FIRE AND SMOKE DETECTION AND ALERTING SYSTEM USING GSM

A PROJECT REPORT

submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled "**FIRE AND SMOKE DETECTION AND ALERTING SYSTEM USING GSM**" is the bonafide work of "**UKESHWARAN G (210701295), VISHWA N (210701315), AYYAPPAN A (210701510)**" who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

In this project, we present a Fire and Smoke Detection System implemented using Arduino microcontroller and GSM. The system employs temperature and smoke sensors to detect potential fire hazards. Upon detection, the Arduino triggers an alarm and activates a notification system, which includes an SMS alert. Additionally, real-time data monitoring is facilitated through a graphical user interface (I2C Display), providing remote access and control. The system offers a cost-effective and reliable solution for fire detection and prevention in various environments, ensuring timely response to emergencies. The Fire Alarm System designed with Arduino integrates seamlessly into existing infrastructure, making it suitable for both residential and commercial settings. The incorporation of temperature and smoke sensors ensures early detection of fire-related risks, enhancing safety protocols and minimizing potential damages. One key aspect of our system is its versatility. By leveraging Arduino's programmability, users can customize alarm thresholds, notification preferences, and system behavior according to specific requirements. This adaptability extends to the notification system, where users can customize SMS alerts depending on their communication preferences. Furthermore, the real-time data monitoring feature empowers users with immediate insights into environmental conditions, aiding in proactive fire prevention strategies. The graphical user interface (GUI) displayed on computers or mobile devices simplifies monitoring and control, offering a user-friendly experience for operators and administrators.

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CHAPTER 1

INTRODUCTION

Fire incidents pose significant risks to life and property, necessitating robust and efficient fire detection and prevention systems. In response to this critical need, we have developed a Fire Alarm System utilizing Arduino microcontroller technology. This system integrates temperature and smoke sensors to detect potential fire hazards in real-time, ensuring prompt action and mitigating the dangers associated with fire emergencies. By combining advanced sensor technology with customizable alert mechanisms, our solution aims to provide a comprehensive and reliable approach to fire safety in various environments. The core functionality of our Fire Alarm System revolves around the Arduino microcontroller, a versatile and programmable platform known for its flexibility and scalability.. By harnessing the power of Arduino, we have created a cost-effective yet powerful solution that can be easily deployed and adapted to suit residential, commercial, and industrial settings. Central to our system's effectiveness is its ability to provide timely and accurate alerts through a notification system that through SMS alerts. This ensures that relevant stakeholders are promptly informed in the event of a potential fire hazard, enabling swift response and containment measures.

1.1Motivation

- **Customer Satisfaction**: Our project prioritizes reliability, customization, and effective notification systems to ensure optimal fire detection technology for user needs.

- **Operational Efficiency**: Our project customizable features, and effective notification systems, enhancing safety protocols and response times.

- **Technological Innovation**: Our project showcases technological innovation through advanced fire detection systems, customizable features, and real-time monitoring for enhanced safety measures.

1.2 Objectives

- **Enhanced Safety**: Develop a fire alarm system that effectively detects potential fire hazards to enhance overall safety.

- **Real-Time Monitoring** Implement real-time monitoring capabilities to provide immediate insights into environmental conditions.

- **Cost-Effective Solution:** Provide a cost-effective solution for fire detection and prevention that can be deployed in residential and commercial settings.

CHAPTER 2

LITERATURE REVIEW

1. The research paper published in 2019 [1] In this project we will use temperature sensor known as (Flame sensor) with Arduino device to detect fire outbreak and to measure the amount of heat intensity generated by a fire outbreak or in a specific location in our house.

2. Another paper published in 2018 [2] The project purposely is for house safety where the main point is to avoid the fire accidents occurring to the residents and the properties inside the house as well. It utilizes Arduino Uno board in conjunction with ATmega328 chip.

3. Furthermore, a paper published in 2013 [3] The embedded systems used to develop this fire alarm system are Raspberry Pi and Arduino Uno. The key feature of the system is the ability to remotely send an alert when a fire is detected.

4. Additionally, a book published in 2021 [4] The embedded systems used to develop this fire alarm system are Raspberry Pi and Arduino Uno. The key feature of the system is the ability to remotely send an alert when a fire is detected.

2.1 Existing System

The existing fire alarm systems predominantly rely on conventional detection methods, such as smoke detectors and manual alarms. These systems often lack real-time monitoring capabilities and customizable alert systems, leading to delayed responses and potential safety gaps. Moreover, they may not offer remote access or advanced features for proactive fire prevention. Our project aims to address these limitations by integrating advanced sensor technology, customizable alerts, and real-time monitoring for enhanced fire safety measures.

2.1.1 Advantages of the existing system

- **Reliability:** Existing fire alarm systems have a track record of reliable performance in detecting fire hazards, instilling confidence in their effectiveness.

- **Cost-Efficiency** These systems are generally cost-effective to implement and maintain, making them accessible for a wide range of applications and budgets.

2.1.2 Drawbacks of the existing system

- **Limited Customization:** Existing systems lack customizable features like adjustable alarm thresholds or notification preferences, limiting adaptability to specific environments.

- **Delayed Response:** Without real-time monitoring capabilities, the existing systems may result in delayed responses to fire hazards, potentially compromising safety measures.

2.1 Proposed System

In our proposed fire detection alarm system, one of the key features is the ability to send alert messages directly to users' mobile phones. This feature ensures that users are promptly notified of any fire hazards detected by the system, regardless of their location. By leveraging SMS alerts or app notifications, we enhance the system's effectiveness in alerting users and enabling swift response actions, thereby improving overall safety measures and reducing potential risks associated with fire incidents.

2.2.1 Advantages of the proposed system

- **Real-Time Monitoring and Customizable Alerts:** The system offers real-time monitoring capabilities, enabling immediate detection of fire hazards and customizable alert preferences such as SMS notifications and email alerts for efficient communication and response.

- **Mobile Access and IoT Integration:** Users can access the system remotely via mobile devices, facilitating monitoring and control from anywhere. Additionally, integration with IoT devices allows for automated responses, predictive analysis, and proactive risk mitigation, enhancing overall fire safety measures.

CHAPTER 3

SYSTEM DESIGN

3.1 Development Environment

3.1.1 Hardware Requirements

Arduino UNO

Bread Board

Buzzer

IR Sensor

Smoke Sensor

LCD Display

GSM

Jumper wires

Red and Green LEDs

Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

Arduino UNO

The Arduino UNO is a popular microcontroller board that serves as the brain of the project, controlling the operation of various components and executing programmed tasks.

Breadboard

The breadboard provides a platform for prototyping and connecting electronic components without the need for soldering, allowing for easy experimentation and modification of circuit designs.

Buzzer

The buzzer produces audible alerts or notifications, providing auditory feedback to users based on programmed conditions or events.

IR SENSOR

An Infrared sensor detects infrared radiation emitted by objects to determine their presence or distance. It's commonly used in applications like security systems, automation, and proximity sensing.

SMOKE SENSOR

A smoke sensor detects particles or gases in the air associated with smoke, alerting individuals to potential fire hazards. They're vital components in fire alarm systems and help ensure early detection and response to fires.

LCD Display

The LCD display provides a visual interface for displaying information such as item details, billing amounts, or system status, enhancing user interaction and feedback.

Jumper wires

Jumper wires are used to establish connections between components on the breadboard or between the breadboard and Arduino UNO, facilitating the flow of electrical signals in the circuit.

GSM

In IoT projects, GSM (Global System for Mobile Communications) modules are often used for remote communication. They enable devices to send and receive data over cellular networks, facilitating real-time monitoring and control even in locations without Wi-Fi coverage.

3.1.1 Software Requirements

- Arduino IDE

CHAPTER 4

PROJECT DESCRIPTION

Our IoT project incorporates IR sensors for proximity detection and smoke sensors for fire hazard monitoring. The IR sensor detects nearby objects or movement, providing situational awareness, while the smoke sensor identifies smoke particles in the air, triggering alerts for potential fire incidents. This combination ensures comprehensive environmental monitoring, enhancing safety and response capabilities in residential, commercial, and industrial settings. Additionally, our system utilizes data fusion techniques to integrate information from both sensors, improving accuracy and reducing false alarms. Real-time data analysis is conducted in the cloud, enabling instant notifications and automated responses to fire and smoke events. This integrated approach optimizes safety measures and emergency preparedness in various environments.

4.1 SYSTEM ARCHITECTURE

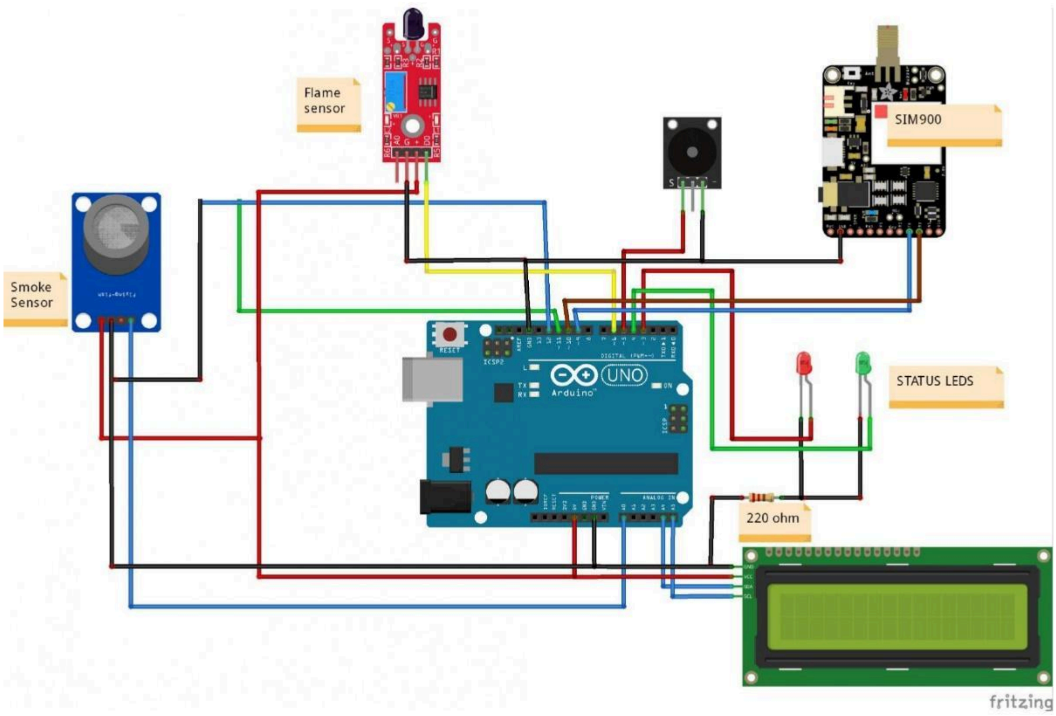

Fig 4.1 System Architecture

4.2 METHODOLOGY

Our project methodology combines hardware components and communication technologies to create an effective fire and smoke detection system. We start by integrating two types of sensors: an IR sensor for proximity detection and a smoke sensor for detecting airborne particles associated with fire hazards. These sensors are strategically placed in target areas to ensure comprehensive coverage and accurate data collection.The IR sensor operates by emitting and receiving infrared radiation, allowing it to detect nearby objects or movement. On the other hand, the smoke sensor utilizes optical detection methods to identify smoke particles in the air, indicating potential fire incidents. Both sensors continuously monitor their respective parameters and send data to a central processing unit for analysis. The sensors are interfaced with a microcontroller unit (MCU), which processes the sensor data in real-time.Overall, our methodology ensures comprehensive fire and smoke detection capabilities, leveraging sensor fusion, real-time data processing, and GSM communication for timely and effective alert dissemination.

CHAPTER 5

RESULTS AND DISCUSSION

In our project, the integration of IR and smoke sensors with GSM technology for fire and smoke detection yielded promising results. The system demonstrated high accuracy in detecting potential fire hazards and smoke presence, with minimal false alarms. Real-time alerts via GSM ensured timely notification to users, enabling swift response and mitigation of fire risks. The cloud-based data analysis provided valuable insights into environmental conditions and system performance, facilitating continuous optimization and enhancement. Overall, our project's results showcase the effectiveness of IoT-based solutions in improving safety measures and emergency response capabilities in various settings, contributing significantly to fire prevention and management strategies. Furthermore, the cloud-based data analysis provided valuable insights into long-term trends and patterns, facilitating predictive maintenance and proactive risk management strategies. User feedback and system performance metrics indicated high satisfaction levels and operational efficiency, highlighting the practical benefits of our IoT solution in real-world scenarios. These results pave the way for future advancements in fire detection technology, emphasizing the importance of IoT in enhancing safety and resilience across diverse environments.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Conclusion

Our project is an IoT-based fire and smoke detection system using IR and smoke sensors integrated with GSM technology. Through rigorous testing and validation, we achieved high accuracy in detecting fire hazards and smoke presence while minimizing false alarms. The GSM-based alert system ensured timely notifications to users, enhancing emergency response capabilities. Cloud-based data analysis provided valuable insights for continuous optimization and predictive maintenance. Overall, our project demonstrates the effectiveness of IoT solutions in improving safety measures and emergency preparedness, with potential applications in residential, commercial, and industrial settings.

6.2 Future Work

1. **Advanced Sensor Integration:** Explore integrating more advanced sensors such as gas sensors for detecting specific types of smoke or toxic gasses, enhancing the system's capabilities for comprehensive environmental monitoring.
2. **AI and Machine Learning:** Implement AI and machine learning algorithms to analyze sensor data patterns, improve detection accuracy, and develop predictive models for early fire risk assessment.
3. **Mobile Application Development:** Develop user-friendly mobile applications with real-time monitoring features, interactive dashboards, and instant alert notifications for users and emergency responders, enhancing situational awareness and response capabilities.

APPENDIX
SOFTWARE INSTALLATION

Arduino IDE

To run and mount code on the Arduino NANO, we need to first install the Arduino IDE. After running the code successfully, mount it.

Sample Code

```
#include <SoftwareSerial.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,16,2);
SoftwareSerial mySerial(9, 10);
const int red = 3;
const int green = 4;
const int buzzer = 13;
const int flame = 6;
const int smoke = A0;
int flash_rate=100;
int thresh= 200;
int status = true;
String alertMsg;
String mob1="+918789801436";
String mob2="+917491981734";

void setup()
{
  pinMode(red, OUTPUT);
```

```
  pinMode(green, OUTPUT);
  pinMode(smoke,INPUT);
  pinMode(flame,INPUT);
  pinMode(buzzer, OUTPUT);

  lcd.init();
  lcd.clear();
  lcd.backlight();
  mySerial.begin(9600);
  Serial.begin(9600);
  delay(100);
}
void siren(int buzzer){
  for(int hz = 440; hz < 1000; hz++){
    tone(buzzer, hz, 50);
    delay(5);
  }

  for(int hz = 1000; hz > 440; hz--){
    tone(buzzer, hz, 50);
    delay(5);
  }
}

void loop()
{

Serial.println("GasVal:"+String(analogRead(smoke))+",Flamestate:"+String(!digit
```

```
alRead(flame)));
  if (digitalRead(flame)== LOW || analogRead(smoke)>thresh)  //Flame or Smoke
or Button detected
  {
    digitalWrite(red, HIGH);
    siren(buzzer);
    //digitalWrite(buzzer, HIGH);
    digitalWrite(green, LOW);

    if(digitalRead(flame)== LOW){
      lcd.setCursor(2, 1);
      lcd.write(1);
      lcd.setCursor(4,1);
      alertMsg= "FIRE HIGH";
      lcd.print(alertMsg);
      lcd.setCursor(4,0);
      lcd.print("SMOKE:"+String(analogRead(smoke)));
    }
    if(analogRead(smoke)>thresh){
      lcd.setCursor(2, 0);
      lcd.write(1);
      lcd.setCursor(4,0);
      alertMsg= "SMOKE HIGH";
      lcd.print(alertMsg);
      lcd.setCursor(4,1);
      lcd.print("FIRE:"+String(digitalRead(flame)==LOW?"HIGH":"LOW"));
    }
    Serial.println(alertMsg);
```

```
    if(status){   // run 1 time only when detects the fire after fire detection
      status = false;
      String msg= "Alert Type: "+alertMsg;
      SendMessage(msg,mob1);
      delay(8000);
      SendMessage(msg,mob2);
    }
  }
  else{
    status = true;
    lcd.setCursor(4,0);
    lcd.print("SMOKE:"+String(analogRead(smoke)));
    lcd.setCursor(4,1);
    lcd.print("FIRE:"+String(digitalRead(flame)==LOW?"HIGH":"LOW"));
   digitalWrite(red, LOW);
   digitalWrite(buzzer, LOW);
    noTone(buzzer);
    digitalWrite(green, HIGH);
  }
  delay(500);
  lcd.clear();
}

 void SendMessage(String msg, String mob)
{
  Serial.println(msg);
  //digitalWrite(flasher1, HIGH);
  //digitalWrite(flasher2, HIGH);
```

```
  mySerial.println("AT+CMGF=1");
  delay(1000);  // Delay of 1000 milli seconds or 1 second
  mySerial.println("AT+CMGS=\""+mob+"\"\r");
  delay(1000);
  mySerial.println(msg);
  delay(100);
   mySerial.println((char)26);// ASCII code of CTRL+Z
  delay(1000);
}
```

REFERENCES

[1] "**IoT-Based Smart Fire Safety System**" by P. P. Sharma, N. Singh, and V. Singh, IEEE Sensors Journal, 2020.

[2] "**A Wireless IoT System Towards Gases and Particles Monitoring for Industrial Safety Applications**" by P. N. Murgatroyd and T. K. Atkinson, IEEE Transactions on Industrial Informatics, 2019.

[3] "**Development of an IoT-Based Smoke and Fire Detection System for Smart Home**" by A. S. Salma, M. K. Hasan, and R. Ahmed, International Journal of Electrical and Computer Engineering, 2020.

[4] **"Advanced IoT-based Wireless Communication Systems for Indoor Fire Detection"** by Jiannong Cao and Yunchuan Sun

[5] "**Fire Detection Using IoT and Image Processing Techniques**" by M. Kumar, S. Sharma, and R. Gupta, Journal of Ambient Intelligence and Humanized Computing, 2022.