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Project: SABER: Site-Aerial-Basin Emissions Reconciliation

Current project: Development of Transfer Functions: Mapping Low-Cost Sensor Responses to High-Accuracy Measurements

Project Overview

This research aims at developing transfer functions that bridge the inherent gap between low-cost sensors and high-precision methane analyzing instruments, facilitating reliable and cost-efficient methane sensing. The transfer function is a mathematical expression that will represent the relationship between the signals from the low-cost sensors and the methane analyzers. This approach will enable inexpensive but accurate multiple-points methane emissions monitoring on oil and gas fields. Leveraging a Raspberry Pi-based platform, four low-cost sensors - the Integrated IR (INIR), IR12BD, FOGARO 2600, and TGS2600 - will be synchronized to provide synchronous data collection in an active emission field setting. Each sensor is first calibrated in accordance with the manufacturer's guidelines prior to deployment.

The INIR, employing infrared technology, provides a user-friendly digital gas sensing experience with enhanced reliability. The IR12BD utilizes the Non-Dispersive Infrared (NDIR) principle, offering precise gas identification and concentration determination. The FIGARO 2600 and TGS2600 sensors exhibit heightened sensitivity to low concentrations of gaseous contaminants, particularly hydrogen and carbon monoxide, illustrating their capabilities in detecting trace methane levels.

The project's approach involves continuous monitoring over a three-month period, factoring in various environmental conditions and emission scenarios. To supplement the accuracy of this study, the integration of a '46 HAWK 3.0 Laser Diode Methane Detector and the Micro portable gas analyzers GLA131 Series, will serve to enhance the dataset with reference-grade measurements. Concurrently, a weather station is deployed to capture environmental variables that may influence methane dispersion and sensor performance, ensuring a comprehensive understanding of the contextual factors impacting sensor responses.

The system setup and data collection are developed to ensure continuous data streaming, and provides the ability to quality control the data as it streams in. The data acquisition workflow is as below:

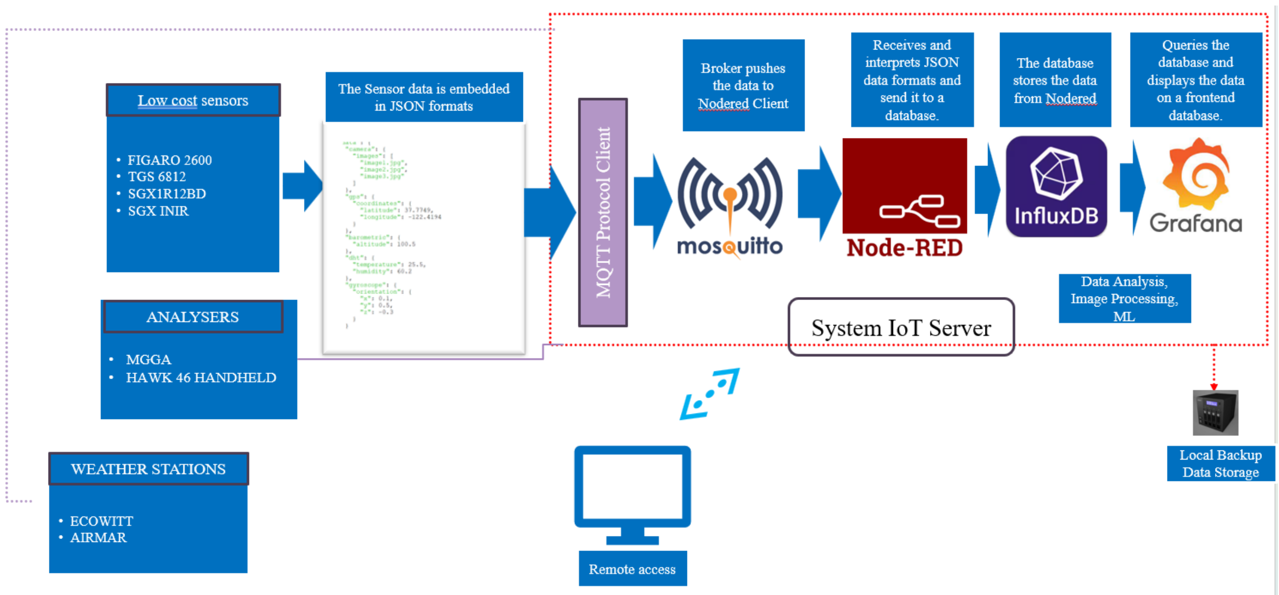

Figure 1: Data acquisition and storage channel

Through analyzing the collected data, the aim is to identify patterns, correlations, and potential biases in the responses of the low-cost sensors. A successful development of transfer functions, enriched by high accuracy instruments as a reference, will not only empower the deployment of low-cost sensors for extensive monitoring but also facilitate affordable large-scale, real-time emissions assessments.

This research attempts to answer the following question:

1. Can low-cost sensor data be synthesized to closely replicate high-accuracy analytical instruments?
2. What is the level of agreement between the methane concentrations measured by low-cost sensors and the reference-grade measurements provided by the '46 HAWK 3.0 and ABB LGR-ICOS instruments?
3. How does calibration on low-cost sensors vary over prolonged periods of time?
4. Can accurate oil field methane monitoring be achieved using low-cost sensors?

Research plan and Progress

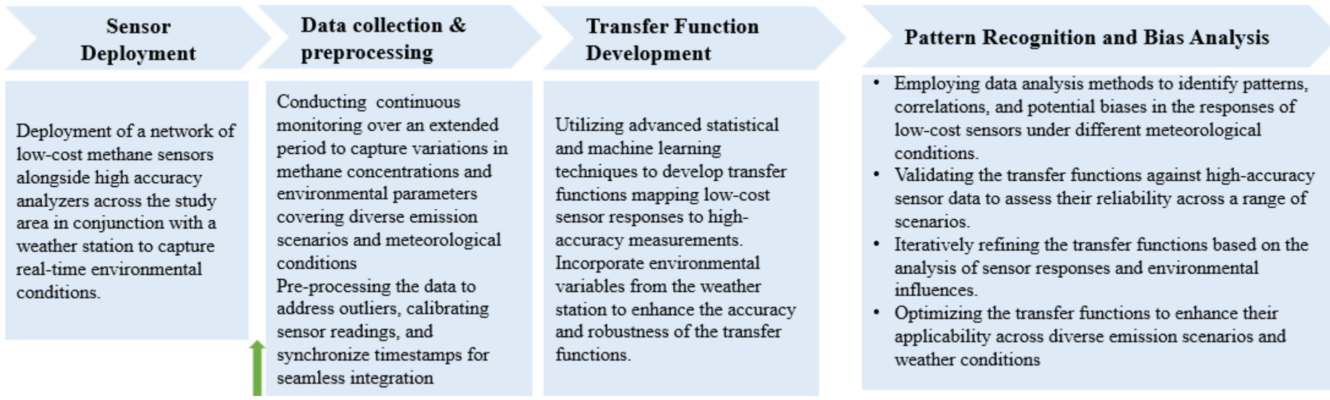

Figure 2: Research progress

Long-term project (Based on SABER)

Temporal and Spatial Variability of Non-Oil and Gas Methane Emissions in DJ Basin

The Denver-Julesburg (DJ) Basin is a focal point of energy production, with oil and gas extraction operations dominating the environmental discourse. Additionally, there is significant non-oil and gas methane emissions within this basin including agriculture, waste, urban, and peri-urban emission sources. This study investigates the temporal and spatial variability of these non-oil and gas methane emissions, shedding light on a previously understudied dimension of methane emissions in the basin.

This research integrates data from remote sensing techniques, driving surveys, and utilizes analysis to quantify and understand the dynamics of non-oil and gas methane emissions. Temporal variations are explored by assessing seasonal trends, diurnal fluctuations, and year-to-year changes, while spatial variability is examined through the mapping of emission sources and the assessment of their distribution across the basin.

Preliminary findings indicate that non-oil and gas methane emissions in the DJ Basin exhibit intricate temporal patterns, influenced by meteorological conditions and land use changes. The spatial distribution of these emissions reveals hotspots and varying emission source contributions, which call for a more nuanced approach to mitigation strategies.

The outcomes of this research not only contribute to a deeper understanding of the temporal and spatial dynamics of non-oil and gas methane emissions in the DJ Basin but also offer valuable insights for policymakers, industry stakeholders, and environmental organizations seeking effective strategies to reduce emissions.

Project 2 plan

Driving surveys	Source attribution	Meteorological Modeling	Comprehensive Data Analysis
Weekly drive surveys to capture diurnal and seasonal variations in methane concentrations at specific locations in DJ basin.	Using isotopic analysis and other advanced techniques to distinguish between different methane sources, including natural sources, agriculture, and urban activities.	Using meteorological modeling to enhance the understanding of how meteorological conditions influence the temporal and spatial variability of non-oil and gas methane emissions.	• Implementing statistical analysis techniques to identify temporal patterns, assess seasonal trends, and analyze year-to-year changes in non-oil and gas methane emissions. • Conducting correlation analyses with meteorological data to understand the influence of weather conditions on emission dynamics.