switched on, warning the occupants about a possible fire. The temperature sensor provides an additional safety measure since a quick rise in temperature may also mean the presence of a fire even before massive smoke has been produced. The two sensors design improves the credibility and precision of the system, lowering chances of false alarms and appropriate alerts become timely.

2.PROBLEM STATEMENT AND OBJECTIVES

2.1 Problem Statement

In residential, commercial and industrial locations, fire hazards may occur unpredictably owing to a number of sources, including electrical errors, gas leakage, unattended cooking, or accidents in the laboratory. Such accidents may cause serious property damage, injuries or even deaths. Although traditional fire alarm systems are useful in fire detection, it can be costly, complex to install and is heavily dependent on advanced infrastructure and therefore is inaccessible by a small home, school, laboratory and other small business

The need to have a simple, cost-effective, and efficient fire detection system, which could effectively monitor early conditions leading to fire including smoke or unusual rise in temperature and automatically alert the occupants, has been on the increase. This type of system must be simple to install, and it needs to have minimum maintenance and be able to provide real-time monitoring in places where the traditional systems are highly inappropriate or too expensive.

2.2 Objectives

The main objectives of this project are:

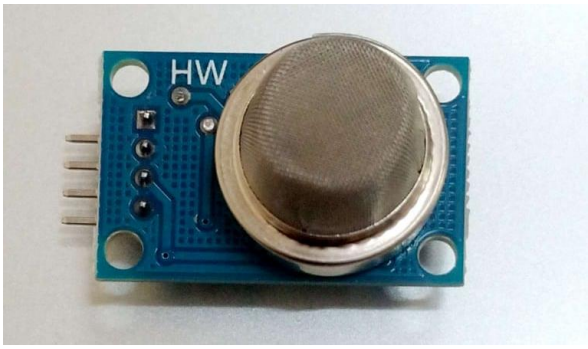
1. To detect smoke and combustible gases using the MQ2 sensor.
2. To monitor environmental temperature and humidity using the DHT11 sensor.
3. To trigger a light/buzzer alarm during fire-risk conditions.
4. To display real-time sensor readings through the Serial Monitor.

3.THEORETICAL BACKGROUND

3.1 MQ2 Smoke Sensor

The MQ2 sensor is widely used for detecting smoke, LPG, methane, propane, hydrogen, and other combustible gases.

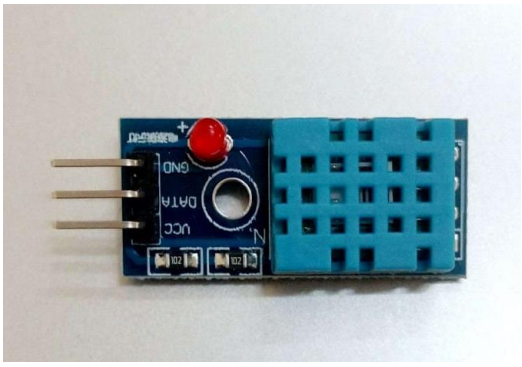
1. It provides an **analog output** proportional to smoke concentration.
2. As smoke increases, output voltage increases.
3. MQ2 uses a heating element and a metal-oxide semiconductor for gas detection.



3.2 DHT11 Temperature & Humidity Sensor

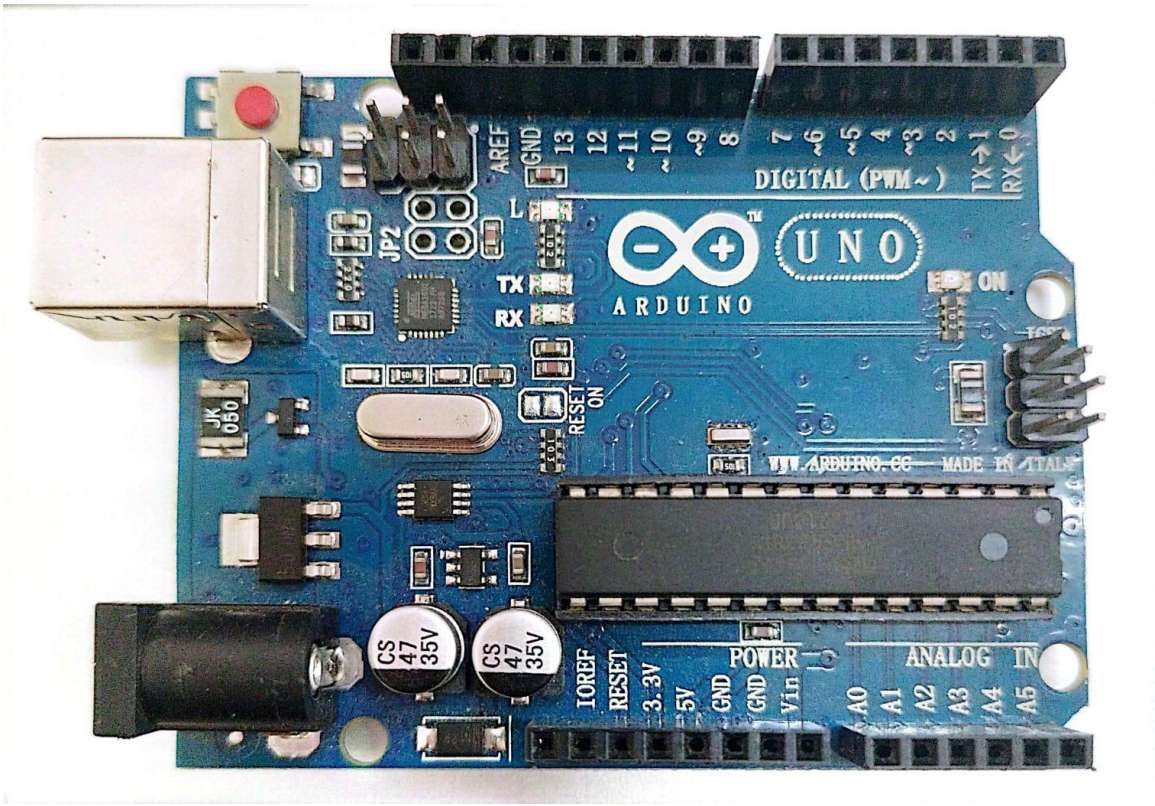
The DHT11 is a basic digital sensor used for measuring temperature and humidity.

1 It outputs calibrated digital data.
2 High temperature combined with smoke is a strong indicator of fire.



3.3 Arduino Microcontroller

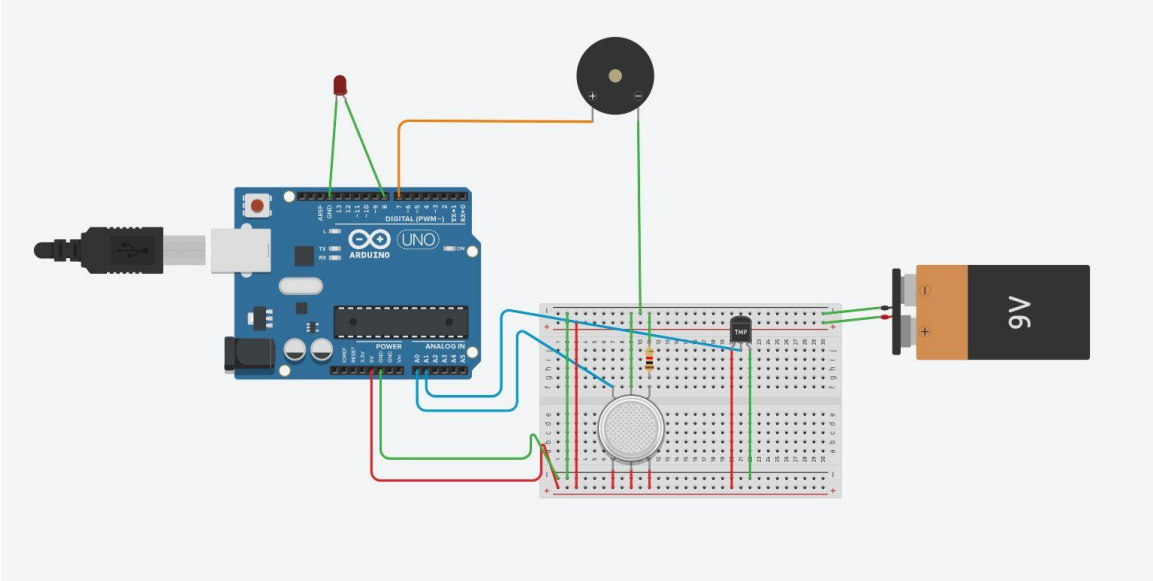
Arduino UNO/Nano acts as the central controller.Reads analog and digital data from MQ2 and DHT11 sensors.Compares sensor readings against predefined fire thresholds.Triggers buzzer when conditions exceed safe limits.Sends real-time data to Serial Monitor for monitoring.



4.SYSTEM ARCHITECTURE AND METHODOLOGY

4.1 System Architecture (Circuit Diagram).

1. MQ2 and DHT11 sensors continuously monitor environmental parameters.
2. Arduino processes the readings.
3. Smoke or heat above threshold → light/buzzer ON.
4. Data displayed for real-time monitoring.



4.2 Methodology

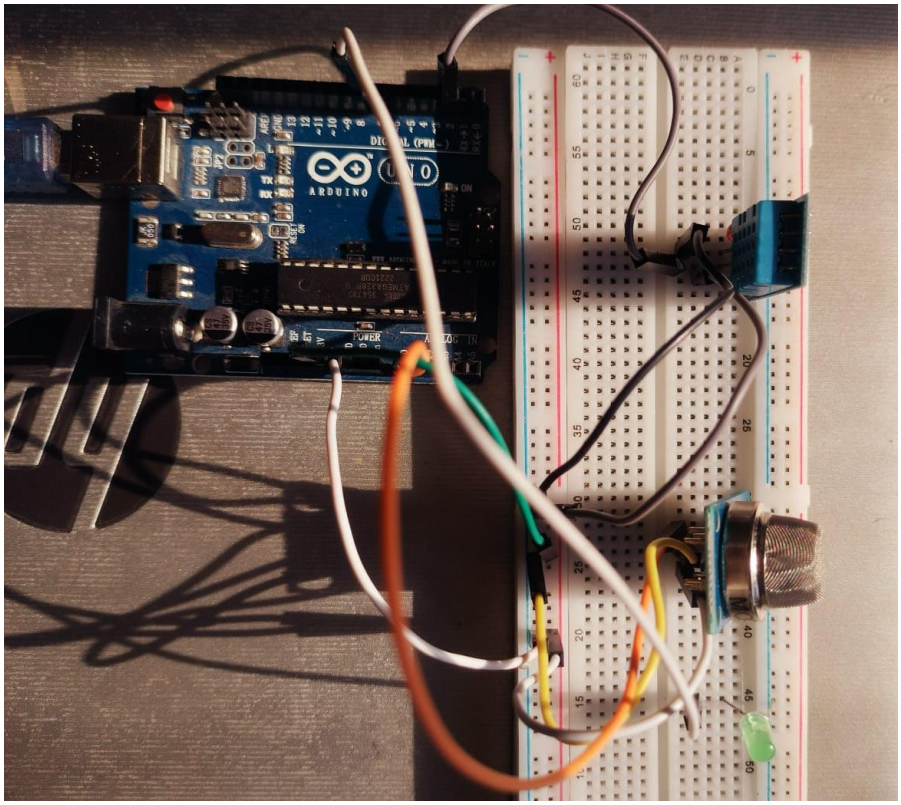
Initialize sensors and serial communication.Read MQ2 analog values for smoke/gas concentration.Read DHT11 digital values for temperature and humidity.Compare smoke values with predefined **SMOKE_THRESHOLD**.If smoke > threshold, activate light.Display all sensor readings on Serial Monitor.Repeat the process continuously for real-time monitoring.

5.IMPLEMENTATION DETALILS

5.1 Arduino code

```
#include <DHT.h>
#define DHTPIN 2
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
int mq2Pin = A0;
int buzzer = 8;
int SMOKE_THRESHOLD = 250;
void setup() {
Serial.begin(9600);
dht.begin();
pinMode(buzzer, OUTPUT);
digitalWrite(buzzer, LOW);
}

void loop() {
  int smokeValue = analogRead(mq2Pin);
  float h = dht.readHumidity();
  float t = dht.readTemperature();

  Serial.print("Smoke: ");
  Serial.print(smokeValue);
  Serial.print("  Temp: ");
  Serial.print(t);
  Serial.print("C  Humidity: ");
  Serial.println(h);

  if (smokeValue > SMOKE_THRESHOLD) {
    // Beeping buzzer
    digitalWrite(buzzer, HIGH);
    delay(200);

  } else {
    digitalWrite(buzzer, LOW);
  }

  delay(500);
}
```

5.2 Implementation



5.2 Working

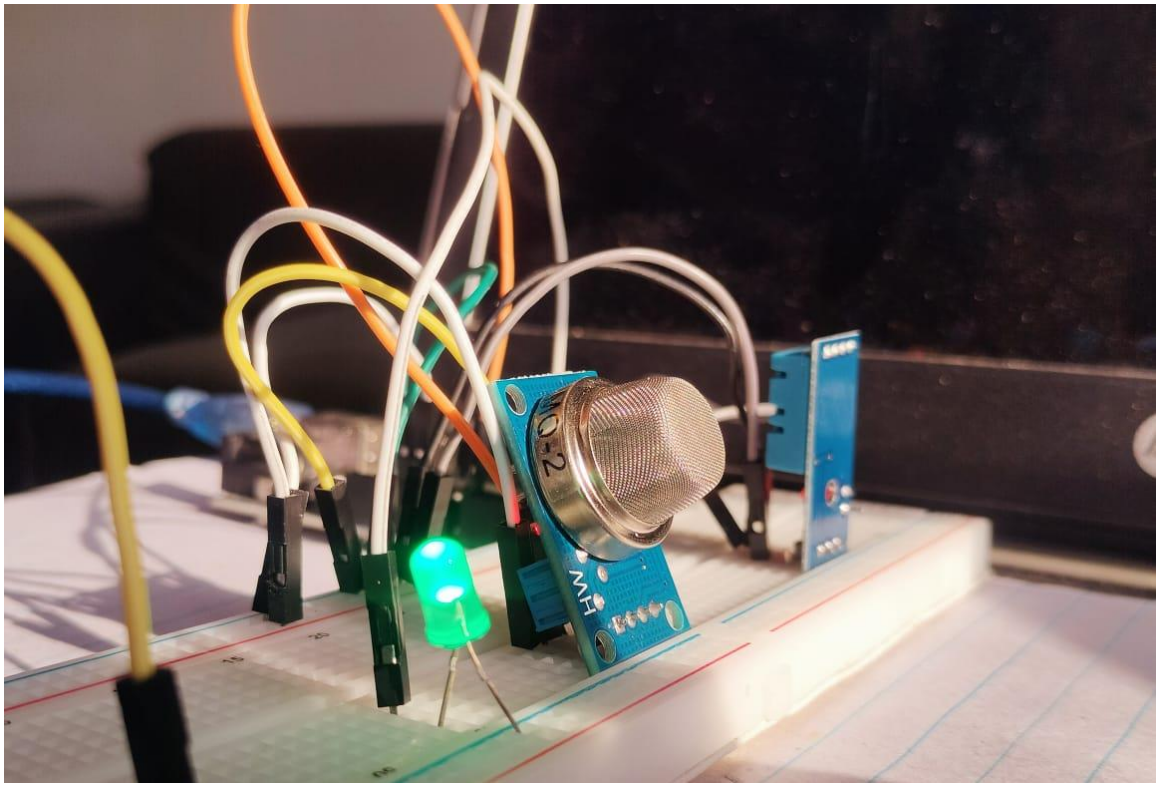
Here is the link of video on full working of project

https://youtube.com/shorts/YEG8zik8eho?si=-5RtPmSyrwhR16-g

6.RESULTS AND DISCUSSION

6.1 Observation

During testing, the **led was activated whenever the smoke level exceeded 350**, which was set as the threshold. Under normal conditions, with no smoke present, the buzzer remained off, indicating correct threshold operation. The **temperature and humidity readings from the DHT11 sensor were updated every second**, allowing continuous monitoring of environmental conditions. The system was able to **detect small-scale fire hazards early**, demonstrating its effectiveness in providing prompt warnings in case of smoke or gas presence.



6.2 Discussion

The **MQ2 sensor responded quickly** to the presence of smoke, ensuring that potential fire hazards were detected immediately. The **DHT11 sensor contributed to system reliability** by monitoring changes in temperature and humidity, which can indicate environmental conditions affecting safety. Overall, the system proved **suitable for indoor safety monitoring and real-time alerts**. It is simple, low-cost, and effective for homes, laboratories, offices, and classrooms.

For larger or industrial-scale applications, the system can be **extended with IoT integration** for remote monitoring or **flame detection sensors** for more accurate detection.

8. CONCLUSION AND FUTURE SCOPE

7.1 Conclusion

The **Fire Detection and Safety Monitoring System** successfully provides early warnings for potential fires. It is **low-cost, easy to implement, and reliable**. With real-time monitoring capabilities, it can be **deployed in various indoor environments** such as homes, schools, laboratories, and offices. The integration of both smoke and environmental sensors ensures accurate and timely alerts, making it an effective safety solution.

7.2 Future Scope

Future improvements can further enhance the system's functionality:

1. **Add LCD or LED displays** to show real-time sensor readings locally.
2. **Integrate IoT alerts** using modules like ESP8266 or ESP32 for mobile notifications.
3. **Include flame sensors** for more accurate fire detection.
4. **Add automatic fire suppression** mechanisms using relay-controlled devices for active response.