Gas Monitoring Station

Type of the project
Semester project (min 10 Credits)

Laboratory
SKIL

Professor
To be determined

Supervisor
To be determined

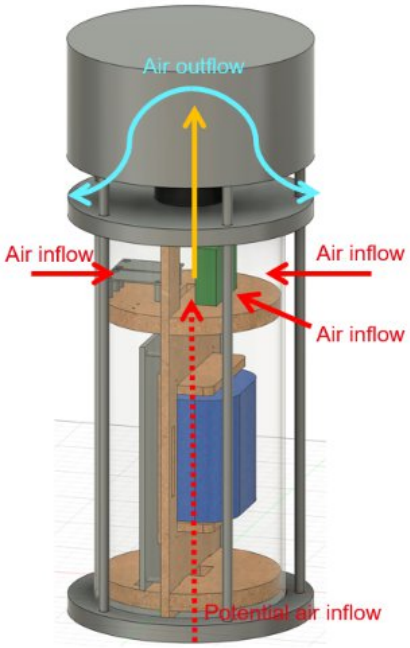
Contact person at Sailowtech
Vadim Paccaud

Student
To be determined

Context

Sailowtech is an association and a MAKE project that aims to raise awareness on environmental issues, particularly those relating to aquatic environments. It promotes frugal and participative field science, open-source science, and low-tech approach. To achieve this, Sailowtech organizes scientific sailing expeditions in lakes, seas, and oceans to discover field science and test the protocols and devices built by students during the semester.

Description of the project



The development of the gas monitoring station strives for a successful balance between affordability, functionality, and sustainability in the context of marine environmental monitoring. Designed to operate under the constraints of sailboat expeditions, the station aims to offer a compact, low-cost, and repairable solution for tracking key atmospheric pollutants—ozone (O_3), carbon monoxide (CO), and particulate matter (PM)—along with solar irradiance. It also features humidity, temperature and pressure sensors to help fine tune and calibrate the gas sensors.

The station already provides a WiFi access to get the recorded data. Despite a limited autonomous battery life of approximately 8 hours, the inclusion of an external power interface via NMEA2000 allows for continuous operation when mounted on sailboats, while still enabling standalone measurements during shorter, battery-powered excursions. This dual-power approach ensures flexibility and reliability across different deployment scenarios. The objective of the project is now the following : Complete the design, integration, and testing of a multi-sensor gas monitoring station. In particular, the project aims to address key areas of improvement identified during initial development phases, including mechanical sealing, electrical redesigns, software enhancements, and user access optimization.

Tasks:

1. **Mechanical Enhancements**
   - Improve waterproofing by integrating O-rings and sealing all cable entry points.
   - Install protective covers on air intake holes and utilize elbow pipes to maintain airflow while limiting water ingress.
   - Mount the pyranometer securely and design a path for internal cable routing.

2. **Electrical Redesign**
   - Redesign PCB to correct RS485-to-TTL and ESP8266/CAN BUS footprint issues.
   - Transition SPS30 sensor communication to the I^2C protocol.
   - Upgrade connectors for the battery and pyranometer for durability and ease of use.

- Integrate a switchable power source (NMEA vs. external battery) and eliminate existing makeshift wiring.
- Modify improve anything you deem worthy of modification

3. **Software and Data Handling**
   - Implement corrections to gas sensor readings using temperature and humidity compensation algorithms.
   - Improve firmware to convert ozone (O_3) concentrations to ppb units automatically.
   - Optimize data transmission by streaming or processing CSV files line-by-line to handle larger datasets efficiently.

4. **Power Management**
   - Analyze and apply power-saving modes for low-power operation without compromising data accuracy.

5. **Field Testing and User Interface**
   - Conduct field trials in diverse environmental conditions to assess durability and sensor performance.
   - Develop a simple and intuitive user interface for station configuration and data retrieval.

Indicative calendar

Weeks 1 to 4 : get acquainted with the project, fix the mechanical part
Weeks 5 to 8 : work on the electrical part and software
Weeks 9 to 12 : test the station in the field
Weeks 13 to 14 : work on documentation and reporting

Deliverables

1. Updated and fully functional gas monitoring station hardware and enclosure.
2. Improved firmware with enhanced sensor data accuracy and power management.
3. User interface for configuration and remote data access.
4. An oral presentation at the end and in the middle of the semester to present the results of the project.
5. A document explaining the changes made to the device to make it reproducible as well as presenting the characterization results (can be a part of the final report).
6. Complete the Sailowtech's Github that we will used as documentation
7. Final report detailing design changes, testing procedures, and performance evaluation.

Documentation

You can ask for the previous report in pdf.

Planned interaction with Sailowtech

The objective of this project is to develop a device that can be used during a Sailowtech cruise or instruments tests campaign. Consequently, there will be several meetings with Sailowtech (approximately seven per semester, or as required) to monitor progress. Furthermore, the relevant technical staff at Sailowtech will be available for advice and assistance.
Finally, you will be counted as a member of Sailowtech, and will therefore be able to take part in the various activities and potentially test the device during one of our expeditions.

Contact
Vadim Paccaud, vp.science@sailowtech.ch