A real time project report

on

FLAME DETECTION USING ARDUINO

Project report submitted in partial fulfillment of the requirement for the award of the Degree of B. Tech

By

Ushaswini(22241A0462)

Sohan reddy(22241A0453)

Sai Abhinay(22241A0463)

Under the Guidance

Of

MS Y PRIYANKA

Asst. Professor, Department of Electronics and Communication Engineering

Department of Electronics and Communication Engineering

Gokaraju Rangaraju Institute of Engineering and Technology

(AICTE Approved; Autonomous under JNTU)

Bachupally , Kukatpally, Hyderabad-500090

Gokaraju Rangaraju Institute of Engineering & Technology

Department of Electronics and Communication Engineering

<u>CERTIFICATE</u>

This is to certify that this thesis entitled "**FIRE DETECTION USING ARDUINO**" submitted by **USHASWINI** (22241A0462), **SOHAN REDDY** (22241A0453), **SAI ABHINAY** (22241A0463), in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electronics and Communication Engineering of JNTUH, during the academic year 2023- 24, is a bonafide record of research work carried out by his/her under our guidance and supervision. The contents of this thesis, in full or in parts, have not been submitted to any other university or Institution for the award of any degree or diploma.

Ms. Y Priyanka	**Faculty**	**Dr Usha Kumari**
Internal Guide	Project Evaluation Coordinator	Head of the Department

DECLARATION

I hereby declare that the real time project entitled **“FLAME DETECTION USING ARDUINO”** is the work done during the period from **Jan 2024 to June 2024** and is submitted in the partial fulfillment of the requirements for the award of Bachelor of Technology in Electronics and Communication Engineering from Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous under Jawaharlal Nehru Technology University, Hyderabad). The results embodied in this project have not been submitted to any other university or Institution for the award of any Degree or Diploma.

Ushaswini(22241A0462)

Sohan reddy(22241A0453)

Sai Abhinay(22241A0463)

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Finally, I would like to convey my sincere thanks to each and every person who have supported and helped me for the success of the project.

Ushaswini(22241A0462)
Sohan reddy(22241A0453)
Sai abhinaya(22241A0463)

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ABSTRACT

Fire safety is a paramount concern in both residential and industrial settings. This project presents a comprehensive approach to flame detection using an Arduino microcontroller integrated with flame sensors. The objective is to design a responsive, efficient, and cost-effective system capable of early fire detection to prevent potential hazards and damages.

Flame sensors are devices designed to detect the presence of fire or flame. They operate by responding to specific wavelengths of light emitted by a flame. Integrating these sensors with Arduino, an open-source electronics platform, offers a versatile solution for flame detection and fire prevention applications.

The primary objective is to develop a system capable of detecting the presence of a flame and triggering an appropriate response to mitigate potential fire hazards

Keywords: flame detection, potential hazards, flame sensors, Arduino, sensor integration.

LIST OF FIGURES

LIST OF ACRONYMS

Arduino UNO	Arduino Universalis
LED	Light Emitting Diode

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Fire detection is a critical safety component in various settings, including homes, industries, and public spaces. Early detection of fires can help prevent damage, injury, and even loss of life. Traditional fire detection systems can be expensive and complex, but with the advent of microcontrollers like Arduino, it is now possible to create a cost-effective and efficient fire detection system.

This project aims to design and develop a fire detection system using Arduino, which can detect fires accurately and promptly alert users. The system will utilize sensors to detect temperature, smoke, and flame, and will trigger an alarm and notification system in the event of a fire. The system's accuracy, reliability, and ease of use make it a promising solution for fire detection in various applications.

1.2 FEATURES

- **Real time detection.**
- **Sensor integration.**
- **Low cost.**
- **Power efficiency.**
- **Low maintenance and Easy installation.**

1.3 PROBLEM DEFINITION

The main aim of the project is to detect the flame presence and take appropriate action when detected.

1.4 OBJECTIVE

- **Early detection**

To detect flames at an early stage, allowing for prompt action to prevent damage and potential harm.

- **Accurate detection**

To accurately detect flames and distinguish them from other light sources or false triggers.

- **Real-time alerting**

To trigger alarms and notifications in real-time, alerting users to potential fires.

- **Automation**

To automatically trigger fire suppression systems or shut off power supplies in the event of a fire.

- **Cost-effectiveness**

To provide a cost-effective solution for flame detection, compared to traditional systems.

- **Portability**

To create a portable and compact flame detection system, suitable for various applications.

- **Ease of use**

To design a user-friendly system, easy to assemble, program, and operate.

- **Reliability**

To ensure the system's reliability and durability, with minimal false alarms and accurate detection.

- **Customizability**

To allow users to adjust sensitivity, alarm thresholds, and notification settings to suit specific needs.

- **Integration**

To integrate with other safety systems, such as fire alarms, security cameras, and emergency response systems.

CHAPTER 2

LITERATURE REVIEW

2.1 Wireless Sensor Networks for Building Fire Emergency Detection and Response Seán g Murphy, Lanny Sitanayah, Tatiana Maria Tabirca, Thuy Truong, Ken Brown, and Cormac J.

Wireless sensor networks (WSNs) offer a low-cost alternative for maintenance and installation, and building refurbishment and retrofitting are especially simple with wireless technology. Fire emergency detection and response in building environments is a fresh application area for wireless sensor network deployment.For successful building automation in such a sensitive context, fast data capture, detection, and response are required. This paper provides an overview of our recent research in this area. First, we will discuss research on communication protocols that are appropriate for this problem. The work on the use of WSNs to improve fire evacuation and navigation is then described.

2.2 Avoidance of a Train Fire Using a ZigBee Wireless Sensor Network M. Praveen Kumar1, R. Pitchai Ramasamy1, S. Sarath Kumar2, and R. Raghu Raman3:

The primary goal of our suggested system is to protect people's lives and government property. This study will concentrate on the system that will detect and control railway fires. Real-time monitoring of internal characteristics such as temperature and humidity in each coach is possible. The relevant system or engine driver can make faster decisions for firefighting, alarms, and automatic water sprinkler system based on the information acquired by the sensor system. The engine driver will stop the train and take the necessary action after getting the signal.

Fire alarm system, fire prevention systems, wireless sensor network, automatic sprinklers, signal transmission are some of the terms used.

Trains are medium-sized vehicles used to transport people and commodities. People generally prefer rail travel for larger distances because it is less expensive. The Indian Railways has not taken fire accidents seriously since the introduction of trains for passenger transit. The only preventative signs regarding the fire in each compartment are "Do not smoke" and "Do not carry inflammable material." However, fire accidents in trains occur regularly due to failures in the routine maintenance system or the activity of illicit social elements.

2.3 AUTOMATIC FIRE DETECTION: A SURVEY FROM A WIRELESS SENSOR NETWORK PERSPECTIVE Majid Bahrepour, Nirvana Meratnia, and Paul Having a Pervasive Systems Group, University of Twente:-

Automatic fire detection is critical for detecting and fighting fires as soon as possible. Numerous investigations have been conducted to determine the optimum sensor combinations and acceptable approaches for early fire detection. In past studies, fire detection was either considered an application of a certain field (e.g., event detection for wireless sensor networks) or the primary concern for which approaches were specifically devised (e.g., fire detection utilising distant sensing techniques). These various techniques arise from the diverse backgrounds of fire researchers, which include computer science, geography and earth observation, and fire safety. In this study, we examine prior studies from three perspectives:(1) fire detection strategies for residential areas, (2) forest fire detection techniques, and (3) sensor network contributions to early fire detection

There are numerous challenges in automatic fire detection, the most important of which are diverse sensor combinations and appropriate techniques for rapid and noise tolerant fire detection. Fires have been studied by scientiststaking place in diverse locations such as residential areas (Milke and McAvoy 1995), forests (Yu, Wang et al. 2005; Bagheri 2007), and mines (Tan, Wang et al. 2007) to identify some methods for fire monitoring.

2.4 SUMMARY

The prototype created in this work allows a user to remotely control the fire alarm system. This is useful if the user is not in the building or is ignorant of the emergency situation. The use of this prototype will prevent an unanticipated or critical circumstance from arising in residential locations without the resident's knowledge. The home alert system is demonstrated to be operational by activating the fire extinguisher. It was discovered that using a connected sensor of a temperature sensor and a smoke detector was more appropriate than using only one of them. Though the prototype was successful in extinguishing the fire, portability can be substantially enhanced by efficient assimilation of the various elements. This system should also ensure that each module can be simply replaced by a better sensor and equipment with updated technology. The microcontroller can be programmed with the contact information for local authorities and fire departments. Because of its versatility and ease of use, the proposed prototype can be used in smart cities (for example, dwellings, hostels, hotel industries, and factories).

CHAPTER 3

PROPOSED METHODOLOGY

3.1 System overview

Creating a fire detection system with an Arduino and a flame sensor is a great project for hobbyists and those looking to understand the basics of electronic sensors and alarms. It demonstrates the potential of simple components and how they can be used to create life-saving systems. With the right setup and programming, anyone can build a basic fire detection system that increases safety and provides a quick response to potential fire outbreaks.

3.2 Requirement engineering

3.2.1 Hardware requirements

>> Flame sensor

A flame-sensor is one kind of detector which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The flame detection response can depend on its fitting. It includes an alarm system, a natural gas line, propane & a fire suppression system. This sensor is used in industrial boilers. The main function of this is to give authentication whether the boiler is properly working or not. The response of these sensors is faster as well as more accurate compare with a heat/smoke detector because of its mechanism while detecting the flame.

Figure 3.1 flame sensor

>>Arduino UNO

Arduino UNO is a microcontroller board based on the **ATmega328P**. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

FEATURE

~ Replaceable chip

The ATmega328P can easily be replaced, as it is not soldered to the board.

~ EEPROM

The ATmega328P also features 1kb of EEPROM, a memory which is not erased when powered off.

~ Battery Connector

The Arduino UNO features a barrel plug connector, that works great with a standard 9V battery.

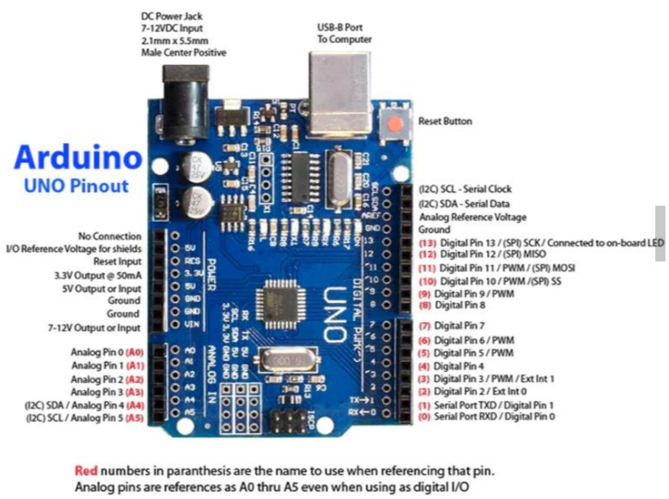


Figure 3.2 Arduino UNO

>>LEDs

To visually indicate the flame detection.

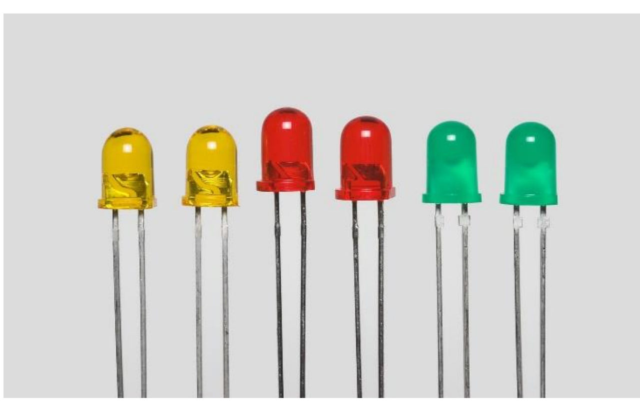


Figure 3.3 LEDs

>>Buzzer

To provide an audible alarm when the fire is detected.

Figure 3.4 Buzzer

>>Breadboard

A breadboard (sometimes called protoboard) is essentially the foundation to construct and prototype electronics.

Figure 3.5 Bread board

>>Jumper wires

To establish connections .

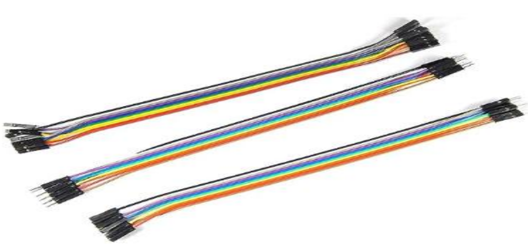


Figure 3.6 Jumper wires

3.2.2 Software Requirements

Arduino IDE software

The Arduino IDE is an open-source software platform used for writing and uploading code to the Node MCU. It supports various libraries and provides a user-friendly interface for coding and debugging.

3.3 Circuit Design

Designing a flame detection circuit with Arduino involves connecting a flame sensor, a buzzer, and optionally an LED’s for visual indication. Here’s a step-by-step guide to creating the circuit

Connections

1.Flame sensor

- **VCC: Connect to the 5V pin on the Arduino.**
- **GND: Connect to the GND pin on the Arduino.**
- **D0: Connect to the digital pin 11 on the Arduino.**

2.Buzzer

- **Positive Terminal (+)**: Connect to digital pin 12 on the Arduino.
- **Negative Terminal (-)**: Connect to the GND pin on the Arduino.

3.LED(green)

- Cathode (-)**: Connect to the GND pin on the Arduino**
- **Anode(+):Connect to digital pin 6 on the Arduino.**

4.LED(red)

- Cathode (-)**: Connect to the GND pin on the Arduino.**
- Anode (+)**: Connect to digital pin 5 on the Arduino.**

3.4 WORKING PRINCIPLE

Sensor Detection:

- The flame sensor detects the presence of a flame by measuring the IR radiation within a specific wavelength range.
- Flame sensors typically have a photodiode or phototransistor that is sensitive to IR light. When IR radiation from a flame hits the sensor, it generates a current proportional to the intensity of the radiation.

Signal Processing:

- The analog output from the flame sensor is fed into one of the analog input pins of the Arduino.
- The Arduino reads the sensor's analog output as a voltage value, which corresponds to the intensity of the IR radiation.

Response Actions:

- When the sensor reading exceeds the threshold, the Arduino triggers predefined actions.
- Common responses include:
  - Activating a buzzer or alarm to alert occupants.
  - Turning on LED to indicate the presence of a flame.
  - Activating other safety measures, such as shutting down equipment or triggering a fire suppression system.

CHAPTER 4

IMPLEMENTATION

CONNECTIONS

Step 1: Connect the flame sensor

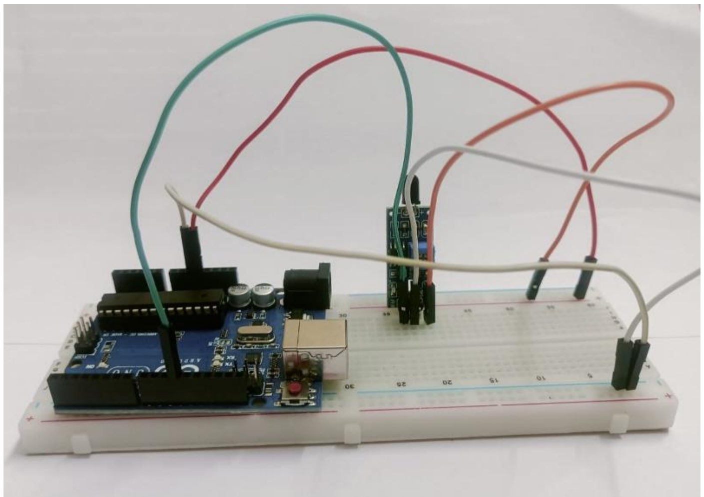


Figure 4.1 step-1

Step 2: Connect LEDs

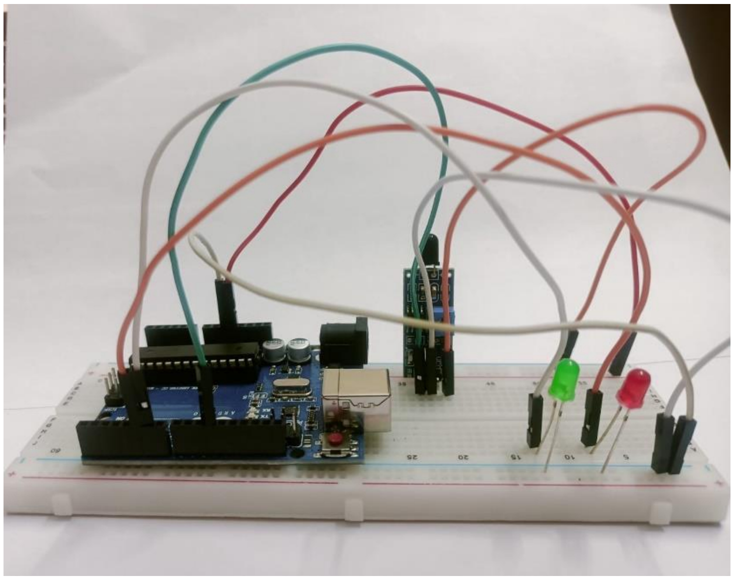


Figure 4.2 step-2

Step 3:connect the buzzer

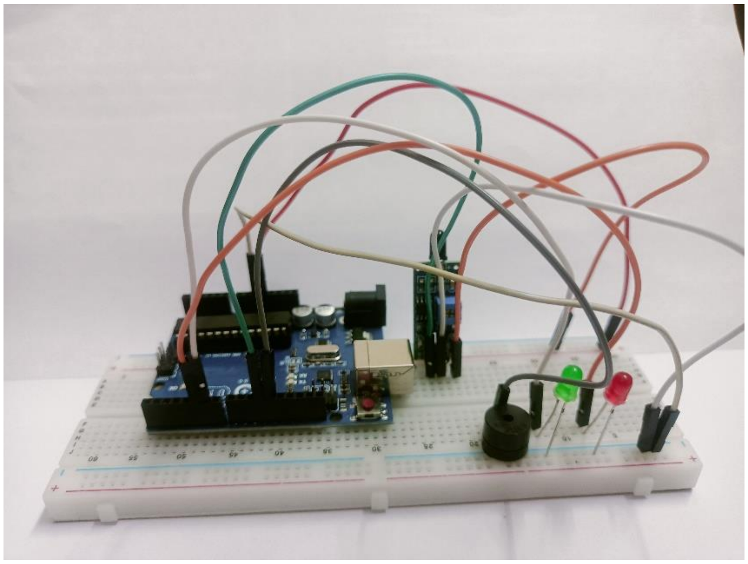


Figure 4.3 step-3

Step 4:Give power supply

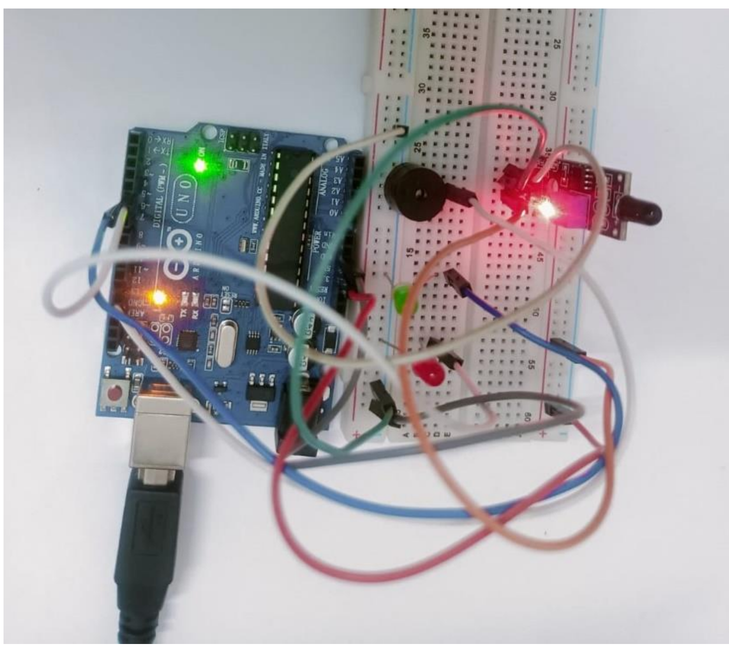


Figure 4.4 step-4

PROGRAM:

```
const int buzzerPin = 12; // Pin connected to the buzzer
const int flamePin = 11;  // Pin connected to the flame sensor
int Flame = HIGH;         // Variable to store the flame sensor state
int redled = 5;           // Pin connected to the red LED
int greenled = 6;         // Pin connected to the green LED
void setup() {
  pinMode(buzzerPin, OUTPUT); // Set buzzer pin as output
  pinMode(redled, OUTPUT);    // Set red LED pin as output
  pinMode(greenled, OUTPUT);  // Set green LED pin as output
  pinMode(flamePin, INPUT);   // Set flame sensor pin as input
  Serial.begin(9600);         // Initialize serial communication at 9600 baud rate
}
void loop() {
  Flame = digitalRead(flamePin); // Read the state of the flame sensor
 if (Flame == LOW) // If fire is detected  {
    digitalWrite(buzzerPin, HIGH);    // Turn on the buzzer
    digitalWrite(redled, HIGH);       // Turn on the red LED
    digitalWrite(greenled, LOW);      // Turn off the green LED
  }
  else // If no fire is detected {
    digitalWrite(buzzerPin, LOW);   // Turn off the buzzer


    digitalWrite(greenled, HIGH);   // Turn on the green LED
    digitalWrite(redled, LOW);      // Turn off the red LED
  }
}
```

CHAPTER 5

RESULTS AND DISCUSSIONS

Benefits

1. **Cost-Effectiveness**: Arduino boards and sensors are relatively inexpensive, making the overall system affordable.
2. **Flexibility and Customization**: Arduino's programmable nature allows for easy customization of detection parameters and response actions.
3. **Ease of Integration**: Arduino can integrate with various sensors and communication modules, enabling the development of comprehensive fire detection systems.
4. **Scalability**: Systems can be easily expanded to include additional sensors or functionalities as needed.
5. **Community and Support**: The extensive Arduino community provides resources, support, and inspiration for developing and troubleshooting projects.

Challenges and Limitations

Despite the advantages, there are challenges associated with Arduino-based fire detection systems:

1. **Sensor Sensitivity and Accuracy**: The performance of the system heavily relies on the quality and calibration of the sensors used.
2. **Environmental Interference**: Factors such as dust, humidity, and ambient light can affect sensor accuracy and lead to false alarms.
3. **Power Consumption**: In wireless setups, power consumption of sensors and communication modules can be a concern, especially in battery-operated systems.
4. **Scalability Issues**: While Arduino systems are scalable, managing large networks of sensors can become complex and may require more robust microcontroller platforms.

Result

Once you have assembled the circuit and uploaded the code, the flame detection system using Arduino should operate as follows:

Expected Behavior

1. **Initial State**:
    - When the system is powered on, the green LED should light up, indicating that the system is ready and no flame is detected.
    - The red LED and buzzer should remain off in the absence of a flame.
2. **Flame Detection**:
    - When a flame is brought near the flame sensor, the sensor will detect the IR radiation from the flame.

- If the sensor's output falls below the predefined threshold value, the Arduino will:
    - Light up the red LED.
    - Sound the buzzer.
    - Turn off the green LED.

3. **No Flame**:
    - When no flame is present, or the flame is removed, the sensor output will be above the threshold value.
    - The Arduino will:
        - Keep the red LED and buzzer off.
        - Keep the green LED on.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

Conclusion

In summary, the flame detection system using Arduino is a practical and effective solution for enhancing fire safety. Its simplicity, cost-effectiveness, and reliability make it an attractive choice for various applications. By detecting flames early and providing immediate feedback, the system plays a crucial role in preventing fire-related accidents and ensuring the safety of people and property. The potential for further enhancements and integration with other safety systems makes this an invaluable tool in modern fire detection and prevention strategies.

Future Directions

Future research and development in Arduino-based fire detection systems could focus on:

1. **Enhanced Sensor Integration**: Developing systems that integrate more advanced sensors and machine learning algorithms to improve accuracy and reduce false alarms.
2. **IoT and Cloud Integration**: Leveraging the Internet of Things (IoT) to connect fire detection systems to cloud platforms for real-time monitoring, data analysis, and remote management.
3. **Energy Efficiency**: Designing low-power systems and exploring energy harvesting techniques to extend the battery life of wireless sensors.
4. **Robustness and Reliability**: Improving the durability and reliability of sensors and systems to ensure consistent performance in harsh environments.

Practical Applications

- **Home Safety**: Provides an additional layer of security in residential buildings by detecting flames from candles, fireplaces, or kitchen fires.
- **Industrial Safety**: Enhances fire safety in factories, warehouses, and other industrial settings where flammable materials are handled.
- **Educational Projects**: Serves as an excellent educational tool for students and hobbyists learning about sensors, microcontrollers, and safety systems.
- **Public Spaces**: Can be deployed in public areas such as shopping malls, schools, and hospitals to improve fire safety measures.

REFERENCES

1. **"Arduino Cookbook" by Michael Margolis**
    a. This book offers a comprehensive guide to using Arduino for various projects, including sensor integration and real-world applications.
    b. ISBN: 978-1449313876
2. **"Arduino Project Handbook: 25 Practical Projects to Get You Started" by Mark Geddes**
    a. Contains practical projects and detailed instructions, useful for beginners and advanced users alike.

    b. ISBN: 978-1593276904
3. **Arduino Official Website**:
    a. Arduino Documentation
    b. Provides official documentation, tutorials, and forums for troubleshooting and community support.
4. **SparkFun Electronics**:
    a. SparkFun Tutorials
    b. Offers tutorials on using various sensors with Arduino, including flame sensors.
5. **Adafruit Learning System**:
    a. Adafruit Tutorials
    b. Contains step-by-step guides and project ideas involving Arduino and sensors.
6. **Instructables**:
    a. Flame Detection Projects on Instructables
    b. A community-driven platform with numerous DIY projects and detailed guides for using flame sensors with Arduino.
7. **"Design and Implementation of Fire Detection System" by M. K. Abdullah and S. A. Kader**:
    a. A research paper discussing the design and implementation of fire detection systems using various sensors.
    b. Available on IEEE Xplore.
8. **Flame Sensor Module Datasheet**:
    a. Provides technical specifications, pin configurations, and application notes for flame sensors.
    b. Available from various manufacturers such as Keyes, DFRobot, etc.
9. **Arduino Uno Datasheet**:
    a. Technical details and pin configurations for the Arduino Uno board.
    b. Available on the Arduino official website.

ACKNOWLEDGEMENT

This work has been in part supported by the provision of a student database and input video of students in the classroom by the Department of Electronics and Communication Engineering at Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad, India.

APPENDIX-1

WHEN NO FLAME DETECTED

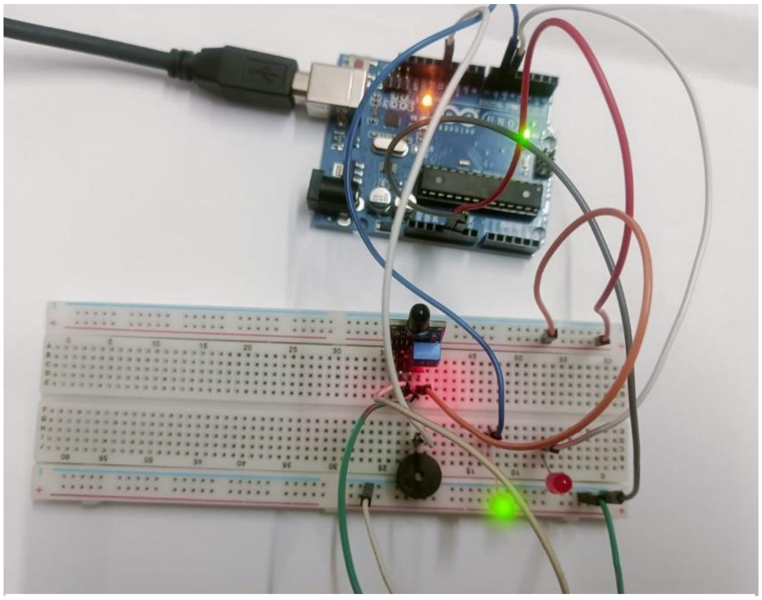
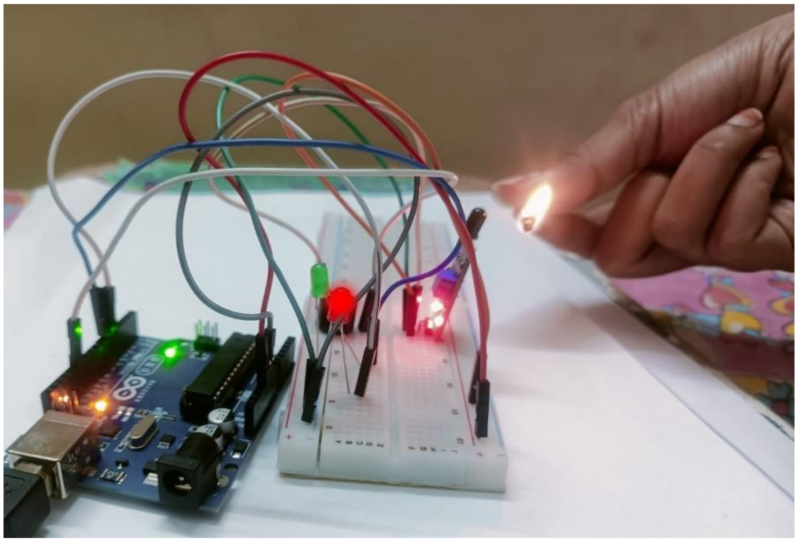


Figure 6.1 no flame detected



WHEN FLAME DETECTED

Figure 6.2 flame detected

Project Outcomes -Course Outcomes- Program Outcomes (GR20) Mapping				
S.No	**Project Outcomes**	**CO**	**PO/ PSO**	**Blooms Level**
1		CO1		
2		CO2		
3		CO3		
4		CO4		
5		CO5		

Program Outcomes (GR20):

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, Engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes (PSOs)

PSO1: Comprehend and analyze real-time engineering problems of communication, signal processing, VLSI and Embedded systems by applying the fundamental concepts of Electronics.

PSO2: Demonstrate proficiency in utilization of modern hardware and software tools along with analytical implementation skills to arrive at appropriate solutions.

Appendix II

Plag report (done at GRIET)

Appendix- III

Full Paper (Published or accepted)

Receipt of Payment

Review Comments

Acceptance letter

Proceedings if published