MINI PROJECT REPORT

ON

"INDOOR OUTDOOR AIR QUALITY MONITORING SYSTEM"

SUBMITTED IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS OF DEGREE OF

BACHELOR OF ENGINEERING

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Certificate

This is to certify that the Mini Project-1A entitled "**INDOOR OUTDOOR AIR QUALITY MONITORING SYSTEM"** is a bonafide work of **Patil Pratik Pravin** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of **"Undergraduate"** in **"Computer Engineering".**

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Mini Project-1A Report Approval

This project report entitled "**INDOOR OUTDOOR AIR QUALITY MONITORING SYSTEM"** submitted by **"**of **Patil Pratik Pravin"** is approved for the degree of **Bachelor of Engineering in Computer Engineering**.

Examiners

1.______________________

Date:

Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included. We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will because for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Air pollution is a significant global concern, and real-time monitoring of air quality is essential to safeguard public health and the environment. This project presents the development of a low-cost air quality monitoring system using an Arduino Mega microcontroller and a set of gas and environmental sensors. The system is designed to measure levels of harmful gases such as Carbon Monoxide (CO), Carbon Dioxide (CO2), Methane (CH4), Liquefied Petroleum Gas (LPG), Butane, and Propane, as well as environmental factors like temperature, humidity, and dust particles. The sensors used in this project include MQ5 (LPG), MQ6 (Butane and Propane), MQ4 (Methane), MQ135 (CO2), MQ7 (CO), DHT11 (temperature and humidity), and GP2Y1010AU0F (dust). A 20x4 LCD display with an I2C module is used to display real-time data, and a buzzer is activated to alert users when gas levels exceed safe thresholds.

This system provides a practical, real-time solution for monitoring air quality in homes, offices, or industrial settings, where the presence of harmful gases and particulate matter can pose health risks. The modular design allows for easy integration into a variety of environments, and the use of inexpensive, readily available components makes this system a cost-effective approach for widespread air quality monitoring.

key words: Air quality monitoring, Arduino Mega, Gas sensors, Carbon Monoxide (CO), Carbon Dioxide, LPG ,Real-time monitoring, LCD display, Pollution detection.

List of Figures

TABLE OF CONTENTS

Chapter 1

Introduction

1. Introduction

Air quality plays a crucial role in determining public health and overall well-being. With increasing industrial activities, urbanization, and vehicle emissions, the presence of harmful gases and particulate matter in the atmosphere has significantly increased. Prolonged exposure to pollutants such as Carbon Monoxide (CO)**,** Carbon Dioxide (CO2)**,** Methane (CH4)**,** Liquefied Petroleum Gas (LPG)**,** Butane**,** Propane, and fine dust particles can lead to serious health issues, including respiratory problems, cardiovascular diseases, and even long-term environmental damage.

In this context, the need for an affordable and efficient air quality monitoring **system** has become more critical than ever. Traditional air quality monitoring solutions are often expensive and require complex setups, making them inaccessible to smaller communities, homes, and offices. This project aims to address these challenges by developing a low-cost, real-time monitoring system using an Arduino Mega microcontroller and various gas and environmental sensors.

The system is designed to measure the concentration of harmful gases in the atmosphere along with environmental factors like temperature and humidity using the DHT11 sensor, and dust particles using the GP2Y1010AU0F dust sensor. These readings are displayed on a 20x4 LCD with an I2C module for easy monitoring. In the event that gas levels exceed safety thresholds, a buzzer is activated to alert the user, ensuring timely action can be taken to mitigate risks.

This project aims to provide a comprehensive, affordable solution for real-time air quality monitoring that can be deployed in various settings such as homes, offices, and industrial areas, helping to protect both health and the environment.

1.1 Background

Air pollution has become one of the most significant environmental issues of the 21st century. The World Health Organization (WHO) reports that millions of premature deaths are attributed to poor air quality each year, caused by exposure to harmful pollutants. With rapid industrialization and urban growth, the concentration of hazardous gases like Carbon Monoxide (CO)**,** Carbon Dioxide (CO2)**,** Methane (CH4)**,** and volatile organic compounds (VOCs) has risen significantly, particularly in densely populated areas. Additionally, fine particulate matter such as dust poses a major health risk, as these particles can penetrate deep into the lungs and cause respiratory and cardiovascular diseases.

Traditional air quality monitoring systems employed by governmental agencies and research institutions are often large, expensive, and difficult to install in homes or small businesses. These systems are primarily used in outdoor settings for regional air quality assessments. However, many pollutants, such as LPG**,** Butane**, and** Propane, can also accumulate indoors due to household appliances, poor ventilation, and industrial leaks, making indoor air quality just as important as outdoor monitoring.

In recent years, advancements in microcontrollers and sensor technologies have made it possible to create more affordable, compact, and efficient air quality monitoring systems. Arduino, an open-source hardware and software platform, has emerged as one of the most widely used tools for building such systems. With its ability to interface with various gas sensors like the MQ series (MQ5, MQ6, MQ7, MQ135) and environmental sensors such as the DHT11 and GP2Y1010AU0F, Arduino allows for real-time data collection and analysis at a fraction of the cost of commercial systems.

The development of this low-cost air quality monitoring system is part of a larger effort to provide accessible tools for measuring and improving indoor and outdoor air quality. This project leverages affordable components, including gas sensors, a dust sensor, and a temperature/humidity sensor, to detect harmful pollutants and environmental conditions, displaying the data on an LCD screen and alerting users via a buzzer when dangerous levels are detected. This approach makes air quality monitoring more feasible for households, small businesses, and local communities.

1.2 Motivation

The rising levels of air pollution in both urban and rural areas pose a growing threat to public health and the environment. With increased industrial activities, vehicle emissions, and the use of fossil fuels, harmful pollutants such as Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), LPG, and other gases are becoming more prevalent in the air we breathe. These pollutants, along with particulate matter such as dust, contribute to a range of health problems, including asthma, lung cancer, and heart disease, affecting millions of people globally.

While many countries have implemented large-scale air quality monitoring stations, they often focus on outdoor environments and are not accessible for monitoring indoor air quality in homes, offices, and smaller industrial settings. Indoor air pollution, caused by poor ventilation, cooking, or malfunctioning gas appliances, can be just as dangerous, if not more so, than outdoor air pollution. Yet, the lack of affordable, easy-to-use air quality monitoring solutions makes it difficult for individuals and small businesses to monitor and manage the quality of the air in their immediate surroundings.

The motivation behind this project is to create an affordable and reliable air quality monitoring system that can detect common pollutants, temperature, humidity, and dust particles in real time. The system is designed to provide early warnings when air quality reaches unhealthy levels, enabling users to take immediate actions, such as improving ventilation or evacuating hazardous areas. The use of an Arduino Mega and readily available gas sensors makes this solution cost-effective and easy to build, allowing it to be implemented in various environments where traditional air quality monitors are too expensive or impractical.

This project aims to empower individuals and small communities to better understand and manage the air quality in their environment. By creating a low-cost, real-time monitoring system, we hope to raise awareness of the dangers of air pollution and offer a tool that contributes to healthier living and working conditions.

Chapter 2

Literature Survey

2.1 Basic Terminologies

Air Quality Index (AQI): A numerical scale used to communicate how polluted the air is or how polluted it is forecasted to become. Higher AQI values indicate higher levels of air pollution, which can affect human health.

Carbon Monoxide (CO): A colorless, odorless, and toxic gas produced by incomplete combustion of carbon-containing fuels such as coal, wood, and gasoline. High concentrations of CO can be deadly, making its detection critical in air quality monitoring.

Carbon Dioxide (CO2): A naturally occurring gas that is also emitted through human activities, particularly from burning fossil fuels. While CO2 is not directly harmful at typical outdoor concentrations, elevated levels indoors can indicate poor ventilation and pose health risks.

Methane (CH4): A colorless, odorless gas that is a potent greenhouse gas and a component of natural gas. Methane leaks can be hazardous as it is highly flammable and contributes to air pollution.

Liquefied Petroleum Gas (LPG): A flammable mixture of hydrocarbons, primarily composed of propane and butane, used as fuel for heating and cooking. LPG leaks in confined spaces can lead to explosions and suffocation.

Butane and Propane: Gases that are components of LPG, used in fuel applications. They are highly flammable, and their leakage can pose significant safety hazards.

Particulate Matter (PM): A mixture of solid particles and liquid droplets found in the air. PM can include dust, dirt, soot, and smoke. Fine particles, especially PM2.5 (particles less than 2.5 microns in diameter), are harmful as they can penetrate deep into the lungs.

Dust Sensor (GP2Y1010AU0F): A sensor that detects particulate matter in the air, providing data on dust concentration. It is used in air quality monitoring to assess the level of airborne particles that can cause respiratory issues.

Gas Sensors (MQ Series): A family of sensors designed to detect different types of gases:

MQ4: Detects methane (CH4).

MQ5: Detects LPG and natural gas.

MQ6: Detects butane and propane.

MQ7: Detects carbon monoxide (CO).

MQ135: Detects a variety of gases, including carbon dioxide (CO2), ammonia (NH3), and more.

DHT11 Sensor: A basic, low-cost digital sensor used for measuring temperature and humidity.

It is commonly used in environmental monitoring systems.

Arduino Mega: A microcontroller board based on the ATmega2560, used to control and interact with sensors, displays, and actuators in electronic projects. It is the core of the air quality monitoring system.

LCD Display (20x4 with I2C): A liquid crystal display used to show real-time data. The "20x4" refers to its ability to display 20 characters per line across 4 lines. The I2C module simplifies wiring and reduces the number of pins required for communication with the microcontroller.

Buzzer: An audio alert device used in the system to sound an alarm when gas levels exceed a predefined threshold, indicating unsafe air quality conditions.

Threshold Value: The predefined limit of gas concentration or particulate matter level at which the system triggers an alert (buzzer). If the sensor readings exceed this value, it signals potential danger.

2.2 Existing system

Air quality monitoring systems are essential for tracking pollutant levels in the atmosphere to ensure environmental and public health. Several established systems are already in place, each with different levels of complexity, accuracy, and cost. Broadly, existing air quality monitoring systems can be classified into government-operated large-scale networks, commercial indoor air quality monitors, and DIY/low-cost systems.

Government-operated Air Quality Monitoring Networks: These are highly sophisticated and expensive systems deployed by environmental agencies such as the Environmental Protection Agency (EPA) in the U.S. or national equivalent agencies around the world. These stations monitor pollutants like CO, CO2, NO2, SO2, Ozone (O3), and PM2.5/PM10 at multiple points in a city or region. The stations are typically equipped with high-precision instruments such as Gas Chromatography, Optical Particle Counters, and Fourier Transform Infrared (FTIR) Spectroscopy for measuring air pollution.

requirements, and the need for specialized personnel to maintain and interpret the data. Additionally, their focus is predominantly on outdoor air quality, leaving indoor air pollution relatively under-monitored.

Commercial Indoor Air Quality Monitors: Over the years, several consumer-grade air quality monitors have entered the market, designed for home and office use. Products from companies like Awair, Dyson, Foobot, and Airthings provide a range of sensors to monitor common pollutants such as CO_2, Volatile Organic Compounds (VOCs), particulate matter (PM), and other indoor air quality factors like temperature and humidity.

These commercial devices tend to offer a user-friendly experience, including smartphone apps for remote monitoring. However, their main limitation is their focus on specific pollutants and lack of customizability. Most of these systems measure CO_2, VOCs, and sometimes PM2.5, but they do not typically include sensors for gases like methane (CH_4), LPG, butane, or propane, which are crucial for detecting leaks from gas appliances. Moreover, they can be expensive for personal use, and their effectiveness is limited to indoor spaces.

Low-cost and DIY Air Quality Monitoring Systems: In recent years, open-source platforms like Arduino and Raspberry Pi have revolutionized the ability to build custom air quality monitoring systems. These systems use inexpensive sensors such as the MQ series gas sensors (e.g., MQ4, MQ5, MQ6, MQ135, MQ7) to detect gases like methane, LPG, carbon monoxide, and carbon dioxide. Paired with dust sensors (such as the GP2Y1010AU0F) and DHT11 for temperature and humidity monitoring, these low-cost systems provide basic real-time monitoring of key pollutants.

Unlike commercial systems, DIY solutions can be tailored to specific use cases, such as detecting specific gases based on the environment. They are scalable, portable, and can be integrated with displays (such as LCD modules), alarms (buzzers), and even wireless communication for remote monitoring. However, these systems require technical knowledge to design, build, and maintain, and their sensors are often less precise compared to professional-grade equipment. Furthermore, they lack formal calibration, meaning the readings may be less accurate or consistent over time without regular maintenance.

2.3 Problem Statement

Air pollution is a growing concern, with harmful gases and particulate matter contributing to serious health problems such as respiratory diseases, cardiovascular issues, and environmental degradation. Traditional air quality monitoring systems are either large-scale and expensive or limited in their ability to measure indoor pollutants like methane (CH_4), LPG, butane, propane, and carbon monoxide (CO). Additionally, indoor air quality monitoring is often overlooked, despite the fact that individuals spend a significant amount of time indoors, where poor ventilation and gas leaks can create hazardous conditions.

Existing solutions such as government-operated monitoring stations are not feasible for small-scale deployment in homes or offices due to their high cost and complexity. On the other hand, commercial air quality monitors often lack the ability to detect certain critical gases and pollutants, or they are prohibitively expensive for widespread use in smaller settings.

There is a need for an affordable, customizable, and real-time air quality monitoring system that can detect a wide range of harmful gases and environmental conditions, including temperature, humidity, and dust particles. The system should be capable of alerting users when air quality reaches unsafe levels, empowering individuals to take action in time to prevent health risks or accidents caused by gas leaks.

Chapter 3

Requirement Gathering

3.1 software and hardware requirements

Software Requirements:

1. **Arduino IDE**

   Used for writing, compiling, and uploading the code to the Arduino Mega. It provides libraries for working with sensors, the LCD, and the I2C interface.

2. **LiquidCrystal_I2C Library**

   This library is necessary for interfacing the 20x4 LCD with the I2C module, enabling easier communication between the microcontroller and the display.

3. **DHT Library**

   Required for reading temperature and humidity data from the DHT11 sensor.

4. **MQ Sensor Libraries (Optional)**

   While not mandatory, libraries specific to the MQ series sensors can be used to simplify reading data from gas sensors like MQ4, MQ5, MQ6, MQ7, and MQ135.

5. **GP2Y Dust Sensor Library (Optional)**

   A library to facilitate reading data from the GP2Y1010AU0F dust sensor.

6. **Code: Blocks or Visual Studio Code (Optional)**

   For developing and managing the code in environments that offer better debugging and code management tools compared to the Arduino IDE.

Hardware Requirements:

1. **Arduino Mega 2560**

   A microcontroller that acts as the brain of the system, handling sensor inputs and outputting data to the display and buzzer.

2. **20x4 LCD with I2C Module**

   Used to display real-time readings of gas concentrations, temperature, humidity, and dust levels. The I2C module simplifies wiring by reducing the number of pins required.

3. **Gas Sensors (MQ Series)**

   MQ4: For detecting methane (CH_4).

   MQ5: For detecting LPG and natural gas.

MQ6: For detecting butane and propane.

MQ7: For detecting carbon monoxide (CO).

MQ135: For detecting carbon dioxide (CO_2) and other gases.

4. **GP2Y1010AU0F Dust Sensor**

   Used for measuring the concentration of dust particles in the air, important for monitoring air quality.

5. **DHT11 Temperature and Humidity Sensor**

   A sensor that measures temperature and humidity, useful for understanding environmental conditions.

6. **Buzzer**

   Provides an audible alert when gas concentrations exceed the safety thresholds, warning users of potential danger.

7. **Resistors and Capacitors**

   Required for proper functioning of the sensors, especially for adjusting the sensitivity of the dust sensor and gas sensors.

8. **1N4148 Diode**

   Used in the circuitry of the dust sensor to protect against reverse voltage and ensure stable operation.

9. **Power Supply**

   Typically a 5V power supply for powering the Arduino Mega and sensors.

10. **Connecting Wires**

    Jumper wires or breadboard wires for making connections between the Arduino Mega, sensors, LCD, and other components.

11. **Breadboard or PCB**

    Used for prototyping and making connections between components. A PCB may be used for a final, more permanent version.

Chapter 4

Plan of Project

4.1 Proposed System Architecture

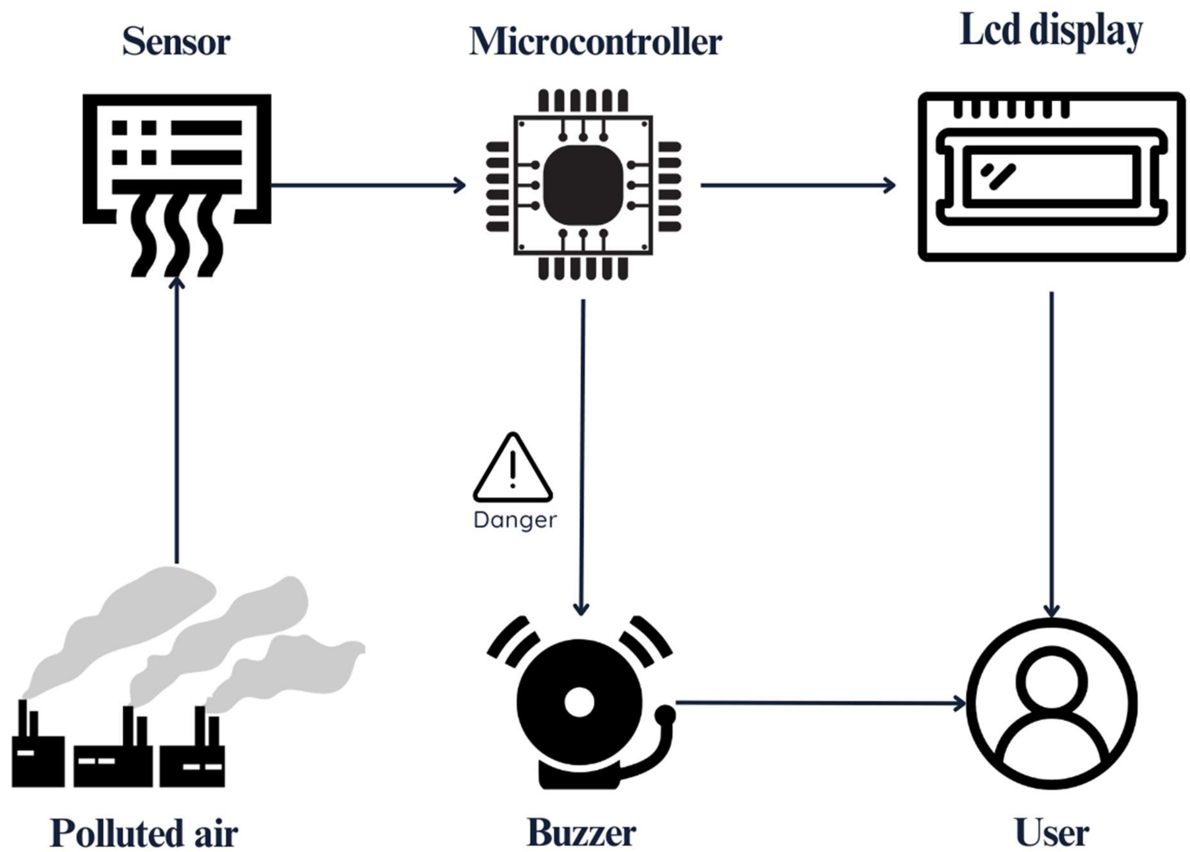

Figure 4.1: System Architecture

4.2 Methodology

The development of the air quality monitoring system involves multiple phases, including system design, sensor integration, data acquisition, threshold alert setup, and display of real-time data. The following steps outline the methodology for building and implementing the system:

1. System Design

The system is built around the Arduino Mega 2560 microcontroller, which collects data from several sensors to monitor air quality parameters. The design is focused on measuring harmful gases (like CO, CO2, CH4, LPG, Butane, and Propane), temperature, humidity, and dust levels. The sensor data is processed and displayed on a 20x4 LCD using an I2C module, and a buzzer provides an audible alert if any pollutant concentration exceeds a predefined threshold. The system is powered by a 5V power source and connected through a breadboard for prototyping.

2. Sensor Integration

Each sensor is connected to the Arduino Mega based on its type (analog or digital):

MQ4 (Methane): Analog pin A2 and digital pin 53.

MQ5 (LPG/Natural Gas): Analog pin A0 and digital pin 49.

MQ6 (Butane/Propane): Analog pin A1 and digital pin 51.

MQ135 (CO2): Analog pin A3 and digital pin 47.

MQ7 (Carbon Monoxide): Analog pin A4 and digital pin 45.

DHT11 (Temperature/Humidity): Digital pin 43.

GP2Y1010AU0F (Dust Sensor): Analog pin A15 and digital pin 41.

3. Data Acquisition

Each sensor continuously monitors its respective pollutant or environmental parameter.

The MQ series sensors provide analog output signals proportional to the concentration of the gases they are measuring.

The DHT11 sensor provides digital readings for temperature and humidity.

The GP2Y1010AU0F dust sensor measures dust concentration and outputs a corresponding analog signal.

The Arduino reads these signals from the sensors and converts them into meaningful data (such as ppm for gases, percentage for humidity, and degrees Celsius for temperature).

4. Threshold Alert Setup

Each sensor has specific threshold values for detecting dangerous levels of gases or particles:

Methane (CH_4), LPG, Butane, Propane, and CO are hazardous when they exceed certain concentrations, and these values are pre-programmed into the Arduino.

When a sensor reading exceeds the defined threshold, the Arduino triggers an alert by activating the buzzer to notify the user of dangerous air quality.

Example threshold levels (can be adjusted based on environment):

Methane (CH_4): >1000 ppm

LPG (Butane/Propane): >500 ppm

Carbon Monoxide (CO): >35 ppm

CO_2: >1000 ppm

Dust Particles: >150 $\mu g/m^3$

5. Display of Real-Time Data

The real-time values of each gas concentration, temperature, humidity, and dust levels are displayed on the 20x4 LCD connected via I2C.

The LCD provides constant updates, displaying the sensor data in a user-friendly format with clear labels (e.g., "CO2: 400 ppm", "Temp: 25°C", "Dust: 100 µg/m³").

The display is refreshed periodically to ensure real-time monitoring of the environment.

6. Data Processing and Calibration

Each sensor's data is processed to convert the raw analog or digital signals into usable values like ppm for gases or percentage for humidity. This requires appropriate calibration based on the sensor's datasheet.

Calibration is performed during the setup phase to ensure that the sensor readings are accurate and reliable for the environment they are being used in.

If necessary, filtering techniques (e.g., averaging) are applied to smooth out any noise in sensor readings.

7. Buzzer Alert System

When the concentration of any gas or dust exceeds the pre-set safety threshold, the buzzer is activated as an alarm.

The alert continues until the air quality improves (i.e., gas levels fall below the threshold) or the system is reset.

8. Testing and Validation

The system is tested in controlled environments where the concentration of gases and dust can be manually varied. This ensures that the sensors are responsive and trigger alerts when threshold values are breached.

Real-world validation is conducted by exposing the system to common gas sources like cooking gas (LPG), and observing its performance in detecting pollutants and providing alerts.

Chapter 5

Result Analysis

5.1 Results and Discussion

Results

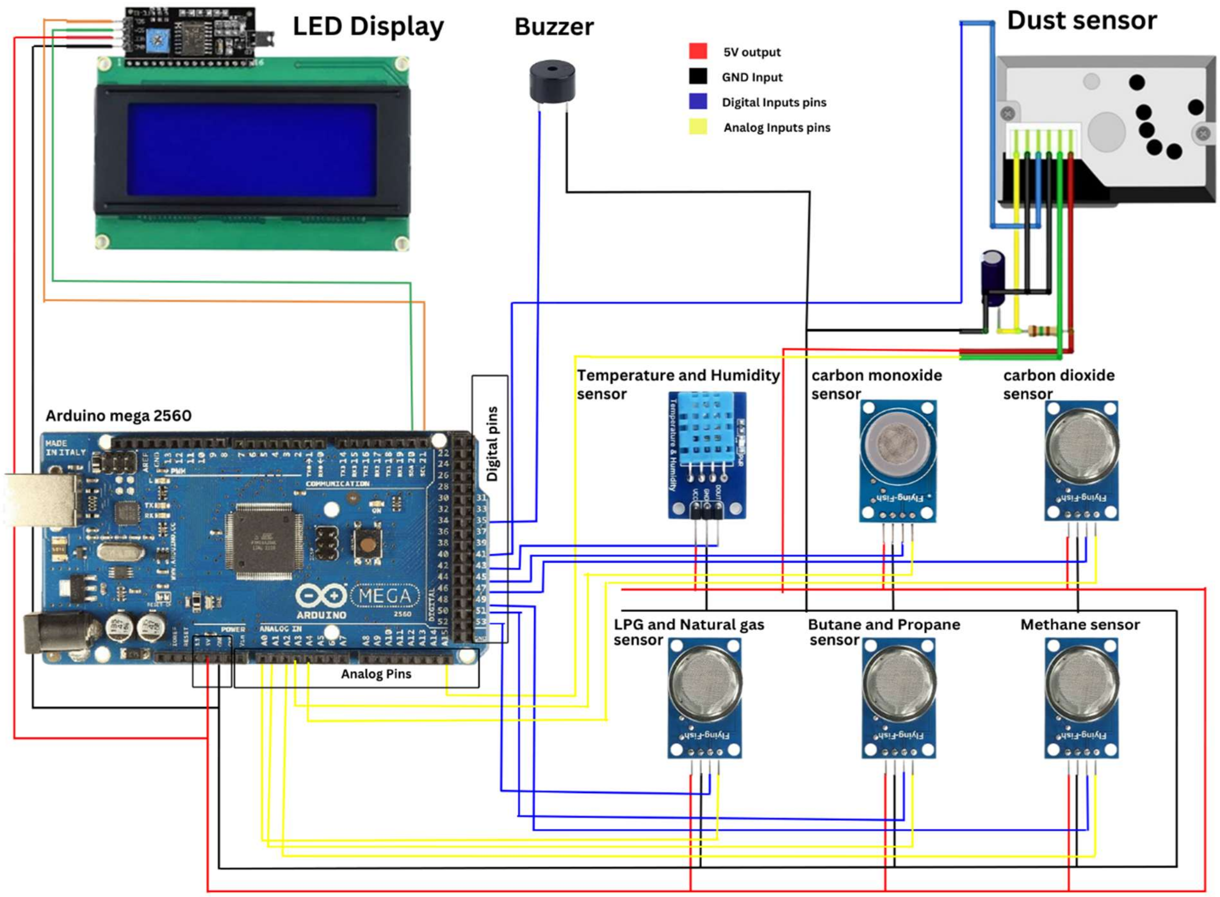

Figure 5.1 Circuit

The air quality monitoring system was successfully implemented using the Arduino Mega, MQ-series gas sensors, DHT11 sensor, GP2Y1010AU0F dust sensor, and a 20x4 LCD for real-time data display. The system was tested in both controlled and real-world environments to evaluate its performance in detecting gas concentrations, temperature, humidity, and dust levels. The following results were observed:

1. Gas Detection

Methane (CH_4), LPG, butane, propane, carbon monoxide (CO), and carbon dioxide (CO_2) were successfully detected by their respective MQ sensors.

Each gas sensor provided reliable readings, showing proportional changes when exposed to varying concentrations of gases.

The system triggered the buzzer alert when gas concentrations exceeded the predefined thresholds, warning the user of potentially dangerous air quality conditions.

2. Temperature and Humidity Monitoring

The DHT11 sensor accurately measured both temperature and humidity levels in the test environment.

The values displayed on the LCD were consistent with standard thermometers and hygrometers, confirming the accuracy of the sensor.

3. Dust Particle Measurement

The GP2Y1010AU0F dust sensor provided real-time readings of dust concentration, which were displayed in micrograms per cubic meter ($\mu g/m^3$).

The system effectively monitored particulate matter levels and provided a clear indication when dust concentrations increased.

Figure 5.2 LCD Display

4. LCD Display

The 20x4 LCD displayed real-time data for all the parameters being monitored: gas concentrations, temperature, humidity, and dust levels.

The display was clear and easy to read, providing the user with an intuitive interface for monitoring the environment.

5. System Alerts

The buzzer provided an immediate audible alert whenever any gas concentration exceeded its threshold. This feature was crucial in ensuring the safety of the environment being monitored.

The system responded to gas leaks and dangerous conditions in a timely manner, preventing potential health risks.

Discussion

1. Effectiveness of Gas Sensors

The MQ-series gas sensors demonstrated effective performance in detecting the presence of various gases. However, the sensors required a brief warm-up period before providing accurate readings. This is a characteristic of the MQ-series sensors, where stabilization is necessary before they can detect gas concentrations reliably.

The sensors were sensitive to even small changes in gas concentration, and the system accurately triggered alerts at appropriate threshold levels. Calibration of these sensors is essential to ensure accurate ppm (parts per million) values, as they can vary depending on environmental conditions such as temperature and humidity.

2. Real-time Monitoring and User Interaction

The system successfully provided real-time monitoring, continuously updating the air quality parameters on the LCD display. This allowed users to easily track changes in their environment, making it possible to take immediate action in case of gas leaks or poor air quality.

The use of a 20x4 LCD with I2C module simplified the wiring and ensured that real-time data was displayed clearly. However, further enhancement could include graphical displays or integration with a mobile app for remote monitoring.

3. Accuracy and Calibration

The DHT11 sensor provided satisfactory results for measuring temperature and humidity, though more precise alternatives (like DHT22) could improve accuracy if needed. Additionally, proper calibration of the gas sensors is vital to ensure consistent and reliable results, as the default sensor outputs may require adjustment depending on environmental factors.

For improved performance in more industrial or critical environments, periodic calibration against known gas concentrations is recommended.

4. Thresholds and Alerts

The system's buzzer alert function effectively notified users of dangerous gas concentrations. The defined threshold values were appropriate for typical household or small-office environments. For different settings, such as industrial environments or specific gas leak detection, the thresholds would need to be customized to the particular gases being monitored.

In future versions, it could be useful to add an option for customizable thresholds, allowing users to set safety levels based on their specific environment.

5. Limitations and Improvements

The MQ sensors are cost-effective but may not provide the same level of precision as industrial-grade gas detectors. For professional applications, higher-grade sensors with more accurate ppm readings may be required.

The system currently uses a buzzer for alerts, but adding additional notification mechanisms such as SMS alerts or Wi-Fi connectivity could enhance usability and allow remote monitoring.

Power consumption may be an issue if the system is intended for continuous use over a long period. A possible solution is to implement power-saving features or use a rechargeable battery.

6. Future Enhancements

Data Logging: Storing sensor data on an SD card or uploading it to a cloud server could allow for long-term monitoring and trend analysis.

7. Mobile Integration: Adding Bluetooth or Wi-Fi capabilities would allow the system to send real-time alerts to a mobile app or display data remotely.

8. Expanded Sensor Suite: Additional sensors, such as those for NOx, SO2, or Ozone (O3), could be integrated to provide even more comprehensive air quality monitoring.

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Chapter 6

Conclusion

6. Conclusion

The air quality monitoring system developed in this project successfully measures and displays real-time levels of harmful gases, dust particles, temperature, and humidity using a combination of MQ-series gas sensors, the DHT11 sensor, the GP2Y1010AU0F dust sensor, and an Arduino Mega microcontroller. The integration of these sensors, along with a 20x4 LCD and a buzzer for alerts, offers an effective, low-cost solution for monitoring air quality in indoor environments.

The system provides accurate detection of gases such as methane (CH_4), LPG, butane, propane, carbon monoxide (CO), and carbon dioxide (CO_2). It also continuously monitors environmental parameters like temperature, humidity, and dust particles, making it a comprehensive tool for air quality assessment.

The real-time display of sensor data and the immediate buzzer alerts for dangerous conditions make the system user-friendly and practical for households, offices, or small industries where air quality is a concern.

While the system performs well in basic environments, future improvements could include data logging, remote monitoring, and integration with mobile applications to enhance functionality. Additionally, the accuracy and scope of monitoring can be extended by incorporating more precise sensors and expanding the system to detect a broader range of pollutants.

In conclusion, this project demonstrates a viable and scalable approach to air quality monitoring, offering an accessible solution to detect harmful air conditions and protect the health and safety of individuals in various settings.

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