Bicycle Detection Case Study

Meeting California Bicycle Timing Requirements Using “In the Box” Intersection Detection

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Presentation Outline

- CA MUTCD Bicycle Detection/Timing Requirement
- Approaches to California Requirement
- Tustin’s Approach to California Requirement
- Study Intersection: Tustin Ranch Road at Walnut Avenue
- Findings/Conclusions
2012 California MUTCD
Section 4D.105(CA) Bicycle/Motorcycle Detection

Standard:
01 All new limit line detector installations and modifications to the existing limit line detection on a public or private road or driveway intersecting a public road (see Section 1A.13 for definitions) shall either provide a Limit Line Detection Zone in which the Reference Bicycle-Rider is detected or be placed on permanent recall or fixed time operation. Refer to CVC 21450.5.

Guidance:
13 Where a Limit Line Detection Zone that detects the Reference Bicycle-Rider has been provided, minimum bicycle timing should be provided as follows:
California
Minimum Bicycle Timing

Table 4D-109 (CA). Signal Operations - Minimum Bicycle Timing

\[ G_{\text{min}} + Y + R_{\text{clear}} \geq 6 \text{ sec} + \frac{(w+6 \text{ ft})}{14.7 \text{ ft/sec}}, \text{ where} \]
\[ G_{\text{min}} = \text{Length of minimum green interval (sec)} \]
\[ Y = \text{Length of yellow interval (sec)} \]
\[ R_{\text{clear}} = \text{Length of red clearance interval (sec)} \]
\[ W = \text{distance from limit line to far side of last conflicting lane (ft)} \]

<table>
<thead>
<tr>
<th>Distance from limit line to far side of last conflicting lane</th>
<th>Minimum phase length (minimum green plus yellow plus red clearance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>Seconds</td>
</tr>
<tr>
<td>40</td>
<td>9.1</td>
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<tr>
<td>50</td>
<td>9.8</td>
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<tr>
<td>180</td>
<td>18.7</td>
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</table>
California
Minimum Bicycle Timing

Benefits:
• Improves intersection safety for bicycles and motorcycles
• Provides for bicycle roadway users (multimodal)

Problem:
• Adverse effects on signal operations by reducing intersection efficiency:
  – Increased cycle lengths
  – Increased delay
  – Reduced LOS
Bicycle Detection/Timing Option

Option:

- A limit line detection system that can discriminate between bicyclists and vehicles may be used to extend the length of the minimum green.
- Supplemental Reference Bicycle-Rider detection zones, new technology, or various signal controller settings may be utilized to adjust the time (Gmin + Y + Rclear) and/or travel distance (W) that bicyclists are exposed to conflicting vehicular traffic.

Problem:

- Limited equipment options available for discrimination
  - Detection
  - Controllers
Approaches to CA Requirement

• Fixed-Time Operation
• Non-Discriminating Detection (must detect bicycle)
  – Inductive loops
  – Video
  – Radar
Approaches to CA Requirement

- Discriminating Detection
  - Inductive bike loops
  - Video
  - Video/Radar
  - Wireless pucks

- Requires separate input to controller, and

- Controller needs separate non-forceable minimum green interval for bike
Typical Non-Discriminating Inductive Bicycle/Motorcycle Detectors

Caltrans

City of Los Angeles
Limit-Line Detection Zone Limitations

Non-Discriminating Detectors

• Min time provided every cycle
Limit-Line Detection Zone Limitations

**Discriminating Detectors**
- Cyclist may not be located where detectors are located
- Detectors may be occupied by vehicle
- Bicycle minimum green is based on discriminating the bicycle
  - No bicycle call = no bicycle minimum time
  - Safety benefit not applied
  - Limited compliance with CA MUTCD
City of Tustin
Orange County California
Tustin’s Approach to CA Requirement

“Inside the Box” Intersection Detection

– Location of cyclist or vehicle at limit line not an issue
– Detection zone is vehicle neutral
– Safety benefits are consistently applied to bicycles
– Precise green time allocation provided to bike or vehicle = more efficient operation of signal
– Full compliance with CA MUTCD
– Separate input to controller is not required
– Separate bicycle min green interval in controller is not required
Radar Technology Used to Think “Inside the Box”

- Wavetronix SmartSensor Matrix was selected for the test bed intersection
  - 90-degree, 140-foot field of view created by high definition radar
  - Off-the-shelf solution with proven stop bar performance
  - The only radar that can detect true presence of vehicles at the intersection
  - Excellent performance under all weather and lighting conditions
  - Wavetronix SmartSensor Matrix is deployed at 1,000’s of intersections in North America.

- Wavetronix participation by offering equipment and staff resources for concept testing
Solution: Pivot Radar Detection
All vehicles are detected through the box
Tustin’s Concept Testing to Deployment

- Concept Testing
  - Test bed intersection performance evaluation
    - Field observation
    - Data collection with TMS
  - Test was complete success with all test goals being met!
  - Radar sees all vehicles at the stop bar including bicycles
  - Radar tracks in true presence all vehicles through the intersection including bicycles
  - The controller sees and holds the detection of the bicycle through the intersection

- Full Deployment
  - Eleven intersections using intersection detection with radar
  - Three additional intersections in design
Study Intersection:
Tustin Ranch Road at Walnut Avenue
Radar Detection
Field of View and Configuration

Radar Field of View

Radar "Lane"

Radar Detector
Radar Detection
Equipment Installation
Study Intersection Cabinet With Radar Detection Equipment Installed
Study Intersection
Performance Demonstration
Findings/Conclusions

• Tustin’s approach meets and/or exceeds the CA MUTCD requirement to detect and provide minimum bicycle timing for a reference bicycle rider

• It accurately detects ALL types of vehicles at the stop bar regardless of specific location

• It dynamically and accurately tracks and extends ALL types of vehicles through the intersection

• Dynamic intersection detection balances the objectives of meeting the bicycle users needs while minimizing compromises to signal efficiency
Questions & Answers