

# 'Sniffing Out the City' - Vehicular Multimodal Sensing for Environmental and Infrastructure Analysis

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## Motivation

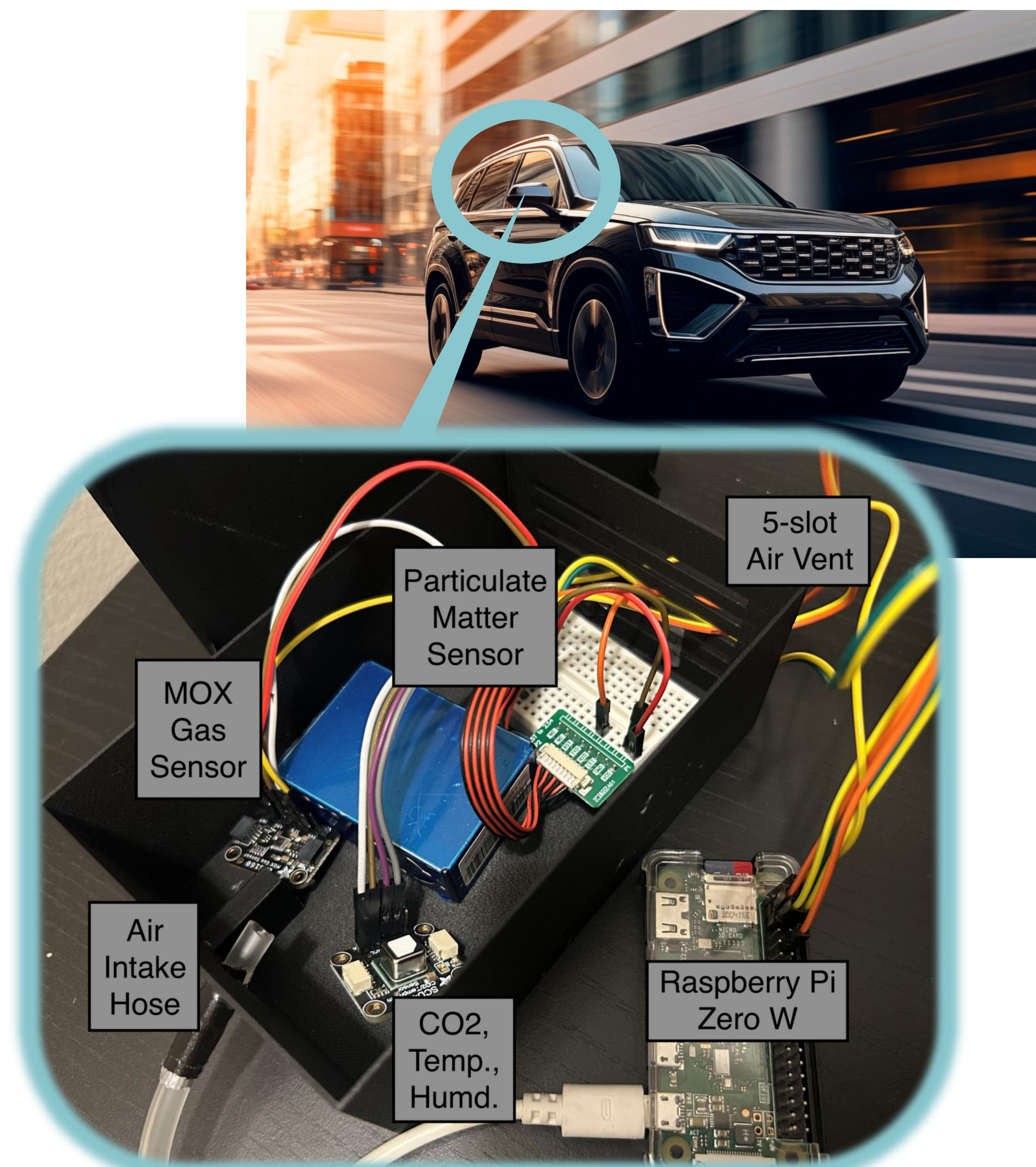
- Urban infrastructure and air quality affect health, safety, & quality of life
- Current traditional assessments methods are time-consuming, subjective, & costly

## Our Approach: Vision + Sensing

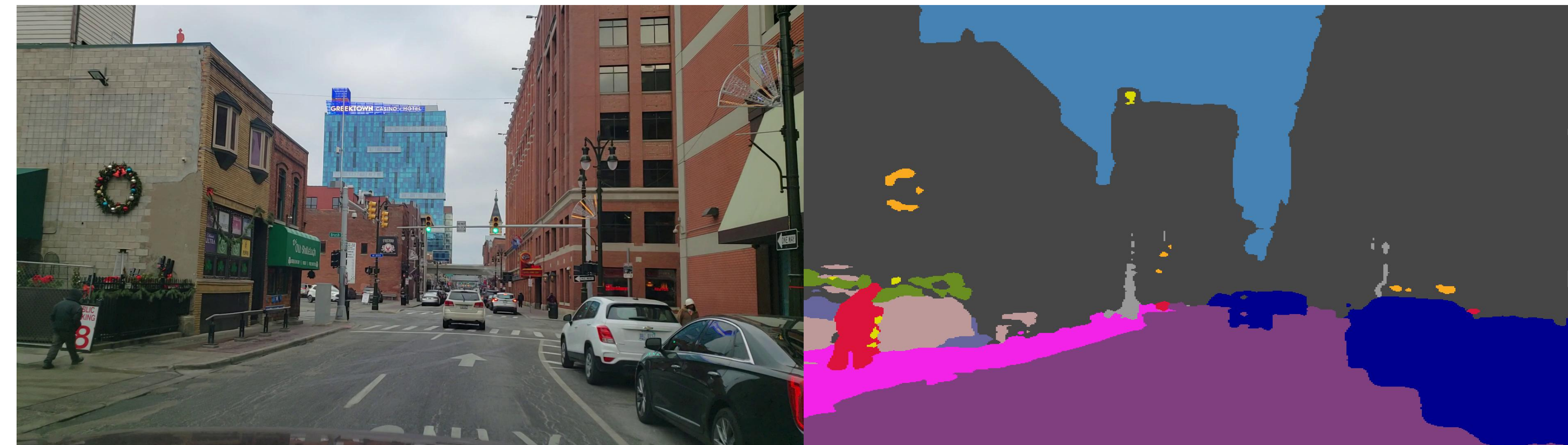
- Fusing visual context (roads, buildings) and environmental metrics (temperature, humidity, CO<sub>2</sub>, TVOC, PM, AQI) to enable deeper urban insights

## System Overview

### Bring the outside in...



**Mobile air quality sensing unit (lid off):** Includes air quality sensors, air intake hose, 5-slot ventilation, and Raspberry Pi Zero W.



**Example segmented video frame** showing classification of roads, buildings, vehicles, pedestrians, sidewalks, and street signs using semantic segmentation.

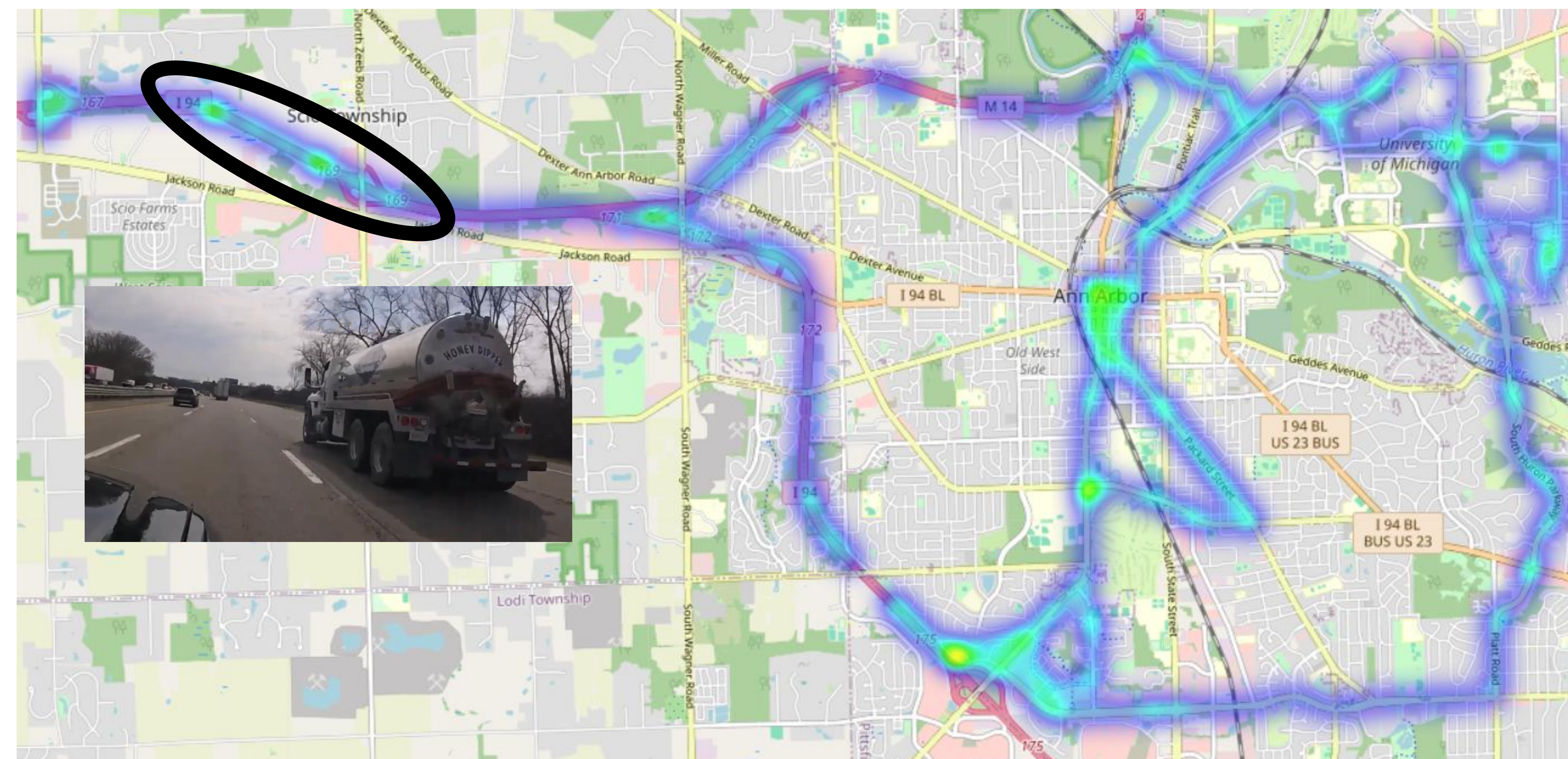
## Preliminary Results

### Visual Analysis (Detroit, MI):

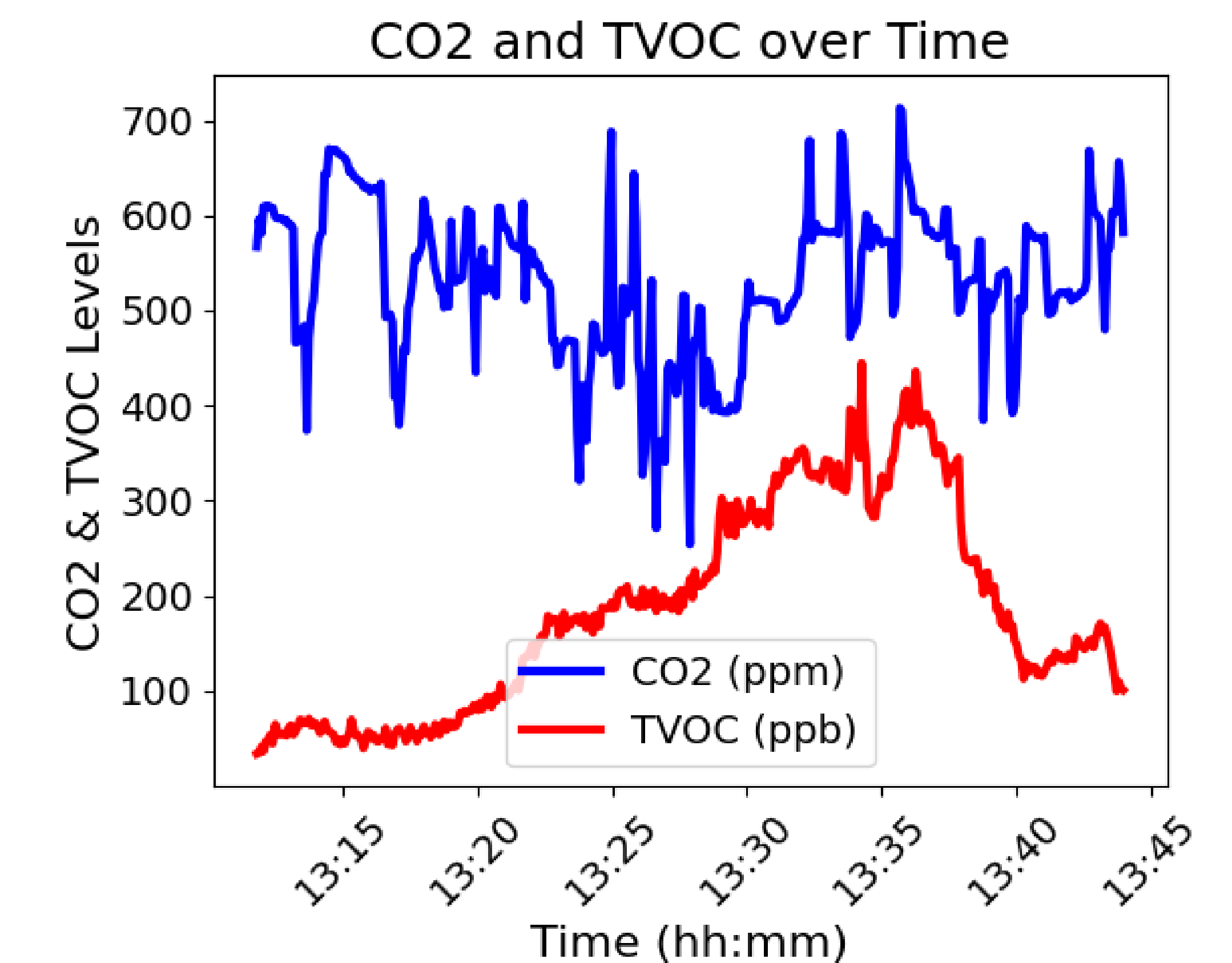
- Tested on Roadbotics video dataset
- Challenges: misclassifications, object occlusion, incorrectly masked areas

### Air Quality Testing (Ann Arbor, MI):

- CO<sub>2</sub> and TVOC spikes in busy areas
- Environmental conditions and internal car temperature can affect readings



**CO<sub>2</sub> Heatmap from Aggregated Ann Arbor Data Collection:** Green & yellow regions indicate elevated carbon dioxide levels. By analyzing surrounding context and video, we can correlate CO<sub>2</sub> variations with specific environmental or human activity events.



Air quality data from Ann Arbor test drive shows correlated CO<sub>2</sub> and TVOC spike in a high-activity urban zone.

## Current & Future Work

### v2 Air Quality Sensing Unit:

- Added gas-specific MQ series sensors
- Use thermal camera for heat islands
- Explore adaptive sensing and odor localization

### Vision Model:

- Combine image analysis, object recognition, NLP-based label filtering
- Explore LLM use for data labeling with environmental data and frame input

## Acknowledgements

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