EnviroGuard

Advanced Indoor Air Quality Monitoring And Purification

Team No : 5

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01. Problem Statement

Existing indoor air quality monitoring solutions are often expensive and inaccessible to a wide range of users, limiting the ability for many individuals to monitor and predict air quality in their indoor spaces. The cost of sensors, data processing, and app development often poses a barrier to entry for those seeking affordable and comprehensive air quality monitoring systems.

02. Abstract

This project introduces a sophisticated Indoor Air Quality Monitoring System leveraging IoT technology. Equipped with sensors measuring oxygen, carbon dioxide, carbon monoxide, nitrogen, dust particles, temperature, and humidity, the system provides real-time data accessible through a dedicated application.The application employs machine learning algorithms to predict air quality, empowering users to make informed decisions about their indoor environment. To actively combat air pollution, the system features a 3-layered HEPA filter for effective particulate and gas removal. Additionally, a Humidifier ensures optimal humidity levels for enhanced comfort and health. In essence, this system offers a holistic solution, combining real-time monitoring, machine learning insights, and active air quality improvement measures.

03. Objective And Scope

- **Real-time Monitoring:** Enable real-time tracking of gases, dust particles, temperature, and humidity for immediate awareness of indoor air quality.
- **Predictive Analytics:** Implement machine learning to analyze historical data, offering users predictive insights into future air quality trends.
- **Comprehensive Filtration:** Integrate a 3-layered filtration system (primary filter, activated carbon filter, HEPA) to effectively capture and eliminate particulate matter and gases.
- **Humidity Regulation:** Incorporate a Humidifier for maintaining optimal humidity levels, ensuring a balanced and comfortable indoor environment.
- **User-Friendly Application:** Develop an intuitive mobile application for seamless real-time monitoring, predictive analytics, and user control over filtration and humidity features.
- **Scope:** Design, develop, and deploy an integrated system covering sensor integration, machine learning, filtration, Humidifier integration, and mobile application development, providing users with a holistic solution for monitoring and enhancing indoor air quality.

04. SRS

Functional Requirements :

Real-time Monitoring: Implement sensors for tracking gases, dust particles, temperature, and humidity in real-time
Predictive Analytics: Utilize machine learning for predictive insights into indoor air quality trends.
Comprehensive Filtration: Integrate a 3-layered filtration system for efficient removal of particles and gases
Humidity Regulation: Incorporate a Humidifier for maintaining humidity levels.
User-Friendly Application: Mobile app for seamless monitoring and control.

Non-Functional Requirements :

Performance: Real-time data with a latency < 1 second; predictive insights within 5 seconds.
Reliability: System uptime of at least 99%.
Scalability: Able to scale for additional sensors and users.

05
Literature Survey

Journal With Year	Summary
Sensing And Predictive Analysis Of Indoor Air Quality Based On Internet Of Things: A Covid-19 Perspective (IRJMETS,2023)	● The Long-and-Short Term Memory (LSTM) model ● COVID-19 and PM 2.5 ● Gas Heaters' CO Danger. ● Temperature and humidity Effects
Development of an IoT-Enabled Air Pollution Monitoring and Air Purifier System, Journal of Metrology Society of India (September 2023)	● Pre/primary filter, activated carbon filter, and HEPA filter ● ThingSpeak Cloud Platform ● Transmit data to Thingspeak Cloud via WiFi Module ● Monitor and purify air by filtering particles (200 to 0.3 lm)
Efficient Monitoring and Adaptive Control of Indoor Air Quality Based on IoT Technology and Fuzzy Inference(September 2022)	● Introduce a fuzzy air quality index (FAQI) model based on fuzzy inference.. ● FAQI Model

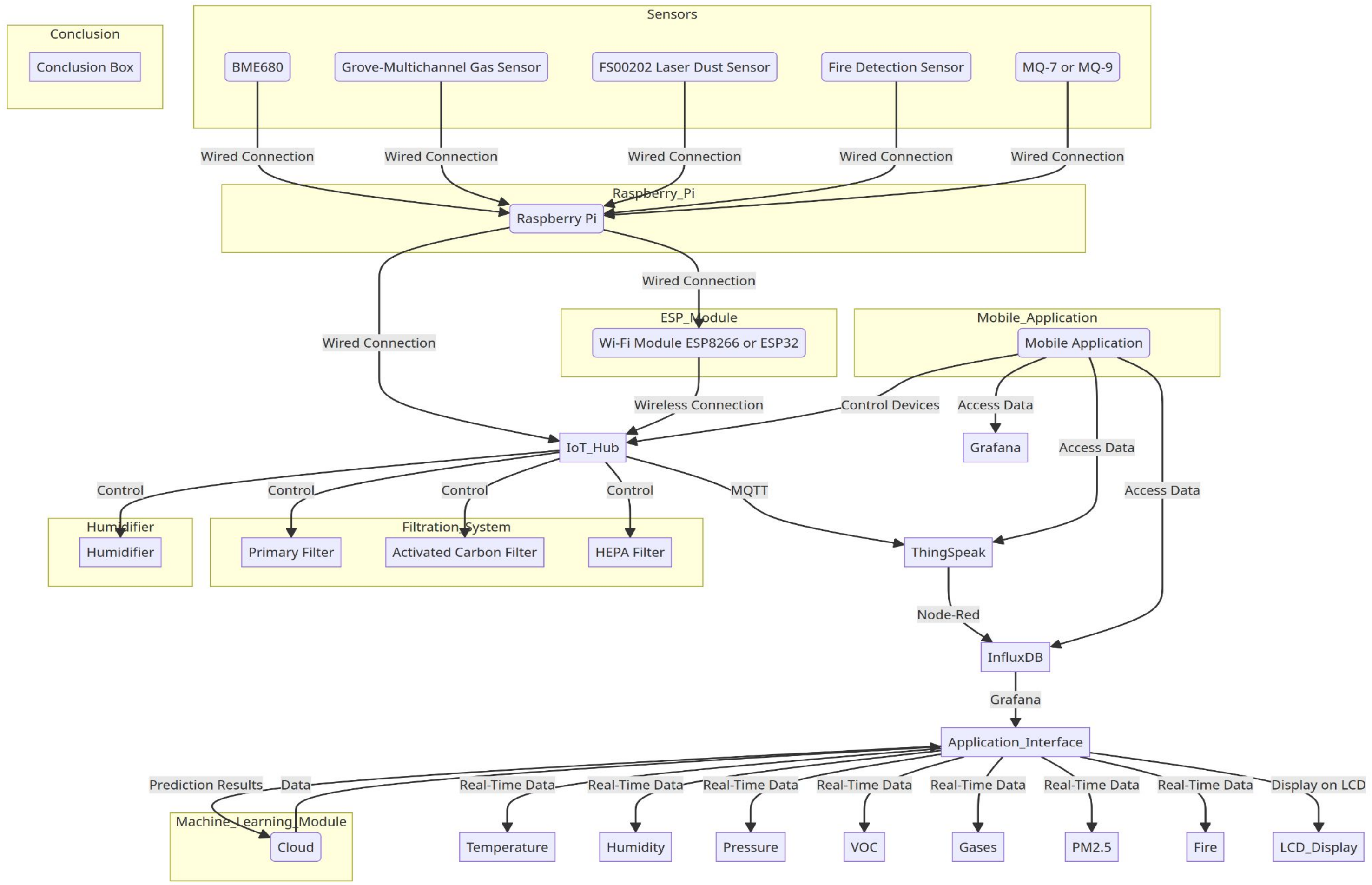
Journal With Year	Summary
Internet of Things (IoT) Based Indoor Air Quality Sensing and Predictive Analytic A COVID-19 Perspective(JAN-2021,MDPI)	• Grove-Multichannel Gas Sensor • LSTM (Long Short-Term Memory) is utilized for indoor air quality prediction, an advanced form of RNN.
IoT monitoring system for air quality assessment and collecting data (IJEEC, September 2022)	• ESP8266 • The need for real-time response led to the adoption of the ESP32 for improved performance
Air Quality Monitoring Using Arduino and Cloud Based System in IoT (IJRASET,July,2022)	• Wi-Fi Module(ESP8266) • ThingSpeak Cloud Based Platform • MQ9 Gas Sensor: measure and monitor CO
LSTM-Based IoT-Enabled CO2 Steady-State Forecasting for Indoor Air Quality Monitoring(December 2022)	• ESP8266 Wifi Module: Provides wireless connectivity. • BME680 IAQ Sensor: Monitors temperature, humidity, pressure, and air quality. • MQ9 Gas Sensor: measure and monitor CO • MQTT , Node-Red, InfluxDB,Grafana

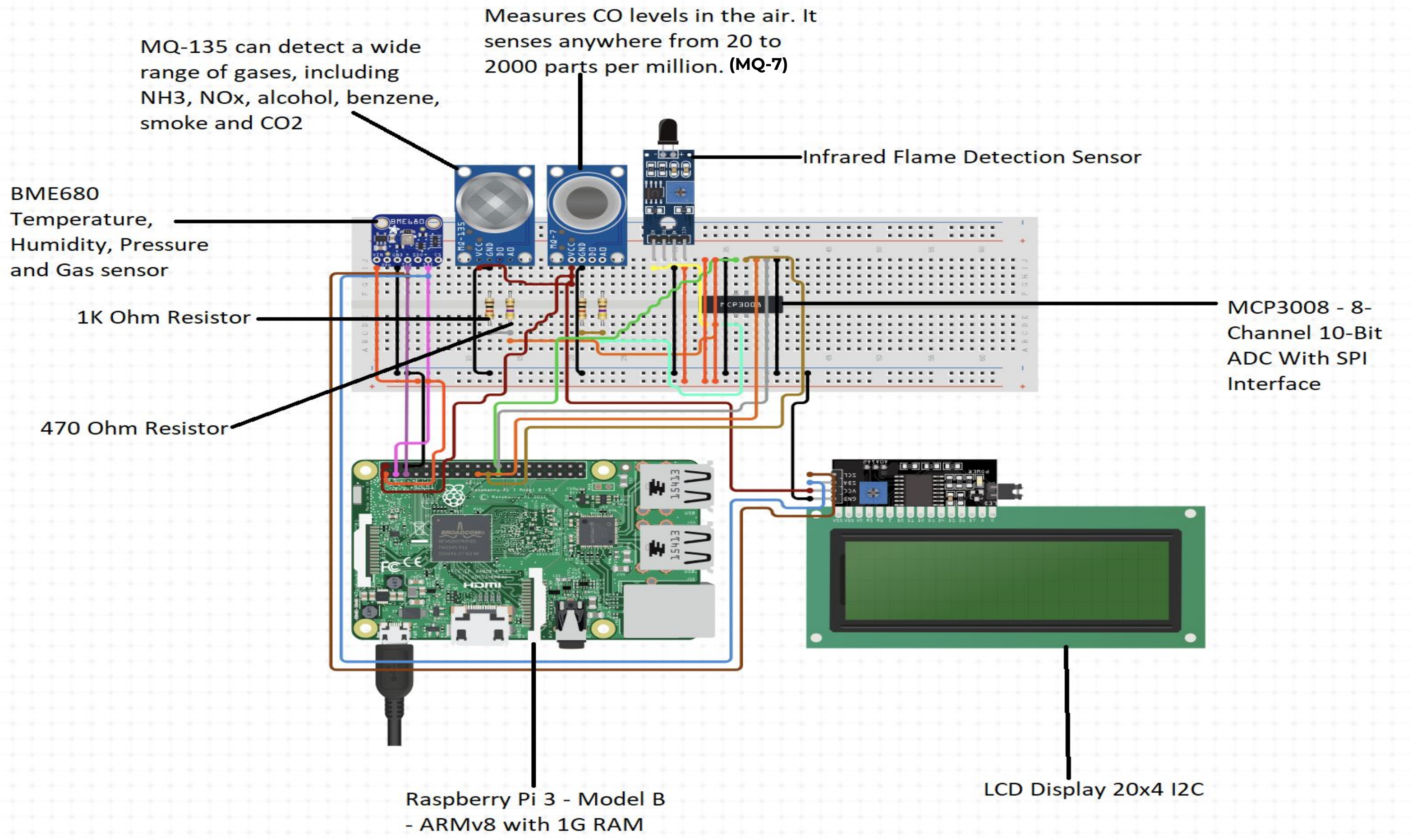
Journal With Year	Summary
IoT based Indoor Air Pollution Monitoring System (IJIREEICE,May,2023)	● BME680: A compact, low-power humidity sensor with high accuracy and EMC robustness. ● MQ-135: Gas sensor for detecting NH3, NOx, Alcohol, Benzene, Smoke, and CO2 with a standalone mode.
AI powered IoT based Real-Time Air Pollution Monitoring and Forecasting(RIACT,2021)	● MQ-7 for Carbon Monoxide, MQ-131 for Ozone, and MQ-135 for Air Quality. ● Raspberry Pi 3-Model B
Air-MIT: Air Quality Monitoring Using Internet of Things (March 2022)	● MQ7 for CO,MQ4 for CH4,MQ2 for Smoke & LPG,MQ137 for NH3, MQ135 for Overall products,MG811 for CO2 ● ThingSpeak: medium to read results from NodeMCU;graphical results.
Air Quality Monitoring System Based on IoT using Raspberry Pi (ICCCA - 2017)	● DSM501A dust sensor, MQ 9 for CO and Combustible gases, MQ 135 for CO2, NH3, alcohol, smoke, DHT 22 for Temperature and Humidity, BMP180 for Pressure ● Raspberry Pi, Node-Red, IDE, MQTT Protocol, IBM Bluemix (IBM Cloud)

Journal With Year	Summary
Iot Based Air Pollution Monitoring System (IJSRET - 2023)	● MQ135 for CO_2, SO_2, CH_4, NH_3, MQ 9 for CO and Propane (C_3H_8), MQ2 for detecting gas leakage ● ESP32 Microcontroller ● Blynk 2.0
A Design of Indoor Air-Quality Monitoring System (J. Phys. - Conf. Ser. - 2022)	● DHT11 Temperature and Humidity Sensor, FS00202 Laser Dust Sensor (PM2.5), FS00602 TVOC Sensor, FS00511 Formaldehyde Sensor ● MCU, WiFi, Elastic Compute Service (ECS), MQTT (Message Queuing Telemetry Transport), MySQL database, WeChat Mini Program
An Improvement Strategy for Indoor Air Quality Monitoring Systems (MDPI - 2023)	● Algorithm for monitoring and control. ● Key parameters monitored include CO_2, VOCs, CO, and PM2.5
An IoT-based handheld environmental and air quality monitoring station (IMEKO - 2023)	● Arduino UNO, nodeMCU (with ESP8266 Wi-Fi module) ● Portable display and a mobile app integrated with a ThingSpeak ● AHT10, MQ-7, BMP280, ZP07-MP50, PMS 5003, MQ 131

Journal With Year	Summary
Air pollution prediction with machine learning: a case study of Indian cities(IJSET,April 2022)	● Six years of air pollution data from 23 Indian cities were analyzed. ● Five machine learning models were employed to predict air quality. ● The XGBoost model outperformed other models. ● Support Vector Machine had the lowest accuracy.
Using Machine Learning Methods to Forecast Air Quality: A Case Study in Macau(MDPI,September 2022)	● Random Forest (RF), Gradient Boosting (GB), Support Vector Regression (SVR), and Multiple Linear Regression (MLR) applied for air quality prediction. ● RF is suggested as the most reliable prediction method.
AIRO: Development of an Intelligent IoT-based Air Quality Monitoring Solution for Urban Areas (Procedia,2023)	● AIRO is a decentralized IoT-based solution for Air Quality Index (AQI) calculation. ● Designed to notify users about hazardous AQI levels. ● A hybrid CNN-Bi-LSTM model is proposed for AQI prediction.
Application of the low-cost sensing technology for indoor air quality monitoring: A review (et&i,April 2022	● 42 studies were analyzed, divided into laboratory (11) and field (31) studies. ● Sufficient precision was observed, especially for qualitative analysis of air quality in indoor microenvironments.

06
Proposed System


Conclusion
Conclusion Box
Sensors
BME680
Grove-Multichannel Gas Sensor
FS00202 Laser Dust Sensor
Fire Detection Sensor
MQ-7 or MQ-9
Wired Connection
Wired Connection
Wired Connection
Wired Connection
Wired Connection
Raspberry_Pi
Raspberry Pi
Wired Connection
Wired Connection
ESP_Module
Wi-Fi Module ESP8266 or ESP32
Mobile_Application
Mobile Application
Wireless Connection
Control Devices
Access Data
Grafana
Access Data
Access Data
IoT_Hub
Control
Control
Control
Control
MQTT
Humidifier
Humidifier
Filtration_System
Primary Filter
Activated Carbon Filter
HEPA Filter
ThingSpeak
Node-Red
InfluxDB
Grafana
Application_Interface
Prediction Results
Data
Real-Time Data
Real-Time Data
Real-Time Data
Real-Time Data
Real-Time Data
Real-Time Data
Real-Time Data
Display on LCD
Machine_Learning_Module
Cloud
Temperature
Humidity
Pressure
VOC
Gases
PM2.5
Fire
LCD_Display


MQ-135 can detect a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2
Measures CO levels in the air. It senses anywhere from 20 to 2000 parts per million. (MQ-7)
Infrared Flame Detection Sensor
BME680 Temperature, Humidity, Pressure and Gas sensor
1K Ohm Resistor
470 Ohm Resistor
MCP3008 - 8-Channel 10-Bit ADC With SPI Interface
Raspberry Pi 3 - Model B - ARMv8 with 1G RAM
LCD Display 20x4 I2C

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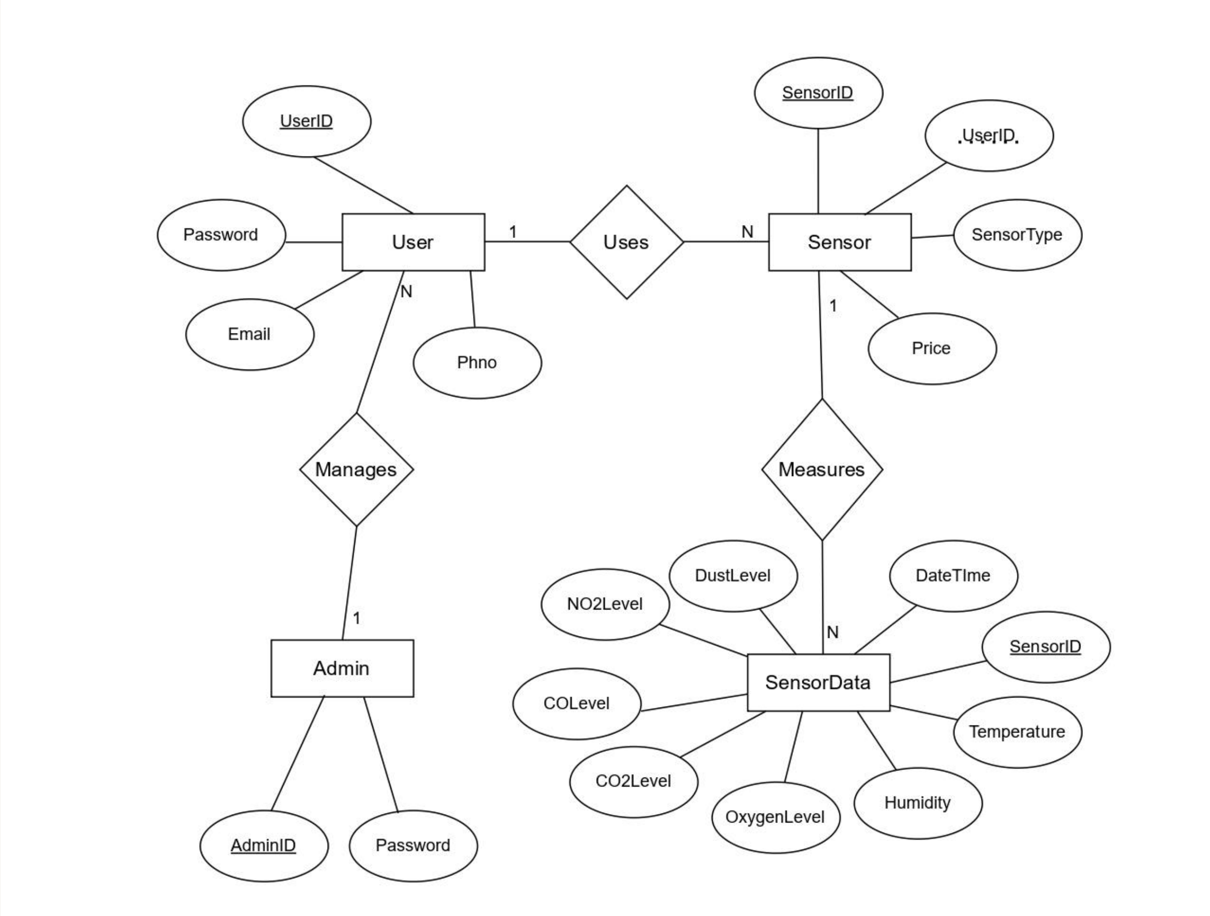
Cost of Proposed System

Component	Unit Price (₹)	Quantity	Total Cost (₹)
Hazardous Gas Sensor - MQ-135	Rs.121.74	1	Rs.121.74
Carbon Monoxide Sensor - MQ-7	Rs.123.41	1	Rs.123.41
Infrared Flame Detection Sensor	Rs.82.55	1	Rs.82.55
BME680 Temperature, Humidity, Pressure and Gas sensor	Rs.1876.16	1	Rs.1876.16
MCP3008 - 8-Channel 10-Bit ADC with SPI Interface	Rs.1876.16	1	Rs.1876.16
470 Ohm Resistor	Rs.8.34	2	Rs.16.68
1K Ohm Resistor	Rs.8.34	2	Rs.16.68
Sub Total			**Rs. 4113.38**

Component	Unit Price (₹)	Quantity	Total Cost (₹)
Raspberry Pi 3 - Model B - ARMv8	Rs. 3335.40	1	Rs. 3335.40
LCD Display 20x4 I2C	Rs.1963.72	1	Rs.1963.72
USB micro-B Cable - 6 Foot	Rs.248.49	1	Rs.248.49
BreadBoard	Rs.687.93	1	Rs.687.93
Jumper Wires Pack - M/M	Rs.162.60	1	Rs.162.60
Jumper Wires Pack - M/F	Rs.162.60	1	Rs.162.60
Humidifier	Rs. 1500	1	Rs. 1500
Filter	Rs. 600	1	Rs. 600
Sub Total			**Rs. 8660.74**
Total Cost(Approximately)			**Rs. 12774.12**

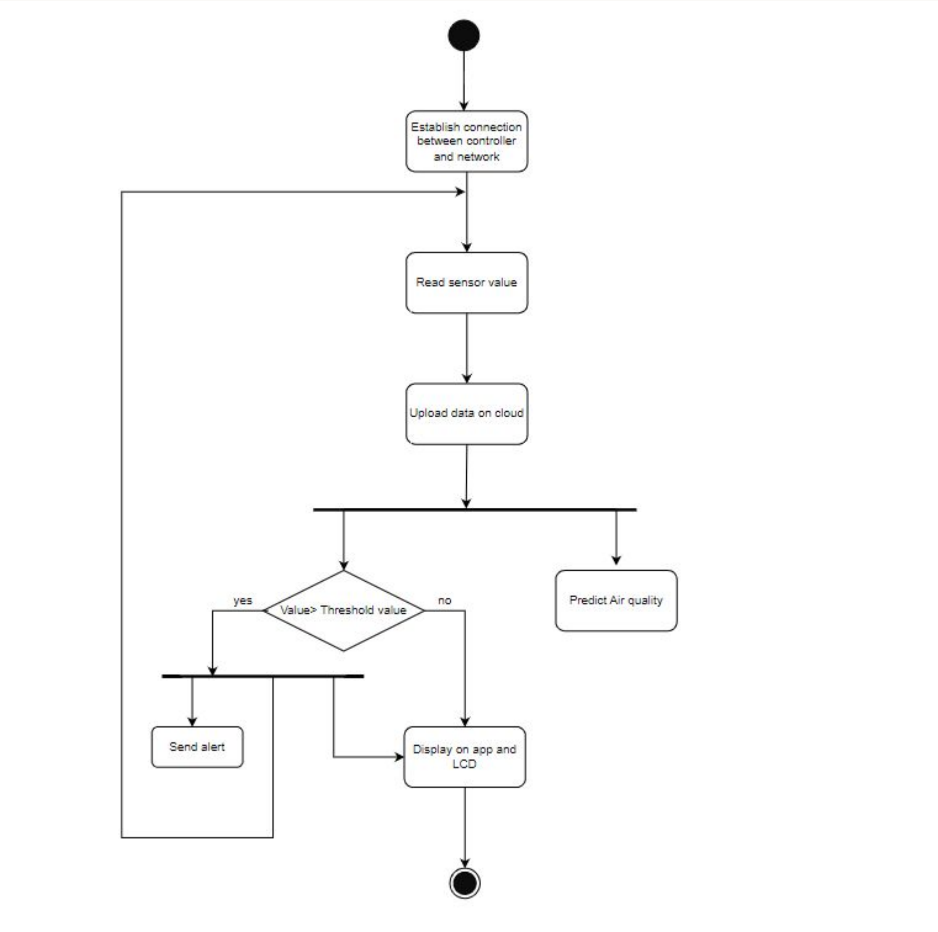
08
Designs

ER Diagram:

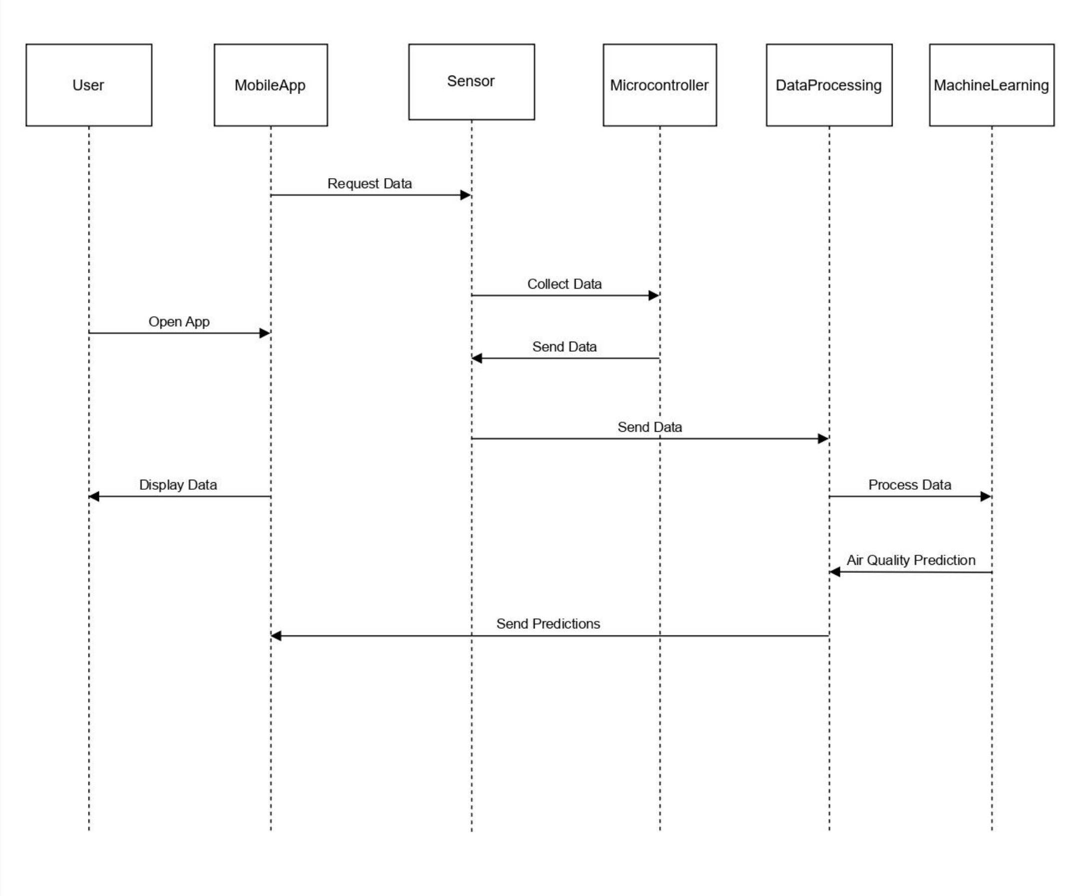


UserID
Password
User
Email
Phno
1
Uses
N
Sensor
SensorID
UserID
SensorType
Price
N
1
Manages
Measures
1
Admin
AdminID
Password
N
NO2Level
DustLevel
DateTIme
SensorID
SensorData
COLevel
CO2Level
OxygenLevel
Humidity
Temperature

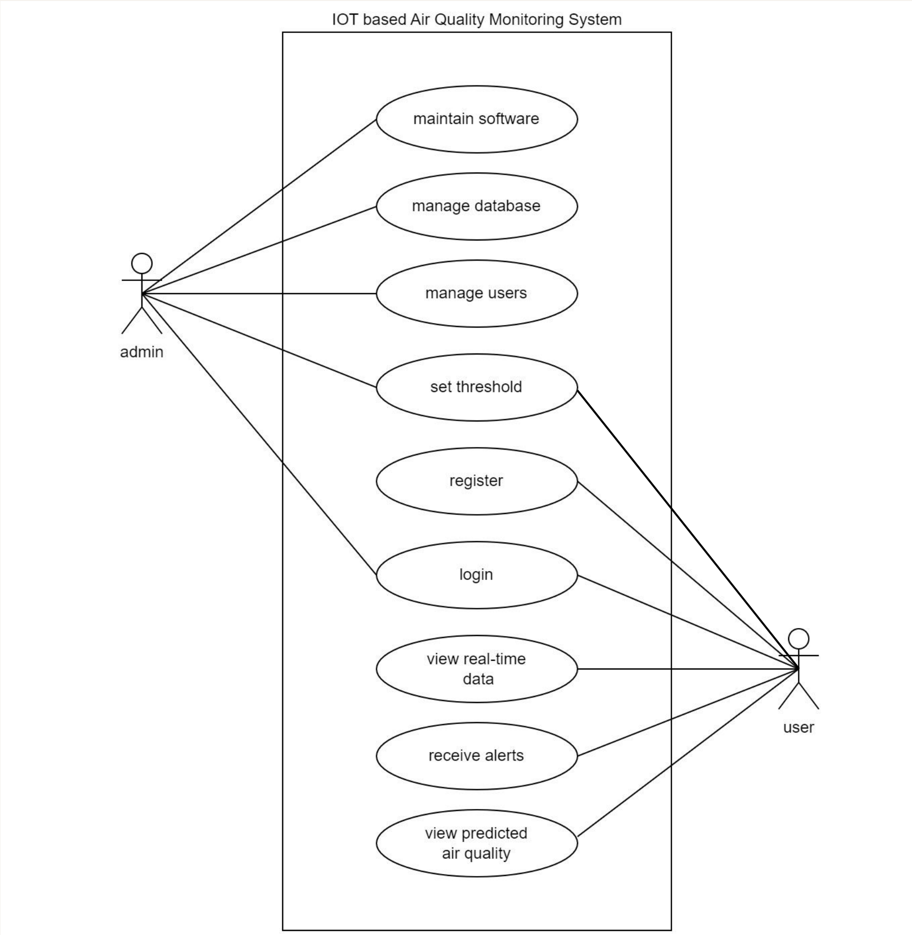
Activity Diagram:



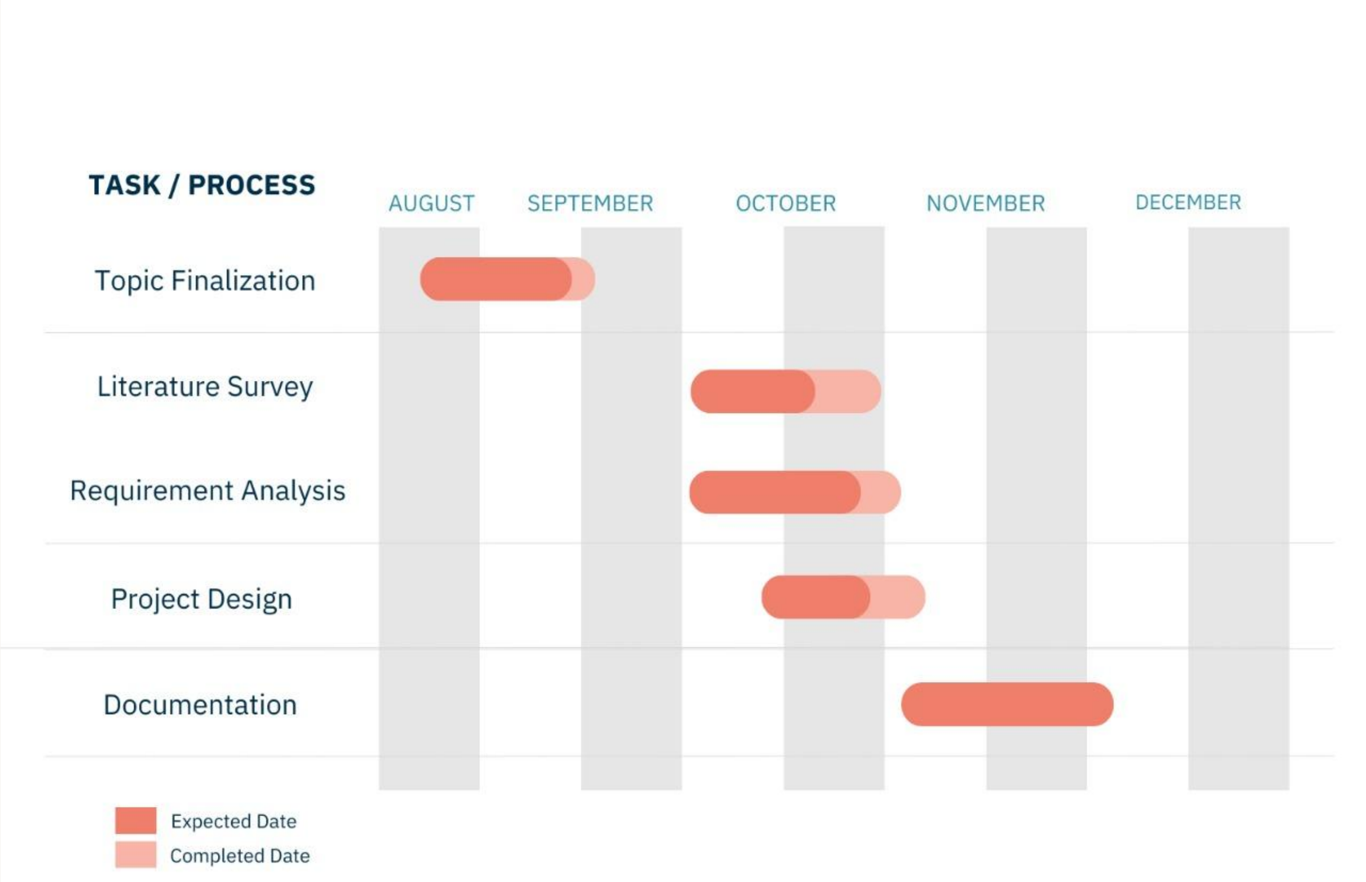
Sequence Diagram:



Use Case Diagram:



09. Gantt Chart:



10. References:

[1] L. Author et al., "LSTM-Based IoT-Enabled CO2 Steady-State Forecasting for Indoor Air Quality Monitoring," in IEEE Transactions on Industrial Informatics, vol. PP, no. 99, pp. 1-1, Dec. 2022.

[2] A. Author et al., "Internet of Things (IoT) Based Indoor Air Quality Sensing and Predictive Analytic: A COVID-19 Perspective," in IEEE Internet of Things Journal, vol. 8, no. 1, pp. 123-134, Jan. 2021.

[3] B. Author et al., "A Design of Indoor Air-Quality Monitoring System," in Journal of Physics: Conference Series, vol. 2000, no. 1, p. 012345, 2022.

[4] C. Author et al., "Development of an IoT-Enabled Air Pollution Monitoring and Air Purifier System," in Journal of Metrology Society of India, vol. 33, no. 3, pp. 215-225, Sep. 2023.

[5] D. Author et al., "IoT monitoring system for air quality assessment and collecting data," in International Journal of Environmental Engineering and Management, vol. 13, no. 3, pp. 123-134, Sep. 2022.

[6] E. Author et al., "IoT Based Air Pollution Monitoring System," in International Journal of Scientific Research in Engineering and Emerging Technologies, vol. 5, no. 8, pp. 1-5, 2023.

[7] F. Author et al., "An Improvement Strategy for Indoor Air Quality Monitoring Systems," in MDPI Sensors, vol. 23, no. 1, pp. 123-134, 2023.

[8] G. Author et al., "IoT based Indoor Air Pollution Monitoring System," in International Journal of Innovations in Electrical and Electronics Engineering, vol. 7, no. 3, pp. 12-18, May 2023.

Thank You!