Data Fusion of 2D Perception Algorithm and 3D Spatial Data for Social Distancing Awareness Application

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REU Project: Artificial Intelligence for Smart Cities

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NSF Engineering Research Center for Smart StreetScapes (CS3)

- **The Center for Smart Streetscapes (CS3)** is a Gen-4 **NSF** Engineering Research Center based at Columbia University (New York) taking a new approach to smart cities with **80+ stakeholders** industry partners, community organizations, municipalities, and K-12 schools – both as collaborative co-producers of knowledge and as auditors of technology research and development.

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NSF Engineering Research Center for Smart StreetScapes (CS3)

With its extensive network of partners, CS3 unites diverse research communities through a convergent research model that delivers innovations across five engineering and scientific areas:

RESEARCH THRUSTS

Wi-Edge
Current 5G & 6G bandwidth, latency, and density concentrations

Situational Awareness
High-accuracy recognition & tracking across fields of view from sensors in complex, dynamic scenes.

Security, Privacy, & Fairness
Emerging technologies pose new challenges that may compromise social equity.

Public Interest Technology
Technology can intentionally or unintentionally produce or reproduce social harms, amplified for data collection in underserved communities.

Streetscape Applications
Cross-layer coordination and optimization, human-streetscape interaction, generalizability, and future streetscape design.

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- **Student Leadership Council** -The Student Leadership Council (SLC) serves as a liaison between the CS3 student body and the center leadership, representing both the undergraduate and graduate levels across all core partner institutions. Its goal is to support open communication, provide leadership development, and create opportunities for collaboration.

- **Research Thrusts & AI for Smart Cities**: *Wi-Edge, Streetscape Applications, Situational Awareness*
  - Fixed Sensing with Cameras (Emily)
  - Tracking with LiDAR Sensors (Jennifer)
  - Scooter & Motor Vehicle Sensing (Ethan)
  - Simulation Environments (Abigail)
  - 3D Data Visualization (Ariana)

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Future of Streetscapes with CS3

- **Machine Vision Helping Humanity in Urban Environments**
  - New opportunity: *AI camera intelligence can detect objects in real-time*
  - This helps us understand human behavior and public safety

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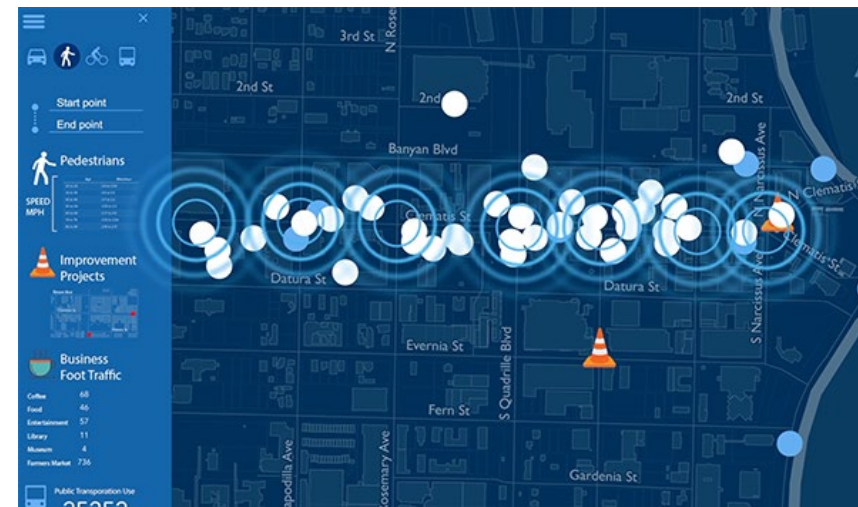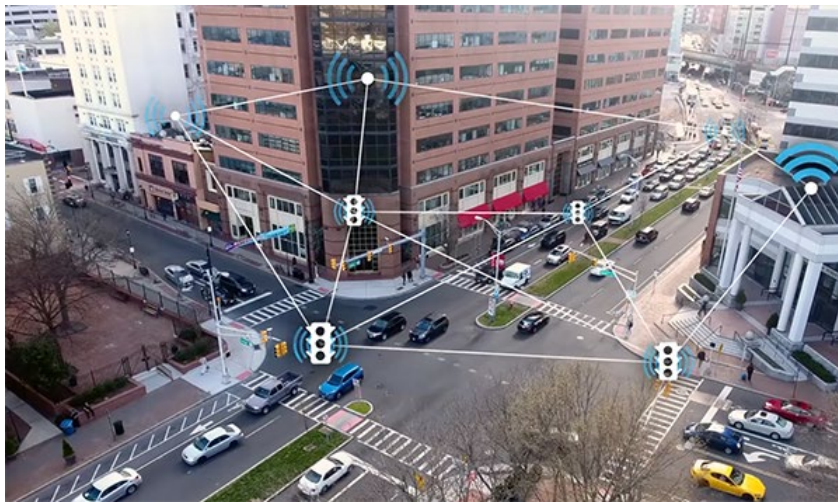
Research Goals

We will test and implement real-time object tracking and classification algorithms, which can contribute to the CS3 WPB testbed.

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Research Goals

Diagram demonstrating YOLOv5 algorithm mechanisms.

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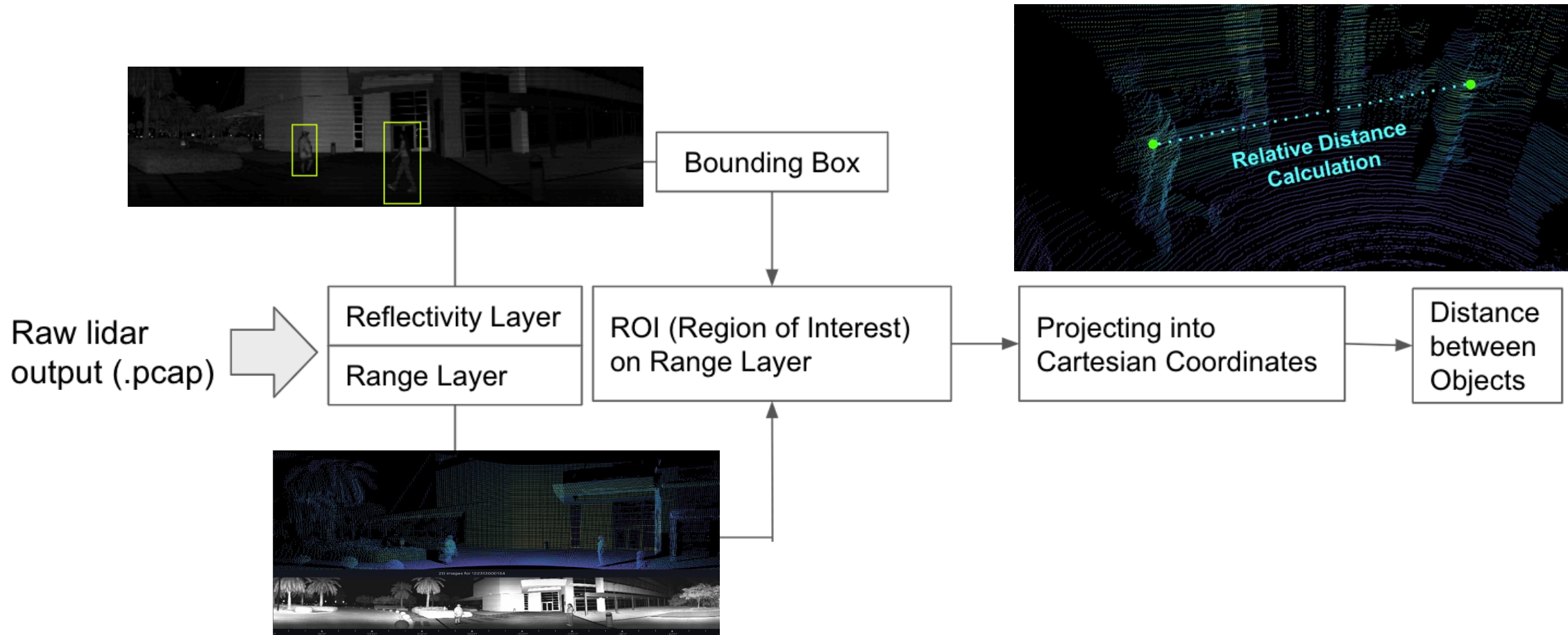
2D camera + 3D point cloud data

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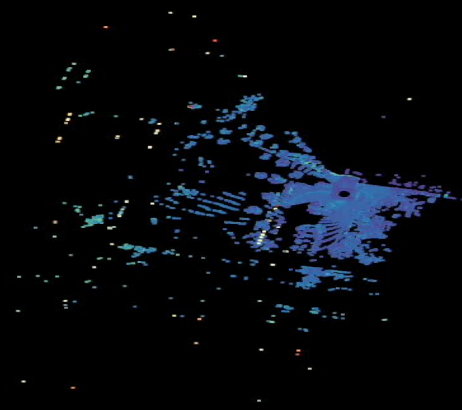
Object Detection & Classification

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Object Tracking & Relative Distance

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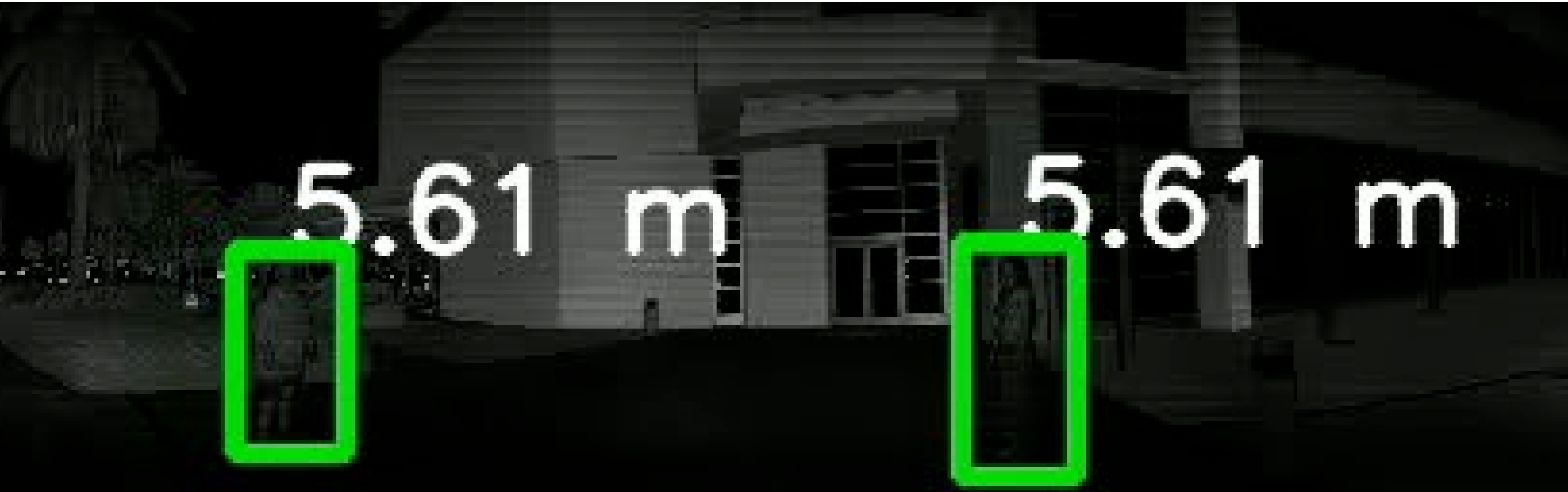
Conclusion

This is just a quick and simple example of how **computer vision algorithms** can be directly combined with LiDAR data. *Since this project is just a proof of concept, we've made some shortcuts in the interest of time.*

- The custom weights of the YOLOv5s model were trained with only 1,000 images. We could try collecting more data to increase the accuracy in different scenes.

- We could try adjusting the color-space and aspect ratio of the reflectivity layer to further improve the detection accuracy.

- Currently, the code only works with recorded data. We could try adding the capability to do object detection and distance calculation from an Ouster lidar live stream.

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Questions & Feedback

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