Counting Bicycles and Pedestrians at Signalized Intersections

PROJECT:
Investigation of Bicycle and Pedestrian Continuous and Short Duration Count Technologies in Oregon

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Outline

• Goals
• Technologies
• Site
• Results by technology
  – Controlled Environment
  – Mixed Traffic
• Conclusions and Recommendations
Goals

• Investigate if and under what conditions existing continuous and short duration, bicycle and pedestrian count technologies are most accurate

• How to cost effectively integrate them into ODOT’s current traffic monitoring and signal operations systems?
Technologies Tested

• Pneumatic tubes
• Inductive loops
  ▪ Diamond
  ▪ Parallelogram
• Thermal Camera
• Pedestrian pushbutton
• Passive infrared

Bicycle counts
Pedestrian counts
Site - Intersection
Inductive Loops – Controlled Environment

-100  -50  0  50  100
Zone1-2  Zone 3-4  Zone 5-6

-100  -50  0  50  100
Tandem+Bike w/ Trailer  Carbon Fiber + Cargo Bicycle  Bikes One Behind the Other  Bikes Side by Side

Error (%)

Error (%)
Inductive Loops – Controlled Environment

![Error Chart]

- Zone 1-2
- Zone 3-4
- Zone 5-6

Error (%)

-100  -50   0    50    100

Types of Bikes:
- Tandem+Bike w/ Trailer
- Carbon Fiber + Cargo Bicycle
- Bikes One Behind the Other
- Bikes Side by Side
Inductive Loops – Bike Lane With Mixed Traffic

<table>
<thead>
<tr>
<th></th>
<th>Bikes in Video</th>
<th>% Error Diamond</th>
<th>% Error Parallelogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>108</td>
<td>550%</td>
<td>420%</td>
</tr>
<tr>
<td>SB</td>
<td>105</td>
<td>540%</td>
<td>160%</td>
</tr>
</tbody>
</table>
Thermal Camera - Controlled Environment

< 1% error for standard bikes approaching the camera

- Error (%)

0 50 100

-100

Tandem, Bike Carbon Fiber w trailer + Extra cycle One behind the other Side by side Bike Type
Thermal Camera – Mixed Traffic

<table>
<thead>
<tr>
<th>Zone</th>
<th>Facility</th>
<th>Modes Counted</th>
<th>Ground Truth</th>
<th>Thermal Camera</th>
<th>Error (%)</th>
<th>Ground Truth</th>
<th>Thermal Camera</th>
<th>Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sidewalk</td>
<td>Pedestrian and Bicycle</td>
<td>65</td>
<td>20</td>
<td>-69</td>
<td>112</td>
<td>34</td>
<td>-70</td>
</tr>
<tr>
<td>2</td>
<td>Right Turn Lane</td>
<td>Bicycles</td>
<td>5</td>
<td>207</td>
<td>4040</td>
<td>9</td>
<td>57</td>
<td>533</td>
</tr>
<tr>
<td>3</td>
<td>Bike Lane</td>
<td>Bicycles</td>
<td>104</td>
<td>63</td>
<td>-39</td>
<td>113</td>
<td>59</td>
<td>-48</td>
</tr>
<tr>
<td>4</td>
<td>Left Turn Lane</td>
<td>Bicycles</td>
<td>3</td>
<td>14</td>
<td>367</td>
<td>1</td>
<td>22</td>
<td>2100</td>
</tr>
</tbody>
</table>
Supplemental Thermal Camera Analysis

- False positives – counts recorded by camera but not ground truth
- False negatives – counts recorded by ground truth but not camera
- More false negatives (missed calls) during late afternoon/early evening hours

<table>
<thead>
<tr>
<th></th>
<th>NB</th>
<th></th>
<th>SB</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>False Positives</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>False Negatives</td>
<td>50</td>
<td>49</td>
<td>55</td>
<td>49</td>
</tr>
</tbody>
</table>
Passive Infrared

Eco-Counter PYRO-Box Counts vs. Ground Truth Counts

$R^2 = 0.9$
Passive Infrared

![Bar Chart]

- **False Negatives**
  - Northbound
  - Southbound

- **False Positives**
  - Northbound
  - Southbound

<table>
<thead>
<tr>
<th>Absolute Error (%)</th>
<th>False Negatives</th>
<th>False Positives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northbound</td>
<td>Southbound</td>
</tr>
</tbody>
</table>
**Pedestrian pushbutton**

The image shows a pedestrian pushbutton with a sign indicating "PUSH BUTTON FOR." Below the button, there is a crosswalk sign. The text on the button is not legible from the image provided.

### Observations (%)

<table>
<thead>
<tr>
<th>Crosswalk</th>
<th>Pedestrian Group Size:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>157</td>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>South</td>
<td>154</td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>124</td>
<td></td>
<td></td>
<td>12</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>167</td>
<td></td>
<td>43</td>
<td></td>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

The bar chart shows the distribution of pedestrian group sizes across different crosswalks, with observations ranging from 0% to 100%.
**Pedestrian pushbutton**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Volume (Video Counts)</td>
<td>217</td>
<td>173</td>
<td>150</td>
<td>278</td>
<td>818</td>
</tr>
<tr>
<td>Pedestrian Phases (2070 Data)</td>
<td>190</td>
<td>145</td>
<td>158</td>
<td>230</td>
<td>723</td>
</tr>
<tr>
<td>Ratio (Pedestrians/Phase)</td>
<td>1.14</td>
<td>1.19</td>
<td>0.95</td>
<td>1.21</td>
<td>1.13</td>
</tr>
</tbody>
</table>

![Graphs showing correlation between logged pedestrian phases and video counts](image)
Conclusions and Recommendations

• Thermal camera and inductive loops (diamond & parallelogram) tested are not appropriate for continuous mixed traffic at intersections at this time.

• Pedestrian pushbutton data can be used to show locations of pedestrian activity.

• In pedestrian only environments with low pedestrian volume, passive infrared counters can be accurate.
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  – Tim Damm
Questions?

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Extra Slides
Parallelogram Loop - TSSU
Special Cases

Tandem Bike

Cargo Bicycle

Carbon Fiber Bike

Bike with Trailer
Thermal Camera False Calls
Thermal Camera Missed Call
Parallelogram and Diamond Loops

SW Hall Blvd.

- 11.6'
- 45°
- 3.6'
- 1.2'
- 6.7'
- 2.5'
- 3.5'
- 5.4'
- 0.7'

SW Hall Blvd.

- 0.7'
- 5.5'
- 3.5'
- 2.5'
- 1.0'
- 9.5'
- 3.4'
- 41.1°
- 0.6'
FLIR Thermal Camera
Eco-Counter PYRO