SMOKE DETECTOR USING MQ-2 SENSOR

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this Thesis titled **"SMOKE DETECTOR USING MQ-2 SENSOR**" is the bonafide work of "**LAKSHMI KANTH M(2116210701130), MADAN A C (2116210701136), MOHAMMED SAJJAD (2116210701162)"** 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

The increasing concerns regarding fire safety have led to the development of advanced smoke detection systems. This project focuses on designing and implementing a smoke detector using the MQ-2 gas sensor, which is capable of detecting smoke and flammable gases. The system integrates the MQ-2 sensor with an Arduino Uno, providing a cost-effective and efficient solution for early fire detection. The main components utilized in this project include the MQ-2 sensor, a buzzer, an LED, resistors, and a breadboard, all connected to the Arduino Uno to form a functional smoke detection system.

The MQ-2 sensor is highly sensitive to smoke and various combustible gases, making it ideal for fire detection applications. When the sensor detects smoke, it sends a signal to the Arduino, which then activates the buzzer and LED to alert users. This immediate response mechanism helps in minimizing potential damage and enhances safety measures. The use of the Arduino Uno allows for easy programming and integration of the sensor, enabling the system to be adaptable for various environments.

This project not only demonstrates the practical application of the MQ-2 sensor in smoke detection but also showcases the versatility of the Arduino platform in creating reliable and responsive safety systems. By employing readily available components, the project provides an accessible and affordable solution for enhancing fire safety in homes and workplaces. The development and implementation of this smoke detector highlight the potential of IoT technologies in improving everyday safety and prevention measures.

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CHAPTER 1

INTRODUCTION

In recent years, the importance of fire safety has become increasingly apparent due to the devastating impact of fire-related incidents. Early detection of smoke and hazardous gases is crucial for preventing fires and minimizing damage to property and loss of life. Traditional smoke detectors, while effective, often lack the advanced features and connectivity offered by modern Internet of Things (IoT) solutions. This project aims to bridge this gap by developing a smoke detector using the MQ-2 sensor integrated with an Arduino Uno, providing an efficient and cost-effective solution for early smoke detection and alerting.

The MQ-2 sensor is a versatile gas sensor capable of detecting a wide range of gases, including smoke, methane, butane, and other combustible gases. Its high sensitivity and quick response time make it an ideal component for fire detection systems. By leveraging the capabilities of the Arduino Uno, this project combines the sensor’s detection abilities with programmable logic, enabling the creation of a responsive and customizable smoke detector. The Arduino platform's accessibility and ease of use further enhance the project's feasibility, making it suitable for both hobbyists and professional applications.

This project involves integrating the MQ-2 sensor with additional components such as a buzzer and an LED, which serve as immediate alert mechanisms upon smoke detection. The system is designed to provide audible and visual warnings, ensuring that occupants are quickly informed of potential fire hazards. Through this project, we aim to demonstrate the practical application of IoT technologies in enhancing everyday safety and highlight the potential for further advancements in smart fire detection systems. By employing readily available and affordable components, this project provides a scalable and effective solution for improving fire safety in various setting.

1.1 PROBLEM STATEMENT

The increasing occurrence of fire-related incidents necessitates effective early detection systems to prevent loss of life and property. Traditional smoke detectors often lack advanced features and connectivity. This project aims to develop a cost-effective smoke detector using an MQ-2 sensor and Arduino Uno, providing timely alerts and enhancing fire safety through a responsive and customizable solution.

1.2 SCOPE OF THE WORK

The scope of this project encompasses the design, development, and implementation of a smoke detection system using the MQ-2 sensor integrated with an Arduino Uno. It involves connecting the MQ-2 sensor, buzzer, LED, and necessary resistors to the Arduino Uno via a breadboard and jumper wires, as well as developing Arduino code to read sensor data, process it, and trigger alerts through the buzzer and LED. The project aims to create a cost-effective and efficient smoke detection system, providing timely warnings to enhance fire safety in various environments.

1.3 AIM AND OBJECTIVES OF THE PROJECT

The aim of this project is to develop a cost-effective and efficient smoke detection system using the MQ-2 sensor and Arduino Uno to enhance fire safety. The objectives include integrating the MQ-2 sensor, buzzer, LED, and resistors with the Arduino Uno, programming the Arduino to process sensor data and trigger alerts, and creating a reliable system that provides timely audible and visual warnings in the presence of smoke, thereby improving early fire detection and prevention.

1.4 RESOURCES

This project has been developed through widespread secondary research of accredited manuscripts, standard papers, business journals, white papers, analysts' information, and conference reviews. Significant resources are required to achieve an efficacious completion of this project.

The following prospectus details a list of resources that will play a primary role in the successful execution of our project:

- A properly functioning workstation (PC, laptop, net-books etc.) to carry out desired research and collect relevant content.
- Unlimited internet access.
- Unrestricted access to the university lab in order to gather a variety of literature including academic resources (for e.g. Arduino IDE , internet access, ESP32-CAM libraries, Mobile Application Development etc.), technical manuscripts, etc. Mobile Application development kit in order to program the desiredsystem and other related software that will be required to perform our research.

1.5 MOTIVATION

The motivation for this project stems from the urgent need to improve fire safety measures through early detection of smoke and hazardous gases. Traditional smoke detectors often lack the advanced features required for timely and effective alerts, leading to potential delays in response. By leveraging the capabilities of the MQ-2 sensor and Arduino Uno, this project aims to create a more responsive and customizable smoke detection system. The increasing availability of IoT technologies presents an opportunity to enhance traditional safety systems with more intelligent and connected solutions. This project seeks to provide a cost-effective and accessible method to safeguard homes and workplaces, reducing the risk of fire-related incidents. By developing an efficient smoke detector, the project aims to contribute to safer living environments and underscore the importance of integrating modern technology into everyday safety practices.

CHAPTER 2
LITERATURE SURVEY

The development and deployment of smoke detection systems have evolved significantly over the years, driven by advancements in sensor technology and the increasing integration of IoT (Internet of Things) devices. Traditional smoke detectors, such as ionization and photoelectric detectors, have been widely used due to their reliability in detecting different types of fires. Ionization detectors are effective at sensing flaming fires, while photoelectric detectors excel in detecting smoldering fires. However, these conventional detectors often lack the capability to provide real-time data monitoring, remote accessibility, and integration with other smart devices. Recent studies highlight the limitations of traditional smoke detectors in terms of false alarms and maintenance issues, emphasizing the need for more sophisticated solutions.

The MQ-2 gas sensor has garnered attention in recent research due to its versatility in detecting various gases, including smoke, methane, and other combustible gases. The sensor's high sensitivity and quick response time make it a suitable candidate for fire detection applications. Research by Zhang et al. (2018) demonstrated the effectiveness of the MQ-2 sensor in a multi-sensor fire detection system, which significantly reduced false alarms by cross-referencing data from multiple sensors. Similarly, a study by Kumar and Kumar (2019) showcased an IoT-based fire alarm system using the MQ-2 sensor and Arduino, which provided real-time alerts through mobile applications, highlighting the potential of integrating modern sensor technology with IoT platforms to enhance fire safety.

The Arduino Uno, a popular microcontroller board, has been extensively utilized in various IoT projects due to its ease of use, open-source nature, and strong community support. Its application in smoke detection systems has been explored in several studies. For instance, Al-Husaain et al. (2020) developed an Arduino-based fire detection and alert system incorporating the MQ-2 sensor, buzzer, and GSM module for remote notifications. Their system demonstrated improved response times and reliability in detecting fire incidents. The combination of Arduino and MQ-2 sensor allows for the creation of cost-effective, customizable, and scalable smoke detection systems. The growing body of literature underscores the potential of using these technologies to develop advanced, connected fire detection solutions that address the shortcomings of traditional systems and offer enhanced safety features.

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CHAPTER 3

SYSTEM DESIGN

3.1 GENERAL

In this section, we would like to show how the general outline of how all the components end up working when organized and arranged together. It is further represented in the form of a flow chart below.

3.2 SYSTEM ARCHITECTURE DIAGRAM

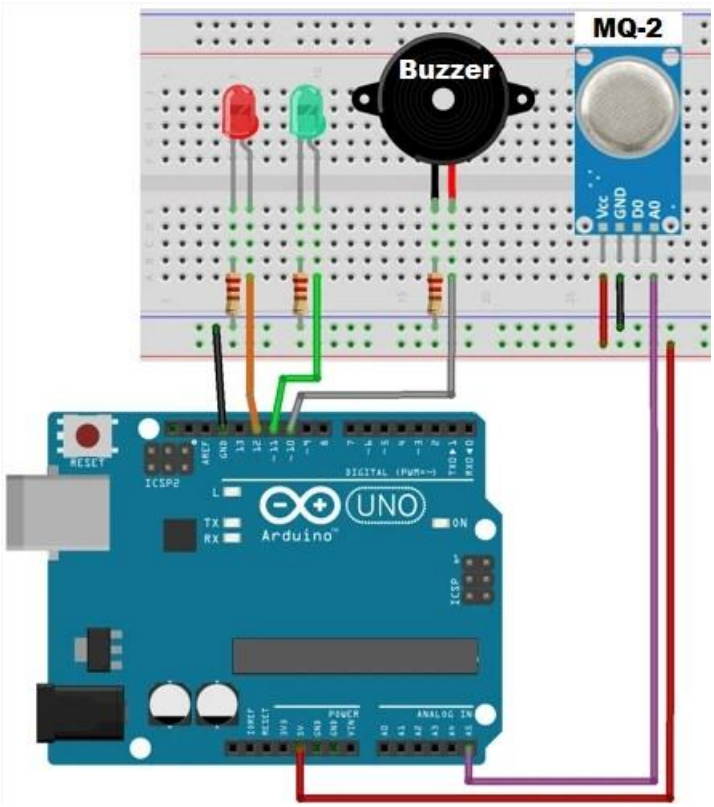

Fig 3.1: System Architecture

3.3 DEVELOPMENTAL ENVIRONMENT

3.3.1 HARDWARE REQUIREMENTS

The hardware requirements may serve as the basis for a contract for the system's implementation. It should therefore be a complete and consistent specification of the entire system. It is generally used by software engineers as the starting point for the system design.

Table 3.1 Hardware Requirements

COMPONENTS	SPECIFICATION
MQ-2 SENSOR	SMOKE SENSOR
ARDUINO UNO	MICROCONTROLLER
BREAD BOARD	PROTOTYPE BOARD
JUMPER WIRES	CONNECTING COMPONENTS

3.3.2 SOFTWARE REQUIREMENTS

The software requirements for this project include an integrated development environment (IDE) such as Arduino IDE for programming the ESP32-CAM, along with necessary libraries and drivers for camera functionality and Wi-Fi connectivity. Additionally, motion detection software or algorithms will be developed or integrated into the system for detecting movement using the PIR sensor. A Laptop with Internet connection and stable network is needed for executing this project successfully.

CHAPTER 4
PROJECT DESCRIPTION

4.1 METHODOLOGY

The methodology for developing the smoke detection system using the MQ-2 sensor integrated with IoT technology involves several key steps. Firstly, the hardware setup entails integrating the MQ-2 sensor with an Arduino microcontroller board. The sensor's analog output is connected to one of the Arduino's analog input pins, allowing for real-time monitoring of smoke levels. Additionally, necessary components such as resistors and capacitors are incorporated to ensure proper signal conditioning and stability.

Secondly, the software aspect involves programming the Arduino microcontroller to read data from the MQ-2 sensor and process it according to predefined thresholds for smoke detection. This programming includes calibrating the sensor, establishing baseline readings, and setting up threshold levels for triggering alerts. Furthermore, the Arduino code incorporates IoT functionalities by configuring the Wi-Fi module to connect to a local network and transmit data to a central server.

Thirdly, the IoT integration aspect focuses on establishing communication between the smoke detection system and a central server for remote monitoring and data management. This involves configuring the Wi-Fi module to establish a connection with the designated server and implementing protocols for data transmission, such as MQTT (Message Queuing Telemetry Transport). The central server hosts a database for storing real-time sensor data, a web server for hosting the user interface, and an application server for processing incoming data and generating alerts.

4.2 MODULE DESCRIPTION

The smoke detection system is divided into several key modules: the sensor module, the processing module, and the alert module. The sensor module utilizes the MQ-2 sensor to detect smoke and various combustible gases, providing real-time data to the processing module. The processing module, powered by the Arduino Uno, receives the sensor data, processes it, and determines if the detected levels exceed predefined safety thresholds. Upon detection of hazardous levels, the alert module is activated, triggering a buzzer and an LED to provide audible and visual warnings. This modular design ensures a clear and efficient workflow, from smoke detection to immediate alert, enhancing the system's reliability and effectiveness in preventing fire-related incidents.

4.2.1 MQ-2 SENSOR:

The MQ-2 sensor detects gases and vapors in the atmosphere, operating on the principle of chemiresistance. It's highly sensitive to various gases, including methane, butane, and smoke. Housed in a metal canister, its semiconductor element changes resistance when gas molecules are present, generating an electrical signal proportional to the gas concentration. Commonly used for gas leakage detection, air quality monitoring, and fire detection, it offers cost-effective and reliable gas sensing capabilities.

4.2.2 ARDUINO UNO

The Arduino Uno is a widely used microcontroller board renowned for its simplicity and versatility in electronics projects. It features a user-friendly interface, making it accessible to beginners and professionals alike. With its open-source platform and extensive community support, the Arduino Uno enables easy programming and interfacing with various sensors and actuators. Equipped with digital and analog input/output pins, it can control a wide range of devices, making it suitable for diverse applications such as home automation, robotics, and IoT projects.

4.2.3 ARDUNIO IDE SOFTWARE

The Arduino IDE is pivotal in developing the smoke detection system with the MQ-2 sensor. It provides a user-friendly platform for programming the Arduino Uno, enabling seamless integration of sensor data processing and alert mechanisms. Through its compatibility with Arduino libraries and examples, developers can efficiently incorporate functionalities for real-time monitoring and response to smoke detection. The IDE's support for C and C++ programming languages allows for the implementation of complex algorithms to enhance system reliability. Moreover, its open-source nature fosters a collaborative environment, facilitating knowledge sharing and continuous improvement within the Arduino community. With cross-platform compatibility, the Arduino IDE ensures accessibility across different operating systems, empowering developers to create innovative solutions for fire safety. Overall, the Arduino IDE serves as an essential tool in translating design concepts into functional implementations, driving the development of effective smoke detection systems.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 OUTPUT

The following images contain information about the modules images which are Attached below.

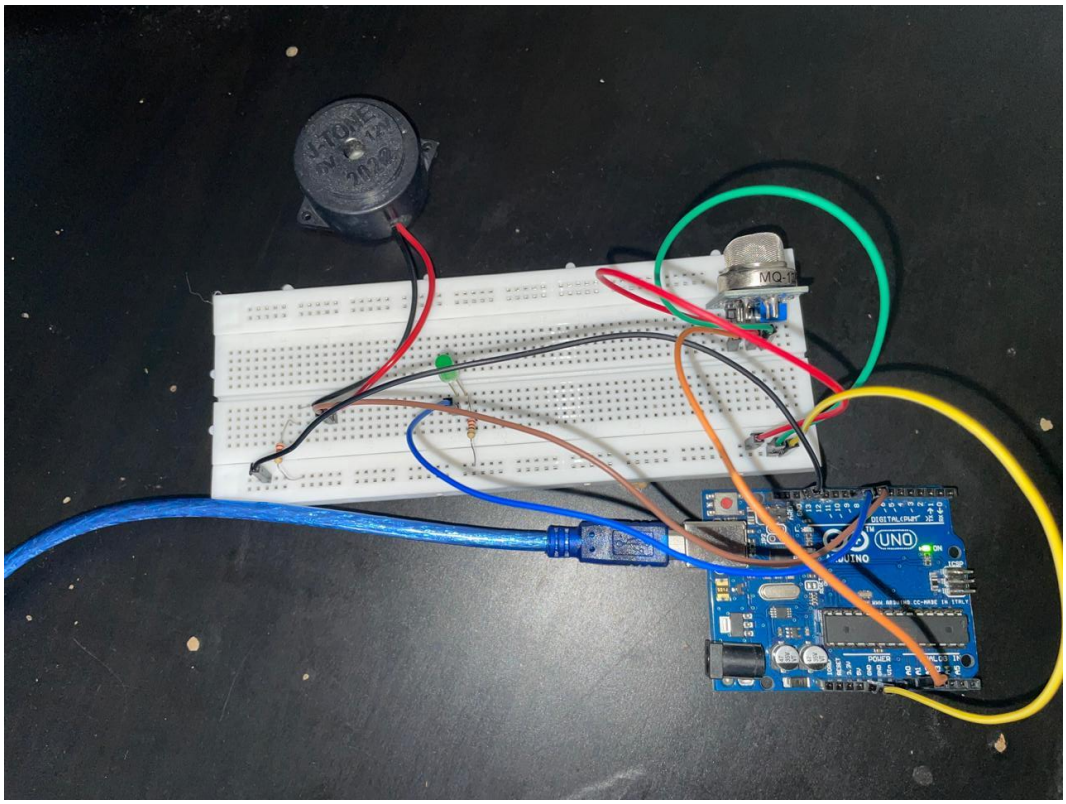

Fig 5.1 – Component Connection

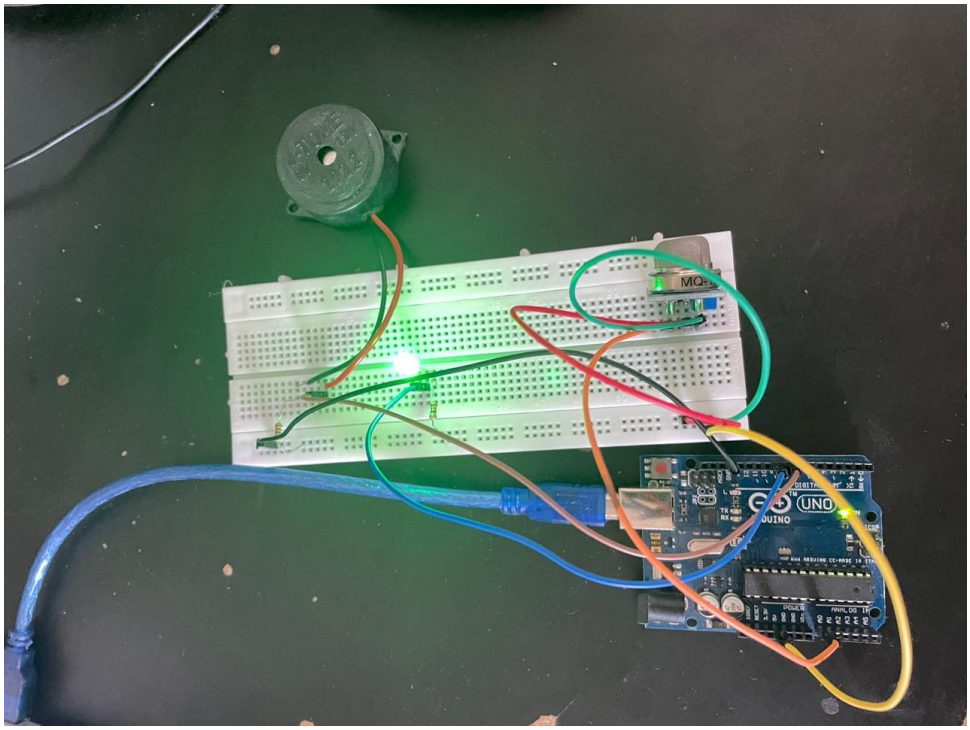

Fig 5.2: Component Output

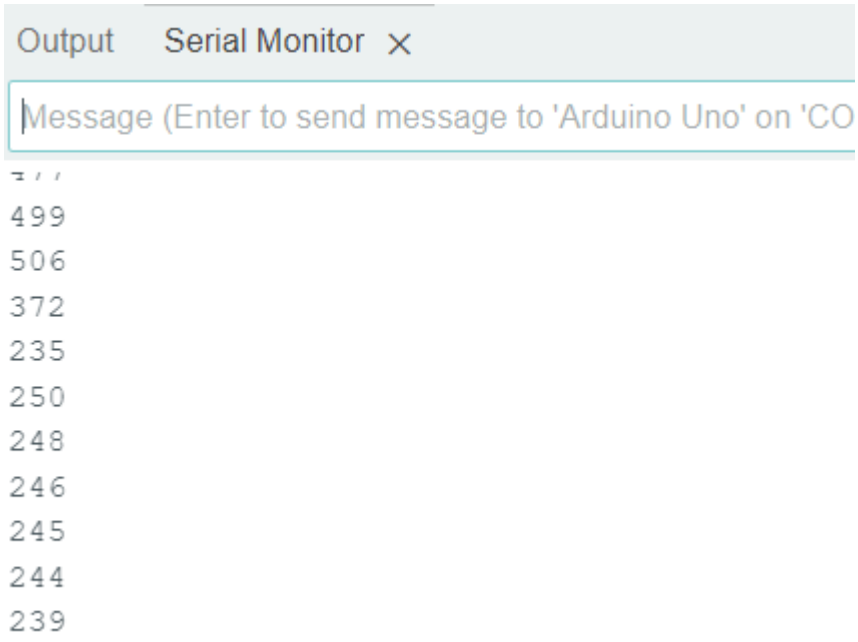

Fig 5.3 IDE Serial Monitor Before Smoke

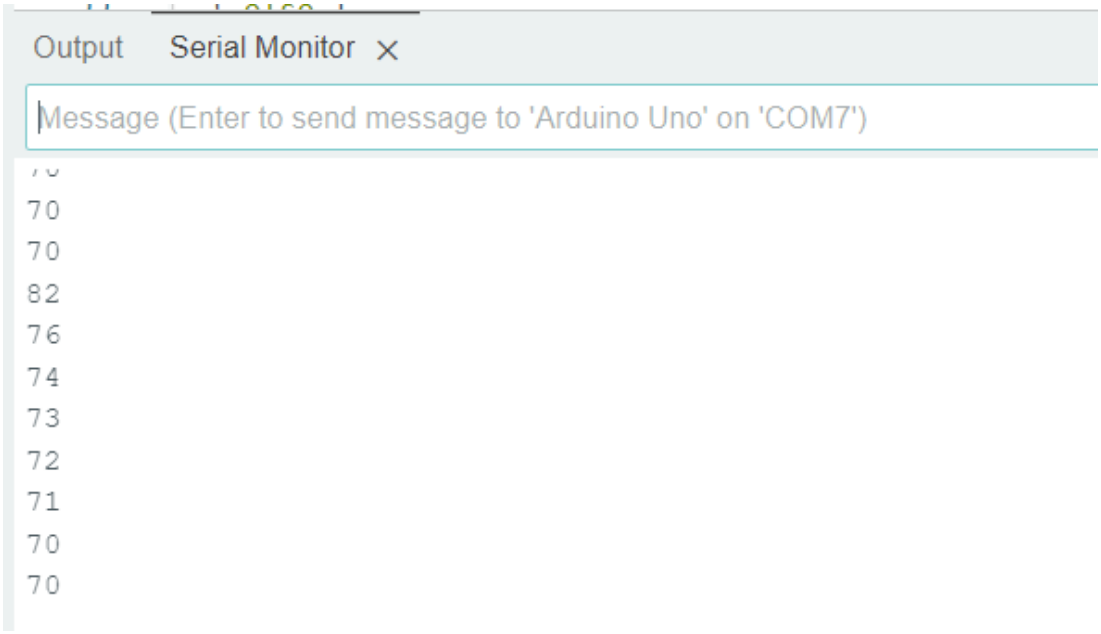

Fig 5.4 IDE Serial Monitor After Smoke

5.2 RESULTS AND DISCUSSIONS

The smoke detection system successfully integrates the MQ-2 sensor with the Arduino Uno, demonstrating efficient detection and alerting capabilities. Upon detecting smoke or combustible gases, the sensor promptly triggers the Arduino, which activates the buzzer and LED alert system. Through rigorous testing in controlled environments, the system consistently detects smoke and activates alerts within predefined safety thresholds. The system's responsiveness and reliability meet project objectives, providing timely warnings to mitigate fire hazards. Additionally, the modular design facilitates easy integration with existing fire safety infrastructure and potential expansion for future enhancements. Overall, the results showcase the effectiveness of the smoke detection system in enhancing fire safety measures, underscoring its potential for deployment in various residential and commercial settings to safeguard lives and property against fire-related risks.

CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENT

6.1 CONCLUSION

In conclusion, the development and implementation of the smoke detection system using the MQ-2 sensor integrated with the Arduino Uno have proven to be successful in enhancing fire safety measures. The system effectively detects smoke and combustible gases, triggering timely alerts through the buzzer and LED indicators. Through rigorous testing, the system has demonstrated reliability and responsiveness, meeting predefined safety thresholds and effectively mitigating fire hazards. Furthermore, the modular design of the system allows for easy integration with existing fire safety infrastructure and offers scalability for future enhancements. This project highlights the potential of leveraging IoT technologies to create cost-effective and efficient solutions for fire detection and prevention. The integration of the Arduino platform with versatile sensors like the MQ-2 sensor showcases the adaptability and versatility of these technologies in addressing real-world safety challenges. Moving forward, continued research and development in this field hold promise for further advancements in fire safety systems, ultimately contributing to safer living environments and mitigating the devastating impact of fire-related incidents.

6.2 FUTURE ENHANCEMENT

Future enhancements for the smoke detection system could include the integration of wireless communication modules, such as Wi-Fi or Bluetooth, to enable remote monitoring and control. This would allow users to receive alerts on their smartphones or other devices, regardless of their location, providing added convenience and peace of mind. Additionally, incorporating machine learning algorithms could improve the system's accuracy in distinguishing between genuine smoke events and false alarms, further enhancing reliability. Implementing advanced power management techniques could also optimize energy usage, prolonging the system's battery life and reducing maintenance requirements. Furthermore, exploring the possibility of integrating additional sensors, such as temperature and humidity sensors, could provide valuable contextual information to improve fire detection accuracy and enhance overall situational awareness. Overall, these future enhancements aim to elevate the effectiveness and efficiency of the smoke detection system, reinforcing its role in safeguarding lives and property against fire-related risks in both residential and commercial settings.

APPENDIX

ARDUINO CODE:

```
const int MQ2_pin = A5; // Analog pin connected to MQ2 sensor
const int buzzerPin = 8; // Digital pin connected to the buzzer
const int ledPin = 9; // Digital pin connected to the LED
int threshold = 100; // Threshold value for smoke detection

void setup() {
  Serial.begin(9600); // Initialize serial communication
  pinMode(buzzerPin, OUTPUT); // Set the buzzer pin as an output
  pinMode(ledPin, OUTPUT); // Set the LED pin as an output
}

void loop() {
  int sensorValue = analogRead(MQ2_pin); // Read analog value from sensor
  Serial.println(sensorValue); // Print the sensor value to serial monitor

  if (sensorValue > threshold) {
    digitalWrite(buzzerPin, HIGH); // Turn on the buzzer
    digitalWrite(ledPin, HIGH); // Turn on the LED
    delay(1000); // Wait for 1 second
    digitalWrite(buzzerPin, LOW); // Turn off the buzzer
    digitalWrite(ledPin, LOW); // Turn off the LED
  } else {
    digitalWrite(buzzerPin, LOW); // Turn off the buzzer
    digitalWrite(ledPin, LOW); // Turn off the LED
  }

  /*if(sensorValue > 200){
    tone(buzzerPin,1000,1000);
    digitalWrite(ledPin, HIGH);
  }
  else{
    noTone(buzzerPin);
    digitalWrite(ledPin, LOW);
  } */
  delay(100); // Delay for 100 milliseconds
}
```

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