Next Generation Traffic Data and Incident Detection from Video
"Video Analytics Project"

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ITS Canada Annual Conference and General Meeting
June 2014

Project Sponsors and Goals

Sponsors:

- Ontario Ministry of Transportation (MTO)
- ENTERPRISE Pooled Fund Program

Evaluation Goals:

- "Proof of Concept" to determine potential for video analytics to be effective for:
  - Traffic data collection
  - Incident detection
  - Wrong-way vehicle detection
- Determine performance levels that can be achieved when deploying the current state of practice in video analytics
- Not a comparison vendor's products

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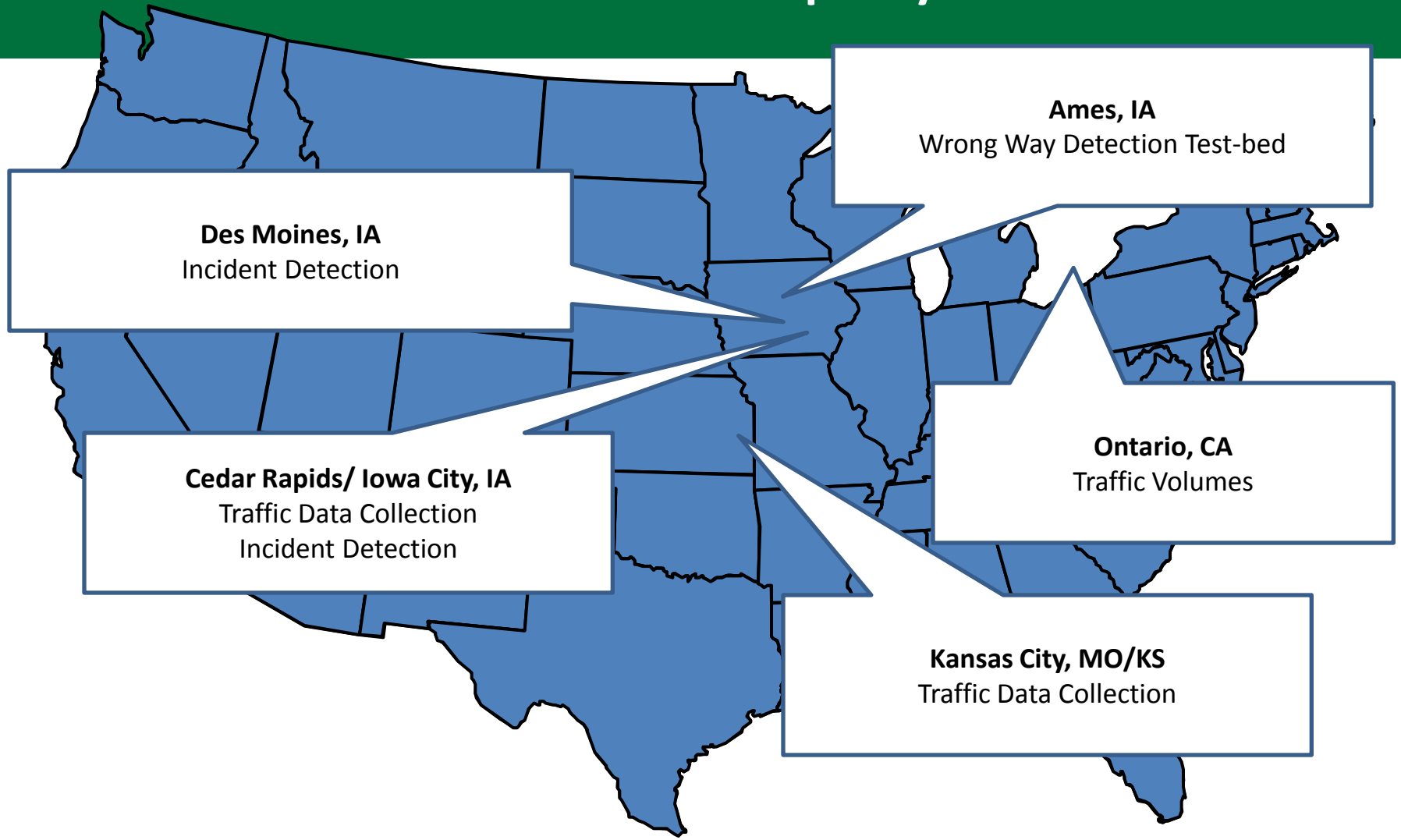
“Virtual Test Bed” Deployment Sites



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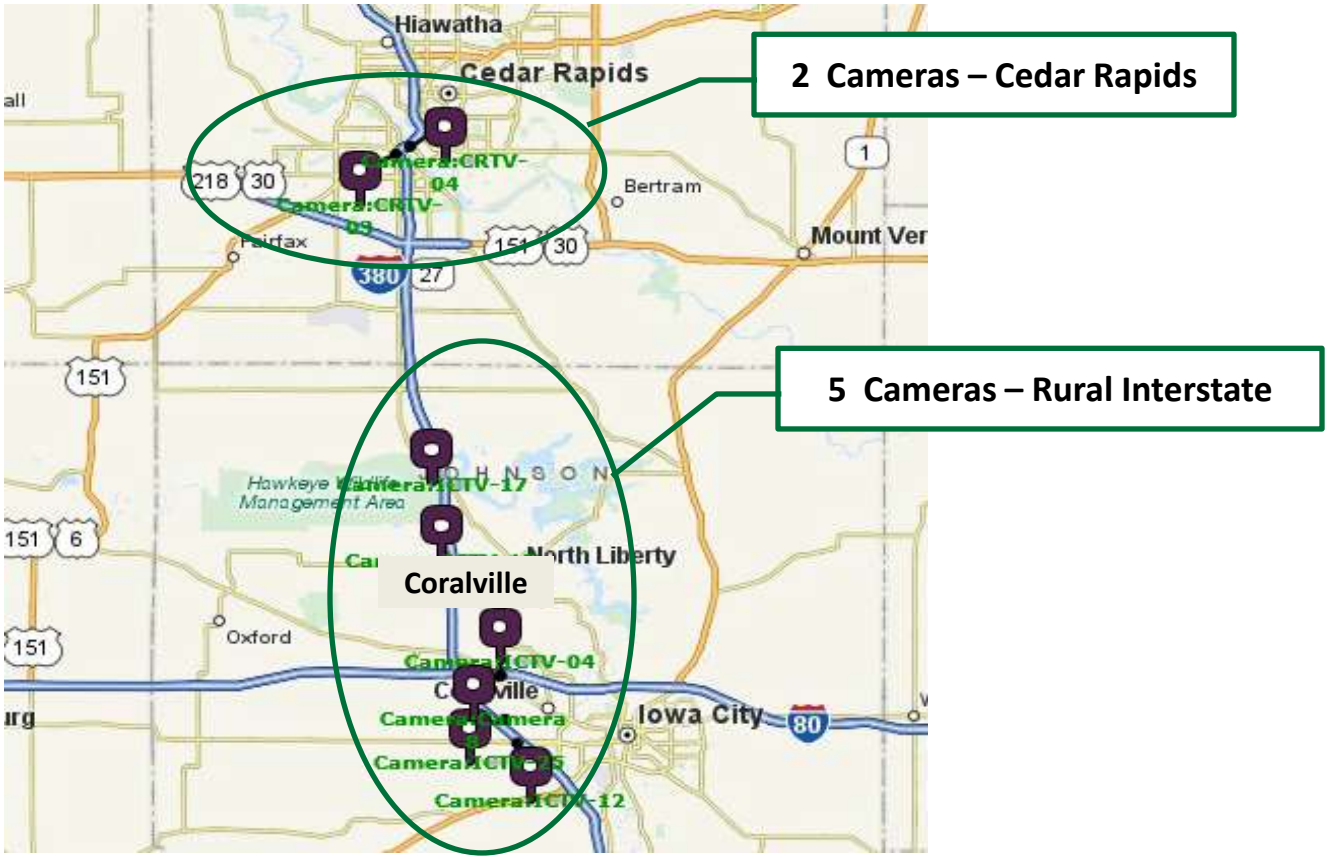
INCIDENT DETECTION

Incident Detection

Cedar Rapids / Rural Deployment

7 cameras instrumented (2 vendors)



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Incident Detection

Des Moines Deployment

7 cameras instrumented (2 vendors)

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Incident Detection

Variation in Camera Views

- 4-lane, 6-lane, 8-lane roadways
- Urban and rural Areas
- Facing N, S, W, E
- Barrier-separated/median-separated
- Curves and underpasses
- Flat roadway vs. grade in road
- Traffic moving away from / toward camera in lanes nearest camera
- Objects (signs, traffic signals) in view

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Incident Detection

Incident Types Detected by Video Analytics

- Stopped Vehicle / Debris in Road
- Slow Traffic / Congestion
- Pedestrian
- Wrong-Way Vehicle

Analysis Approach:

1) Reviewed Detection Alerts: Still Images / Video Clips
2) Classified Alerts:
   - Likely Detection (validated)
   - Detection Not Likely (not validated)
   - Unable to Determine
3) Calculated % validated, % not validated , % unable to determine (as a function of total number of alerts)

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Incident Detection

Results:

Highest Level of Performance
Stopped Vehicle / Debris: 72% alerts validated, 23% not validated, 5% unable to determine (81 alerts during a 44-day period) **Stopped Vehicle / Debris – Remove False alarms from Object in View:** 0% “false alarms” (26 alerts during a 21-day period) **Slow Vehicle/Congestion:** 30% alerts validated, 33% not validated, 37% unable to determine (1111 alerts during a 44-day period) **Pedestrian in Road:** None observed **Wrong-Way Vehicle Movements:** None observed

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Incident Detection

Results

Factors that Impacted Performance
• Objects in the field of view • Weather events / moisture on camera lens • Headlight glare on roadway during nighttime lighting conditions
Factors that Did Not Appear to Impact Performance
• Camera position (zoom level, angle to roadway) • Inaccurate configuration of video analytics to roadway lanes

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TRAFFIC DATA COLLECTION:
Iowa/Kansas City Deployments

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Traffic Data Collection

Deployment Sites and Data Compared

Deployment Site	Comparison Data from Agency	Volumes	Speeds	Vehicle Classifications
Rural Iowa (2 cameras)	Loops/Piezos	X	X	X
Kansas City, MO Metro (4 cameras)	Radar	X	X	

Variation in Camera Views

- Rural/Metro
- 4-6 lane roadways
- Facing N/S/W/E
- Median or Barrier separated
- Side-of-road detection
- Curves and underpasses

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Traffic Data Collection

Traffic Data Types in Analysis

- Volumes (Traffic Counts)
- Average Speeds
- Vehicle Classifications

Classification Categories from Video Analytics	Corresponding FHWA Classifications
Motorcycles	Classifications 1
Cars	Classifications 2-3
Small Trucks	Classifications 4-7
Large Trucks	Classifications 8-13

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Traffic Data Collection

Analysis Approach

- Data collected in 15-minute increments
- Video analytics outputs compared to outputs from DOT detectors
- Absolute Percent Difference (Abs % Diff) Calculation:
  - Calculate 15 min. period difference from DOT data
  - Convert it to absolute difference (remove any '-')
  - Compute Percent Difference
  - Result is Abs % Diff.
- Caveat: Night-time traffic is often very low volumes. Abs % Diff. is not as meaningful.

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Traffic Data Collection

Results

Highest Level of Performance (All results shown are average % diff for one week)	
Traffic Volumes: • 17% Total Avg. % Diff • 9% Avg. % Diff daytime • 23% Avg. % Diff at night	**Vehicle Speeds:** • 5% Total Avg. % Diff • 4% Avg. % Diff daytime • 6% Avg. % Diff at night
Vehicle Classifications: • "Motorcycles" (FHWA Classification 1): Avg. % Diff of 24% at night • "Cars" (FHWA Classifications 2-3): Avg. % Diff of 13% daytime • "Small Trucks" (FHWA Classifications 4-7): Avg. % Diff of 44% daytime • "Large Trucks" (FHWA Classifications 8-13): Avg. % Diff. of 23% daytime	

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Traffic Data Collection

Results

Factors that Impacted Performance
• Low light / dark conditions • Camera position (proximity to traffic, zoomed out, angled to roadway) • Weather events that reduce image quality • Inaccurate configuration of video analytics to roadway lanes • Camera settings (e.g. shutter speed, max gain)
Factors that Did Not Appear to Impact Performance
• Position of camera relative to direction of traffic (e.g. counting headlights vs. tail lights at night)

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TRAFFIC DATA COLLECTION:

Ontario Ministry of Transportation (MTO) Deployment

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Traffic Data: MTO Deployment

MTO Deployment – Focus on Volumes

- 13 cameras instrumented at 4 Locations
- Data collected in 15-minute periods
- Video recorded for 1 week at each camera, sent to video analytics vendor for processing
- Manual counts conducted for comparison
- Manual counts compared to video analytics data outputs to compute percent error

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WRONG-WAY VEHICLE DETECTION

Wrong-Way Vehicle Detection

Controlled Test: Nov. 2013 in Ames, IA

- 3 vendors/technologies at 3 separate freeway ramps
- Ramp closures to test various conditions
  - 3 vehicle sizes/colors
  - Varying speeds
  - Vehicle position in lanes and shoulders
  - Vehicle changing directions
  - Daytime/nighttime lighting
- Detections conveyed via email, web interface, or on-site computer interface
- Recorded “detection” or “non-detection”

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Wrong-Way Vehicle Detection

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Wrong-Way Vehicle Detection

Highest Level of Performance Achieved
Daytime Test: 100% detection for 12 test drives **Nighttime Test:** 83% detection for 12 test drives
Factors that Impacted Detection Rate
Nighttime / Low Light Conditions Slow Speeds
Factors that Did Not Appear to Impact Detection Rate
Color/Size of Vehicle Lane Position (consistent position, shoulder, and/or weaving)

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EVALUATION FINDINGS
and
NEXT STEPS

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Evaluation Findings

- Traffic Data Collection
  - Best performance:
    - » 5-10% error for volumes (during the day); nighttime counts can be much less accurate than daytime counts
    - » 4-6% error for average speeds - similar performance day and night
  - Extremely important to position cameras for optimal data collection detection (zoomed in, no horizon in view, follow vendor recommendations)
- Incident Detection
  - Best performance: 85% accuracy for stopped vehicles/debris and 30% accuracy for slow traffic/congestion
  - Camera position, zoom level, angle to roadway – Do not appear as critical for performance compared to traffic data collection
- Wrong-Way Vehicle Detection
  - Best performance: 100% accuracy during day and 80% accuracy at night
  - Slow speeds and low lighting can impact performance

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Next Steps

- Procurement Support Resources for Agencies
  - Sample Requirements
  - Agency Considerations
  - Vendor Specifications
- Benefit/Cost Analysis
- Final Report
  - Available Fall 2014 on ENTERPRISE website: www.enterprise.prog.org

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Next Steps

Questions?

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Appendix: Incident Management

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Incident Detection

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Incident Detection

Examples of Incidents Detected/Verified

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Incident Detection

Incident detection validated

Stopped Vehicle

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Incident Detection

Incident detection validated

Stopped Vehicle

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Incident Detection

Incident detection validated

Slow Traffic / Congestion

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Incident Detection

Incident detection validated

Pedestrians detected as “Stopped Vehicle / Debris in Road”

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Incident Detection

Incident detection validated

Slow Traffic: Overlay Not in Correct Position

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Incident Detection

Examples of Incidents Not Verified

(False Alarms)

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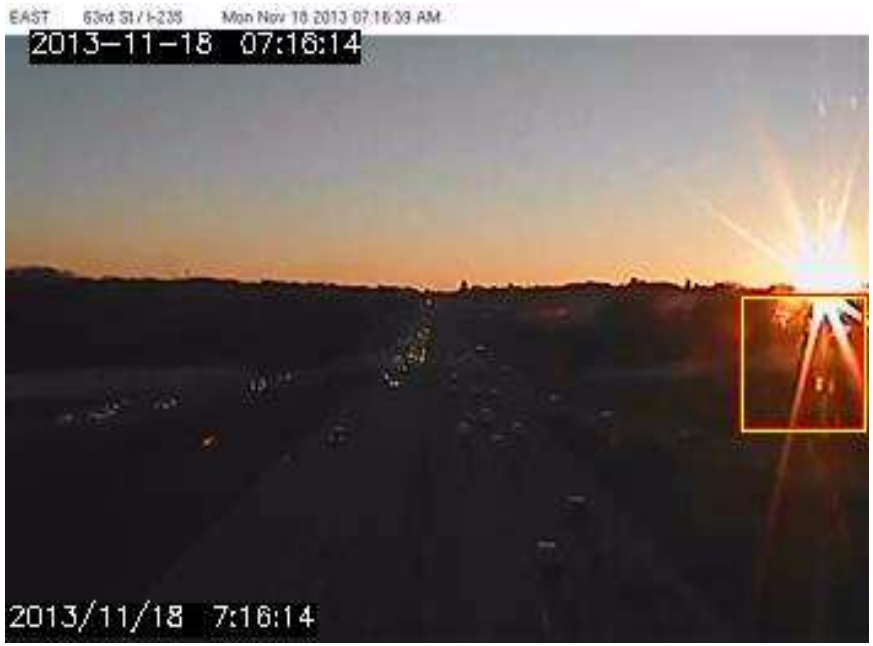
Incident Detection

Incidents Not Validated (false alarms)



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Incident Detection

False Alarms caused by Obstructions in View

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Incident Detection

Examples: Incidents classified as "Unable to Determine"

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Incident Detection

Examples: Unable to Determine

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Traffic Data: MTO Deployment

Results:

Type of Comparison	Configuration/ Setting	% Error
Time of Day	Day[1]	9.1%
	Night	7.9%
Camera Angle	Side	9.4%
	Overhead	6.5%
Camera Type	Axis	7.5%
	Cohu	9.6%

[1] 'Day' analysis was PM peak (16:30-17:30)

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Traffic Data: MTO Deployment

Results / Conclusions:

1. Camera based counting system is appropriate if:
   - Overall Accuracy within 10% is acceptable
   - Vehicle Classification is not critical

2. Camera based counting system may not be suitable if:
   - Counts are to be conducted in work zones or areas with high stop-and-go traffic
   - Accuracy within 5% is required
   - Vehicle Classification is needed
   - Night-time accuracy is important

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Wrong-Way Test: Test Vehicles

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Wrong-Way Vehicle Detection

Deployment Site #1 – Dayton Ave.

90 degree detection

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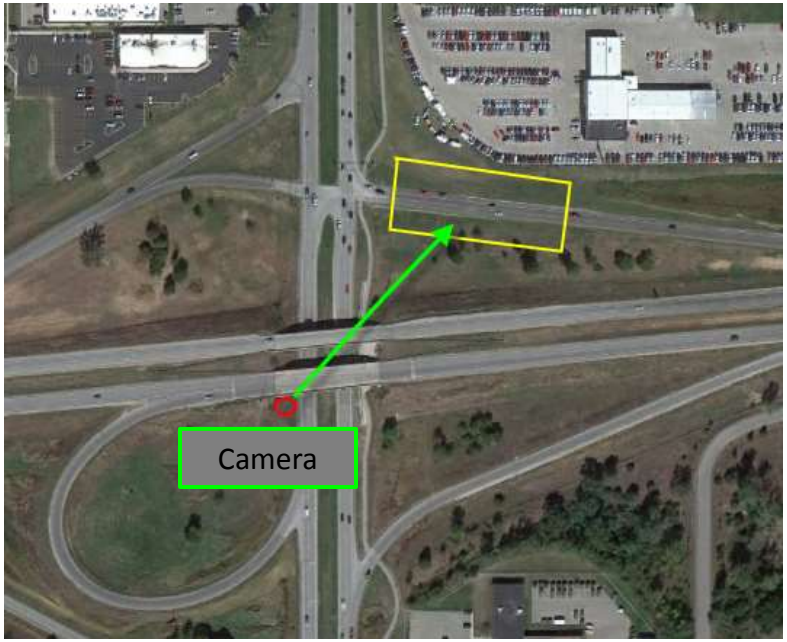
Wrong-Way Vehicle Detection

Deployment Site #2 – Duff Ave.



90 degree detection

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Wrong-Way Vehicle Detection

Deployment Site #3 – University Blvd.

“head-on” detection

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Wrong-Way Vehicle Detection

Email Alerts

Subject: Incident alert: Wrong-way vehicle [WWD @ University Blvd. WB Off]

Message | attachment-1.jpg (19 KB)

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