Assessing the Accuracy of Lidar for Traffic Data Collection in Various Weather Conditions

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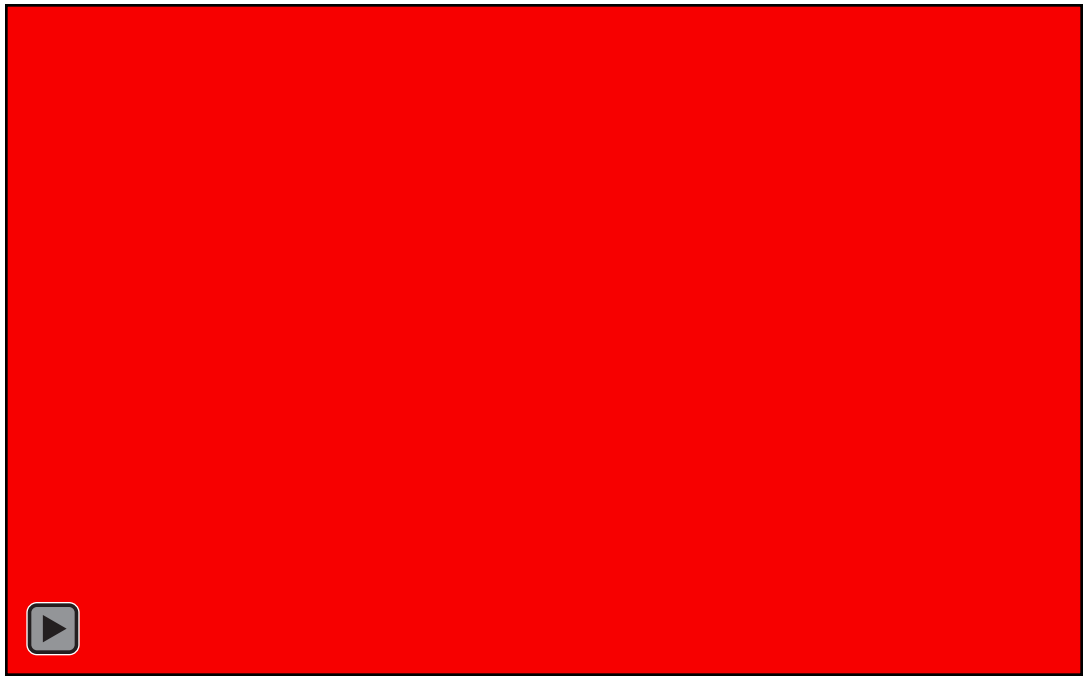
What is LiDAR?

LiDAR uses laser pulses to generate detailed 3D maps.

It measures distance by timing how long laser pulses take to return.

LiDAR offers high resolution and accurate detection, regardless of lighting.



It’s ideal for traffic monitoring, detecting vehicles, bikes, and pedestrians in real-time.

But its performance in bad weather (rain, fog, etc.) is uncertain.

Motivation and Objective

- Growing use of LiDAR in intelligent transportation systems
- Concerns over accuracy in varied weather conditions
- Evaluating LiDAR detection performance across weather scenarios
- Quantifying accuracy and identifying areas for improvement

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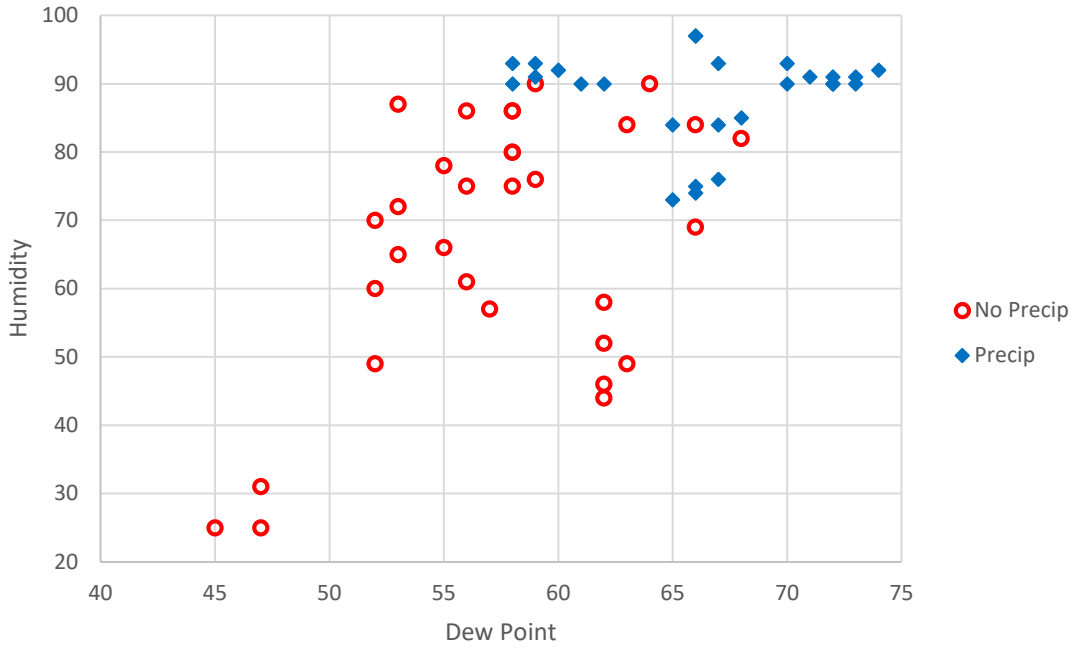
Study Site and Sensor Setup

- Velodyne Ultra Puck VLP-32C installed with a 360° view and 200m range.
- Data collected from May 12 to May 27, 2024.
- Camera used to provide ground truth for validation.

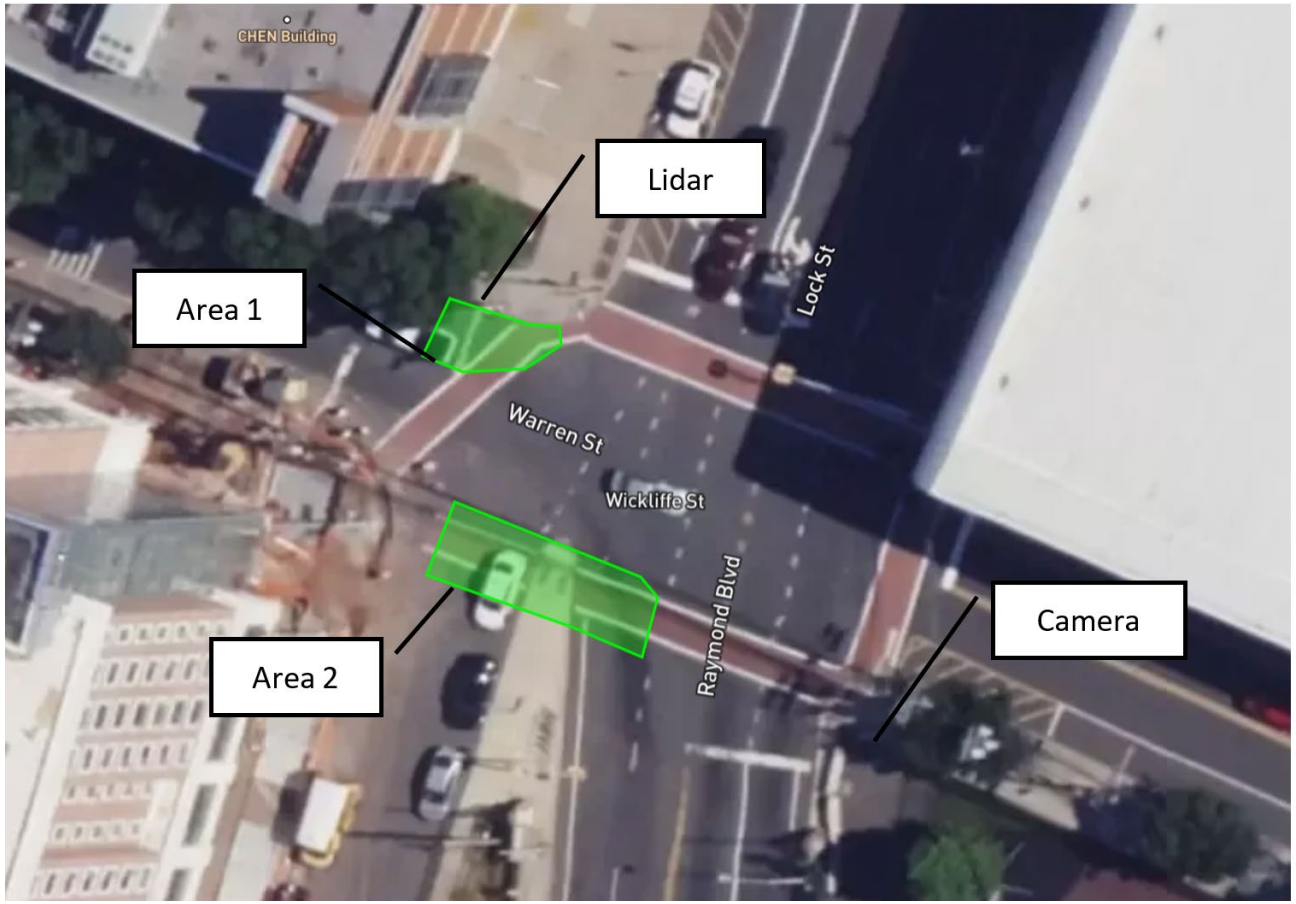
Weather Conditions and Sampling Approach

- Weather data obtained from Newark Liberty Airport station.
- Latin Hypercube Sampling (LHS) is used to select diverse weather periods.
- Over 300 minutes of detection were selected for the study.

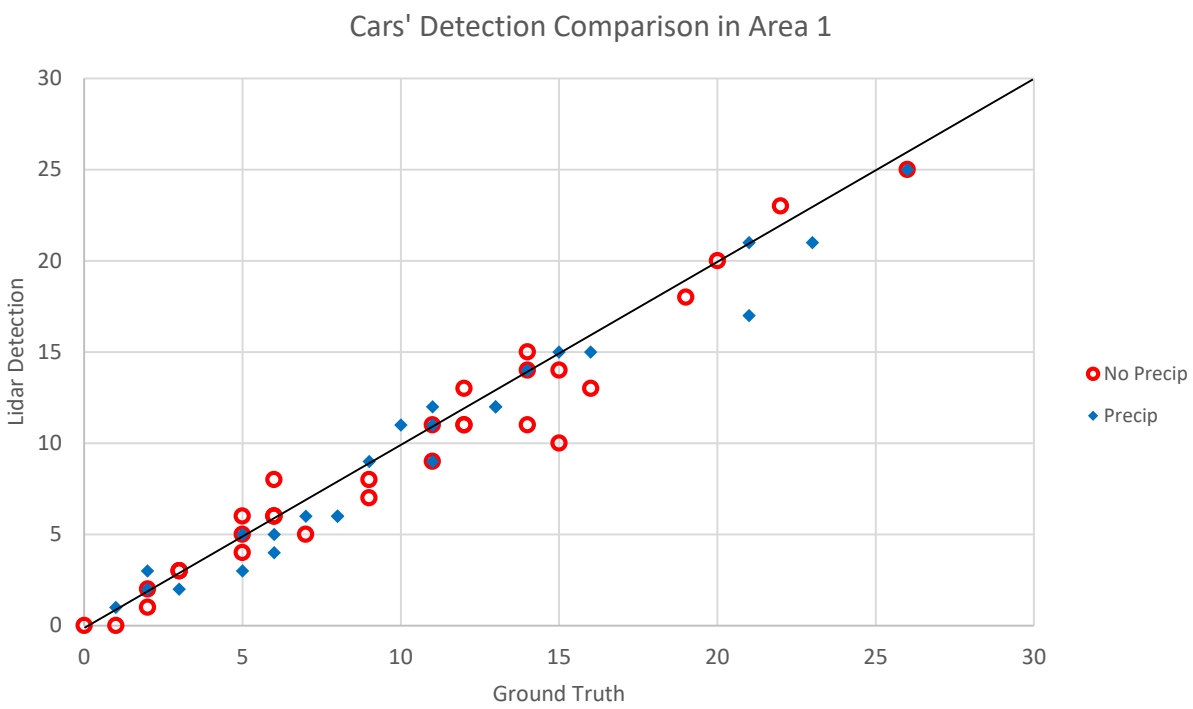


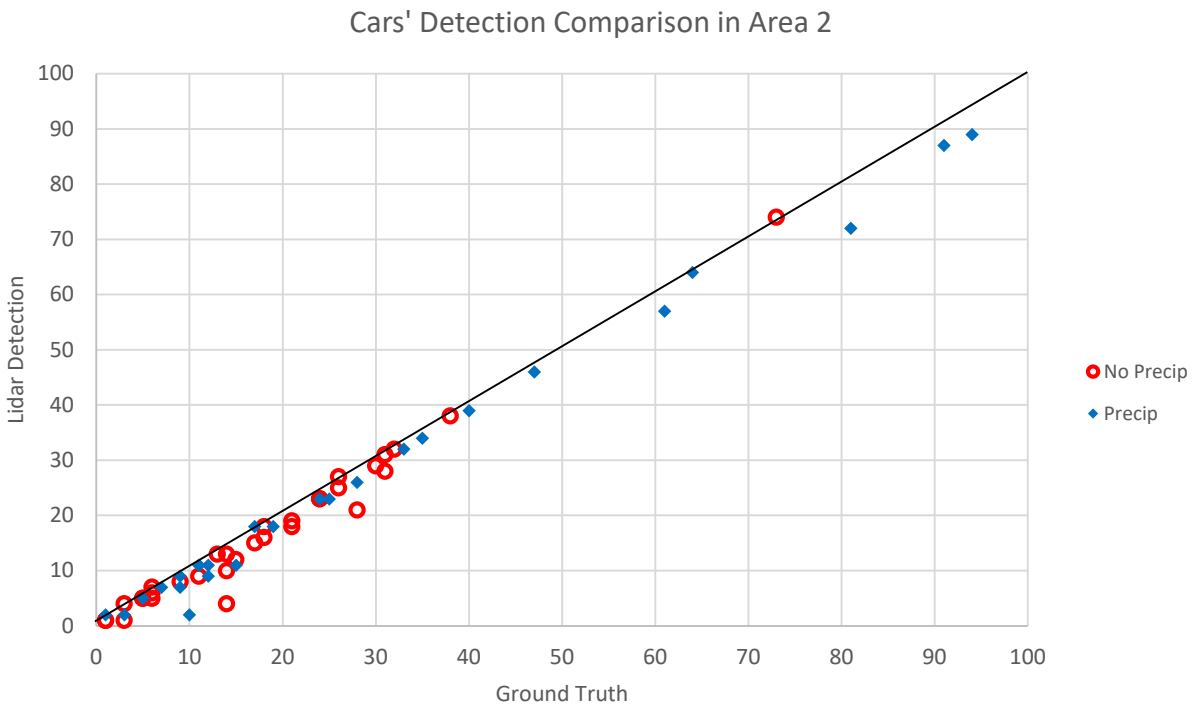
Study Areas & Object Detection

- Area 1: Warren St WB, Lock St RT, Raymond Blvd LT, crosswalks.
- Area 2: Raymond Blvd RT, Wickliff St entrance, crosswalks.
- Automated counting of vehicles and pedestrians from LiDAR.
- Manual video review used for validation.



Accuracy Results – Cars





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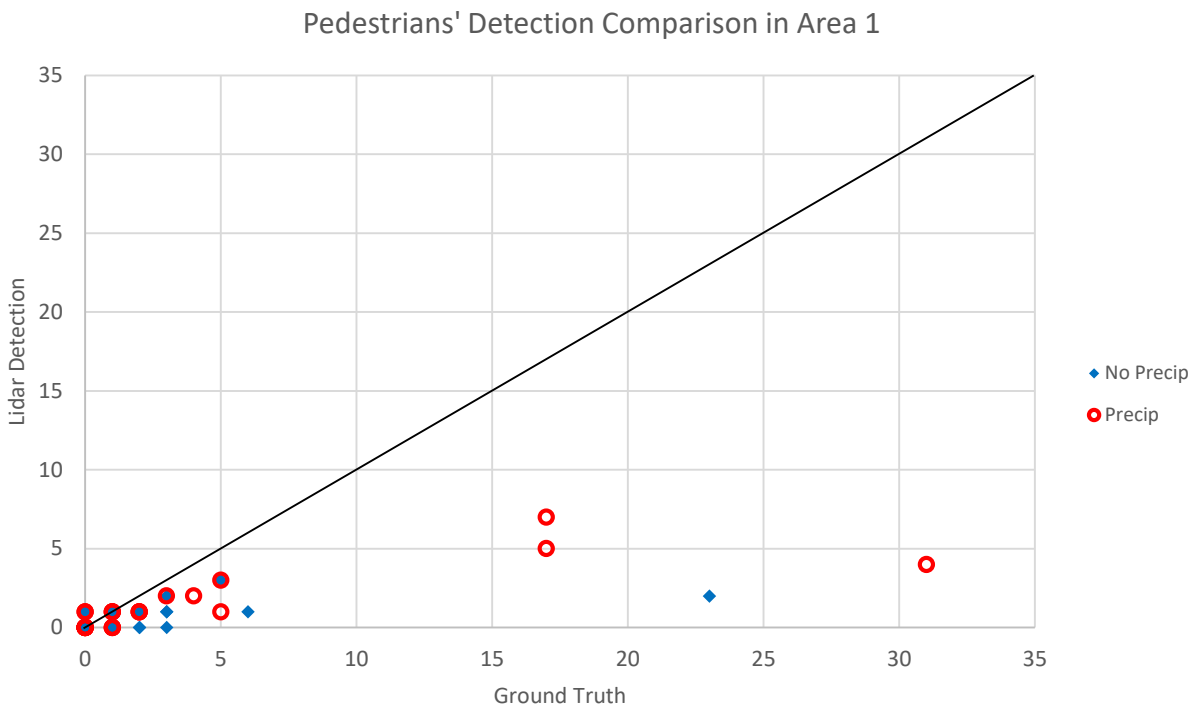
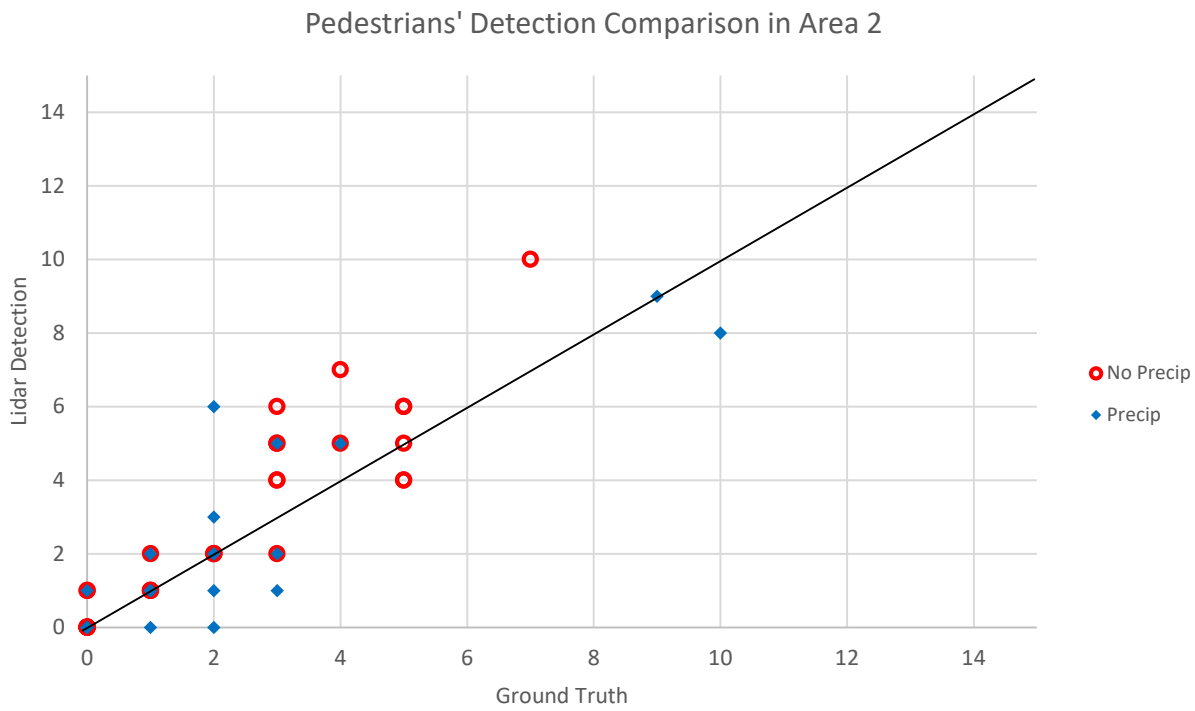
Accuracy Results – Pedestrians





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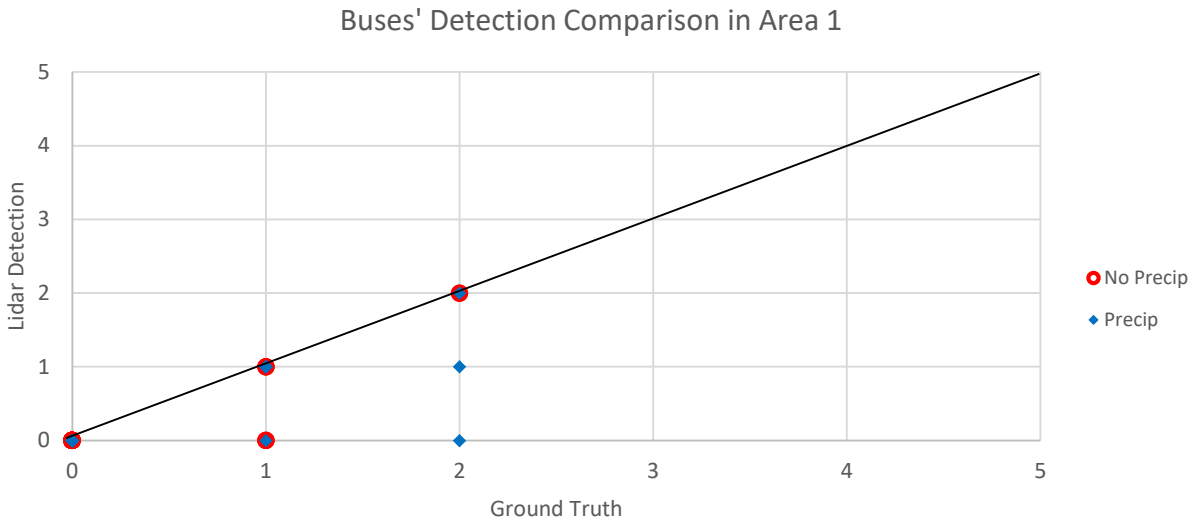
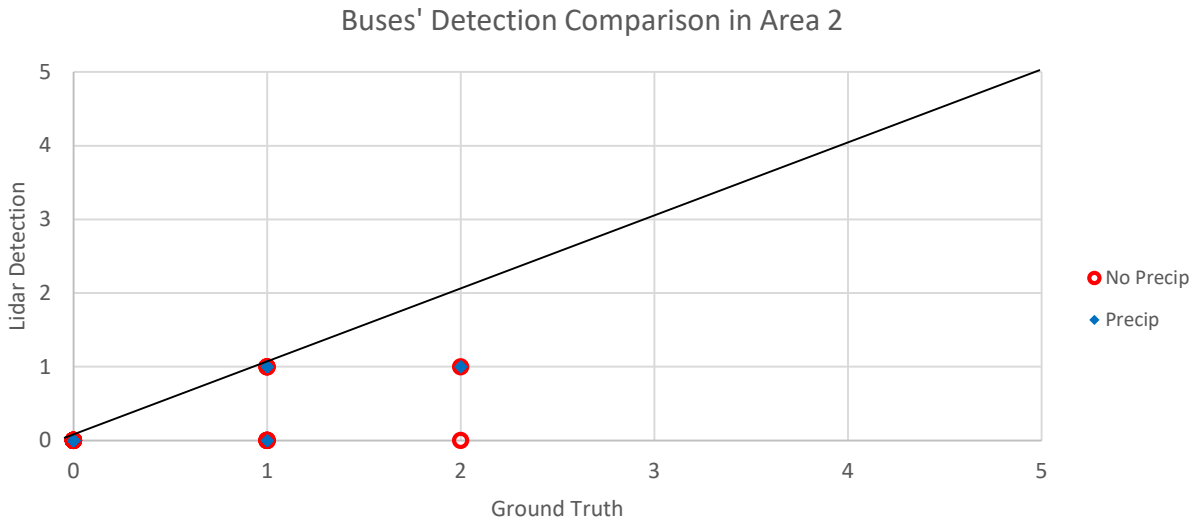
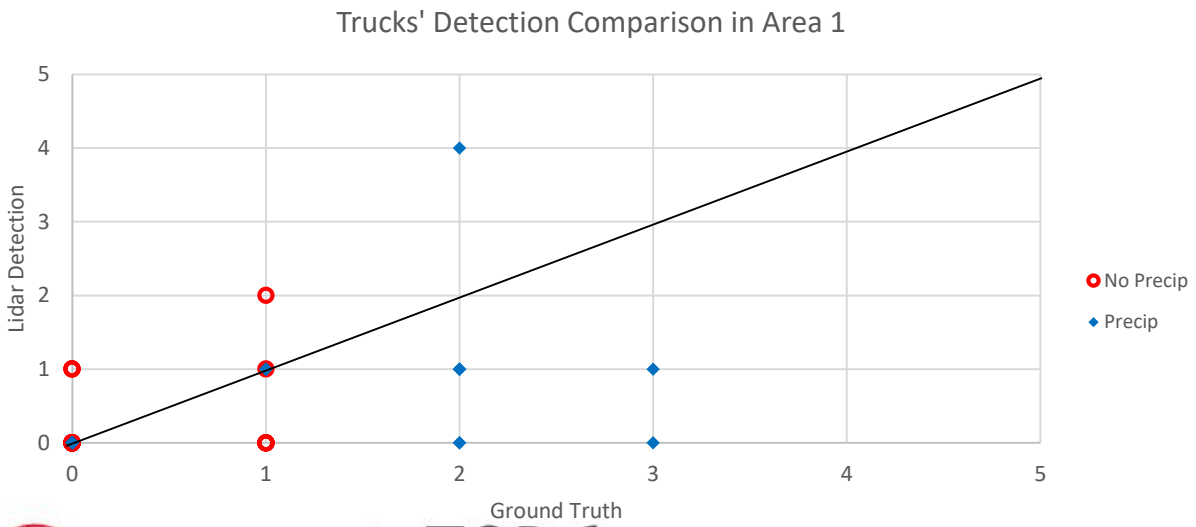
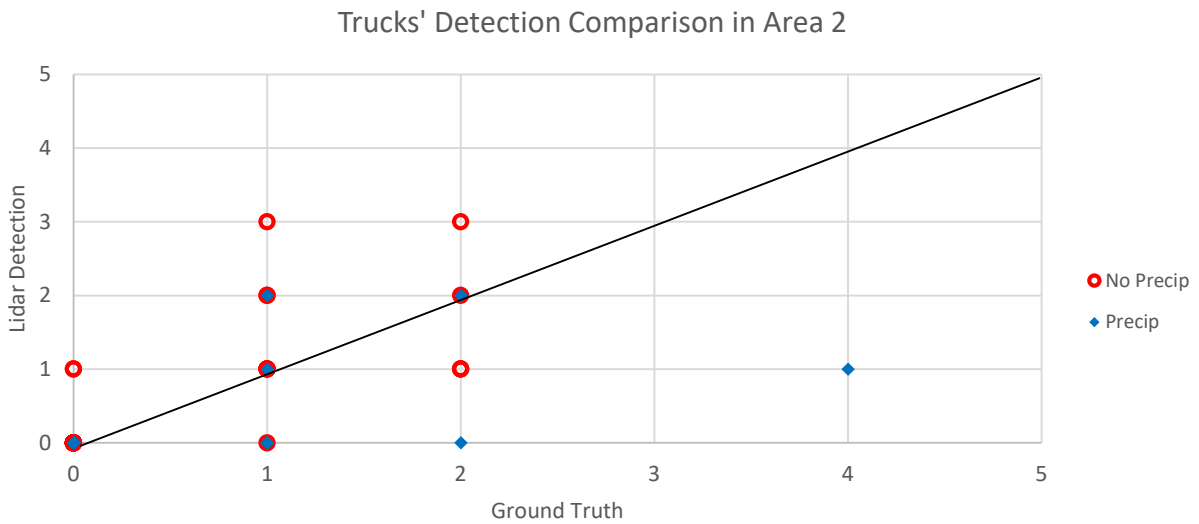
Accuracy Results – Buses and Trucks









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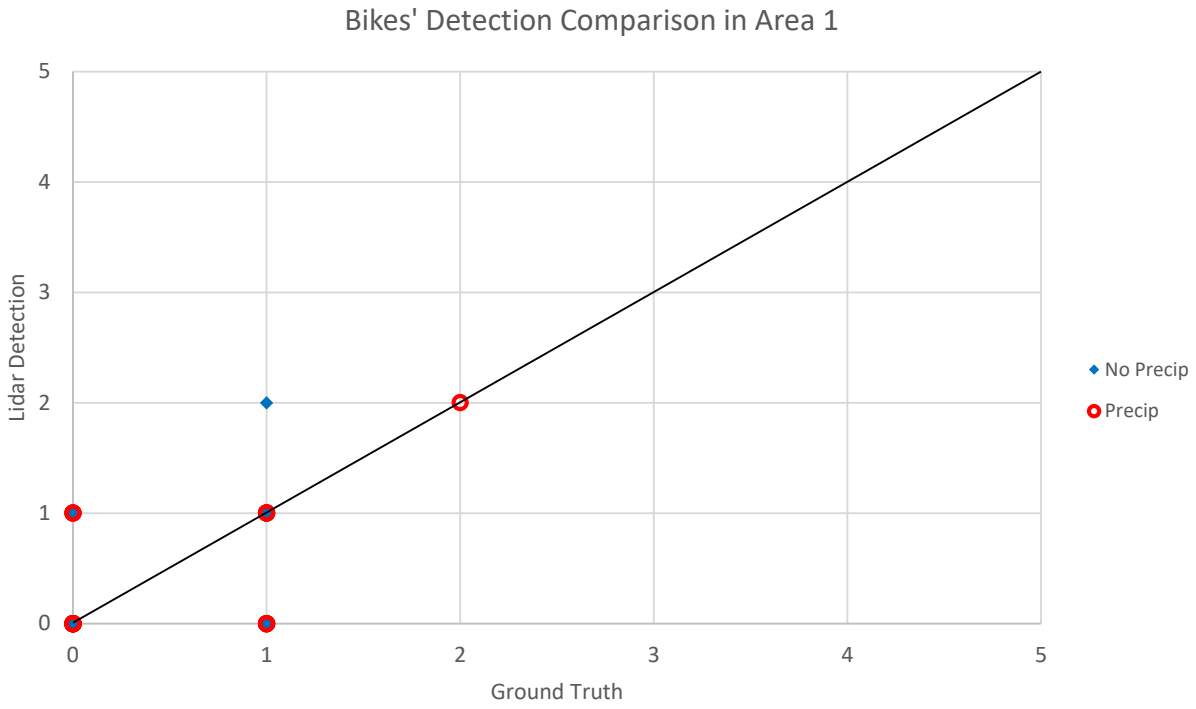
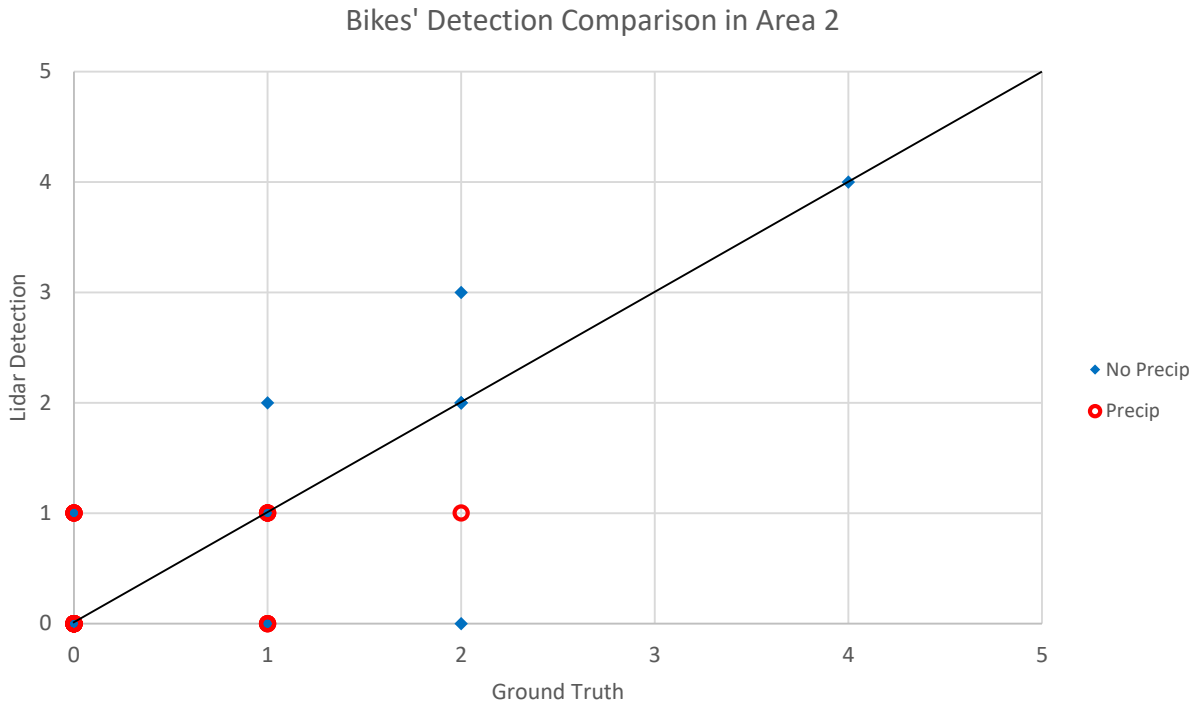
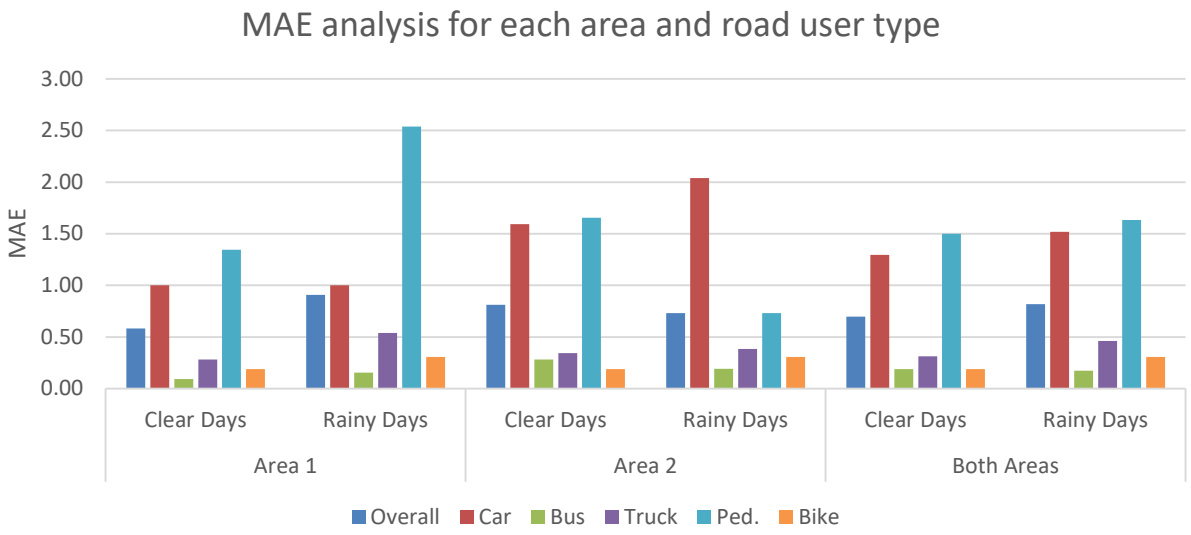
Accuracy Results – Bikes

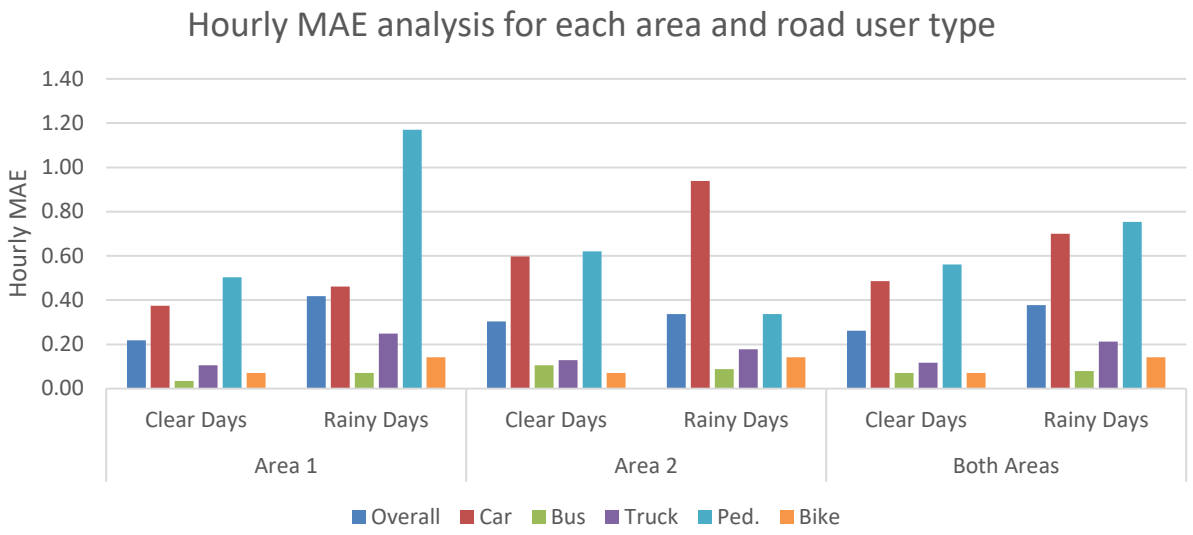




MAE Evaluation

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|Lidar\ Count_i - Ground\ Truth\ Count_i|$$





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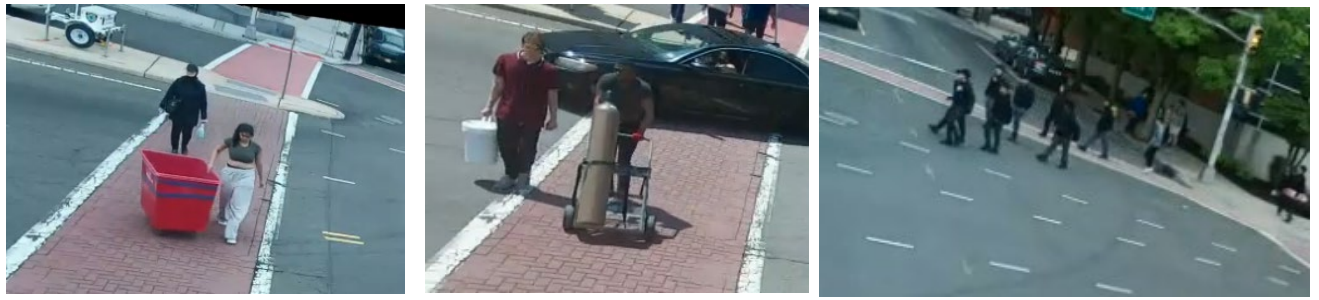
Key Limitations

- Missed or double-counted pedestrians.
- Difficulties with grouped or obscured individuals.
- Confusion between cars and trucks.
- Missed fast-moving vehicles.



Conclusion

- LiDAR performs reliably for vehicles.
- Pedestrian detection needs enhancement in poor weather.
- Error patterns call for calibration and algorithm improvements.

Recommendations

- Improve calibration for pedestrians under adverse weather.
- Refine detection algorithms to prevent double-counting.
- Adapt detection for fast-moving vehicles.
- Conduct more extensive testing.

Questions & Discussion

- Thank you!
- Open for questions.