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Submitted by

SRIRAM YERRA (**21BCE3340**)

Bachelor of Technology

Computer Science and Engineering

Under the guidance of

Prof. Arun Kumar

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TITLE:

To Design and develop an Air Quality Monitoring System to provide real-time monitoring and analysis of air pollutants for improved environmental health and safety for Industrial insight.

PROBLEM STATEMENT:

Air pollution poses a significant threat to public health and the environment, requiring continuous monitoring and management. However, existing air quality monitoring systems often lack comprehensive data visualization capabilities, hindering effective analysis and decision-making. To address this challenge, we propose the development of a Real-Time Air Quality Monitoring System with advanced data visualization features.

SOCIAL NEED OF THE PROBLEM:

Industrial and mining operations play a crucial role in driving economic growth and development. However, these sectors are inherently associated with various occupational hazards and safety risks. Ensuring the safety and well-being of workers in industrial and mining environments is not only a legal and ethical obligation but also a fundamental aspect of social responsibility. Therefore, there is a pressing need to address safety concerns in these sectors to protect workers' lives and promote sustainable industrial practices.

Poor air quality poses significant risks to public health, leading to respiratory diseases, cardiovascular issues, and other health complications. An effective Air Quality Monitoring System (AQMS) is crucial for identifying polluted areas, informing the public about potential health hazards, and facilitating preventive measures to protect community health.

Air pollution contributes to environmental degradation, including damage to ecosystems, loss of biodiversity, and climate change. By monitoring air quality levels, the AQMS helps identify sources of pollution, assess environmental impacts, and support efforts to mitigate pollution and preserve natural habitats.

LIST OF THE HARDWARE AND SOFTWARE USED

HARDWARE USED:

Microcontroller: The microcontroller, such as NodeMCU ESP8266, serves as the brain of the Air Quality Monitoring System (AQMS), controlling sensor data acquisition, processing, and communication with external devices. It enables real-time monitoring and data transmission to remote platforms.

Sensor (MQ135): The MQ135 sensor detects gases such as ammonia, benzene, and carbon dioxide, crucial for assessing air quality. It provides analog output proportional to gas concentration, allowing the AQMS to measure pollutant levels accurately.

Buzzer: The buzzer component emits audible alerts to notify users of critical air quality levels or system malfunctions. It enhances situational awareness and prompts immediate action in response to detected anomalies.

Breadboard: The breadboard serves as a temporary platform for prototyping and connecting electronic components in the AQMS circuit. It facilitates easy experimentation and modification without soldering, allowing for rapid development and testing.

Resistors: Resistors are passive electronic components used in the circuit to limit current flow, set voltage levels, and protect components from damage. They ensure proper operation of sensors, LEDs, and other devices in the AQMS.

Potentiometer: The potentiometer, also known as a variable resistor, adjusts resistance in the circuit to calibrate sensor readings or control LED brightness. It provides fine-tuning capabilities for optimizing system performance.

LEDs (Green and Red): The green and red LEDs serve as visual indicators of air quality status in the AQMS. Green indicates normal or acceptable conditions, while red signals critical or hazardous levels, providing clear and immediate feedback to users.

LCD Display: The LCD display module presents real-time air quality data, including pollutant concentrations and system status, in a user-friendly format. It enhances situational awareness and facilitates data visualization for effective monitoring and decision-making.

Wires (Female to Female and Male to Male): These wires facilitate electrical connections between components on the breadboard and ensure reliable signal transmission in the AQMS circuit. They enable easy assembly and disassembly of the prototype during development and testing phases.

Wi-Fi Module (Node-MCU ESP8266): The Wi-Fi module enables wireless communication and data transmission in the AQMS, connecting the microcontroller to the internet for remote monitoring and control. It facilitates seamless integration with IoT platforms and cloud services for data analytics and visualization.

SOFTWARE USED:

Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software.

Thing Speak

Thing Speak is an IoT platform developed by MathWorks, the company behind MATLAB and Simulink. It provides a platform for collecting, visualizing, and analysing sensor data in real-time.

1. Microcontroller – 1

Name	Requirement	Cost
Arduino Uno	Arduino Uno should support the integration of various sensors for detecting air pollutants such as particulate matter (PM2.5 and PM10), nitrogen dioxide (NO2), sulphur dioxide (SO2), carbon monoxide (CO), ozone (O3), and volatile organic compounds (VOCs).	1099/-

2. Sensors used - 1

Name	Requirement	Cost
MQ135	The MQ-135 sensor should be able to detect a range of gases commonly associated with air pollution, including carbon dioxide (CO2), ammonia (NH3), nitrogen oxides (NOx), and volatile organic compounds (VOCs).	199/-

3. Buzzer – 1

Name	Requirement	Cost
Buzzer1	The buzzer serves as an audible alerting mechanism to notify workers or authorities when hazardous levels of air pollutants are detected.	50/-

4. Breadboard – 1

Name	Requirement	Cost
Breadboard1	The breadboard serves as a platform for prototyping and testing electronic circuits before final assembly, allowing for easy experimentation and modification of sensor connections.	89/-

5. Resistors – 2

Name	Requirement	Cost
Resistor220 Ohm	A 220 Ohm resistor is needed for current limiting in an LED indicator circuit used to visually display certain system states or alerts. The resistor helps control the amount of current flowing through the LED to prevent it from burning out and ensures optimal brightness.	29/-
Resistor220 Ohm	A 220 Ohm resistor is needed for current limiting in an LED indicator circuit used to visually display certain system states or alerts. The resistor helps control the amount of current flowing through the LED to prevent it from burning out and ensures optimal brightness.	29/-

6. Potentiometer – 1

Name	Requirement	Cost
P103	Develop a data visualization component for the Air Quality Monitoring System (AQMS) to present air quality data in an intuitive and informative manner.	99/-

7. led 2 - Green and Red

Name	Requirement	Cost
Green LED	Indicate acceptable or safe air quality levels.	29/-
Red LED	Alert users to hazardous or poor air quality levels.	29/-

8. LCD display – 1

Name	Requirement	Cost
16X2 LCD	The 16x2 LCD display should be able to effectively present the air quality datum, including pollutant concentrations, system status, and alerts, in a clear and readable format.	264/-

9. Wires female to female and male to male

Name	Requirement	Cost
Male – Male wires	Male-male wires provide flexibility in connecting various electronic components within the Air Quality Monitoring System (AQMS) circuit. They allow for the easy interfacing in between the analog sensors, microcontrollers, modules, and the other devices on the breadboard or PCB.	
Female - Female wires	Female-to-female wires are essential for establishing the electrical connections between various components in the Air Quality Monitoring System (AQMS). They enable interconnection between sensors, microcontroller, LCD display, buzzer, and other electronic devices on the breadboard or circuit board.	179/-

10. Wi-Fi module- Node MCU - esp8266

Name	Requirement	Cost
Node MCU – ESP8266	The Node-MCU ESP8266 must provide reliable wireless connectivity to the internet for transmitting air quality data to remote servers or platforms. It should support standard Wi-Fi protocols and encryption methods to ensure secure data transmission.	403/-

DESIGN OF THE CIRCUIT:

Sensor Module:

Include sensors for detecting various air pollutants such as particulate matter (PM2.5 and PM10), nitrogen dioxide (NO2), carbon monoxide (CO), and ozone (O3).

Interface the sensors with the microcontroller using appropriate signal conditioning circuits and voltage dividers.

Microcontroller Unit (MCU):

Select a microcontroller unit (MCU) such as Arduino Uno or ESP8266 for data acquisition and processing.

Connect the MCU to the sensor module and LCD display for data retrieval and visualization.

LCD Display:

Incorporate a Liquid Crystal Display (LCD) module to visually present air quality data, including pollutant concentrations and status indicators.

Interface the LCD display with the MCU for real-time data visualization.

Buzzer Alert System:

Integrate a buzzer as an audible alert system to notify users in case of critical air quality levels or sensor malfunctions.

Connect the buzzer to the MCU and trigger alerts based on predefined threshold values.

Communication Interface:

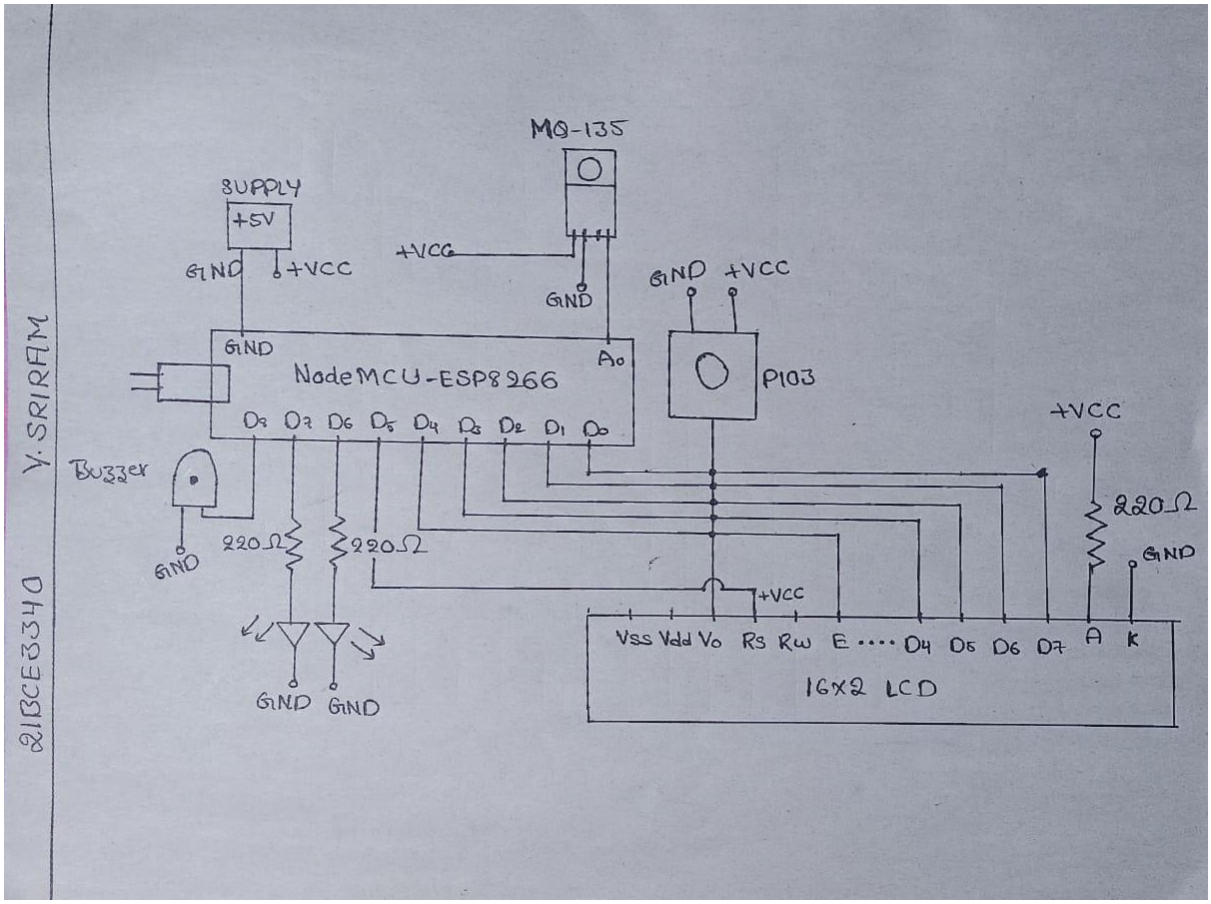
Implement a communication interface, such as Wi-Fi or GSM, to transmit air quality data to a central monitoring system or cloud platform for remote monitoring and analysis.

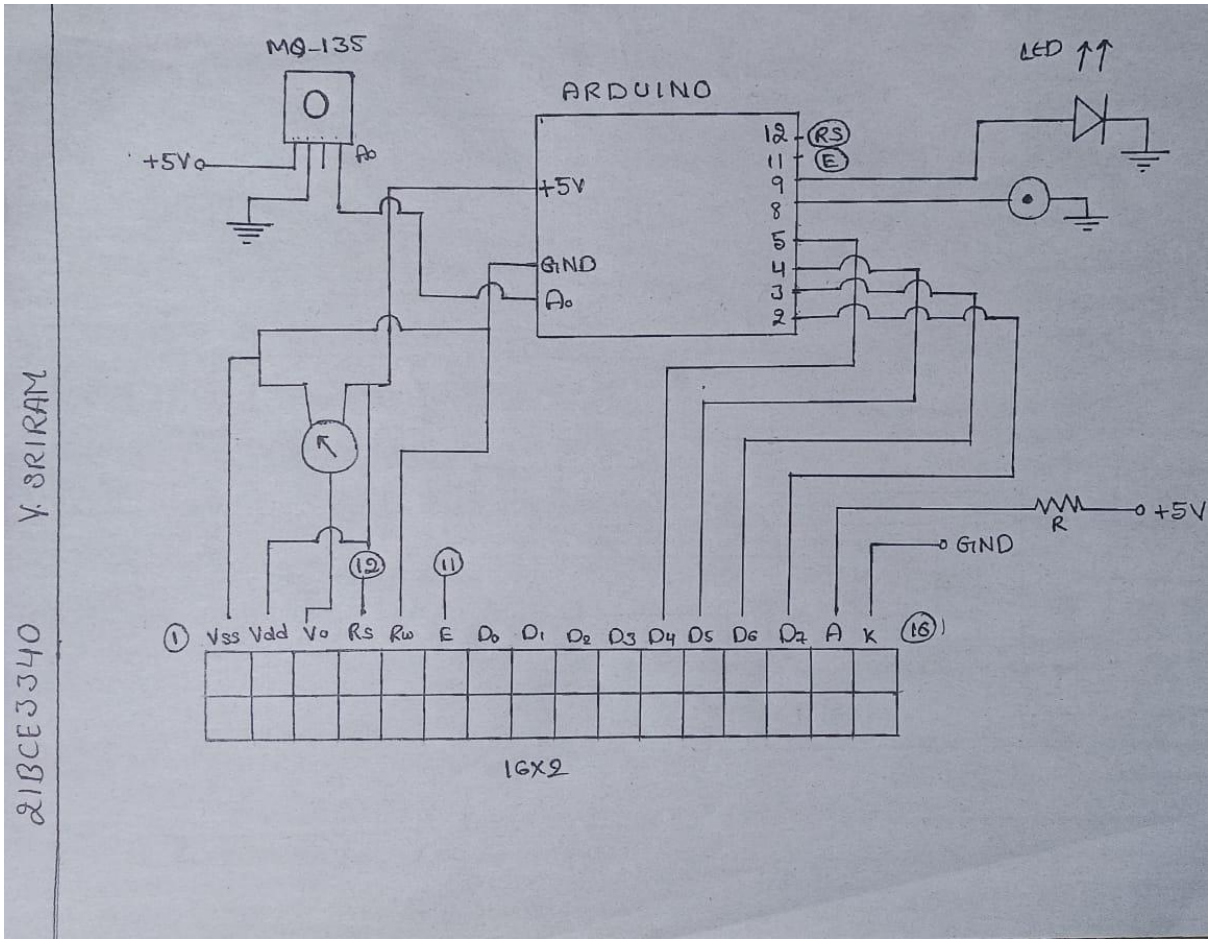
Interface the communication module with the MCU for data transmission and reception.

Power Supply:

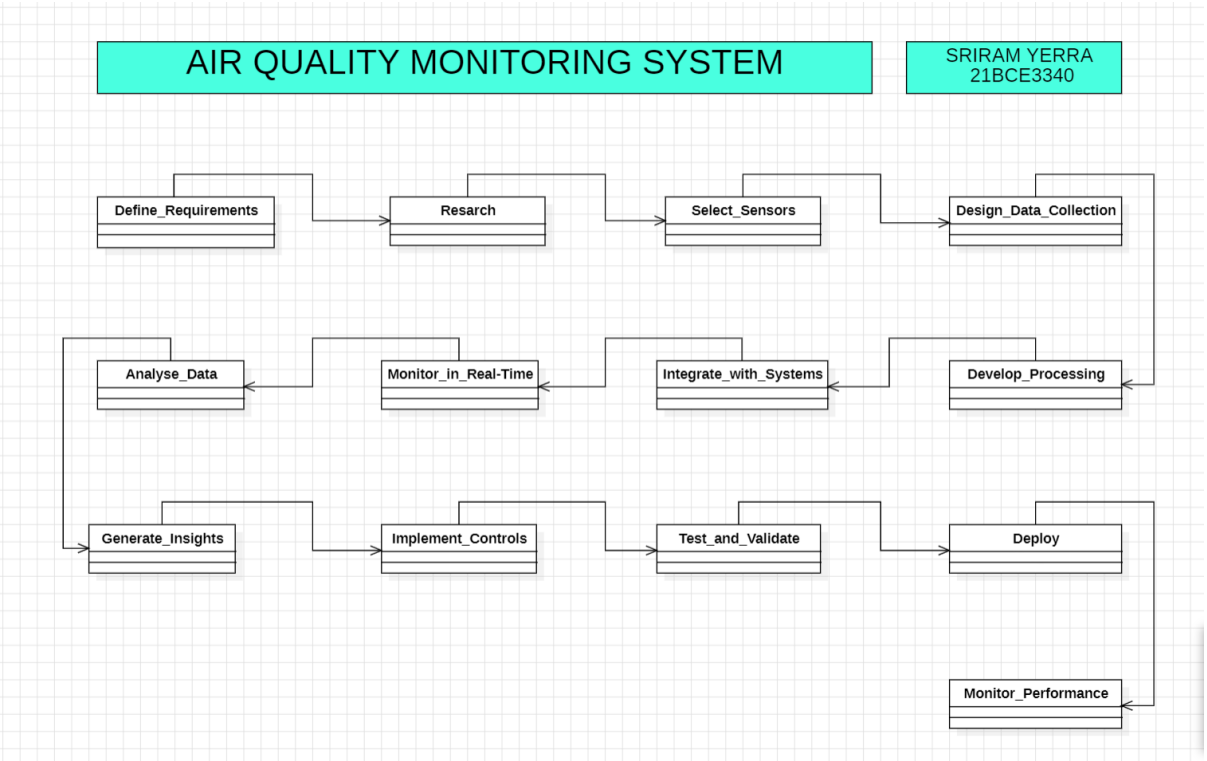
Design a stable power supply unit to provide the required voltage and current to the entire circuit.

Ensure compatibility with both AC and DC power sources, considering the deployment environment.




MQ-135
ARDUINO
LED
+5V
A0
GND
RS
E
R
Vss Vdd Vo Rs Rw E D0 D1 D2 D3 D4 D5 D6 D7 A K
16X2
Y. SRIRAM
21BCE3340

FLOW CHART:


AIR QUALITY MONITORING SYSTEM
SRIRAM YERRA
21BCE3340
Define_Requirements
Resarch
Select_Sensors
Design_Data_Collection
Develop_Processing
Integrate_with_Systems
Monitor_in_Real-Time
Analyse_Data
Generate_Insights
Implement_Controls
Test_and_Validate
Deploy
Monitor_Performance

INPUT VARIABLES:

1. **Particulate Matter (PM2.5 and PM10):** These are fine particles suspended in the air, with diameters of 2.5 micrometres or less (PM2.5) and 10 micrometres or less (PM10). PM2.5 and PM10 levels are critical indicators of air pollution and can have significant health impacts.

2. **Gaseous Pollutants:** This category includes gases such as nitrogen dioxide (NO2), sulphur dioxide (SO2), carbon monoxide (CO), ozone (O3), and volatile organic compounds (VOCs). Monitoring the concentrations of these gases provides insights into the presence of pollutants from vehicle emissions, industrial activities, and other sources.

3. **Temperature and Humidity:** Environmental factors such as temperature and humidity can influence air quality and the behaviour of pollutants in the atmosphere. Monitoring these variables helps in understanding their effects on air pollution levels.

OUTCOME:

Air Quality Index (AQI): The AQI is a standardized index used to communicate the level of air pollution to the public in an easily understandable manner. It is calculated based on the concentrations of different pollutants, such as particulate matter (PM2.5 and PM10), ozone (O3), nitrogen dioxide (NO2), sulphur dioxide (SO2), and carbon monoxide (CO). The AQI provides a numerical value or color-coded scale indicating the severity of air pollution and associated health risks.

Overall, the outcome of an AQMS serves as a critical resource for policymakers, researchers, environmental agencies, and the public to understand, monitor, and address air quality issues effectively. By providing actionable insights and promoting awareness, AQMS outcomes contribute to safeguarding public health, protecting the environment, and promoting sustainable development.