
Breathe
The Air Quality System a Real-Time Monitoring system

Contents

Challenge: From EarthData to Action

Critical Health Impact

The World Health Organization estimates that over 99% of the world's population breathes air containing pollutant levels exceeding safe limits, leading to 7 million deaths annually from respiratory, cardiovascular, and neurological diseases.

Key Pollutants

Nitrogen Dioxide (NO_2), Formaldehyde (HCHO), Aerosol Index, Particulate Matter (PM1.0, PM2.5, PM10), and ground-level Ozone (O_3) pose immediate health risks.

Sentinel-5 Precursor (TROPOMI) Mission

Provides near-real-time global monitoring of key atmospheric pollutants, including NO_2, O_3, SO_2, CO, formaldehyde, and aerosols, with a spatial resolution of up to 7 × 3.5 km².

Breathe System Three-Layer Architecture

Breathe Node IoT Layer

Portable ESP32-based sensing devices with MQ-131, MQ-4, and PMS5003 sensors for real-time environmental measurements.

Python Server Processing

Flask REST API integrating Sentinel-5P TROPOMI and MERRA-2 atmospheric reanalysis data, OpenWeatherMap, and sensor readings for comprehensive analysis.

Mobile Application Interface

MIT App Inventor-based app providing personalized AQI values, pollutant identification, and health recommendations to users.

Web Platform Interface

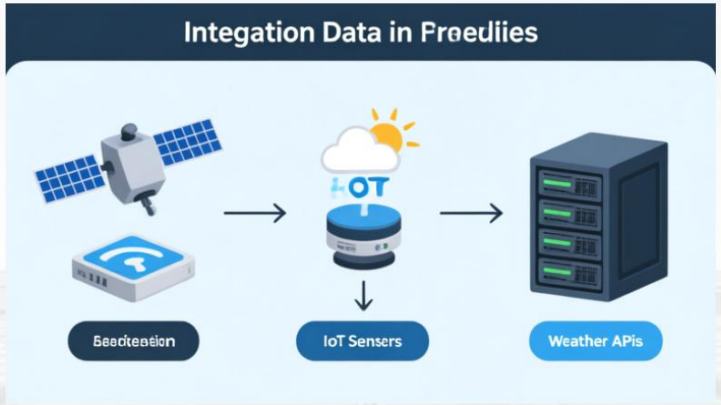
Public portal for project dissemination, detailing the architecture, components, and long-term goals of the Breathe system.

Breathe Node Hardware Components

The Breathe Node is a portable IoT device built around ESP32-WROOM-32U microcontroller, designed to capture localized air quality data and complement satellite observations with high-resolution ground measurements.

Component	Function	Measured Variable	Precision	Range
ESP32-WROOM-32U	Microcontroller & Wi-Fi	Data Processing	32-bit	240MHz
MQ-131	Ozone Detection	O_3 (Ozone)	High	10-1000 ppb
MQ-4	Methane Sensor	CH_4 (Methane)	Medium	300-10000 ppm
PMS5003	Particulate Sensor	PM1.0, PM2.5, PM10	Laser-based	0-1000 $\mu g/m^3$
Custom PCB	Integration Board	Signal Processing	Optimized	Multi-sensor

Server Processing Workflow



Data Reception

Receives JSON environmental measurements from Breathe Nodes including gas concentrations, particulate matter via HTTP requests.

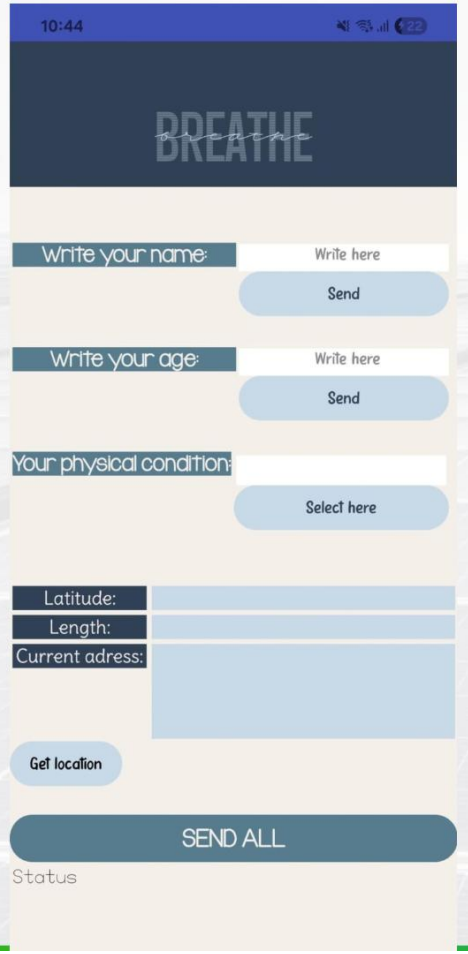
External Integration

Connects to Sentinel-5P TROPOMI and MERRA-2 atmospheric reanalysis data, OpenWeatherMap for meteorological conditions, and OpenAQ for urban air quality information.

Analysis & Output

Processes data within 50km radius, computes AQI, identifies dominant pollutants, and generates personalized health recommendations for users.

Mobile Application User Experience



Personalized Health Insights

Users provide personal details (age, weight, medical conditions, activity level) enabling the system to deliver customized health recommendations based on both air quality conditions and individual risk factors for optimal protection.

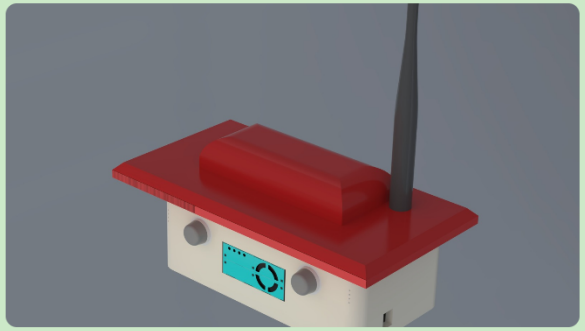
Location-Based Monitoring

GPS integration allows real-time air quality assessment within a 50-kilometer radius, combining satellite data with nearby Breathe Node measurements for accurate local environmental conditions and safety guidance.

AI Chatbot

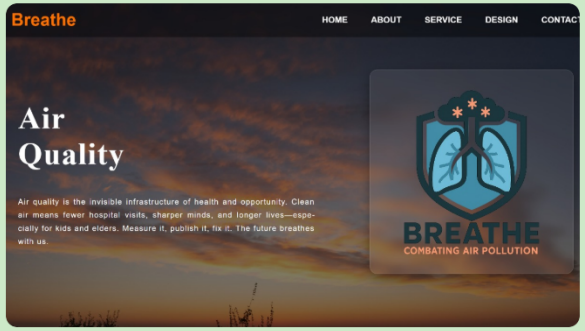
The app integrates an AI-powered chatbot that enables users to: Ask questions about air quality and pollutant levels in natural language, receive personalized protective advice according to their health profile, learn environmental concepts through simple explanations,get daily tips to reduce exposure and raise awareness

Breathe Ecosystem Data Flow & Web Platform



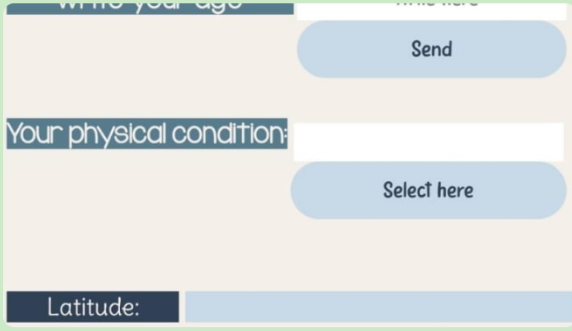
Integrated Data Flow

- Breathe Node captures environmental data and transmits to server
- Python server processes data and retrieves external API information
- Mobile app receives response and updates interface with recommendations



Public Outreach Platform

- HTML y CSS website for project promotion and education
- Documents integration of python server and IoT sensor technologies
- Raises awareness about citizen-driven environmental monitoring initiatives



MIT App Inventor Application

- Displays real-time AQI values and identifies dominant pollutants in area
- Provides personalized health recommendations based on user profile
- AI-powered chatbot integrated with ChatGPT

Future Vision and Potential Impact

AI-Enhanced Predictions

Implement machine learning algorithms to analyze historical data and cross-reference satellite and meteorological information, developing models capable of predicting high-pollution events hours in advance for preventive action.

Expanding Citizen Network

Promote Breathe Node adoption to create increasingly dense hyperlocal monitoring networks, improving global model accuracy and identifying street-level pollution hotspots invisible to satellite data alone.

Public Policy Integration

Transform collected data into valuable resources for academic institutions, environmental organizations, and governments through open-data portals enabling scientific studies and informed public policy design for urban air quality improvement.

Gitihub

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Thank You For Your Attention

Breathe represents the future of citizen-driven environmental monitoring for healthier communities worldwide.