Neural Sense Environmental Intelligence System

A Minor Project Report

in partial fulfillment for the award of the degree

of

Bachelor of Technology

in

Electronics and Communication Engineering

Submitted By

Abhijeet Kumar(22BEC001)

Aditya Kumar Singh (22BEC008)

Aditya Nath Pandita (22BEC009)

Nimmada Sandhya(22BEC065)

Under the Guidance of

Dr. Manish Shabraj (Associate Professor)

School of Electronics & Communication Engineering

Shri Mata Vaishno Devi University

Kakryal, Katra, J&K-182320

2025

Student Declaration

We hereby declare that the work presented in the B. Tech Minor Project Report entitled "Neural Sense Environmental Intelligence System," in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Electronics & Communication Engineering, and submitted to the School of Electronics & Communication Engineering, Shri Mata Vaishno Devi University, Katra, J&K, is an authentic record of our own work. This work was carried out during the period from January 2025 to May 2025 under the guidance of Dr. Shashi Bhushan Kotwal. The matter presented in this report has not been submitted elsewhere by us for the award of any other degree.

Abhijeet Kumar(22BEC001)

Aditya Kumar Singh (22BEC008)

Aditya Nath Pandita (22BEC009)

Nimmada Sandhya(22BEC065)

Certificate

This is to certify that the minor project entitled "Neural Sense Environmental Intelligence System" being submitted by Abhijeet Kumar(22BEC001), Aditya Kumar Singh (22BEC008), Aditya Nath Pandita (22BEC009), and Nimmada Sandhya (22BEC065) to the School of Electronics and Communication Engineering has been completed under the supervision and guidance of Dr. Manish Shabraj. The report meets the standards and fulfills the requirements of the regulations related to the degree.

We wish the best for his endeavor.

Dr. Manish Shabraj
(Guide)

Dr. Vikram Singh
(Examiner)

Dr.Kumud Ranjan Jha
(Examiner)

Abstract

Neural Sense Environmental Intelligence System

The Neural Sense Environmental Intelligence System (NSEIS) is a compact IoT-based system designed for real-time air quality and meteorological monitoring. Utilizing low-power sensors and cloud analytics, NSEIS provides accurate assessments of pollutants and climate conditions, making it ideal for smart cities and environmental studies.

Working

Data Collection: The MQ135 sensor detects various volatile organic compounds (VOCs) and pollutants, while the DHT11 sensor measures temperature and humidity.
Transmission: An ESP8266 microcontroller sends the collected data to cloud platforms such as Firebase or ThingSpeak via Wi-Fi.
Processing: Cloud-based AI analytics are employed to detect anomalies and trends in the environmental data.
Visualization: Real-time data is displayed on mobile and web dashboards, enabling users to monitor environmental conditions remotely.

Components

ESP8266 (NodeMCU): A Wi-Fi-enabled microcontroller that processes and transmits sensor data.
MQ135 Gas Sensor: Detects a range of air pollutants.
DHT11: Measures ambient temperature and humidity.
Firebase/ThingSpeak: Cloud platforms for data storage and analytics.
Mobile/Web Interface: Provides real-time monitoring and visualization of environmental data.

Faculty Guide **Faculty Signature**
Dr. Manish Shabraj

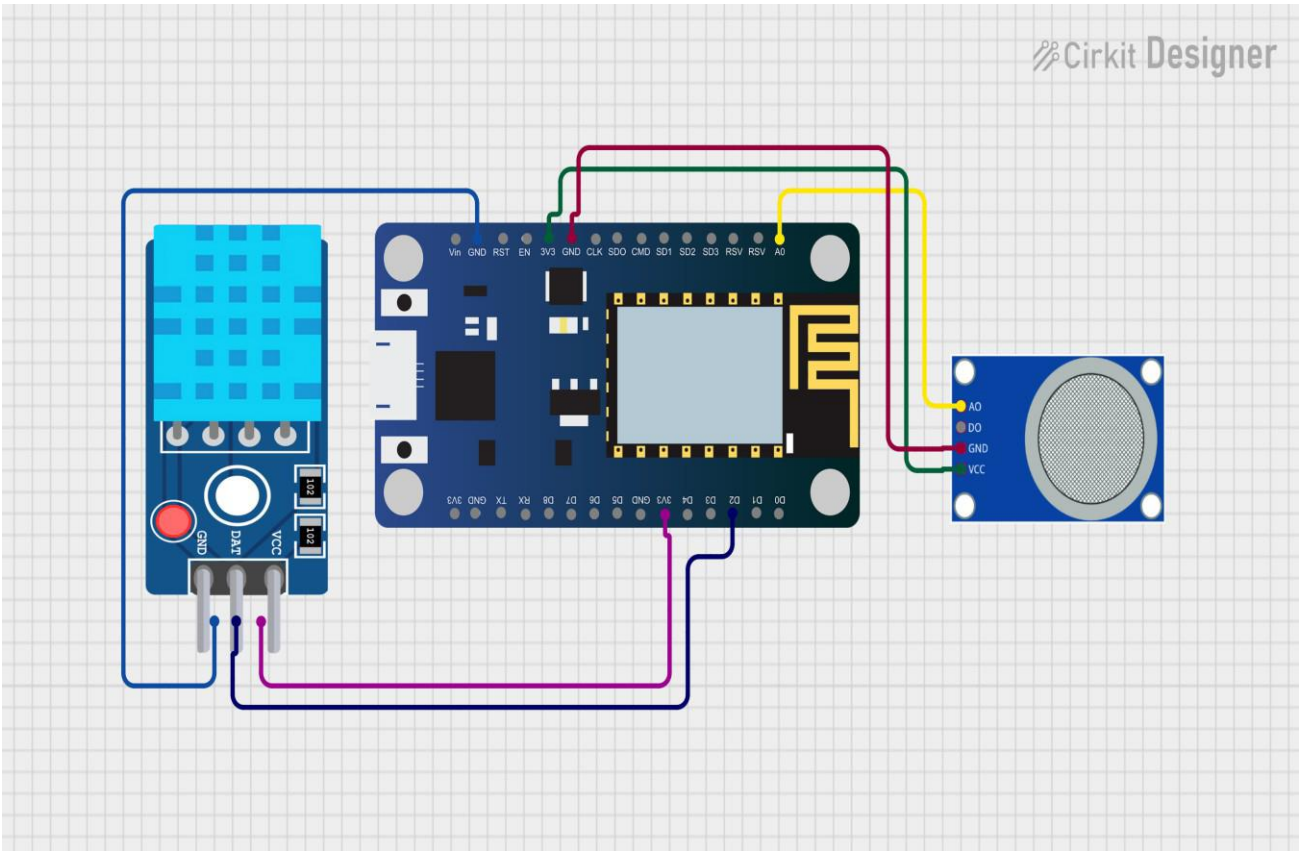
Group Members
Abhijeet Kumar (22BEC001)
Aditya Kumar Singh (22BEC008)
Aditya Nath Pandita (22BEC009)
Nimmada Sandhya (22bec065)

Table of contents

Introduction

The Neural Sense Environmental Intelligence System (NSEIS) is designed to enhance environmental monitoring by detecting and analyzing key atmospheric parameters that impact air quality and climate conditions. This system integrates various technologies to automatically collect, process, and transmit environmental data, providing valuable insights for both urban and rural settings.

At the core of the NSEIS is the Environmental Sensing Module, which utilizes advanced sensors to measure critical parameters such as temperature, humidity, and the presence of volatile organic compounds (VOCs). These sensors are strategically deployed to ensure comprehensive coverage and accurate data collection. The system is connected to a central processing unit, which coordinates the sensors and adjusts their operational parameters to mimic sophisticated environmental monitoring networks. This setup enables the system to deliver real-time, precise environmental assessments, contributing to improved public health, safety, and urban planning.



Circuit diagram

Components Used

1. ESP8266 (NodeMCU)

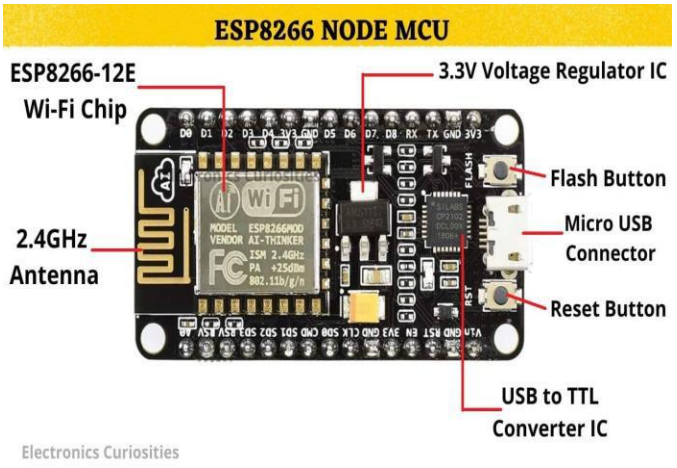
a. **Functionality**: The ESP8266 is a low-cost Wi-Fi microcontroller that serves as the central processing unit of the system. It processes inputs from the sensors, manages data transmission, and handles connectivity with cloud platforms.

b. **Key Features**:

i. Integrated Wi-Fi for seamless wireless communication.

ii. Capable of handling HTTP requests and interacting with REST APIs.

iii. Performs edge processing, including data calibration and formatting.



2. MQ135 Gas Sensor

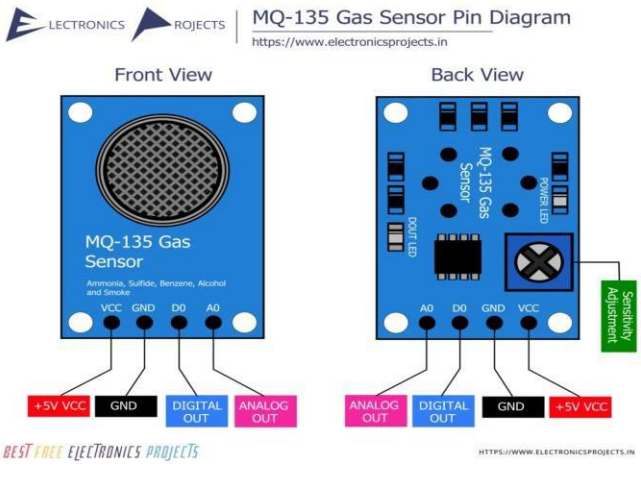
a. **Functionality**: This analog gas sensor detects a range of airborne pollutants and volatile organic compounds (VOCs), such as NH3, NOx, alcohol, benzene, smoke, and CO2.

b. **Key Features**:

i. High sensitivity to a wide range of gases.

ii. Requires preheating for accurate readings.

iii. Provides raw analog output that needs calibration to interpret in Parts Per Million (PPM).



3. DHT11 Temperature and Humidity Sensor

a. **Functionality**: Measures ambient temperature and relative humidity.

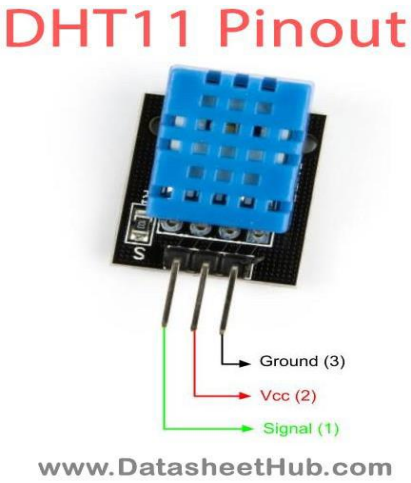
b. **Key Features**:

i. Provides digital output via a single-wire serial interface.

ii. Temperature range: 0–50°C with ±2°C accuracy.

iii. Humidity range: 20–90% RH with ±5% accuracy.

iv. Compact size and low power consumption, making it ideal for various applications.



4. ThingSpeak

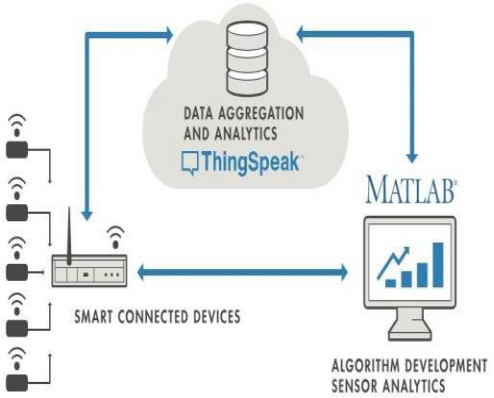
a. **Functionality**: Cloud platforms used for data storage, analytics, and visualization. They receive data from the ESP8266 and provide tools for real-time monitoring and historical data analysis.

b. **Key Features**:

i. Time-series data storage optimized for handling timestamped data streams.

ii. Supports advanced analytics, trend detection, and anomaly flagging.

iii. Provides secure and scalable data handling with authentication tokens or API keys.

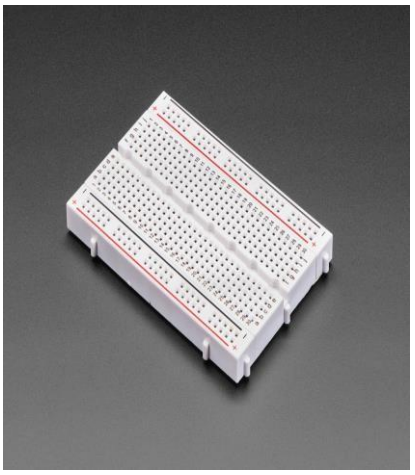


5. Breadboard and Jumper Wires

a. **Functionality**: Used for prototyping and testing electronic circuits without

soldering. The breadboard allows components to be easily connected and reconfigured, while jumper wires facilitate electrical connections.

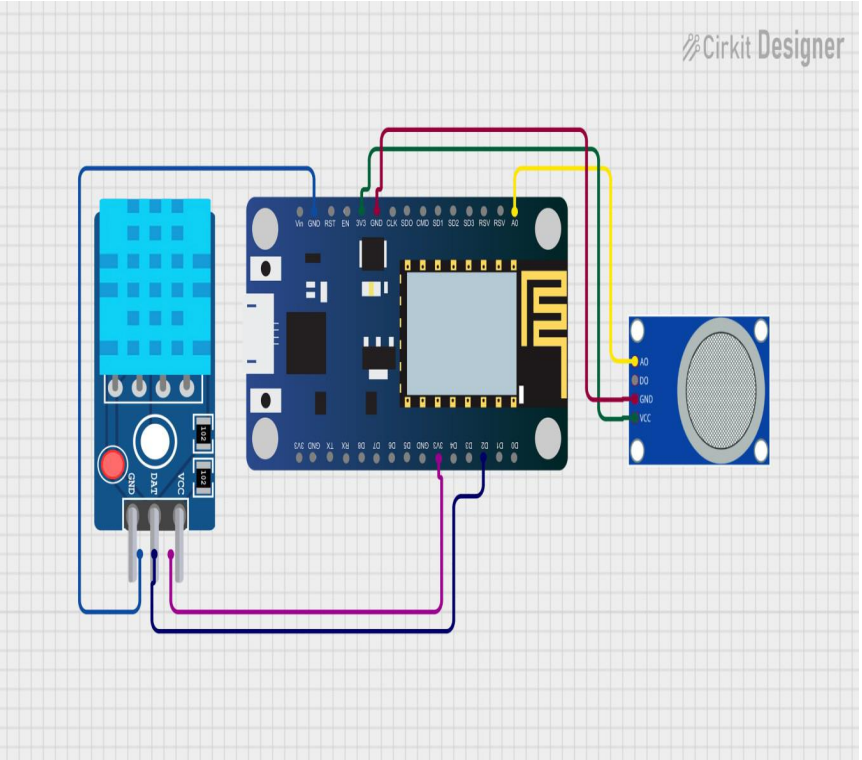
b. **Key Features**:
    i. Enables easy modifications and troubleshooting during the development phase.
    ii. Essential for learning, experimentation, and temporary circuit design.



6. USB Cable

a. **Functionality**: Connects the ESP8266 microcontroller to a computer for programming, power supply, and serial communication.
b. **Key Features**:
    i. Essential for uploading code and monitoring device output.
    ii. Facilitates data transfer and power supply to the microcontroller.

Circuit diagram



Pin description

Sensor	Sensor Pin	Connects to NodeMCU Pin
DHT11 (Temp/Humidity)	VCC	3V
	GND	GND
	DATA/OUT	D4(GPIO2)
MQ135(Air quality)	VCC	3V
	GND	GND
	AOUT	A0

Working of the Neural Sense Environmental Intelligence System

The Neural Sense Environmental Intelligence System (NSEIS) operates through a series of coordinated steps that involve data collection, processing, transmission, cloud analytics, and visualization. Here's a breakdown of each stage:

1. Initial Setup
    a. The system is powered on, initializing the ESP8266 microcontroller and all connected sensors.
    b. The MQ135 gas sensor and DHT11 temperature and humidity sensor are calibrated to ensure accurate readings.
    c. The system connects to a local Wi-Fi network to enable data transmission to cloud platforms.

2. Data Collection
    a. MQ135 Gas Sensor: Continuously monitors the air for various pollutants and VOCs. It emits an analog signal corresponding to the concentration of detected gases.
    b. DHT11 Sensor: Measures ambient temperature and humidity, providing digital output that is read by the microcontroller.
    c. The ESP8266 microcontroller collects raw data from both sensors at regular intervals.

```
[Data] Temperature: 29.80 *C
[Data] Humidity: 82.00 %
[Data] Air Quality (Corrected CO2 PPM): 128083.74
```

Figure. Data Collection

3. Data Transmission
    a. The microcontroller processes the raw sensor data, converting analog signals to digital values and applying calibration formulas.
    b. Processed data is formatted into a payload, typically in JSON or CSV format, and timestamped for accurate record-keeping.
    c. Using its Wi-Fi capabilities, the ESP8266 transmits the data payload to a designated cloud platform (e.g., Firebase or ThingSpeak) via HTTP protocols.

```
[Network] Attempting to update ThingSpeak channel...
channel updated sucessfully.
```

Figure. ThingSpeak Channel Update

4. Cloud Processing and Analytics

a. The cloud platform receives and parses the incoming data packets.
b. Data is stored in a time-series database, optimized for handling sequential data points indexed by time.
c. Advanced analytics are performed on the stored data, including trend analysis, anomaly detection, and pattern recognition. This helps in identifying unusual environmental conditions and predicting potential issues.

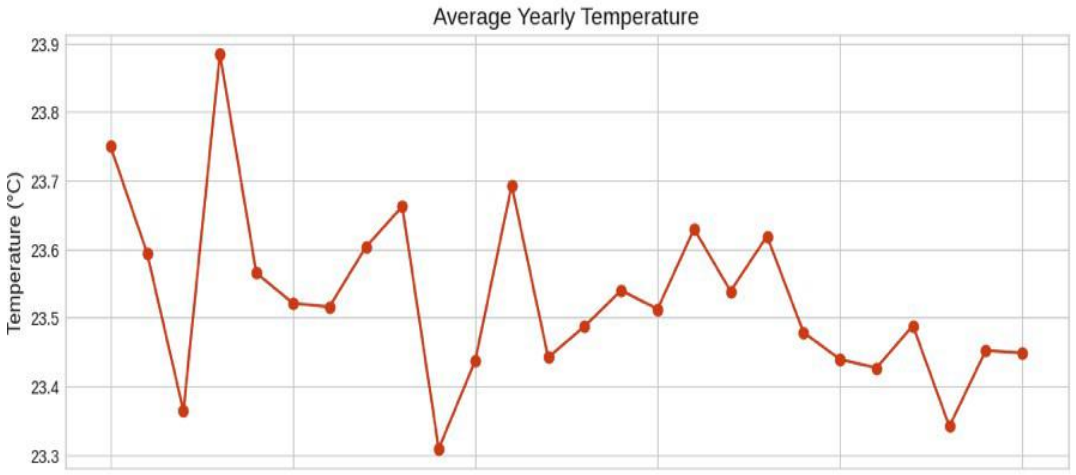
5. Data Visualization

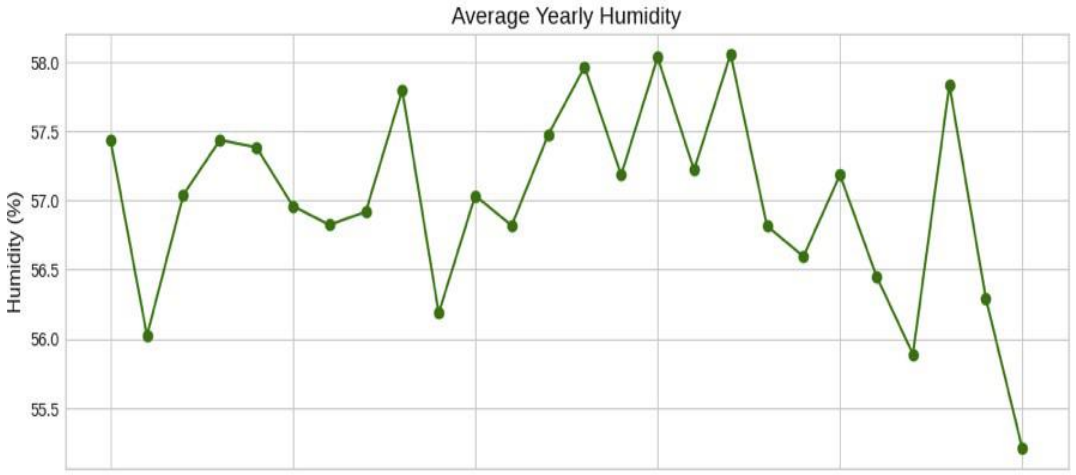
a. The processed data is made accessible through web-based dashboards or mobile applications.
b. Real-time visualizations, such as line charts and graphs, display current environmental conditions, including temperature, humidity, and pollutant levels.
c. Historical data can be viewed and analyzed through various time-based filters, allowing users to track environmental trends over time.
d. Alerts and notifications are generated if any readings exceed predefined thresholds, ensuring timely responses to critical environmental changes.

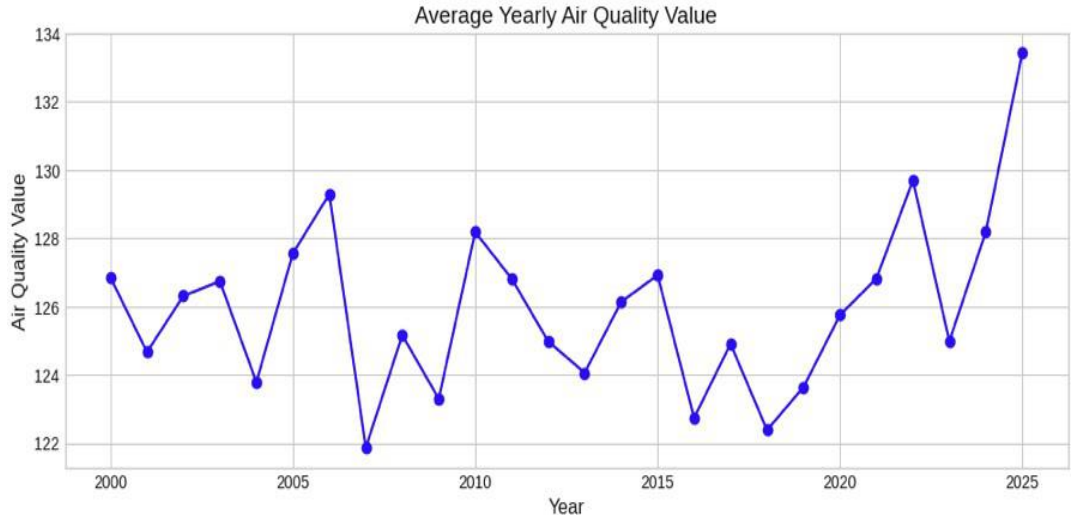
6. Continuous Monitoring

a. The system operates continuously, with sensors regularly collecting and transmitting data to the cloud.
b. The ESP8266 microcontroller ensures reliable connectivity and data transmission, with built-in retry logic to handle network issues.
c. Users can access the system remotely, enabling real-time monitoring and management of environmental conditions from anywhere with an internet connection.

Result


Average Yearly Temperature
Temperature (°C)
23.9
23.8
23.7
23.6
23.5
23.4
23.3


Average Yearly Humidity
Humidity (%)
58.0
57.5
57.0
56.5
56.0
55.5


Average Yearly Air Quality Value
Air Quality Value
134
132
130
128
126
124
122
2000
2005
2010
2015
2020
2025
Year

Conclusion

The Neural Sense Environmental Intelligence System (NSEIS) represents a significant advancement in the field of environmental monitoring, leveraging the power of IoT technology and cloud analytics to provide real-time, accurate assessments of air quality and meteorological conditions. By integrating low-cost sensors such as the MQ135 and DHT11 with the ESP8266 microcontroller, the system effectively captures and transmits critical environmental data to cloud platforms like Firebase and ThingSpeak. This seamless data flow enables comprehensive analysis and visualization, empowering users to make informed decisions based on real-time insights.

The NSEIS project demonstrates the potential of IoT-based solutions to address pressing environmental challenges, offering scalable and adaptable applications for smart cities, public health monitoring, disaster management, and educational purposes. The system's ability to operate continuously and provide remote access to environmental data underscores its value in enhancing situational awareness and facilitating timely responses to environmental changes.

Moreover, the modular design of the NSEIS allows for future enhancements, such as the integration of additional sensors, advanced AI analytics, and the development of dedicated mobile applications. These improvements will further expand the system's capabilities and contribute to its broader adoption in various sectors.

In summary, the Neural Sense Environmental Intelligence System stands as a testament to the transformative potential of IoT and cloud technologies in environmental monitoring. By providing a reliable, efficient, and cost-effective solution for real-time environmental intelligence, the NSEIS paves the way for a more sustainable and informed approach to managing our natural resources and protecting public health.

Code Link:- https://github.com/AKSA-1/NSEIS