AIR QUALITY MONITORING SYSTEM USING ARDUINO

A MINOR PROJECT - III REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this **18ECP105L – Minor Project III** report **"AIR QUALITY MONITORING SYSTEM USING ARDUINO"** is the bonafide work of **ABINAYA T (927621BEC005), DHANUSRI R P (927621BEC035), DHARSHINIPRIYA R (927621BEC044), GANISKA S (927621BEC052)** who carried out the project work under my supervision in the academic year **2023-2024 ODD**.

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This report has been submitted for the **18ECP105 – Minor Project - III** final review held at M. Kumarasamy College of Engineering, Karur on ______________.

PROJECT COORDINATOR

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives

PEO1: **Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

Program Outcomes

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: 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.

PO 3: 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.

PO 4: 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.

PO 5: 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.

PO 6: 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.

PO 7: 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.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: 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.

PO 11: 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.

PO 12: 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

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

Abstract	Matching with POs, PSOs
Environment, Arduino, Survival of human, Sensor, Awarness	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2**

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Our sincere thanks to **Thiru.M.Kumarasamy, Chairman** and **Dr.K.Ramakrishnan, Secretary** of **M.Kumarasamy College of Engineering** for providing extraordinary infrastructure, which helped us to complete this project in time.

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ABSTRACT

Measuring Air Quality is an important element for bringing lot of awareness in the people to take care of the future generations a healthier life. Based on this, Government of India has already taken certain measures to ban Single Stroke and Two Stroke Engine based motorcycles which are emitting high pollutions comparatively. We are trying to implement the same system using IoT platforms like thing speak or Cayenne, we can bring awareness to every individual about the harm we are doing to our environment. Already, New Delhi is remarked as the most pollution city in the world recording Air Quality above 300PPM. Air pollution is a major problem that affects the health and wellbeing of people worldwide. In this study, an air quality monitoring and alert system is designed and implemented using Arduino Uno and MQ135 gas sensor. The MQ135 gas sensor is used to detect the presence of pollutants such as carbon dioxide, ammonia, nitrogen oxides, and sulfur dioxide in the air. The data collected by the sensor is processed by Arduino Uno, and the parts per million is calculated based on the detected gas concentration. The PPM level is displayed on an LCD screen, and if the ppm exceeds a certain threshold, an alarm is triggered to alert users of the poor air quality. The system also sends an alert message to the user's smartphone via Bluetooth module. This system provides a low-cost and efficient solution for monitoring air quality and alerting users in real-time. The system can be installed in homes, offices, and public spaces, helping to raise awareness and promote healthy living by reducing exposure to harmful air pollutants.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

S No	ABBREVIATION	EXPANSION
01	PPM	Parts-Per-Million
02	DC	Direct Current
03	AC	Alternating Current
04	MUC	Microcontroller Unit

CHAPTER 1

INTRODUCTION

Nowadays the air condition is very polluted. In recent years, car emissions, chemicals from factories, smoke, and dust are everywhere. That is the reason why now air condition is very polluted. The effect of air pollution is very bad for our health, especially for a place where the air in our body is taken for breathing. Air pollution cannot be detected by human feelings. Air pollution may contain a lot of dangerous substances such as ozone, particulate matter sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead. This proposed system uses a wireless sensor network with low-cost sensors. The air pollution monitoring system is installed in a particular locality where there are traces of acute air pollution to detect the constituent gases of air which may lead to harmful effects on human health and other leaving beings. Substances in the polluted air are very dangerous. For example, if the carbon monoxide is above 100ppm, it makes humans feel dizzy, nauseous, and within minutes they could die. This research makes humans find out which content of the air is polluted. With module node MCU**.** The system is developed using Arduino, Raspberry Pi 3, and Zigbee which proves to be cost-ineffective and having low power consumption. The sensors will gather the data of various environmental parameters and provide that data to Raspberry Pi via Zigbee from the Arduino. The sensors will gather the data of various environmental parameters and provide it to the raspberry pi which acts as a base station. Realization of data gathered by sensors is displayed on Raspberry pi 3 based Webserver. Experimental results demonstrated that the system can accurately measure the concentrations of carbon monoxide, carbon dioxide, combustible gases, smoke, and air quality.

1.1 Scope of the work

Based on the objective of the project, there are several scopes has been outlined its features air sensors that help keep track of airborne chemicals, temperature, mold growth and humidity. The device alerts you if action is necessary to clean the air, and uses a color-coded system based on air quality levels. It will show the air quality in PPM on the LCD and as well as on webpage so that we can monitor it very easily. we have used MQ135 sensor which is the best choice for monitoring Air Quality as it can detects most harmful gases and can measure their amount accurately. In this IOT project, you can monitor the pollution level from anywhere using your computer or mobile. This paper assumed completely wrong assumption where they have showed the output 997PPM as the fresh air, where Delhi which is the most polluted city recording 350PPM. Its clear understanding that they haven’t calibrated the sensor and didn’t even convert the raw sensor data into PPM using derivations we did.

CHAPTER 2
LITERATURE REVIEW

Air quality monitoring systems play a crucial role in safeguarding human health and the environment. These systems use various sensors and technologies to measure and analyze air pollutants, providing real-time data for informed decision-making. In recent years, the use of Arduino-based air quality monitoring systems has gained significant attention due to their affordability, versatility, and ease of customization. This literature review aims to provide an overview of the research and developments in this field, highlighting key findings and trends. The level of pollution has increased with times by lot of factors like the increase population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor In this project we are going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will trigger a alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2, smoke, alcohol, benzene and NH3. It will show the air quality in PPM on the LCD and as well as on webpage so that we can monitor it very easily. In this IOT project, you can monitor the pollution level from anywhere using your computer or mobile The main objective of this project is to monitor the air eminence in industrial and urban areas. The proposed outline includes a set of gas sensors (CO, and NO2) that are positioned on masses and structure of a IOT (Internet of things) and a dominant server to support both short-range realtime incident management and a continuing deliberate planning. In this Arduino platform is used to communicate the data simply and quickly. WSN (Wireless sensor network) acts as the trans receiver. This provide a real-time low rate monitoring system over the use of low rate, low information rate, and little control wireless communication technology. The projected monitoring system can be transferred to or shared by different applications. Through IOT we can able to visualize the values from the globe. The problem in this paper is they haven’t calibrated the sensor and not even converted the sensor output value into PPM. As per the guidelines by UN Data, 0-50 is SAFE value and 51-100 is moderate. Delhi is the most polluted city in the world recorded 350PPM. While using two sensors, as both sensors have internal heat element, it draws more power(P= VxI), so though the both sensors are turned ON, its output voltage levels varies and shows unpredicted values due to insufficient drive. So we used a 9V battery and a 7805 family REGULATOR for the CO sensor MQ7. For MQ135 we have given the power from Arduino The level of pollution has increased with times by lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor In this project we are going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will trigger a alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2, smoke, alcohol, benzene and NH3. 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A fundamental component of any air quality monitoring system is the sensor technology used to measure various pollutants. Researchers have explored a wide range of sensors compatible with Arduino platforms. The literature reveals the popular use of gas sensors, including MQ series sensors, as well as more advanced sensors like optical particulate matter (PM) sensors. Various studies have compared the accuracy and reliability of different sensor types, emphasizing the importance of calibration and sensor drift compensation. Arduino-based air quality monitoring systems collect and process data from various sensors. Many studies discuss data acquisition techniques, signal conditioning, and data processing algorithms. Some authors have developed novel methods for enhancing data accuracy and reliability. Data fusion approaches, which combine information from multiple sensors, have been investigated to improve measurement precision. Recent trends in air quality monitoring emphasize the importance of IoT (Internet of Things) integration. Researchers have explored wireless communication protocols, such as Wi-Fi and Bluetooth, to enable real-time data transmission to cloud-based platforms. The integration of Arduino with IoT has facilitated remote monitoring and data sharing, contributing to the development of smart cities and environmental initiatives. One recurring challenge in Arduino-based air quality monitoring is the need for calibration and validation. Various studies discuss the importance of periodic calibration to ensure data accuracy and reliability. Authors have proposed different methods, including laboratory calibration and in-situ calibration, to address this issue. The literature provides insights into diverse applications of Arduino-based air quality monitoring systems. Researchers have applied these systems for indoor air quality assessment, urban air pollution mapping, and environmental studies. Case studies highlight the successful deployment of such systems in various real-world scenarios, contributing to a better understanding of air quality dynamics. Arduino platforms are often battery-powered, and power management is a significant consideration. Studies have explored energy-efficient strategies to prolong the system's operational life, such as low-power sleep modes and solar power integration, making these systems more sustainable for long-term deployment. Despite the many advantages of Arduino-based air quality monitoring systems, challenges remain. Researchers have identified issues related to sensor drift, sensor cross-sensitivity, and the need for continuous maintenance. The literature also suggests future directions, including the development of more robust sensor technologies and the incorporation of machine learning algorithms for advanced data analysis. The literature on air quality monitoring systems using Arduino demonstrates a growing interest in leveraging affordable and customizable platforms for environmental monitoring. Researchers have made significant strides in sensor technology, data acquisition, IoT integration, and practical applications. However, ongoing efforts are required to address calibration challenges, enhance system sustainability, and advance the field to meet evolving air quality monitoring needs.

CHAPTER 3
EXISTING SYSTEM

3.1 Introduction

The Arduino Uno is a microcontroller board based on the ATmega328. 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. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

3.2 Block diagram

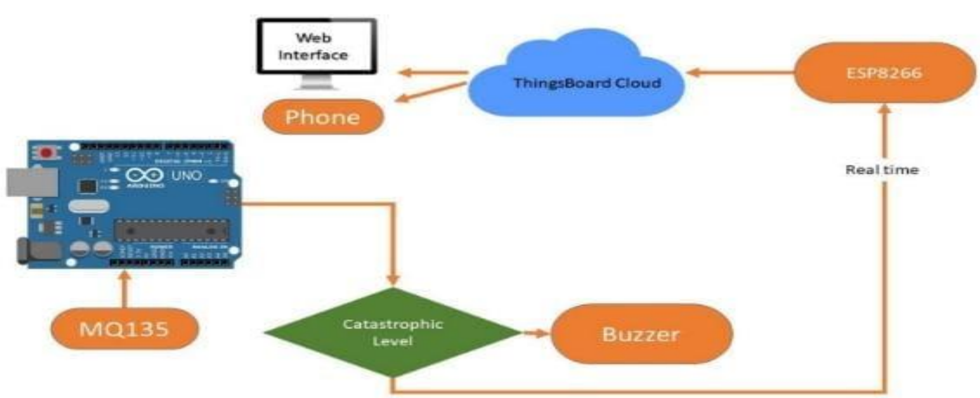

Figure 3.1 Block Diagram

3.3 Description of Various blocks

The first component of the system is the MQ135 gas sensor, which is used to detect and measure the concentration of various air pollutants such as carbon dioxide, ammonia, nitrogen oxides, and sulfur dioxide. The MQ135 gas sensor provides analog output proportional to the concentration of pollutants detected in the air. The second component of the system is the Arduino Uno microcontroller board, which receives the analog data from the MQ135 sensor and processes it to calculate the PPM level. The Arduino board also controls the various components of the system, including the LCD display, buzzer, and LED indicators. The LCD display is used to show the calculated PPM value on the screen. The display also shows other information such as the status of the air quality and the type of gas detected. The buzzer is used to sound an alarm when the PPM exceed a certain threshold level, alerting users to the poor air quality and prompting them to take necessary precautions. The LED indicators are used to show the status of the air quality. A green LED can be used to indicate good air quality, a yellow LED can be used to indicate moderate air quality, and a red LED can be used to indicate poor air quality. The LED indicators provide a visual indication of the air quality status and help users to quickly assess the air quality conditions.

At the core of the system are various sensors that measure air quality parameters. These sensors may include gas sensors (for gases like CO2, CO, NO2, etc.), particulate matter (PM) sensors, temperature and humidity sensors, and others. These sensors provide raw data about the air quality. The Arduino microcontroller serves as the central processing unit of the system. It collects data from the sensors and manages the overall operation of the monitoring system. The Arduino can be an Arduino Uno, Arduino Mega, or any other compatible model. Depending on the type of sensors used, signal conditioning circuits may be required to amplify, filter, or otherwise preprocess the sensor data to make it suitable for input to the Arduino.

This block represents the analog-to-digital converter (ADC) within the Arduino, which converts the analog sensor data into digital values that can be processed by the microcontroller. The Arduino runs code or a program that processes the sensor data. This code may include calibration algorithms, data smoothing, and statistical analysis to ensure data accuracy and reliability. The system typically includes a display component to show real-time air quality information. This can be an LCD screen, LED display, or any other visual output method. The system can be equipped with wireless communication modules, such as Wi-Fi, Bluetooth, or LoRa, to transmit data to external devices or cloud-based platforms. This enables remote monitoring and data sharing. The power supply unit provides the necessary electrical power to run the system. This can include batteries, solar panels, or other power sources. This block represents periodic calibration and maintenance procedures required to ensure the accuracy and reliability of the sensor readings. For IoT-based systems, there is often an internet connection symbol, indicating the system's ability to transmit data to the internet for remote monitoring and data analysis. This block may include external devices like a computer, smartphone, or tablet that can receive and display data from the monitoring system through the wireless communication module. In cases where user interaction is necessary, a user interface element, like buttons or a touchscreen, can be included for settings adjustment or data retrieval. Environmental Parameters: These can include additional sensors for measuring environmental parameters such as ambient temperature, humidity, and atmospheric pressure, which can be important for interpreting air quality data. In some setups, there may be a data storage unit, such as an SD card or external memory, to log and save historical air quality data for further analysis. An alerting component can be added to notify users or authorities when air quality readings exceed predefined thresholds or when unusual events occur. For cloud-based monitoring systems, a cloud platform symbol represents the server or cloud service where the data is stored and analyzed

CHAPTER 4
PROPOSED SYSTEM

4.1 Introduction

DC motor is a machine that converts electrical energy into mechanical energy by supplying DC power (voltage and current). DC motor can be seen everywhere. For example, in home appliances which are washer, rolling mills in factories and robotic arm control in electronic field. These applications demand high speed control accuracy and may be direction too. The DC motor uses in drive system in many industrial applications are still significant. This is all result from the availability of speed controllers in wide range, easily and many ways. For example, in speed control using voltage control method, when the motor gets the full power supply where the voltage is high, it will rotate at maximum speed. When no power is supplied, the motor will start to slow and eventually stop as the power is decrease. By varying the voltage supplied, the motor will rotate according to the voltage given. 2 DC motor is useful in many applications because it provides high torque due to flux and torque are perpendicular causes, they have less inertia characteristic. By mastering in handling both speed and direction of DC motor will definitely gain advantages in motor performance. The simplicity of control speed made DC motors to be common in devices ranging from toys, house appliances, and robotics to industrial applications.

4.2 Circuit diagram

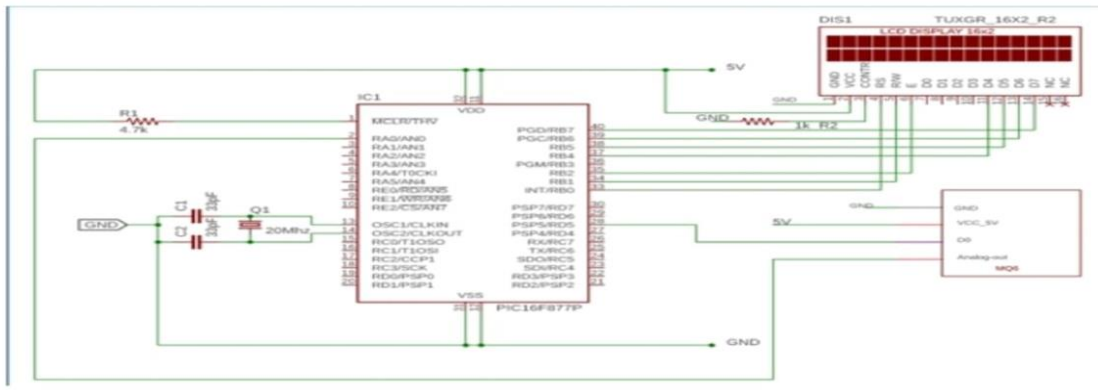

Figure 4.1 Hardware Circuit Diagram

4.3 Description of components

S.No	Components Used	No.	Cost in Rs.
1	Arduino	4	700
2	MQ 135	2	200
3	Dot Board	1	110
4	16*2 LCD Display	2	230
5	5v Power supply	1	200
6	10k potentiometer	1	15
7	1k resistor	5	5
8	Buzzer	1	40
	TOTAL		**1500**

4.3.1 Arduino

Arduino is an incredibly versatile and popular open-source platform that has revolutionized the world of electronics and programming. At its core, Arduino utilizes a microcontroller as its brain, making it capable of a wide range of tasks. What sets Arduino apart is its accessibility; whether you're a novice or an expert, Arduino welcomes you with open arms. With the user-friendly Arduino IDE, you can write, compile, and upload code to the board, using a simplified version of C/C++.

One of Arduino's key features is its extensive set of input/output pins, which allow you to connect various sensors, actuators, and displays. You can read digital or analog signals, control motors, and interface with an array of devices. The possibilities are virtually endless. Additionally, Arduino's modular design enables the use of "shields," expansion boards that easily snap onto the main board, offering a wealth of specialized functionalities. Whether you want to add wireless communication, a GPS module, or motor drivers, there's likely a shield for your needs.

Arduino also fosters a thriving community and an abundance of resources. Countless online tutorials, forums, and libraries make it accessible for beginners to learn the ropes, while advanced users can delve into complex projects. The open-source nature of Arduino means that the hardware and software designs are freely available for anyone to modify and share, leading to a rich ecosystem of compatible boards and accessories.

In essence, Arduino empowers individuals to bridge the gap between the digital and physical worlds. Whether you're creating interactive art installations, building robots, developing home automation systems, or conducting scientific experiments, Arduino provides a user-friendly, versatile, and cost-effective platform for turning your ideas into reality. It's a gateway into the exciting world of electronics and programming, limited only by your imagination.

4.3.2 MQ 135 sensor

The MQ-135 gas sensor is a critical component in air quality monitoring and gas detection applications. As its name suggests, it is particularly well-known for its ability to detect a wide range of gases, making it a versatile choice for various environmental and safety-related projects.

The MQ-135 sensor operates based on the principle of gas conductivity. Inside the sensor, there is a sensitive layer made of tin dioxide (SnO_2) that can detect a variety of gases, including ammonia (NH_3), nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). When these gases are present in the environment, they interact with the SnO_2 layer, causing changes in its electrical conductivity.

One of the distinctive features of the MQ-135 sensor is its ability to provide analog output. As the concentration of the target gas changes, the electrical resistance of the SnO_2 layer changes accordingly, resulting in an analog voltage signal. This analog signal can be read and processed by a microcontroller, such as an Arduino, or an analog-to-digital converter.

The MQ-135 sensor is widely used in air quality monitoring systems and gas detection devices due to its affordability and ease of integration. It is employed in a range of applications, including indoor air quality assessment, gas leakage detection in industrial settings, and even in wearable devices for personal safety.

To use the MQ-135 sensor effectively, it is essential to calibrate it properly for the specific gas or gases you want to detect. Calibration ensures accurate readings and minimizes false alarms. Keep in mind that the sensor's sensitivity can change over time, so regular calibration and maintenance are essential for reliable performance.

4.3.3 LCD display

Liquid Crystal Displays (LCDs) are ubiquitous in our daily lives, appearing in devices from digital watches and calculators to smartphones and large-screen televisions. These versatile displays offer a means of visually conveying information with high clarity, making them an essential component in countless applications. Here, we'll delve into the key aspects of LCD displays.

At the heart of an LCD is a liquid crystal solution sandwiched between two transparent panels. These liquid crystals have a unique property: they can change the orientation of their molecules when an electric field is applied. This change in molecular orientation influences the passage of light through the display, resulting in the creation of visible images or text.

One of the primary benefits of LCD technology is its energy efficiency. Unlike older technologies like cathode ray tubes (CRTs), LCDs consume relatively little power. This makes them ideal for battery-powered devices, such as laptops, tablets, and smartphones, as well as for various industrial and consumer applications.

LCDs offer sharp and crisp images, thanks to their ability to display a wide range of colors with excellent clarity and contrast. They are also known for their stable and uniform image quality, making them suitable for applications that require consistent visual performance, such as medical monitors and professional displays.

The versatility of LCD displays is evident in their diverse range of sizes and form factors. From small monochrome character displays used in electronic devices to large, high-definition screens for televisions and computer monitors, LCDs can be tailored to fit various applications. They are often categorized by parameters like resolution, screen size, and backlighting technology.

Backlighting plays a crucial role in LCD technology, as it determines the visibility of the display under different lighting conditions. Common backlighting methods include LED (Light Emitting Diode) and CCFL (Cold Cathode Fluorescent Lamp). LEDs are now the standard due to their energy efficiency, longer lifespan, and environmental benefits.

LCDs have seen remarkable advancements over the years, resulting in the development of various subtypes, such as TFT (Thin-Film Transistor) LCDs, OLED (Organic Light Emitting Diode) displays, and e-ink displays. Each subtype has its own set of advantages and disadvantages, making them suitable for specific applications.

4.3.4 LED

LED (Light Emitting Diode) displays are a common and versatile technology used for visual information dissemination across a wide range of applications. From digital clocks and traffic signs to giant outdoor billboards and stadium scoreboards, LED displays have become a ubiquitous part of our daily lives. In this exploration, we'll delve into the fundamental aspects and diverse uses of LED displays.

At the core of an LED display are individual light-emitting diodes, which are semiconductor devices that emit light when an electric current passes through them. Unlike traditional light sources, such as incandescent or fluorescent bulbs, LEDs are highly efficient, durable, and long-lasting. Their small size, low power consumption, and rapid response make them ideal for creating vibrant, dynamic displays.

LEDs can be categorized into two main types: discrete LEDs and LED matrices. Discrete LEDs are individual, standalone LED components used for simple visual indicators, like power status LEDs on electronic devices. On the other hand, LED matrices consist of an array of closely spaced LEDs, arranged in rows and columns. These matrices are used to create more complex and dynamic displays, such as seven-segment displays for numeric readouts or full-color LED video walls.

One of the primary advantages of LED displays is their exceptional brightness and color range. LED technology allows for the creation of displays that are visible even in direct sunlight, making them ideal for outdoor signage and billboards. Furthermore, LED displays can produce a wide spectrum of colors, and advancements in technology have led to the development of full-color LED displays that can reproduce lifelike images and videos.

LED displays are characterized by their resolution, which refers to the number of pixels or LEDs within the display. Higher resolution displays can show more detailed images, while lower-resolution displays are suitable for text and simple graphics. For example, a digital billboard used on the side of a highway may have a lower resolution than an LED screen used in a sports stadium for broadcasting live events.

LED displays are also known for their adaptability. They can be curved, flexible, or even transparent, allowing for creative and unconventional installations. Flexible LED displays can be bent or shaped to fit curved surfaces, making them perfect for retail spaces, architectural installations, and artistic creations. Transparent LED displays are designed to allow light to pass through, enabling applications like transparent storefront windows that double as digital signage.

These displays have a wide range of applications, such as outdoor advertising, transportation information boards, sports venues, concert stages, information kiosks, and even indoor home lighting. In addition, they are used in control rooms for monitoring critical data and in public spaces for broadcasting news and entertainment.

CHAPTER 5
RESULT AND DISCUSSION

5.1 Hardware Implementation

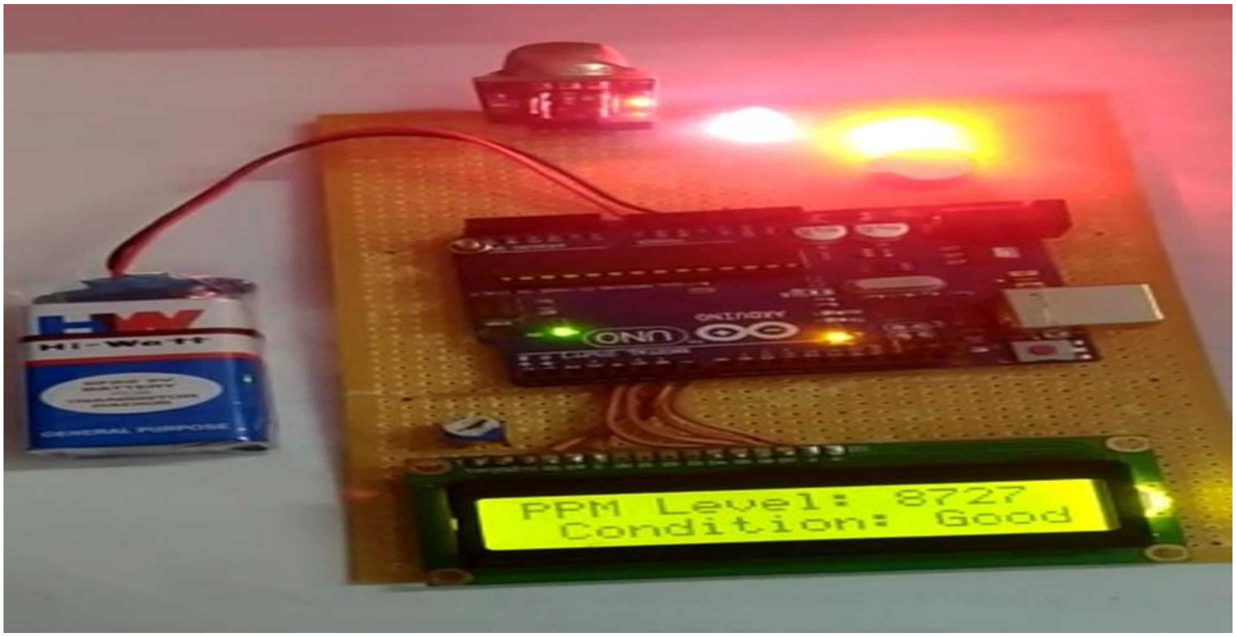

Figure 5.1 Project Hardware

- Connect normally closed terminal of both relays to positive terminal of battery.
- Connect normally open terminal of both relays to drain terminal of MOSFET.
- Connect source of MOSFET to negative terminal of battery and to Ground pin of
  Arduino UNO.
- Gate terminal to PWM pin 6 of Arduino.
- Connect 10k resistor from gate to source and 1N4007 diode from source to drain.
- Connect motor in between the middle terminal of relays.

- Out of two remaining terminals, one goes to the Vin pin of Arduino Uno and other
  to the collector terminal of transistor (for each relay).
- Connect emitter terminal of both transistor to GND pin of Arduino.

5.2 Working of Project model

Air quality monitors are fitted with multiple sensors made to detect different types of pollutants. These sensors work on the principle of measuring the attenuation of infrared radiation (of a specific wavelength) in the air. The sensors consist of an infrared radiation source (bulb), a light-water tube and an infrared detector with an appropriate filter. An electrochemical sensor detects oxygen levels and the presence of toxic gas by reducing it through an electrode and measuring its concentration. The air quality monitoring and alert system using Arduino with MQ135 works by detecting and measuring air quality using the MQ135 gas sensor and processing the data using the Arduino Uno microcontroller board. The system provides real-time information about air quality and alerts users to poor air quality conditions, helping to promote healthy living by reducing exposure to harmful air pollutants.

At the core of the air quality monitoring system are the sensors that detect specific air pollutants. These sensors typically include gas sensors like the MQ series (e.g., MQ-135 for CO2, CO, and other gases) and particulate matter (PM) sensors. Additionally, temperature and humidity sensors may be integrated to provide comprehensive environmental data. These sensors continuously collect data from the surrounding air. The collected sensor data is fed into an Arduino microcontroller, which serves as the brain of the system. The microcontroller, often an Arduino Uno or similar model, is programmed to read analog and digital data from the sensors. It processes this raw data, performs calibration if required, and prepares it for presentation. Data processing may include averaging values, error correction, and filtering to ensure reliable readings.

processed air quality data is displayed in a user-friendly format for easy interpretation. Most systems feature an LCD (Liquid Crystal Display) or an OLED (Organic Light Emitting Diode) screen to present real-time readings. The display may include numerical values for various pollutants, graphical representations, and environmental parameters like temperature and humidity. This visual output enables users to quickly assess air quality conditions. To enhance user awareness and safety, an alerting system is often incorporated. If the air quality readings surpass predefined thresholds or if hazardous conditions are detected, the system triggers alerts. This can include visual indicators on the display (e.g., flashing red warning), audible alarms, and even notifications via email or text messages, especially if the system is connected to the internet. For remote monitoring and data sharing, the air quality monitoring system integrates wireless communication modules. This can be achieved through Wi-Fi, Bluetooth, LoRa, or other wireless protocols. With wireless capabilities, users can access air quality data from their smartphones or computers, even when they are away from the monitoring system.

Many advanced air quality monitoring systems feature data logging capabilities. They store historical data on an SD card or in external memory, allowing users to analyze trends and patterns in air quality over time. Data logging is valuable for research, environmental studies, and long-term monitoring. Calibration is a crucial aspect of the system's operation. Periodic calibration ensures that the sensors provide accurate readings over time. In-situ calibration or laboratory calibration methods can be employed to correct sensor drift and maintain measurement precision. Additionally, regular maintenance and sensor replacement, if necessary, are essential to guarantee reliable performance.

In summary, an air quality monitoring system using Arduino is a sophisticated and critical tool for assessing and managing air quality. It operates by collecting data from a sensor array, processing and displaying the information in a user-friendly format, providing alerts in case of poor air quality, enabling wireless communication and remote monitoring, and supporting data logging and cloud integration. Regular calibration and maintenance are essential to ensure accurate and reliable readings, making this system valuable for various applications, from indoor air quality assessment to environmental research and urban planning.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

By effectively monitoring indoor air quality, employers are able to ensure workers can enjoy healthier spaces with cleaner air, free from potentially harmful chemicals and pollutants. As a result, employers report higher retention levels, increased productivity, and a reduction in absenteeism.

6.2 Applications

With air quality monitoring systems, industries can detect the presence of these toxics and monitor air quality to take intelligent measures to improve the quality of air for their workers. This leads to an increase in productivity, reduced equipment damage, and effective regulatory compliance. IOT Based Air Pollution Monitoring System is used to monitor the Air Quality over a web server using Internet. It will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient number of harmful gases present in the air like CO_2, smoke, alcohol, benzene, NH_3 and NO_x.

Air quality monitoring systems using Arduino have gained increasing importance in recent years due to growing concerns about air pollution, environmental health, and sustainable urban development. These systems find a wide range of applications in various domains, from environmental monitoring to public health management. In this discussion, we will explore the diverse applications of air quality monitoring systems using Arduino.

One of the most common applications of these systems is indoor air quality assessment. Ensuring good air quality indoors is vital for human health, as people spend a significant portion of their time inside homes, offices, and schools. Arduino-based systems can monitor indoor air quality parameters such as carbon dioxide (CO_2) levels, volatile organic compounds (VOCs), humidity, and temperature. These systems can alert occupants to take necessary actions when indoor air quality deteriorates, ensuring a healthy and comfortable environment. Air quality monitoring systems are instrumental in mapping urban air pollution.

In densely populated cities, traffic emissions, industrial activities, and construction projects can contribute to poor air quality. Arduino-based systems, when deployed strategically across a city, can collect real-time data on air pollutants. This data can be used to create pollution maps, helping urban planners and policymakers make informed decisions to reduce pollution and improve air quality.

Environmental researchers and scientists use air quality monitoring systems to gather data for various research projects and studies. These systems provide valuable insights into the impact of industrial emissions, agricultural activities, and natural phenomena on the environment. The data collected is crucial for understanding long-term trends in air quality and assessing the effectiveness of pollution control measures. In healthcare settings, maintaining clean and sterile air is paramount. Air quality monitoring systems are employed to ensure that hospital environments, including operating rooms, patient wards, and laboratories, meet the required air quality standards. These systems help in preventing the spread of airborne diseases and maintaining optimal conditions for patient recovery.

Industrial facilities that produce gases, dust, and fumes must monitor the air quality to protect the health and safety of workers. Arduino-based systems can be installed in factories and workplaces to continuously monitor the concentration of harmful gases, particulate matter, and volatile compounds. When air quality deviates from safe levels, alarms can be triggered to evacuate workers and prevent exposure to hazardous conditions.

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Industrial facilities that produce gases, dust, and fumes must monitor the air quality to protect the health and safety of workers. Arduino-based systems can be installed in factories and workplaces to continuously monitor the concentration of harmful gases, particulate matter, and volatile compounds. When air quality deviates from safe levels, alarms can be triggered to evacuate workers and prevent exposure to hazardous conditions. Air quality monitoring systems can also play a role in agriculture. They help farmers assess the air quality within greenhouses, poultry farms, and livestock facilities.

Monitoring parameters like ammonia levels and humidity can improve animal welfare and crop yields, ensuring optimal conditions for growth and productivity. Air quality monitoring systems can be used to raise public awareness about pollution and its health implications.

These systems can be installed in public places and schools, providing real-time data that informs the community about air quality conditions. Such initiatives encourage individuals to take personal actions to reduce pollution and protect their health. Air quality data is essential for weather forecasting and climate studies. It helps meteorologists predict air quality-related weather events like smog, haze, and heatwaves. Additionally, long-term air quality data contributes to climate studies by assessing the impact of air pollutants on global climate change. During natural disasters or industrial accidents, air quality can deteriorate rapidly. Arduino-based air quality monitoring systems can be used in emergency response and disaster management. These systems provide real-time information to assess the safety of affected areas, protect first responders, and guide evacuation procedures.

In conclusion, air quality monitoring systems using Arduino are versatile tools with a wide range of applications. These systems have a significant impact on public health, environmental protection, urban planning, industrial safety, and scientific research. As technology continues to advance, these systems will become even more sophisticated and accessible, further contributing to a cleaner, healthier, and more sustainable future.

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