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DESIGN AND IMPLEMENTATION OF A FIRE ALARM SYSTEM USING ARDUINO UNO

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ABSTRACT

This project presents a low-cost, efficient fire alarm system utilizing an Arduino microcontroller. The system is designed to detect fire hazards by monitoring environmental temperature and smoke levels through sensors such as the DHT11 (temperature) and MQ-2 (smoke) sensors. When the sensor readings cross predefined thresholds, the Arduino triggers an alarm using a buzzer or activates further safety measures like alert notifications or turning on exhaust fans. This compact and reliable system is ideal for residential, commercial, and industrial safety applications. It demonstrates how embedded systems and sensors can be integrated to provide a real-time, automated fire detection solution.

Keywords: Arduino, Fire Alarm, Smoke Sensor, Temperature Sensor, MQ-2, DHT11, Embedded System, Safety System, Real-time Monitoring, Automation.

1. INTRODUCTION

Fire hazards pose a significant risk to property and human life. Traditional fire alarm systems are often expensive and lack flexibility. The proposed system leverages Arduino technology to provide an affordable and customizable solution. This paper outlines the components, circuit design, and operation of an Arduino-based fire alarm system.

Circuit Design: The system is constructed using the connections illustrated in the image provided. The MQ-2 sensor is connected to the analog input A0 of the Arduino, while the TMP36 temperature sensor connects to A1. The 16x2 LCD is interfaced using digital pins 7, 6, 5, 4, 3, and 2. The buzzer is connected to digital pin 8, and LEDs to pins 9, 10, and 11, respectively. A potentiometer is used to control the contrast of the LCD.

2. METHODOLOGY

The MQ-2 sensor detects the presence of smoke, while the TMP36 sensor monitors the ambient temperature. The Arduino continuously reads data from these sensors. When the smoke level or temperature exceeds a predefined threshold, the system activates the buzzer and lights up the red LED. Simultaneously, the LCD displays a fire alert message. If the readings are within safe limits, the green LED remains on and the system remains in standby mode.

2.1 Hardware Setup :

The system hardware was assembled on a breadboard for prototyping. The sensors, LCD, LEDs, and buzzer were connected to the Arduino UNO as per the designed circuit diagram. Each component was tested individually before integration to ensure functionality.

2.2 Software Development

The Arduino was programmed using the Arduino IDE. Libraries for the LCD and sensor handling were imported. The code includes sensor calibration, threshold comparisons, and control logic for activating alerts. Serial monitoring was used during development for debugging and validation.

3. MODELING AND ANALYSIS

The fire detection model is based on threshold values for smoke (from MQ-2) and temperature (from TMP36). The system was analyzed under different environmental conditions by simulating smoke and heat to observe the system's response. Data readings were recorded and evaluated to ensure accuracy and consistency in detection. The results confirmed the model's

ability to reliably trigger alerts when hazardous conditions were present.

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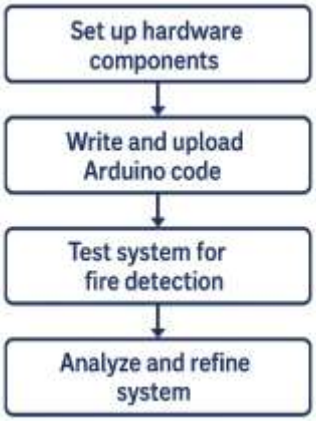
Ardiuno code implementation :




```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
int cel; //for converting the voltage of tmp36 into Celsius
void setup() {
//pinmode setup
pinMode(A0,INPUT);
pinMode(A2,INPUT);
pinMode(7,OUTPUT);
pinMode(10,OUTPUT);
pinMode(9,OUTPUT);
Serial.begin(9600);
lcd.begin(16,2);
}
void loop() {
cel = map(((analogRead(A0) - 20) * 3.04), 0, 1023, -40, 125);
// Convert voltage values to temperature in Celsius
int gas_indi = analogRead(A2);
digitalWrite(10,HIGH);
digitalWrite(9,LOW);
if (gas_indi > 100 || cel >= 58) { // 58 used for fire detection
digitalWrite(10,LOW);
digitalWrite(9,HIGH);
lcd.clear();
lcd.setCursor(0,0);
if (gas_indi > 100) {
lcd.print("Nearby gas");
lcd.setCursor(0,1);
lcd.print("detected!");
delay(1000);
lcd.clear();
lcd.print("Take Precautions!");
delay(1000);
tone(7,400,1000);
}
if (cel >= 58) {
```

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```
lcd.clear();
lcd.setCursor(0,0);
lcd.print("EMERGENCY!");
delay(1000);
lcd.setCursor(0,1);
lcd.print("TAKE CAUTION!");
delay(1000);
tone(7,400,1000);
}
delay(500);
} else {
digitalWrite(10,HIGH);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("ALL CLEAR");
delay(1000);
lcd.setCursor(0,1);
lcd.print("No fire nearby");
delay(1000);
}
}
```

4. RESULTS AND DISCUSSION

The prototype successfully detects smoke and heat. When smoke is introduced or the temperature rises beyond the threshold, the buzzer sounds and the red LED illuminates. The LCD shows real-time temperature and alerts. This confirms the system's reliability in identifying potential fire hazards.

Table 1. Sample Comparison

Criteria	Traditional system	Arduino based system	Smart (IOT based) system
Cost	Hight	Low	High
Ease of installation	Moderate	Easy	Complex
Customization	Limited	High	Moderate
Smoke detection	Yes	Yes (MQ-2 sensor)	Yes
Temperature detection	Rare	Yes (TMP36 sensor)	Yes
User Interface	Siren only	LCD display + Buzzer	Mobile app + Siren
Remote Monitoring	No	No (can be added)	Yes

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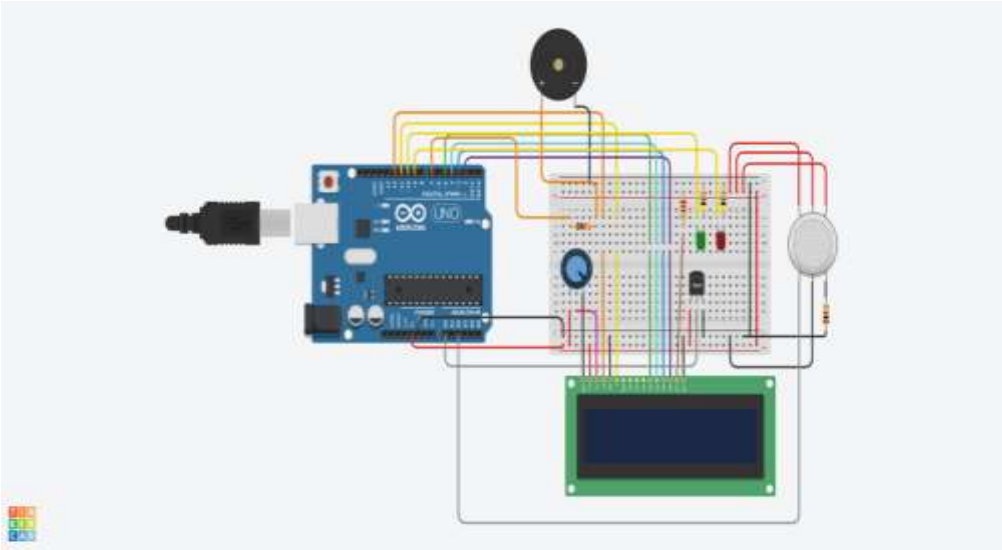

Figure:1 Arduino Board

5. CONCLUSION

This Arduino-based fire alarm system provides an effective and low-cost method for early fire detection. It is ideal for home and small business use, and can be enhanced with GSM modules for SMS alerts or IoT integration for remote monitoring.

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