Macroscopic Evaluation of Non-Invasive Vehicle Detection

Mid-Continent Transportation Research Symposium

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Agenda

- Introduction
- Motivation
- Deployment Sites
- Data Collection
- Data Analysis
- Conclusions
- Recommendations
Motivation

<Generic Traffic Agency Name> scraps adaptive traffic light system...

The system performed better with the adaptive algorithm turned off...

We paid how much???

It was bad before, but it’s worse now...

Who funded this???
Oregon DOT SPR 781

• Project Title: Improving Adaptive / Responsive Signal Control Performance: Implications of Non-Invasive Detection and Legacy Timing Practices

• Objectives
  – Different detection sources provide varying levels of accuracy
  – The impact of less than optimal detection on traditional call and extend operation is well known
  – How does sub-optimal detection impact the operation of higher level control algorithms, such as adaptive and/or traffic responsive?

• Report published February, 2017
General Workplan

- Identify locations with redundant detection
  - Loops combined with non-invasive unit
- Collect data via event based data logger
- Ground truth inductive loops
- Model data across all sites looking at various performance data items used in adaptive control
- Develop recommendations for ODOT
Data Flow for Event Based Data Logger

Vehicle Detectors

Radar

Detector Status

Video

Detecto Status

Loops

Traffic Controller

Event Log

Dynamic Overlay

Fit PC

Video Feed

Event States
Data Logger
Site Locations
Town Center Loop West & Wilsonville Road, Wilsonville
97th & Lawnfield, Clackamas County
US 20 & Robal Rd, Bend
122nd & SE Division, Portland
Data Collection

• Minor issues occurred at 97th / Lawnfield & TCLW / Wilsonville related to MS Windows pop-ups
• Major issues at Bend severely limited data collection
• 122nd / SE Division was uneventful

<table>
<thead>
<tr>
<th>Location</th>
<th>Data Collection Dates</th>
<th>Good Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW Wilsonville Rd. and Town Center Loop W</td>
<td>5/11/15 – 6/18/15</td>
<td>507 hrs (~21 days)</td>
</tr>
<tr>
<td>SE 97th Ave. and SE Lawnfield Rd.</td>
<td>6/18/15 – 7/28/15</td>
<td>599 hrs (~25 days)</td>
</tr>
<tr>
<td>US 20 and Robal Rd.</td>
<td>6/25/15 – 11/6/15</td>
<td>196 hrs (~8 days)</td>
</tr>
<tr>
<td>SE Division St. and SE 122nd Ave.</td>
<td>10/20/15 – 11/16/15</td>
<td>626 hrs (~26 days)</td>
</tr>
</tbody>
</table>
Loop Verification

• Premise is that loops are accurate, and other sources vary

• Must complete ground truth
  – 15 minutes for each inductive loop
  – Completed for every loop in study
  – 11:00 AM – 11:15 AM (moderate traffic)
Sensor Analysis

• Advance Metrics (75’+ from stopbar)
  – Device mounted at stopbar

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>5-min Activation</th>
<th>5-min Occupancy</th>
<th>Time to Gap-out (Gap &gt;3.5 sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>Number of activations observed during 5 min period</td>
<td>Percentage of time the detector was occupied during 5 min period</td>
<td>Time to find the first gap greater than 3.5 sec during a 2-min interval</td>
</tr>
<tr>
<td><strong>Use in Traffic Control</strong></td>
<td>Used for assessing demand on the main street</td>
<td>Used for assessing demand on the main street</td>
<td>Used for implementing Dilemma Zone Protection</td>
</tr>
</tbody>
</table>

– Analysis undertaken separately between video / radar
## Advance – Activations, Video

<table>
<thead>
<tr>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>122 div. (15,43) SB TH 188 ft</td>
<td></td>
</tr>
<tr>
<td>97th, (10,42) SB TH/RT 110 ft</td>
<td></td>
</tr>
<tr>
<td>97th, (20,52) NB TH/RT 110 ft</td>
<td></td>
</tr>
<tr>
<td>97th, (5,38) SB LT 75 ft</td>
<td></td>
</tr>
<tr>
<td>Wilsonville, (11,29) EB TH/RT 110 ft</td>
<td></td>
</tr>
<tr>
<td>Wilsonville, (21,4) WB TH/RT 110 ft</td>
<td></td>
</tr>
<tr>
<td>Wilsonville, (5,28) EB LT 75 ft</td>
<td></td>
</tr>
</tbody>
</table>
Advance – Occupancy, Video

- 122div, (15,43), SB, TH, 188 ft
- 97th, (10,42), SB, TH/RT, 110 ft
- 97th, (20,52), NB, TH/RT, 110 ft
- 97th, (5,38), SB, LT, 75 ft
- Wilsonville, (11,29), EB, TH/RT, 110 ft
- Wilsonville, (21,4), WB, TH/RT, 110 ft
- Wilsonville, (5,28), EB, LT, 75 ft

Loop occupancy vs. video occupancy for various locations.
Advance Time to Gap, Video
Sensor Analysis

- **Stopbar Metrics (< 75’ from stopbar)**

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Stopbar Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time to gap out</strong></td>
<td><strong>Green Occupancy Ratio</strong></td>
</tr>
<tr>
<td>(Gap &gt; 2.0 s)</td>
<td><strong>Red Occupancy Ratio (first 5 sec)</strong></td>
</tr>
<tr>
<td><strong>Definition</strong></td>
<td><strong>Time to First Sustained Call during Red Time</strong></td>
</tr>
<tr>
<td>Time to find first gap</td>
<td>Percentage of green time for which detector was turned on</td>
</tr>
<tr>
<td>greater than 2 second</td>
<td>Percentage of first 5 seconds of red time for which the detector was occupied</td>
</tr>
<tr>
<td>during a green interval</td>
<td>Time from the start of red interval when a call was placed which lasted for</td>
</tr>
<tr>
<td></td>
<td>the remaining red duration</td>
</tr>
<tr>
<td></td>
<td><strong>Use in Traffic Control</strong></td>
</tr>
<tr>
<td>Used for implementing a</td>
<td>GOR + ROR5 are together used to detect split failure</td>
</tr>
<tr>
<td>gap out logic to</td>
<td></td>
</tr>
<tr>
<td>terminate the active</td>
<td></td>
</tr>
<tr>
<td>green phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used for placing a call for service by a given phase. It is also used to</td>
</tr>
<tr>
<td></td>
<td>calculate delay by some algorithms</td>
</tr>
</tbody>
</table>
Time to Gap, Video
Time to First Sustained Call (TFSC), Video
Recommendations

• Advance detection
  – Avoid stopbar mounted video for activations or occupancy
  – Radar was reasonable, but limited data
  – Video should not be used for Time to Gap, but radar looks promising
Recommendations

• Stopbar detection
  – Time to Gap and Time to First Sustained Call: Video reasonable, but expect modest performance differences in moderate traffic
  – Split Failure: Video GOR generally similar to video, but ROR_5 all over the map; not recommended to use occupancy based metric from stopbar video
Recommendations

• Detector health monitoring is incredibly important
  – Loops as well as non-invasive, given issues experienced with loops

• No broad brushed mathematical guidance possible
  – Each technology, site, and installation is unique

• Adaptive control vendors should work with video / radar vendors for algorithm development (this is happening)
  – Technologies develop data differently; it should be processed differently
Acknowledgements

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  – Jon Lazarus, Roger Boettcher, Dave Hirsch and SPR 781 TAC
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• Clackamas County
  – Bikram Raghubansh
• Portland Bureau of Transportation
  – Paul Zebell
• Final Report:
  http://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR781_Adaptive_Responsive_Signal.pdf
Questions?

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