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Development and Evaluation of a Pedestrian Crossing Alert (PCA) System Using LiDAR Sensor

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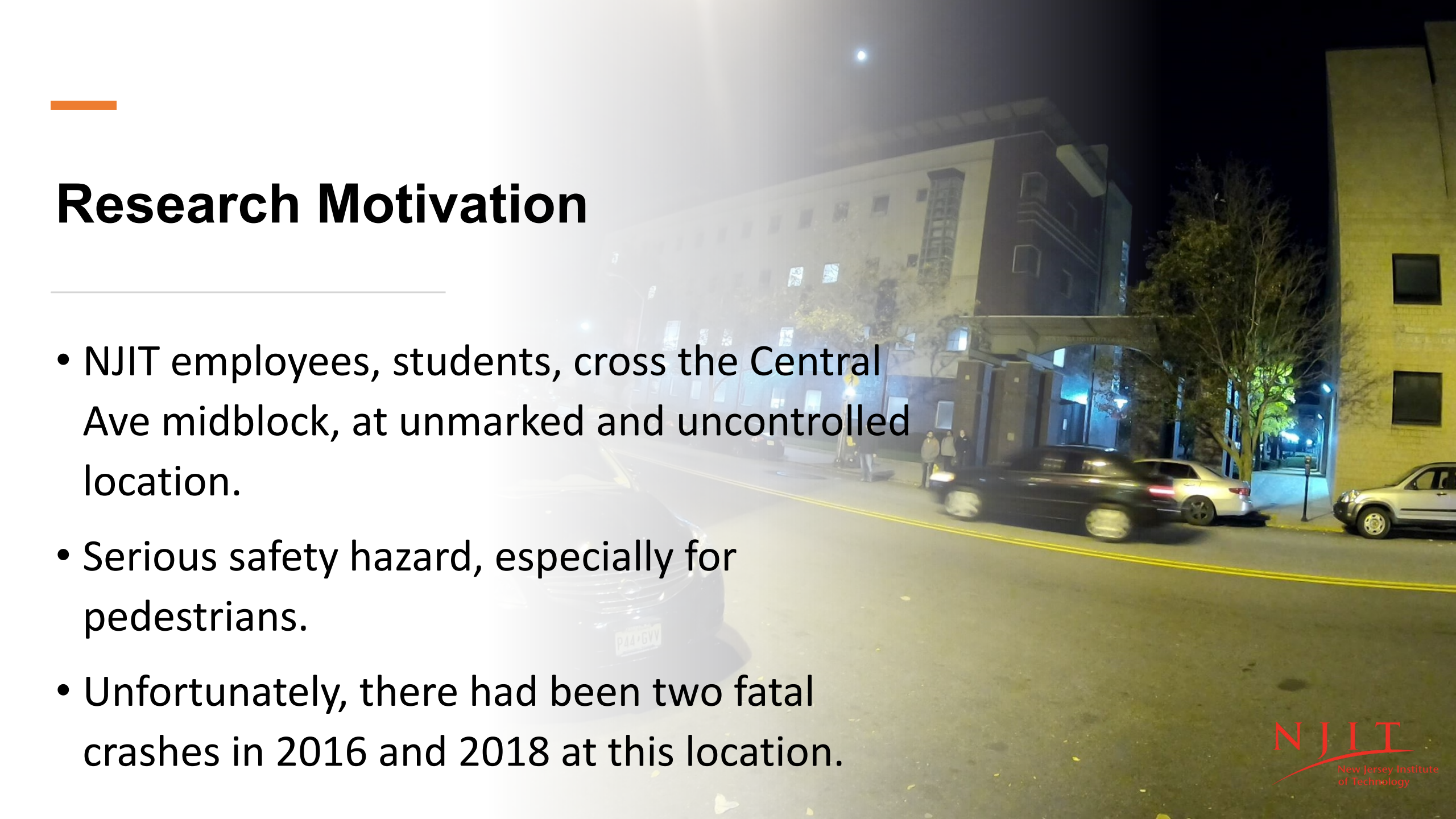
24th Annual NJDOT Research Showcase
October 26, 2022

Research Motivation



- NJIT employees, students, cross the Central Ave midblock, at unmarked and uncontrolled location.
- Serious safety hazard, especially for pedestrians.
- Unfortunately, there had been two fatal crashes in 2016 and 2018 at this location.

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Pedestrian Crossing Alert (PCA) System

- Passively detect pedestrians as they step to the curb.
- Alert the oncoming traffic of the pedestrians crossing the street.
- Use low-cost, reliable, easy to deploy detection system.
- Consideration of diverse alert media (roadside signalization, potential for CV/CV2X integration)

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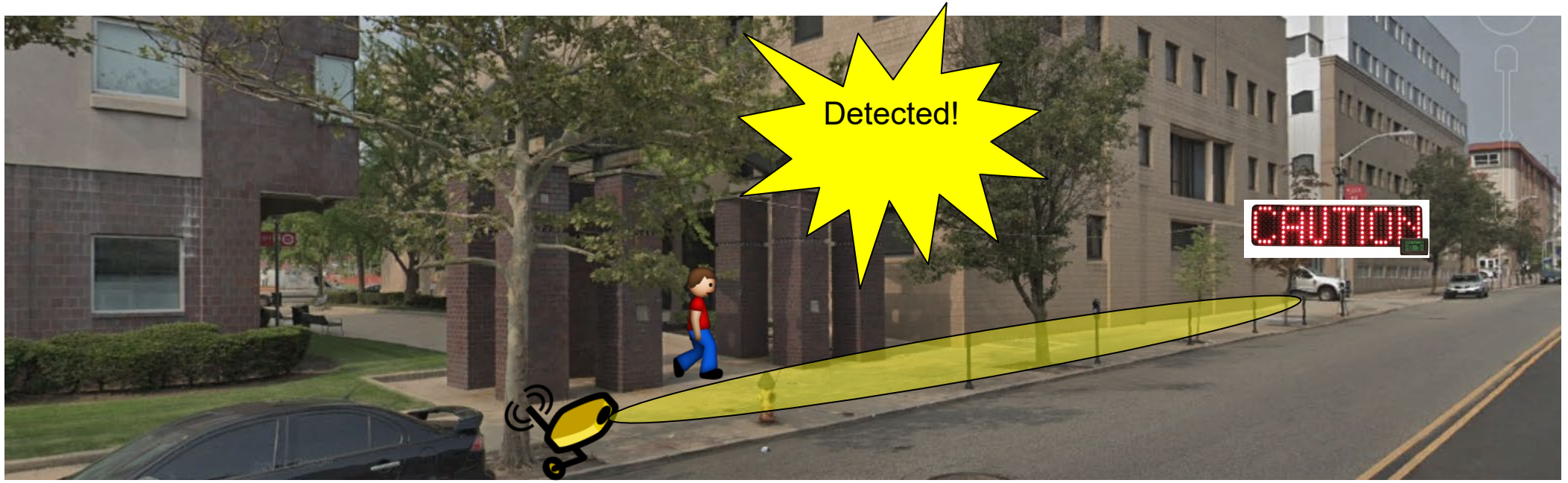

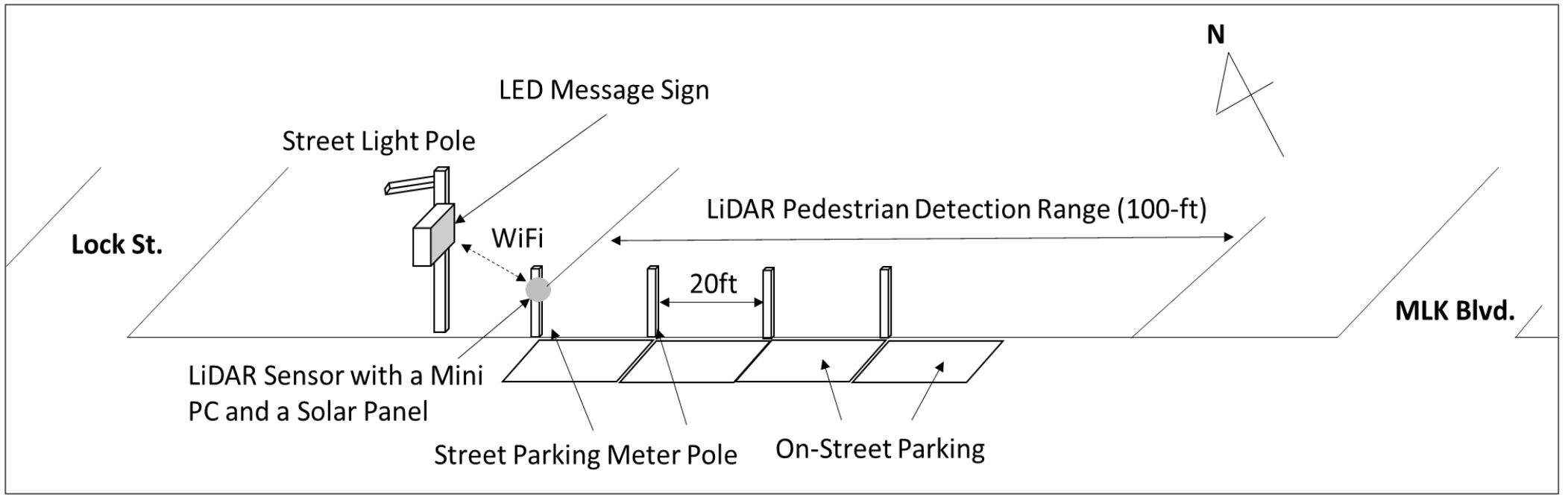

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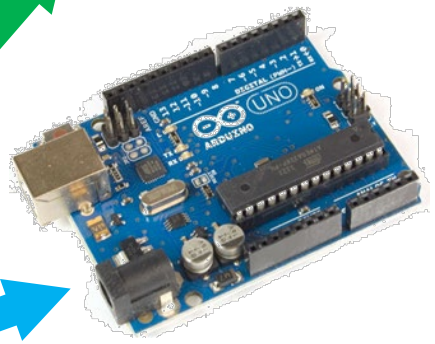

Prototype PCA System

Light Detection and Ranging (LiDAR) sensor – directional or 2D scanner, detects the presence of pedestrians

LED strobe flashing light – alerts the oncoming traffic

Microcontroller – receives and processes the data from LiDAR and controls the LED strobe flashing light

Photovoltaic battery – provides power to all system components.

Proof of Concept Experiment

- Hypothesis: Drivers will slow down after receiving an alert (i.e., a pedestrian crossing warning)
- Measurements:
  - Radar: measure speeds of approaching vehicles
  - Camera and video processing: overlay the vehicle image and speed redout
- Experiment: conduct the measurements by repeatedly crossing the street without activating PCA, and then with active PCA system
- Analysis: evaluate whether a speed reduction is detected with active PCA system

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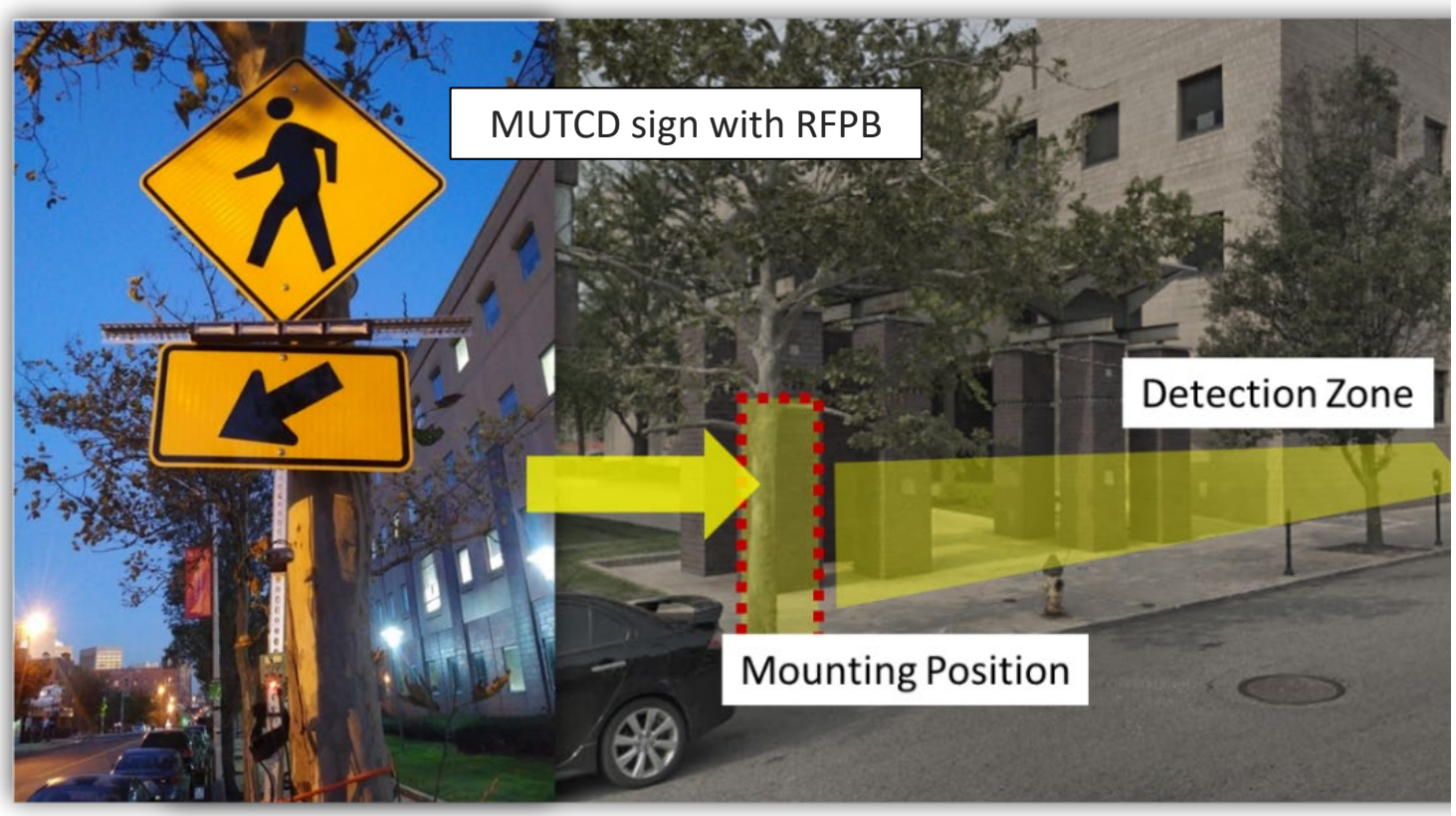

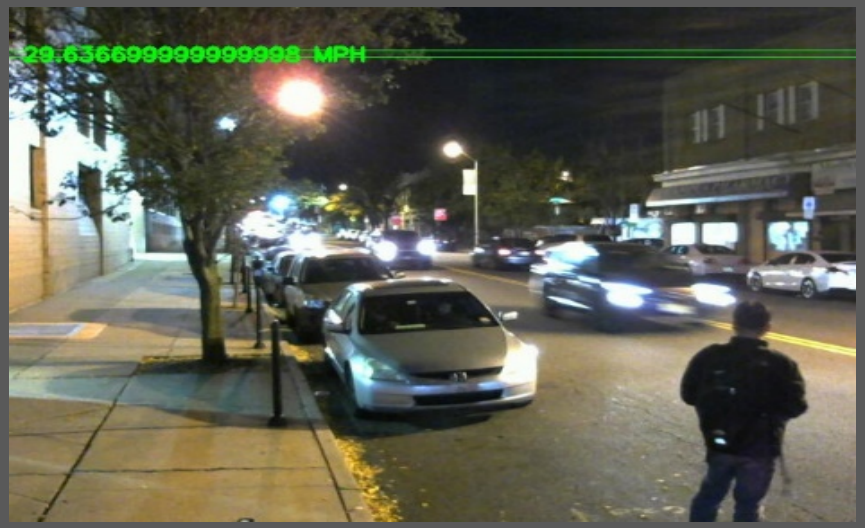

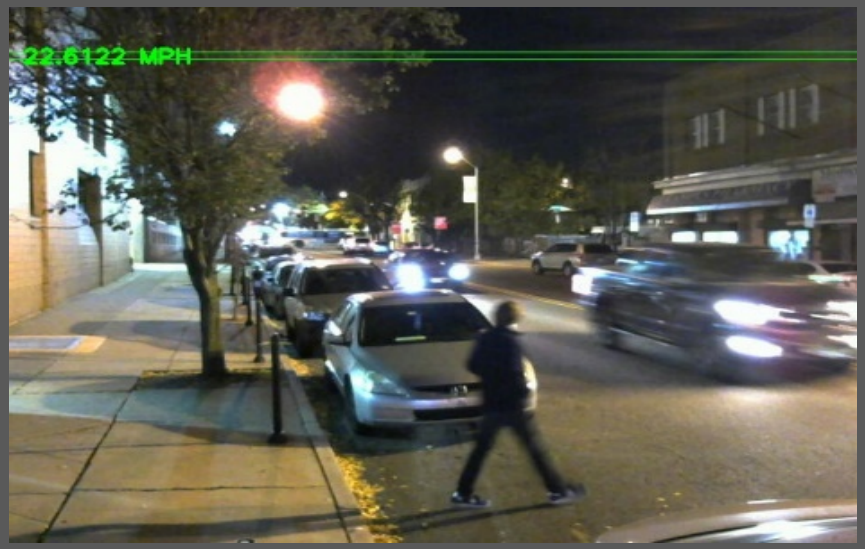

System passively detect presence of pedestrians at the street curb, and instantly provide a visual alert of the crossing pedestrian(s) to the motorists approaching the location.

Experiment

- Conducted in the evening hours, 5:30 pm – 6:30 pm
  - 30 minutes without PCA
  - 30 minutes with active PCA
- Pedestrians were actively crossing at the location, while the vehicle speed was collected using the video/radar setup
- 915 vehicles recorded with inactive PCA, 465 recorded vehicles with active PCA
- Two-sample t-test was conducted to determine whether the speed difference (“with PCA” vs. ”without PCA”) is statistically significant

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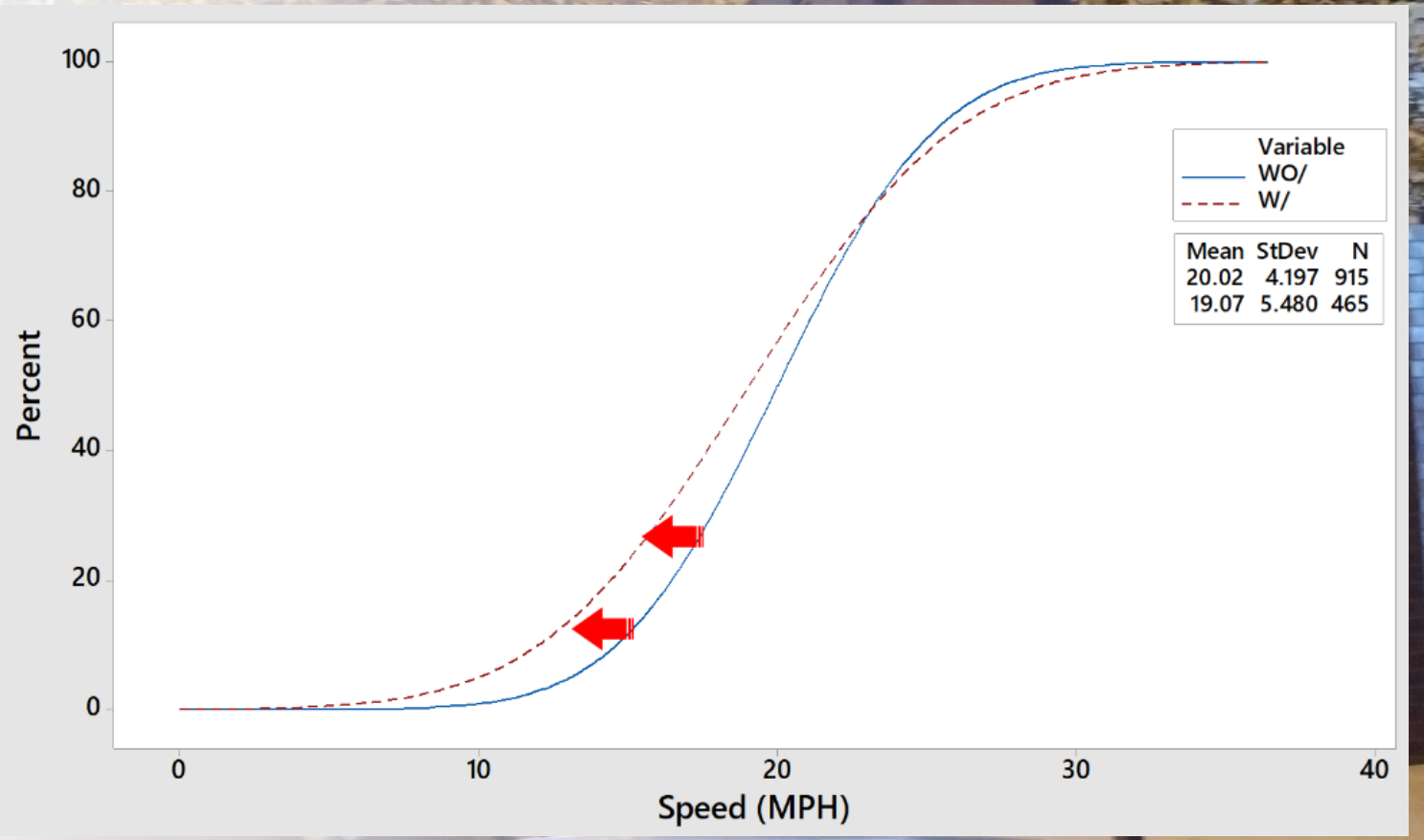
Statistical Analysis

- Speed CDF “with PCA” shifted to the left of the Speed CDF “without PCA”.
- This shift in the CDF indicates that there exist an actual speed reduction.
- With t-statistics of 3.31 and very small p-value, the two vehicle speed samples have different means (99% confidence).



Experiment	Observations	Mean	St. Dev	St. Err.	Two-sample t-test	
					t-statistic*	p-value
Without PCA	915	20.02	4.20	0.14	3.31	≤ 0.000
With PCA	465	19.07	5.48	0.25		

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Findings and Conclusions

- With active PCA, some drivers reduced the speed to almost a full stop to let the pedestrians cross.
- Without PCA, no drivers were observed stopping for the pedestrians without PCA.
- The proposed system appears effective in increasing pedestrian safety at the unprotected unmarked pedestrian crossings.
- The proposed system is characterized by a simple, inexpensive design.
- Can be easily deployed at both marked pedestrian crossings and unmarked locations known for hazardous pedestrian crossing activity.
- The proposed system can be integrated in a CV2X platform to broadcast a pedestrian warning message, thus alerting the incoming vehicles of pedestrian crossing activity ahead.

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Thank you !

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