

Seeing Black: Employing Computer Vision and Machine Learning Techniques to Estimate Black Carbon Emissions from Traffic Activities

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1 Unequal Attention: Wide Deployment of Traffic Surveillance, Zero Visibility on Urban Black Carbon

Black carbon (BC)

- The 2nd largest contributor to climate warming after CO₂.
- Traffic is one of the main sources of urban BC pollution.
- Canada's marginalized communities are more likely to face higher exposure from living in hotspots [1,2].
- Standard BC monitoring devices are costly, demand regular maintenance and specialized expertise.

Traffic Surveillance

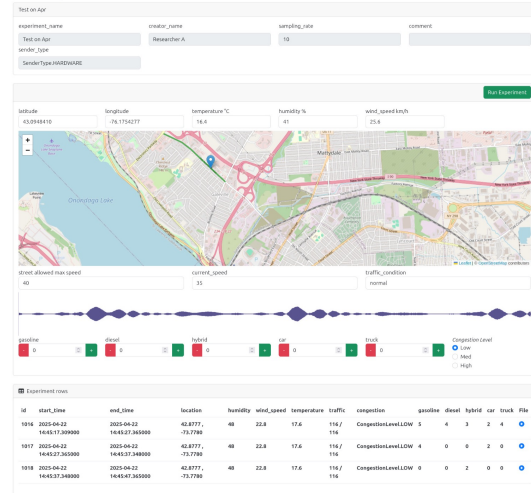
- CNBC estimated > 770 million cameras worldwide; 18% located in the Americas and 54% in China [3].
- Higher deployments in low-income neighborhoods for community safety raised equity concerns [4].

This disconnect prompts a critical question:

How can traffic data collected in abundance be leveraged to draw inferences about black carbon emissions from traffic?

2 Implementation: The Hardware and Software We Developed, The Study We Conducted

Fig. 1: Online dashboard consolidating data obtained through API calls, manual observations and sensors



3 The System We Built: Computer Vision and Machine Learning Driven Approach to Estimate BC Concentration from Vehicles in Traffic

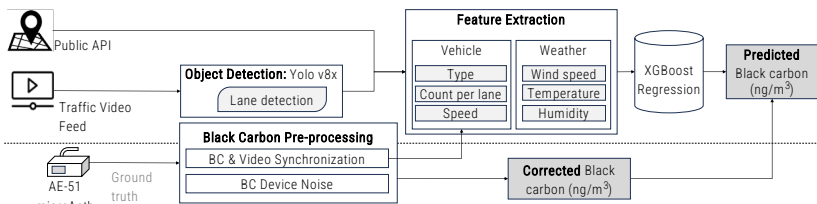


Fig. 4: System overview, primarily using real-time traffic footage

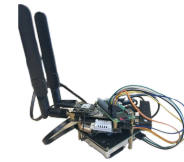


Fig. 2: Raspberry Pi-powered PM sensors with real-time data transmission to the cloud



Fig. 3: Instrument deployed for user study, using a microaethalometer as ground truth

4 Early Findings: Spikes in BC Concentration Correspond with High Traffic Activity and Stop-and-Acceleration Vehicle Motions

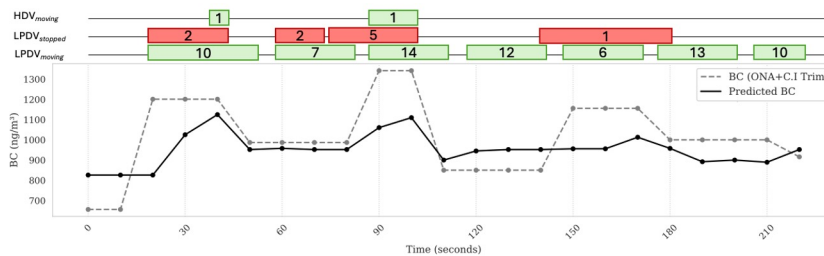


Fig. 5: Relationship between BC concentration measured by microaethalometer and traffic vehicle counts. HDV = heavy-duty vehicles; LDV = light-duty vehicles.

References

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