Next Generation Traffic Data and Incident Detection from Video
“Video Analytics Project”
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
“Virtual Test Bed” Deployment Sites

- Des Moines, IA
  Incident Detection
- Cedar Rapids/Iowa City, IA
  Traffic Data Collection
  Incident Detection
- Ontario, CA
  Traffic Volumes
- Kansas City, MO/KS
  Traffic Data Collection
- Ames, IA
  Wrong Way Detection Test-bed
INCIDENT DETECTION
Incident Detection

Cedar Rapids / Rural Deployment
7 cameras instrumented (2 vendors)

2 Cameras – Cedar Rapids
5 Cameras – Rural Interstate

Coralville
Incident Detection

Des Moines Deployment
7 cameras instrumented (2 vendors)
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
 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)
## Incident Detection

### Results:

<table>
<thead>
<tr>
<th>Highest Level of Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stopped Vehicle / Debris:</strong></td>
</tr>
<tr>
<td>72% alerts validated, 23% not validated, 5% unable to determine</td>
</tr>
<tr>
<td><strong>Stopped Vehicle / Debris – Remove False alarms from Object in View:</strong></td>
</tr>
<tr>
<td>0% “false alarms” (26 alerts during a 21-day period)</td>
</tr>
<tr>
<td><strong>Slow Vehicle/Congestion:</strong></td>
</tr>
<tr>
<td>30% alerts validated, 33% not validated, 37% unable to determine</td>
</tr>
<tr>
<td><strong>Pedestrian in Road:</strong></td>
</tr>
<tr>
<td>None observed</td>
</tr>
<tr>
<td><strong>Wrong-Way Vehicle Movements:</strong></td>
</tr>
<tr>
<td>None observed</td>
</tr>
</tbody>
</table>
# 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
TRAFFIC DATA COLLECTION:
Iowa/Kansas City Deployments
## Traffic Data Collection

### Deployment Sites and Data Compared

<table>
<thead>
<tr>
<th>Deployment Site</th>
<th>Comparison Data from Agency</th>
<th>Volumes</th>
<th>Speeds</th>
<th>Vehicle Classifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Iowa (2 cameras)</td>
<td>Loops/Piezos</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Kansas City, MO Metro (4 cameras)</td>
<td>Radar</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

### 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
Traffic Data Collection

Traffic Data Types in Analysis
• Volumes (Traffic Counts)
• Average Speeds
• Vehicle Classifications

<table>
<thead>
<tr>
<th>Classification Categories from Video Analytics</th>
<th>Corresponding FHWA Classifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles</td>
<td>Classifications 1</td>
</tr>
<tr>
<td>Cars</td>
<td>Classifications 2-3</td>
</tr>
<tr>
<td>Small Trucks</td>
<td>Classifications 4-7</td>
</tr>
<tr>
<td>Large Trucks</td>
<td>Classifications 8-13</td>
</tr>
</tbody>
</table>
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.
Traffic Data Collection

Results

<table>
<thead>
<tr>
<th>Highest Level of Performance</th>
<th>Traffic Volumes:</th>
<th>Vehicle Speeds:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(All results shown are average % diff for one week)</td>
<td>• 17% Total Avg. % Diff</td>
<td>• 5% Total Avg. % Diff</td>
</tr>
<tr>
<td></td>
<td>• 9% Avg. % Diff daytime</td>
<td>• 4% Avg. % Diff daytime</td>
</tr>
<tr>
<td></td>
<td>• 23% Avg. % Diff at night</td>
<td>• 6% Avg. % Diff at night</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vehicle Classifications:</th>
<th>Traffic Volumes:</th>
<th>Vehicle Speeds:</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Motorcycles” (FHWA Classification 1): Avg. % Diff of 24% at night</td>
<td>• 17% Total Avg. % Diff</td>
<td>• 5% Total Avg. % Diff</td>
</tr>
<tr>
<td>“Cars” (FHWA Classifications 2-3): Avg. % Diff of 13% daytime</td>
<td>• 9% Avg. % Diff daytime</td>
<td>• 4% Avg. % Diff daytime</td>
</tr>
<tr>
<td>“Small Trucks” (FHWA Classifications 4-7): Avg. % Diff of 44% daytime</td>
<td>• 23% Avg. % Diff at night</td>
<td>• 6% Avg. % Diff at night</td>
</tr>
<tr>
<td>“Large Trucks” (FHWA Classifications 8-13): Avg. % Diff. of 23% daytime</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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)
TRAFFIC DATA COLLECTION:
Ontario Ministry of Transportation (MTO) Deployment
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
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”
Wrong-Way Vehicle Detection
Wrong-Way Vehicle Detection

<table>
<thead>
<tr>
<th>Highest Level of Performance Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daytime Test:</strong> 100% detection for 12 test drives</td>
</tr>
<tr>
<td><strong>Nighttime Test:</strong> 83% detection for 12 test drives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factors that Impacted Detection Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime / Low Light Conditions</td>
</tr>
<tr>
<td>Slow Speeds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factors that Did Not Appear to Impact Detection Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color/Size of Vehicle</td>
</tr>
<tr>
<td>Lane Position (consistent position, shoulder, and/or weaving)</td>
</tr>
</tbody>
</table>
EVALUATION FINDINGS

and

NEXT STEPS
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
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
Next Steps

Questions?

Contact Information:
Mike Barnet
Ontario Ministry of Transportation
mike.barnet@ontario.ca
Appendix: Incident Management
Incident Detection
Incident Detection

Examples of Incidents Detected/Verified
Incident Detection

Incident detection validated
Stopped Vehicle
Incident Detection

Incident detection validated

Stopped Vehicle
Incident Detection

Incident detection validated

Slow Traffic / Congestion
Incident detection validated

Pedestrians detected as “Stopped Vehicle / Debris in Road”
Incident Detection

Incident detection validated

Slow Traffic: Overlay Not in Correct Position
Incident Detection

Examples of Incidents Not Verified (False Alarms)
Incident Detection

Incidents Not Validated (false alarms)
Incident Detection

False Alarms caused by Obstructions in View
Incident Detection

Examples: Incidents classified as “Unable to Determine”
Incident Detection

Examples: Unable to Determine
# Traffic Data: MTO Deployment

## Results:

<table>
<thead>
<tr>
<th>Type of Comparison</th>
<th>Configuration/Setting</th>
<th>% Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Day</td>
<td>Day&lt;sup&gt;1&lt;/sup&gt;</td>
<td>9.1%</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>7.9%</td>
</tr>
<tr>
<td>Camera Angle</td>
<td>Side</td>
<td>9.4%</td>
</tr>
<tr>
<td></td>
<td>Overhead</td>
<td>6.5%</td>
</tr>
<tr>
<td>Camera Type</td>
<td>Axis</td>
<td>7.5%</td>
</tr>
<tr>
<td></td>
<td>Cohu</td>
<td>9.6%</td>
</tr>
</tbody>
</table>

<sup>1</sup> ‘Day’ analysis was PM peak (16:30-17:30)
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
Wrong-Way Test: Test Vehicles
Wrong-Way Vehicle Detection

Deployment Site #1 – Dayton Ave.

Camera

Off-ramp traffic

90 degree detection
Wrong-Way Vehicle Detection

Deployment Site #2 – Duff Ave.

90 degree detection
Wrong-Way Vehicle Detection

Deployment Site #3 – University Blvd.

“head-on” detection
Wrong-Way Vehicle Detection

Email Alerts