ITS-NY 32ND ANNUAL MEETING & TECHNOLOGY EXHIBITION

AI IN MOTION: Video Analytics for Automating Pavement Inspection and Work Zone Detection

Dr. Jingqin "Jannie" Gao, Assistant Director of Research
C2SMART Center, New York University

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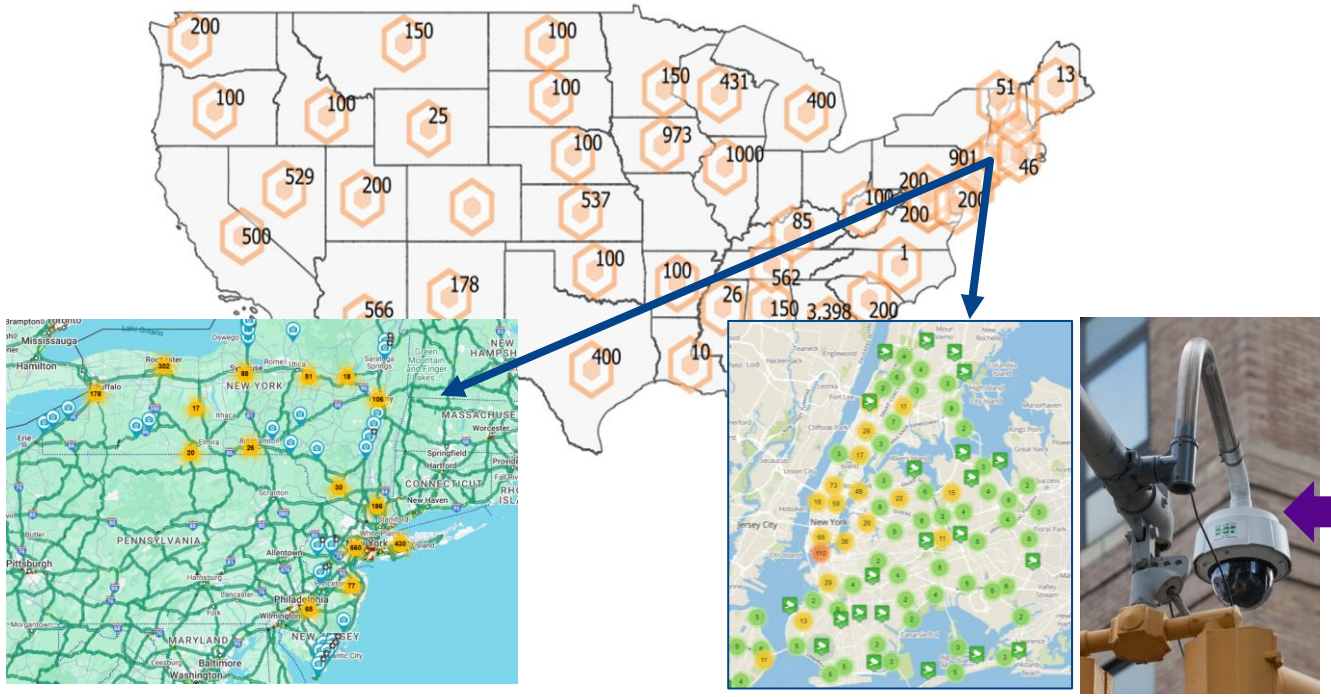
Image source: n-ix

Computer Vision for Smart Transportation

Computer vision is increasingly used in smart transportation systems to detect and classify vehicles, pedestrians, and cyclists in real time—supporting data-driven operational needs and infrastructure planning.

Existing CCTV Traffic Cameras in the U.S.



Builds on existing resources

Watching City Traffic on Camera

(Source: NYCDOT, NYT, invisibleboxes.info)

NY has 1600+ traffic cameras

(Source: C2SMART, 2022; 511NY, NYCDOT)

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Real World Deployments

- Observing social distancing & traffic during COVID-19
- **Improving mobility** and **safety** of vehicles and vulnerable road users
- Pilots with **multiple agencies**
  - NYC DOT and NYC Dept. of Design & Construction cameras
  - NJSEA and Metlife Stadium for **pre-world cup** preparation
  - Port Authority of NY&NJ's multi-billion dollar **Airport** reconstruction
  - Asset management, event management, and emergency response

More at: https://c2smarter.engineering.nyu.edu/computer-vision-2025/

Collaborate with **10+ agencies, industry, academic** partners

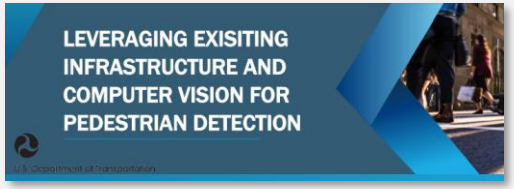
Results in **10+** research articles, whitepapers & one patent

Research highlighted in

IEEE Spectrum

AI Tool for COVID Monitoring Offers Solution for Urban Congestion ›Researchers at NYU have developed an AI solution that can leverage public video feeds to better inform decision makers

Deployment Case Study Highlighted in **USDOT ITSJPO** Deployment Evaluation Database



Fixed Camera-Based Analysis

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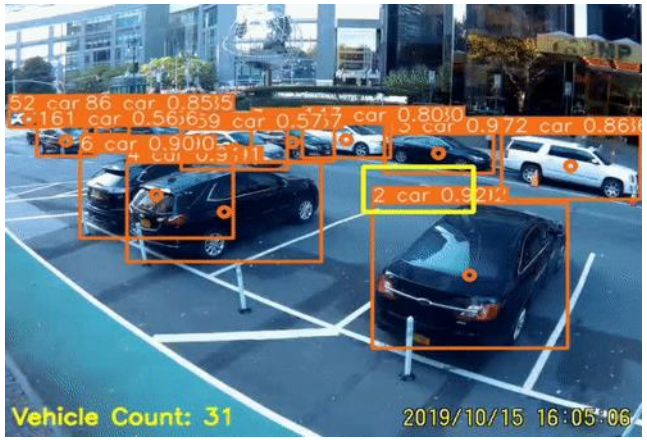
Apps developed by C2SMARTER

Partners: TOWN +GOWN NYC · NEW YORK CITY DOT · NYC PLANNING · NYC OTI Office of Technology & Innovation · PORT AUTHORITY NY NJ AIR LAND RAIL SEA



Vehicle/Bike-Mounted Camera Apps

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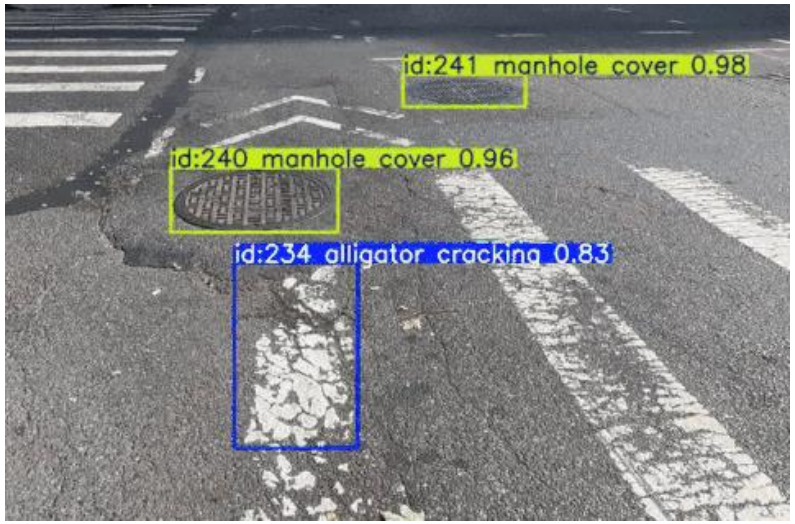
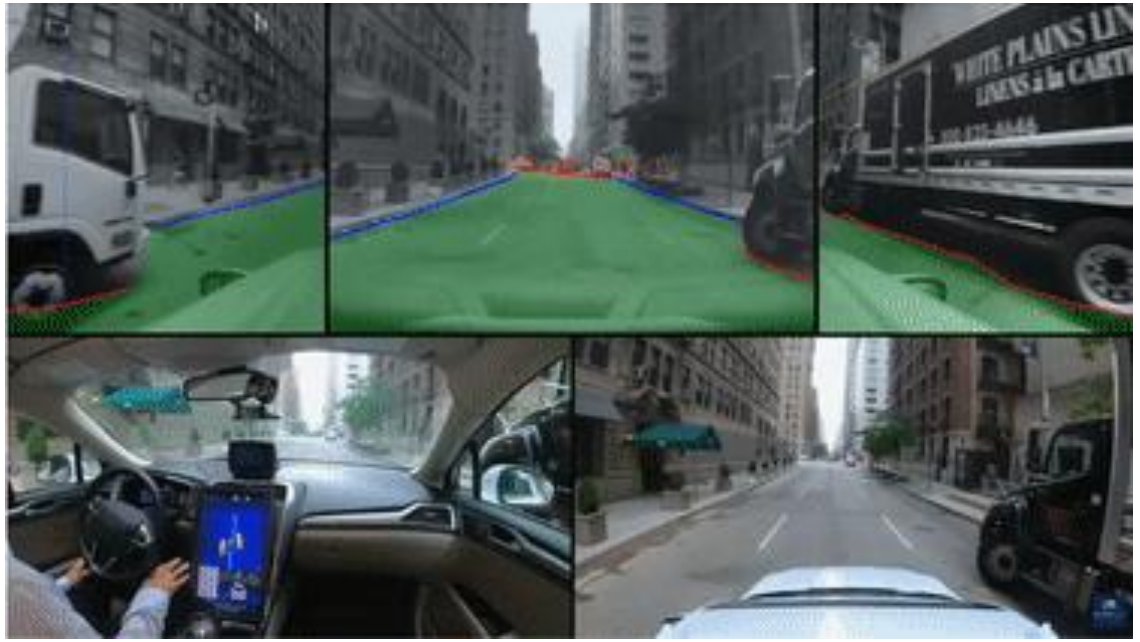
Bike-mounted cameras for bike safety

(Source: C2SMART)



Vehicle-mounted cameras for sensing the driving scenes

(Source: C2SMART industry partner - Mobileye)



Current real-time roadway analysis through your windshield

Partners:

Automated Pavement Detection

Vision-Based Automated Pavement Inspection Technologies for Bike Lanes

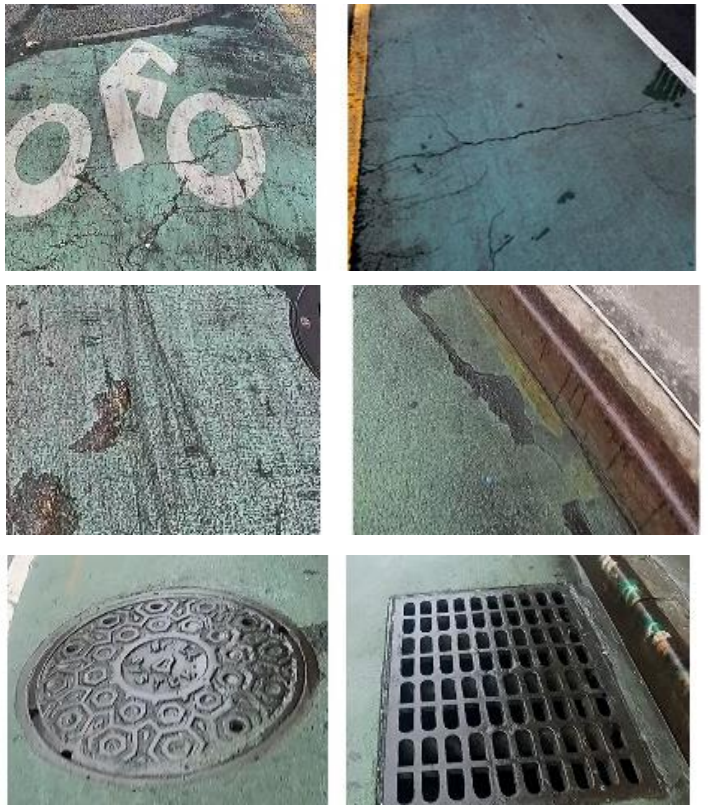
C2SMART

NEW YORK UNIVERSITY

Problem: Cycling is a sustainable transportation choice, helping reduce emissions and urban congestion. NYC now has **600 miles protected bike lanes**—double since 2008. Maintaining these lanes requires regular inspections and prioritization, but traditional methods are impractical for protected bike lanes.

Research Question: How can **AI** and **mobile sensing technologies** be utilized to assess bike lane pavement conditions automatically?

Collaborator: NYC Department of Transportation



ALFRED P. SLOAN FOUNDATION

This project is supported by **Alfred P. Sloan Foundation** via the Cornell Tech Pilot Policy Studio

Vision-Based Automated Pavement Inspection Technologies for Bike Lanes

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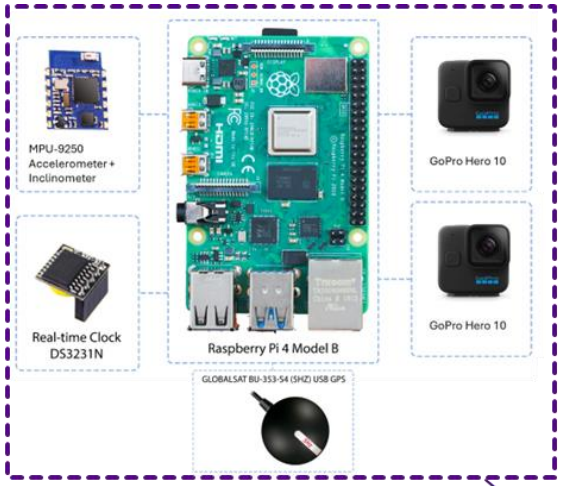
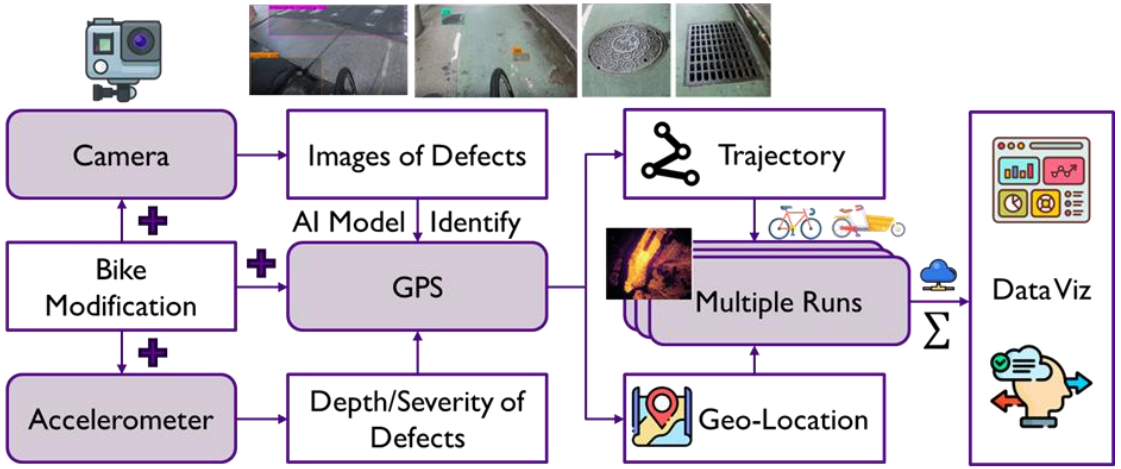
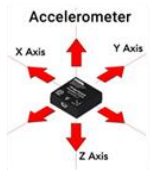
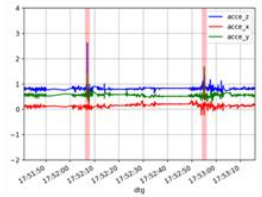
Our solution – Introducing **BSAFE 360**, a mobile data platform for bicycles that uses advanced **image recognition** and **bike-mounted sensors** to detect and assess pavement distress in bike lanes, supporting proactive infrastructure maintenance and cyclist safety.

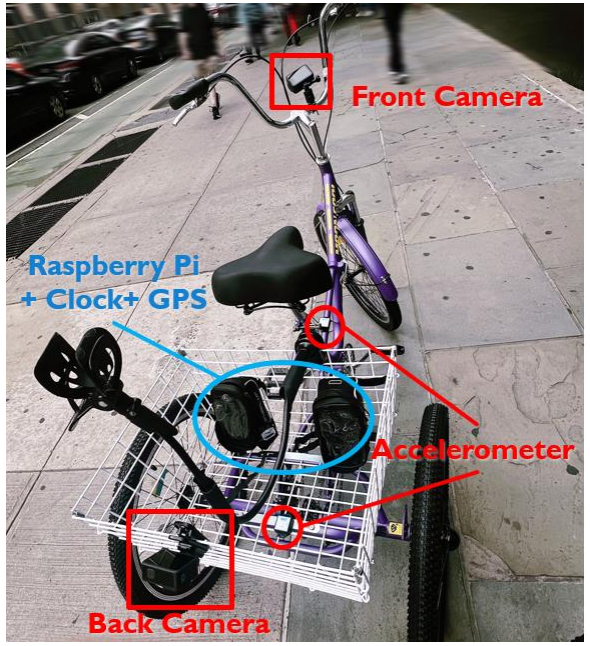




Bsafe-360
Bike Sensor System







Duran Bernardes, S., & Ozbay, K. (2023). BSafe-360: An All-in-One Naturalistic Cycling Data Collection Tool. Sensors, 23(14), 6471.

Vision-Based Automated Pavement Inspection Technologies for Bike Lanes

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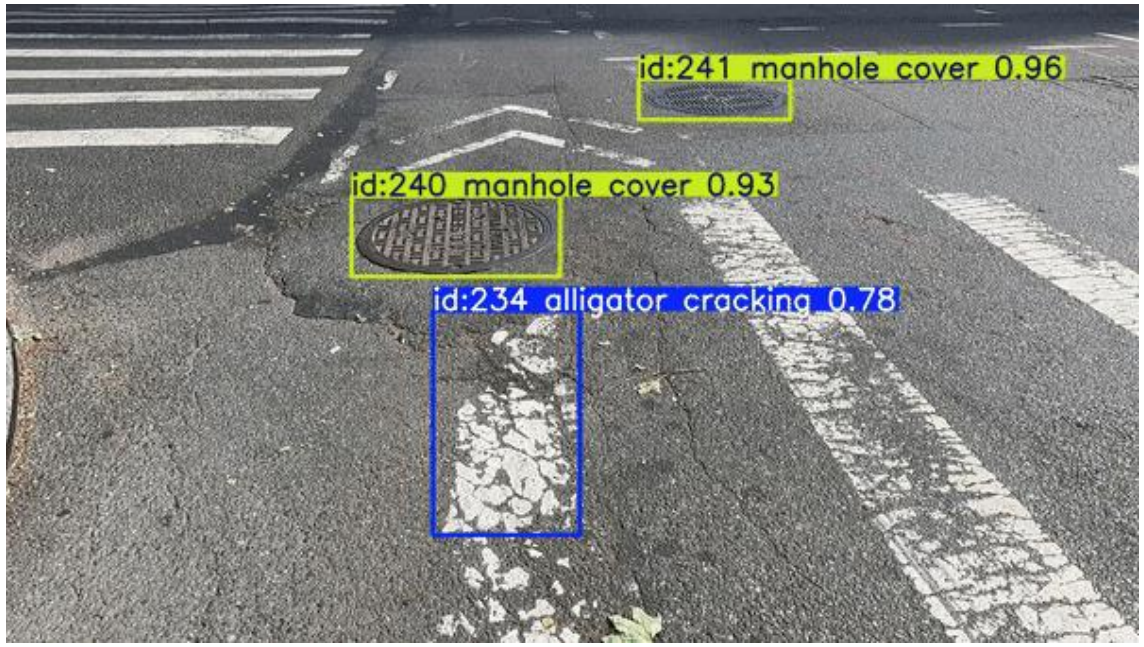
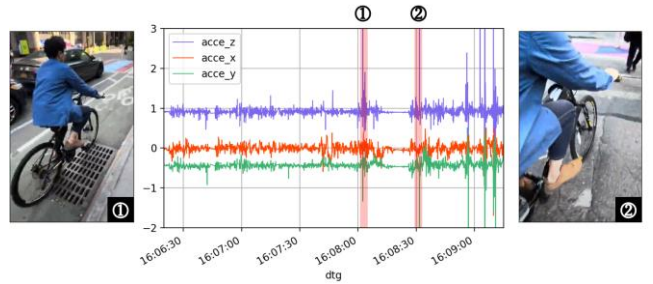
- **Performance:** Achieved an mAP50 of **0.8534** in identifying **13 types** of pavement distress and street hardware.
- The **first vision-based model** with **sufficient practical performance** for identifying real-world bike lane defects.

Planning:

- Human-in-the-loop machine learning training
- Integrate these results into the broader inspection process





Work Zone Detection

Work Zone Detection

Challenges:

- Lack of training data
- Existing application focus on off street/highway work zones
- Detection of work zone related objects does not mean a work zone is presented

Opportunities:

- Have a multi-year dataset of CCTV images in NYC that contain urban work zones

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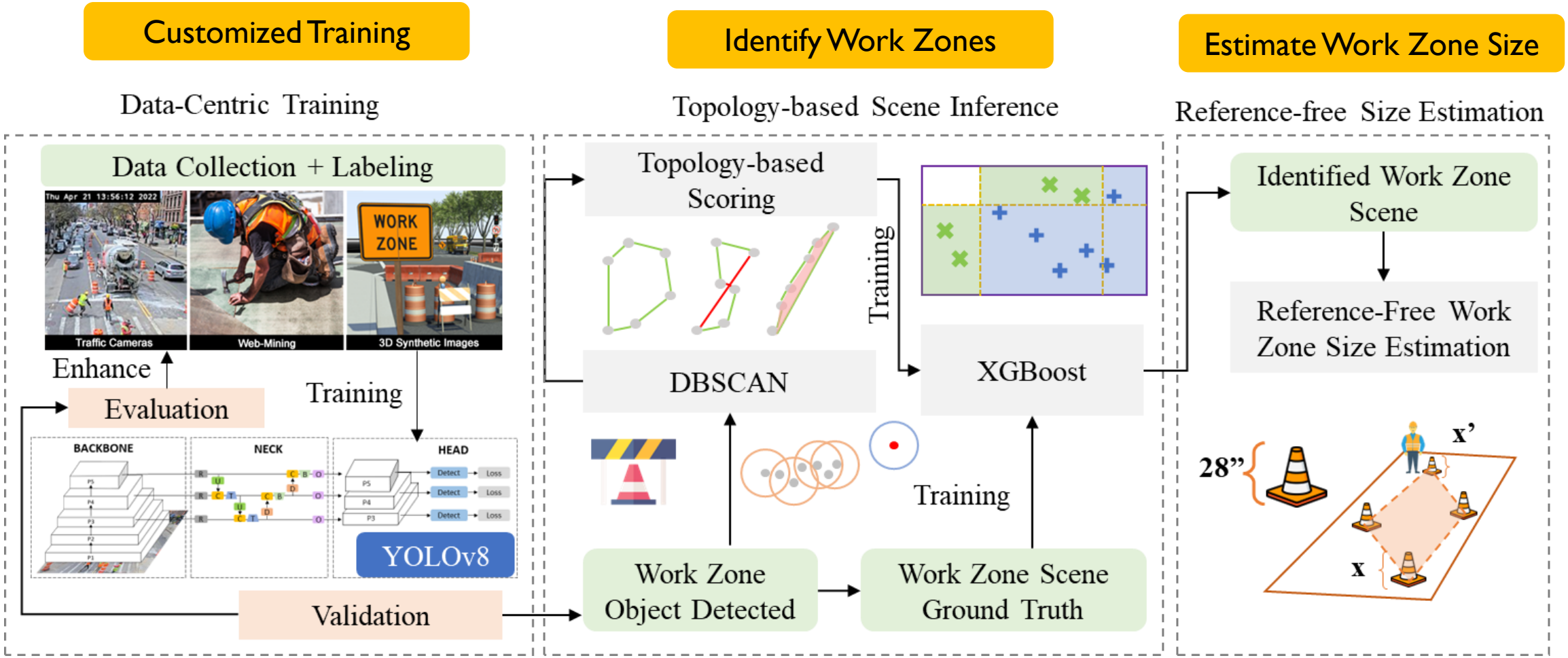
Framework



Reference: Zuo, F., Gao, J., Ozbay, K., Bian, Z., & Zhang, D. (2023, September). ***Urban Work Zone Detection and Sizing: A Data-Centric Training and Topology-Based Inference Approach****. In 2023 IEEE 26th International Conference on Intelligent Transportation Systems (ITSC) (pp. 3235-3240). IEEE.*

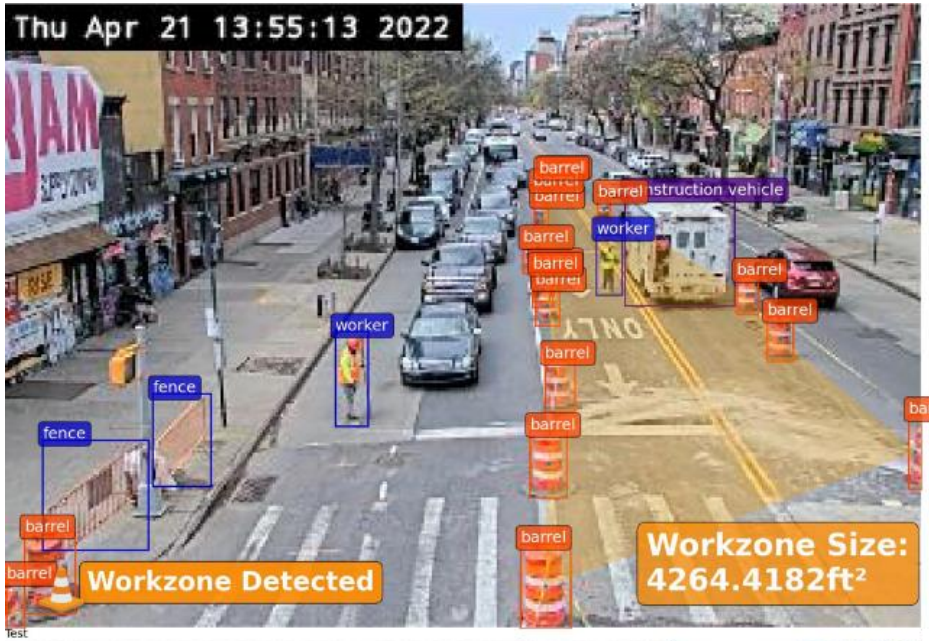
Training Data

- **11 work zone related objects**
- We begin with collecting a customized dataset of **2,600** work zone images & **15,000** labels.
- Web-mined and 3D synthetic images primarily serve to **fill the gaps in certain subcategories** of the training data
- For instance, web-mining is a good supplemental source for augmenting training images for construction vehicles.

Examples of Detection Output

DAYTIME

- **Element-level precision: 0.741**
- **Work zone identification accuracy: 98.4%**



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Examples of Detection Output

NIGHT TIME

- **Element-level precision: 0.741**
- **Work zone identification accuracy: 98.4%**

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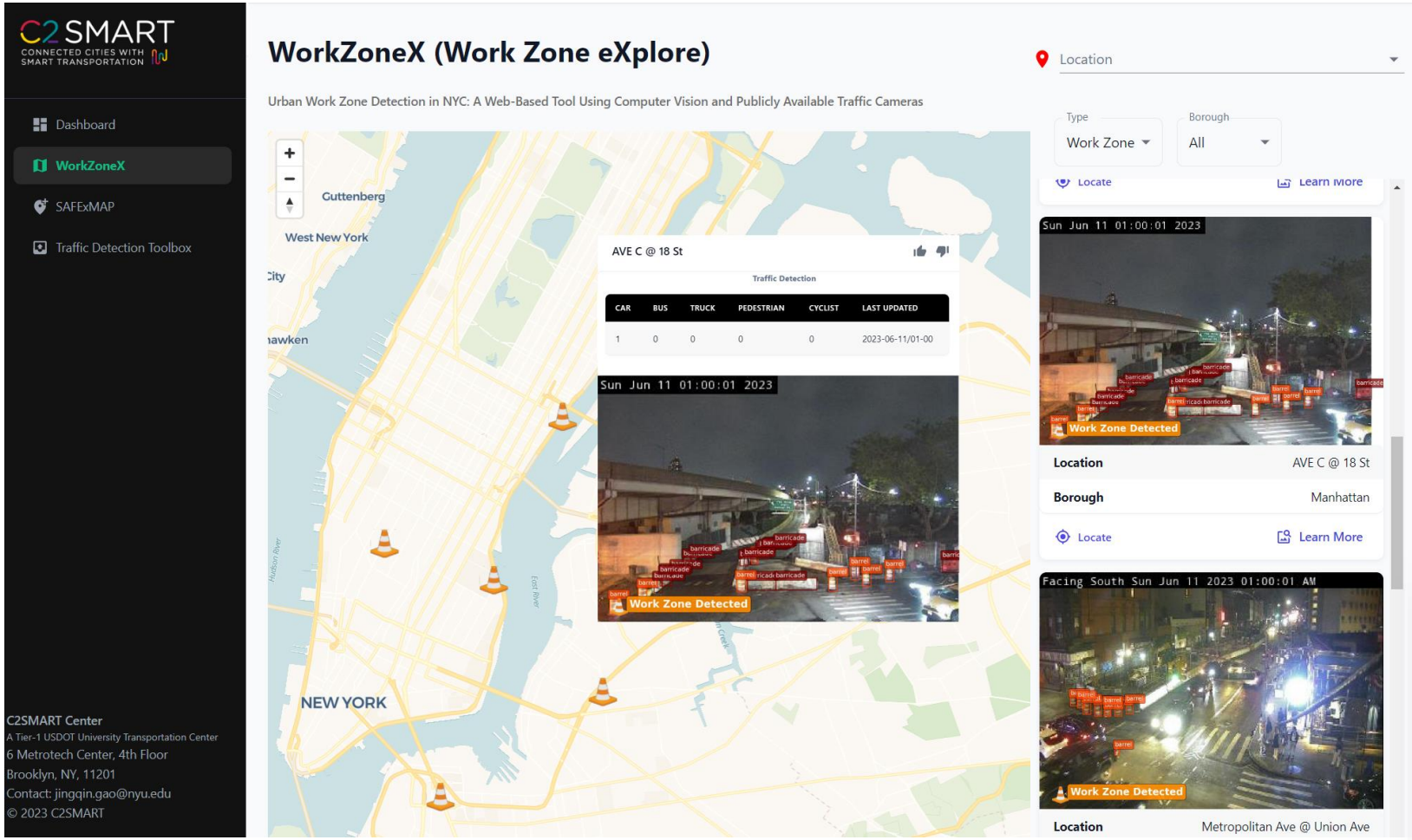
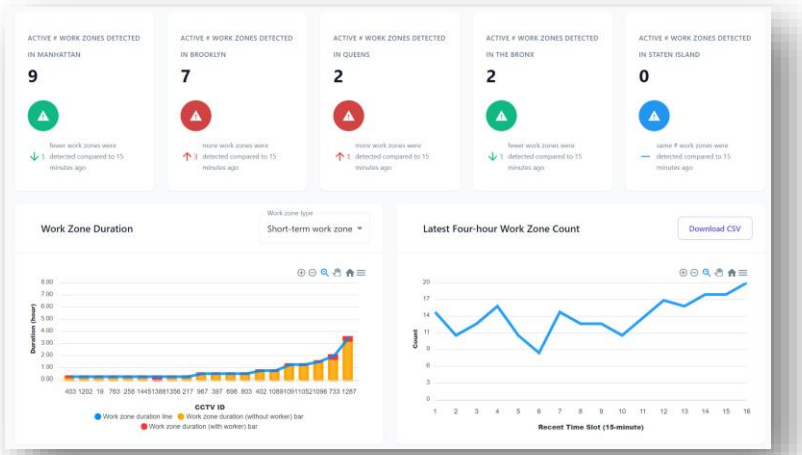
Web-Base Application



Key Features

- Show detected work zones on a map
- Detecting **active work zones with workers**
- Detecting traffic around work zones
- Provide real-time statistics on the duration and number of work zones spatially



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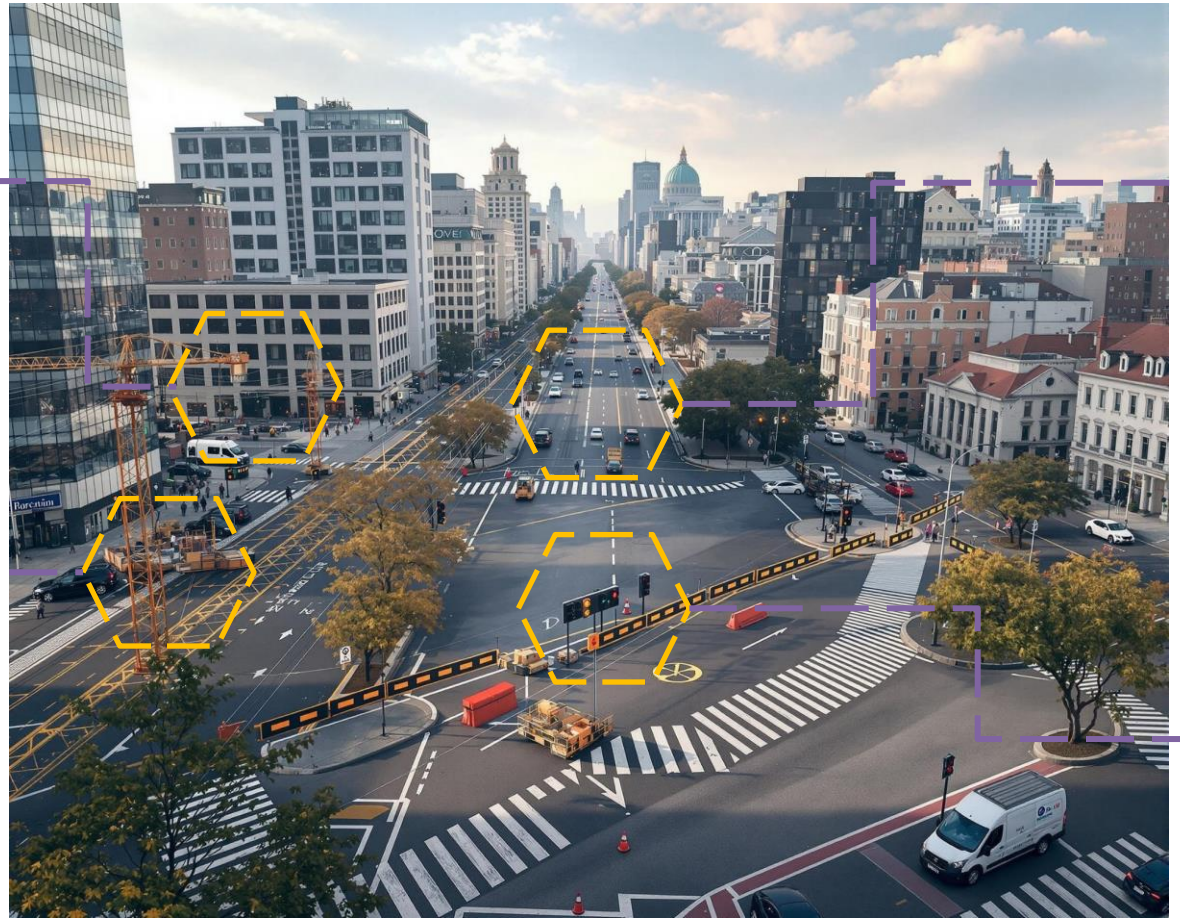
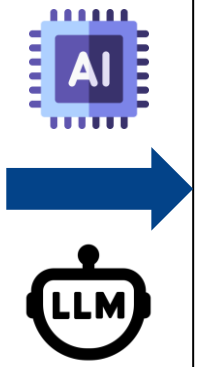
The Road Ahead for AI/Video Analytics in Transportation



The Road Ahead for AI/Video Analytics in Transportation

- **Generative Artificial Intelligence**? More advanced interpretation using emerging technologies such as Large Language Models (LLMs)



[Scene environment]: A sunny day with a dry road, in a residential area, with an intersection roadway, during daytime with light traffic.

[Potential conflict in trajectory]: True. Vehicle veh_1.0 slowed down from frame 28 to 32 due to the pedestrian ped_1.0 being present in the same lane.

[Event type]: Near-miss.

[Justification]: The pedestrian's pose points show a sudden change in direction and speed, indicating a reaction to the vehicle's presence. The vehicle's trajectory also shows a slight deviation from its original path, suggesting a possible attempt to avoid the pedestrian. The distance between the pedestrian and vehicle is decreasing, but not close enough to be considered a collision.

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Zhang, R., Wang, B., Zhang, J., Bian, Z., Feng, C., & Ozbay, K. (2025). When language and vision meet road safety: leveraging multimodal large language models for video-based traffic accident analysis. Accident Analysis & Prevention.

OUR TEAM

Demonstrating Computer Vision techniques for Smart City Expo and STEM middle school students

Principle Investigator and Co- Principle Investigator

Dr. **Jingqin Gao**
Assistant Director
NYU C2SMART

Dr. **Kaan Ozbay**
Director & Professor
NYU C2SMART

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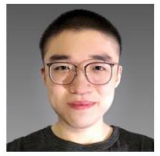
CONNECTED CITIES WITH SMART TRANSPORTATION

Graduate & Undergraduate Researchers at NYU

Fan Zuo
Transportation



Liu Yang
Full Stack Developer

Omar Hammami
Computer Science

Daniel Zhang
Computer Science

Lukelo Thadei Luoga
Computer Engineering

Angela Zhang
Computer Science

Dachuan Zuo
Transportation

Shuo Zhang
Transportation

Suzana Duran Bernardes
Transportation

Donglin Zhou
Computer Science

C2SMART leadership team

C2SMART

NYU TANDON

Thank you!

Dr. Jingqin Gao
jingqin.gao@nyu.edu

C2SMART Center
New York University
Tandon School of Engineering
6 MetroTech Center, Brooklyn, NY 11201

c2smart.engineering.nyu.edu
c2smart@nyu.edu