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WINLAB | Wireless Information Network Laboratory

Open Arduino-Based Environmental Sensor Package for COSMOS Nodes

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Project Page

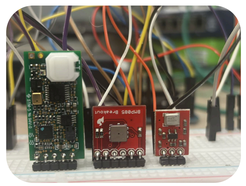
Background

COSMOS is a city-scale wireless testbed deployed across New York City. This project adds a low-cost, open-source environmental sensor package for real-time atmospheric monitoring at future node deployment locations.

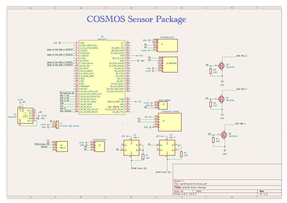
Proposed sensor package placement

Sensor Integration

Multiple environmental sensors were integrated with a Teensy 4.0 using I^2C, SPI, digital, and analog interfaces. Custom voltage-divider and heater-control circuits were added to safely connect the gas sensors and support coordinated data collection.



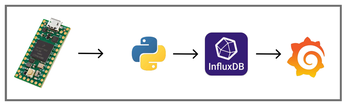
Initial Breadboard Sensor Integration

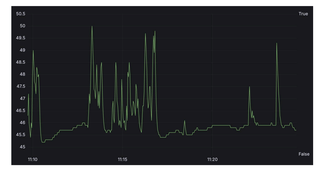


Circuit Design

Data Pipeline

Sensor measurements were transmitted from the Teensy 4.0 over serial and parsed using a Python script. The processed data were written to InfluxDB and displayed through Grafana dashboards for real-time monitoring and analysis.





Grafana Visualization

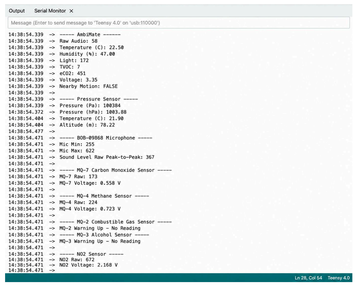
Goals

Goal 1: Design the sensor integration architecture, including schematics, interfaces, and software libraries.

Goal 2: Build and test a breadboard prototype for reliable, stable, and accurate data acquisition.

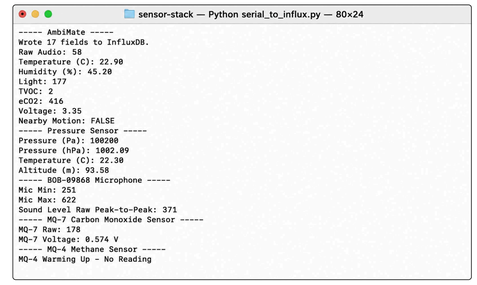
Goal 3: Develop a compact, scalable enclosure suitable for future manufacturing and deployment.

Data Acquisition



Real-time Teensy 4.0 Data Output

Dedicated Arduino libraries were used to initialize the I^2C and SPI sensors and retrieve their measurements. Analog sensors were sampled using the Teensy 4.0 ADC, and all readings were printed to the serial monitor for real-time verification.



Serial data parsed in Python and written to InfluxDB

Sensor Selection

Sensor	Data
AmbiMate MS4	Temperature, humidity, light, TVOC, eCO_2, raw audio, motion, and supply voltage
BMP085	Pressure and altitude
SPS30	PM1.0, PM2.5, PM4.0, PM10, particle count, and particle size
MQ-7	Carbon Monoxide
MQ-4	Methane
MQ-3	Alcohol Vapor
MQ-2	Combustible gas and smoke
MiCS-2714	Nitrogen Dioxide
ADXL345	3-Axis Acceleration

Modular Enclosure

The enclosure was designed with a compact 85 mm diameter while maximizing ventilation around the sensors. Its lower vented structure was inspired by a Stevenson screen, allowing outside air to circulate while helping protect the sensing components. The modular design also has custom cases for the Teensy 4.0 and SPS30 particulate matter sensor.

Enclosure Design

Future Work

Official deployment in Manhattan: Convert the current modular sensor architecture into a single integrated sensor board, with only the microcontroller and high-power heaters connected externally. This would reduce cost, save space, simplify assembly, and improve manufacturability.

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