AI -BASED AIR QUALITY INDEX MONITORING AND SUGGESTION SYSTEM

PROBLEM STATEMENT:

Currently, urban areas face significant challenges related to air pollution, with harmful gases such as particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), and volatile organic compounds (VOCs) adversely affecting public health. Traditional air quality monitoring systems often lack the granularity and real-time capabilities needed to provide timely and accurate information. Furthermore, they do not typically account for the varying susceptibilities of different age groups to air pollution, leading to generalized health advisories that may not adequately protect vulnerable populations such as children and the elderly. This gap in effective monitoring and targeted health recommendations underscores the need for a more sophisticated solution that leverages modern technologies such as AI and machine learning to deliver precise, actionable insights into air quality and its health impacts.

PROPOSED SOLUTION:

Our proposed solution involves developing a hardware device using the Sipeed Maixduino board equipped with sensors to read pollutant values. These readings are updated in real-time to an Excel sheet. A pre-trained CNN or random forest regression model predicts the AQI index from these values, which is also logged in the Excel sheet. Based on the AQI range, the system provides health suggestions, displayed on the hardware's screen. This setup offers an integrated, portable, and user-friendly solution for real-time air quality monitoring and guidance, enhancing public awareness and promoting proactive health measures.

EXISTING METHODOLOGY:

ARIMA

Earlier air pollution prediction models included statistical linear methods for predicting the AQI metrics. However, the statistical linear models have poor estimation results due to time series data variations. Additionally statistical models require complex computations in the prediction process. Statistical methods like the autoregressive integrated moving average (ARIMA) used for air quality prediction do not provide reliable prediction results for the non-linear data.

To overcome the computation complexity in statistical linear methods, machine learning models are used in recent times. For nonlinear regression forecasting, support vector regression, random forest regression is used. However, due to large data volume this regression models lags in performance. Thus, the complexity can be reduced by selecting optimal features from the dataset in the prediction process.

POLLUDRONE

With real-time data on many pollutants, such as particulate matter (PM1, PM2.5, PM10), gasses (CO, NO2, SO2, O3), and volatile organic compounds (VOCs), Polludrone is an advanced air quality monitoring device. In addition, it monitors other ambient factors like humidity, temperature, and noise levels. With its cutting-edge sensors, Polludrone guarantees excellent precision and dependability. The Air Quality Index (AQI), which provides a condensed measure of overall air quality and related health hazards, is calculated using its data. Polludrone's data is publicly available and may be accessed by anyone by indicating their location on a mobile app or web platform. One known drawback in Delhi practice is the possibility of server outages that impact website data accessibility.This can be avoided by using a hardware kit that doesn't rely on an API to provide ongoing local monitoring and data accessibility.

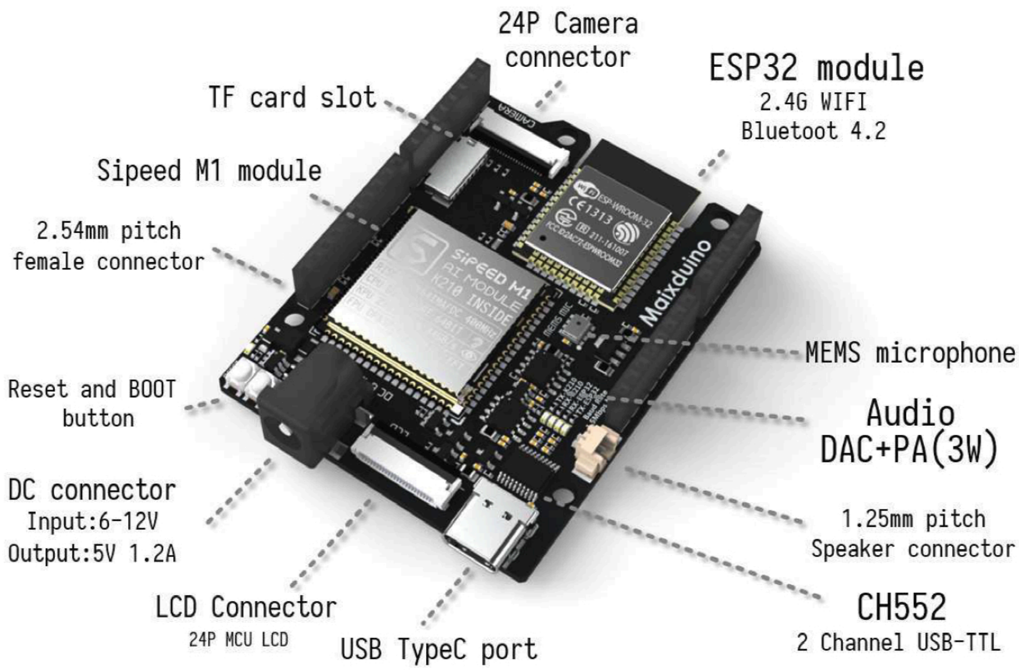
FOOT BOT

With real-time tracking of contaminants like volatile organic compounds (VOCs), particle matter (PM2.5), carbon dioxide (CO2), temperature, and humidity, Foobot is a smart indoor air quality monitor. It finds these pollutants using cutting-edge sensors, then transfers the information to an app so users can view historical trends and in-depth analysis. When pollution levels above safe criteria, the app notifies users and provides advice on how to improve the quality of the air. Furthermore, Foobot is compatible with smart home appliances, allowing for automated reactions to preserve a hygienic interior environment. But one significant drawback of Foobot is that it can only be used indoors, which limits its usefulness for monitoring outdoor air quality.

PROPOSED METHODOLOGY:

1. **BOARD WE CHOOSE:**

Sipeed Maixduino Board



Specifications

- SIPEED MaixDuino is an Arduino-compatible development board based on our M1 module **(main controller: Kendryte K210).**
- **Kendryte** supports CNN and Random forest Regression.
- The Sipeed MaixDuino can be powered via a USB Type-C connection (5V) or a single-cell Li-Po/Li-Ion battery (3.7V). The power input range is **3.3V to 5V.**

2.SENSORS INTEGRATION

Nova PM Sensor SDS011

Measuring output: PM2.5,PM10

- Range: 0.0-999.9 ug/m3
- Power supply voltage: 5V
- Life span: 2-3 years

MQ131-H(Ozone gas sensor)

- Detection range:10-1000ppm
- Working conditions: Loop Voltage : 5±0.1V
- Lifespan : 5 years

MQ-7 (CO Sensor)

- Operating voltage: DC 5 V
- Range: 10 to 1000 ppm
- Life span: 2-3 years

ME -NO2

- Detection range:0 ~ 20ppm
- Temperature range:−20℃ ~ 50℃
- Life span: 2 years
- Operating voltage : 5V

AD 300 RO4A CIT (Sulphur dioxide)

- Measurement Range : 0.1 ppm SO2 to 20 ppm SO2
- Operating Temperature Range : -40°C to 55°C
- Lifespan : 4 years
- Operating Voltage: 3V

3.GOOGLE SHEET INTEGRATION

For a AQI calculator project using the Sipeed Maixduino board, we will be measuring the concentrations of six types of gases in the air. The Maixduino, equipped with sensors like MQ series or similar, will gather real-time air quality data. The Maixduino board features an ESP32 Wi-Fi module, which allows it to connect to the internet and facilitate data communication. To store this data in Google Sheets, you'll need to leverage the Google Sheets API. This involves setting up a Google Cloud project, enabling the Sheets API, and obtaining the necessary credentials for authentication.

In your Maixduino firmware, we can write code to read sensor data and format it into an HTTP request. Using the Wi-Fi capability of the ESP32, we can send these HTTP requests to the Google Sheets API. Typically, this involves using the `HTTPSClient` library to manage secure connections. The HTTP request will include the sensor data in a JSON payload, specifying which cells in the spreadsheet to update. On the Google Sheets side, we can set up a script to handle the incoming data and populate the appropriate rows and columns.

The integration of the Maixduino with Google Sheets ensures that your air quality data is not only measured accurately but also stored in an organized and accessible manner. This setup allows you to monitor air quality in real-time from anywhere, provided you have internet access.

4.INTEGRATION OF MACHINE LEARNING ALGORITHMS

The machine learning component leverages either a Convolutional Neural Network (CNN) or Random Forest Regression model, pre-trained on historical AQI data, to predict thecurrent AQI based on real-time sensor inputs. These predictions are then recorded back into the Google Sheet. Based on the predicted AQI range, the system provides tailored suggestions displayed on the hardware, advising on outdoor activity levels and indicating which age groups are most at risk. This integration of hardware and ML models enables a comprehensive, real-time AQI monitoring solution that not only tracks air quality but also provides meaningful, user-specific advice, thereby promoting healthier lifestyle choices and ensuring public safety in varying air quality conditions.

5.DISPLAYING SUGGESTIONS

Integrating the display with the Maixduino involves connecting an OLED or LCD display using the appropriate communication protocol, such as I2C or SPI, and installing any necessary libraries for display control, like u8g2 for OLED displays. The next step is to retrieve AQI and suggestion data by using the Maixduino to send sensor data to a Flask server and receive the AQI value and suggestions, followed by parsing the response to extract AQI and suggestion strings. Finally, format the AQI value and suggestions for clear and readable display output.

NOVELTY

- Machine learning models excel at recognizing complex patterns in the data that traditional AQI calculators might miss, leading to more precise predictions. Additionally, the system can continuously improve its accuracy by learning from new data, refining its predictions, and adapting to changing conditions.

- It is user-friendly, with simple instructions and clear displays, ensuring that even individuals with limited education can easily set up and understand the air quality data.
- The novelty of this project lies in its development of a self-contained, hardware-based AQI monitoring system that does not rely on web-based platforms or servers. Unlike current systems that face issues like server downtime or limited accessibility, especially for uneducated individuals, our solution offers real-time monitoring and data analysis directly on the device.

AQI Basics for Ozone and Particle Pollution

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.