PROJECT NAME: AIR QUALITY MONITORING

PHASE 2: INNOVATION

In this phase Innovation of the AQM system is mentioned considering the problem definition in the phase 1.

I. MICROCONTROLLERS:

i. Arduino UNO R3

- It does not have Operating System on its own.
- Arduino just run C/C++ code that is stored in their firmware.
- It is well-suited for simple, real-time data collection and control tasks.
- It is ideal for small-scale, localized air quality monitoring projects.

ii. Raspberry Pi

- It is a small, low-cost computer that connects to a computer monitor.
- Raspberry Pi is a single-board computer with more processing power and capabilities.
- It can handle complex data processing, web connectivity and storage.
- Raspberry Pi is commonly not used as non-local processing of data is required.

iii. ESP8266:

- ESP8266 offers Wi-Fi connectivity but lacks Bluetooth.

- ESP8266 has a single-core processor, which may limit its performance in more demanding applications.
- ESP8266 consumes less power compared to ESP32.

iv. ESP32:

- ESP32 has both Wi-Fi and Bluetooth capabilities, making it versatile for data transmission and communication.
- ESP32 is more powerful in terms of processing and has dual-core processors.
- It can used for complex data and simultaneous process of multiple processes.
- ESP32 can be configured for low-power modes, but it may consume more power compared to ESP8266 in certain scenarios.
- ESP32 may be the better choice for air quality monitoring.

II. SENSORS

i. Particulate Matter Sensor:

- Particulate matter sensor measures the quantity of (fine) dust particles in the air, expressed in PM (Particulate Matter).
- PM2.5 and PM10 Sensors:- These sensors measure the concentration of fine particulate matter in the air, which includes particles with diameters of 2.5 micrometers or smaller (PM2.5) and 10 micrometers or smaller (PM10).

ii. Digital Humidity and Temperature Sensors:

- These sensors provide precise measurements of humidity and temperature, which are crucial for assessing indoor and outdoor air quality.

- There are various types of digital humidity and temperature sensors available, including capacitive, resistive and thermal sensors.
- Digital humidity and temperature sensors offer high accuracy and reliability, making them suitable for applications where precise measurements are essential.
- Proper calibration and maintenance are essential to ensure reliable and accurate measurements in your monitoring system.

iii. Air Quality Index (AQI) Sensors:

- AQI sensors typically measure multiple air pollutants, including:
  - Particulate Matter (PM2.5 and PM10)
  - Ground-level Ozone (O3)
  - Nitrogen Dioxide (NO2)
  - Sulfur Dioxide (SO2)
  - Carbon Monoxide (CO)
- The AQI is calculated based on the concentration of these pollutants and is usually expressed as a numerical value on a scale with different color-coded categories, such as "Good," "Moderate," "Unhealthy," etc.

III. Connectivity

Air quality monitoring systems use various modes of connectivity to transmit data and communicate with central databases or platforms.

i. Fiber Optic:

In high-density urban areas or research facilities, high-speed fiber optic connections may be used for data transmission.

ii. Ethernet

Some monitoring stations are directly connected to the internet via Ethernet cables, which is common for stationary installations in urban areas or research facilities.

iii. LPWAN (Low Power Wide Area Networking):

LPWAN technologies like Sigfox and NB-IoT are used for low-power, long-range connectivity in IoT-based air quality monitoring.

iv. Wi-Fi:

- Wi-Fi connectivity eliminates the need for physical cables, allowing air quality sensors to transmit data wirelessly to a designated network.
- Researchers and environmental agencies can access and control the equipment from a central location, reducing the need for physical site visits.
- Air quality data collected through Wi-Fi-connected sensors is often made accessible to the public through websites or mobile apps.

IV. CLOUD SERVER

The cloud server is a centralized platform for storing, analyzing, and sharing air quality data. It collects data from the communication module and stores it in a database.

The information gathered by each sensor node is uploaded to a cloud server, where it is stored and can be viewed through a web browser at any time and from any location

i. Beeceptor

Beeceptor is a **powerful tool** for testing, mocking, and intercepting HTTP requests. It provides a **dashboard** to intercept and inspect all HTTP requests in real-time.

ii. Alibaba Cloud:

Alibaba Cloud provides cloud computing services with a presence in various regions. It can be used for data storage and processing in air quality monitoring applications, particularly in Asia.

iii. IBM Cloud:

IBM Cloud provides services for data storage and analytics, including tools for data warehousing and machine learning. These services can be employed in air quality monitoring projects.

V. PROTOCOL

i. Environmental Protection Agency:

These are standardized methods for measuring specific air pollutants, such as PM2.5 and criteria pollutants like sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO) and ozone (O3).

ii. Gas Chromatography:

GC is used to analyse volatile organic compounds (VOCs) and other gaseous pollutants. It separates and quantifies different components in a gas sample.

iii. HTTP:

- HTTP (Hypertext Transfer Protocol) is used in AQM to transfer data between the client and server. It is a protocol that defines how messages are formatted and transmitted and what actions Web servers and browsers should take in response to various commands.
- In AQM, HTTP is used to send data from the sensors to the server, where it can be analysed and processed.

The server can then send back information to the client, such as alerts or notifications, using HTTP.

iv. MQTT:

- MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol that is widely used in Air Quality Monitoring (AQM) systems.
- It helps in efficient data transfer.
- It reduces network bandwidth consumption dramatically.
- Suitable for remote sensing and control.

v. AMQP (Advanced Message Queuing Protocol)

AQM is a messaging protocol that is widely used in AQM systems. It is a reliable and efficient way to transfer data between systems, and supports a wide range of messaging patterns, including point-to-point and publish-subscribe models.

VI. FEATURES

- Real-time monitoring: AQM systems provide real-time monitoring of air quality, which helps in identifying and addressing air pollution issues quickly.
- Data collection: AQM systems collect data from various sources, such as sensors, and transmit it to a central server for analysis and processing.
- Data analysis: AQM systems analyse the collected data to identify patterns and trends in air quality.
- Alerts and notifications: AQM systems can send alerts and notifications to users when air quality levels exceed safe limits.