Rural ITS Safety Solution Systems (RITSS)

University of Minnesota – Center for Transportation Studies

22nd Annual Transportation Research Conference

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SEH Inc.
Problem

  - 455 fatalities down from 510 in 2007
  - 33,379 injuries down from 35,318 in 2007
  - Rural areas account for 2 out of 3 fatalities
  - 1/3 involve single vehicle
  - 2/3 involve 2 or more vehicles
  - 2008 crashes cost Minnesota $1.5 billion
Underlying Causes

• In Single Vehicle Crashes
  – Illegal or *unsafe speed* contributing factor most often cited for all drivers

• In Multiple Vehicle Crashes
  – For drivers through age 64 – *driver inattention* or distraction most often cited
    – *Failure to yield* second most common

• Over Age 65 Pattern Reverses
  – *Failure to yield* most common
  – *Driver inattention* or distraction second most common
Driving Conditions

• Most Crashes Occur in Good Driving Conditions
  – 54% of fatal and 2/3 of nonfatal occur during daylight hours
  – Good Weather Conditions
    • 61% of fatal and 56% of nonfatal – “clear” weather
  – Road Surface Condition for Fatal Crashes
    • Usually “good”
    • 10% on wet roads
    • 15% on snowy or icy roads
  – Road Surface Condition for Nonfatal Crashes
    • 60% of nonfatal on dry roads
    • 13% on wet roads
    • 25% on snowy or icy roads
Goal

To develop low-cost, readily deployable, low maintenance systems that can be used to improve safety on rural roadways.
RITSS

- Driver Behavior Evaluation System (DBES)
- Stop Sign Warning System (SSWS)
- Curve Warning System (CWS)
Project Inception

• Mn/DOT Innovative Ideas Program
• SEH
• Network Transportation Technologies, LLC (NTT)
• Mn/DOT – OTST
• Mn/DOT Metro District
• US DOT - FHWA
• Minnesota Counties
  – Freeborn County
  – Hennepin County
  – McLeod County
  – Olmsted County
  – Otter Tail County
  – Washington County
  – Wright County
• SEH / NTT
• Independent Evaluation Consultant (Iteris)
Project Deliverables

- Concept of Operations
- System Requirements
- System Design
- Laboratory Test
- Field Operational Test
Innovation

• Merits of dynamic warning systems
• Moving from research to reality
• Leveraged work on *Intersection Warning System* (2007 *Mn/DOT Innovative Ideas Program Project*)
• Off-the-shelf components
• Solar-powered with battery backup
• Modular design
• Ease of installation and maintenance
• Relative low-cost
System Configurations

Detection Node
- Solar
- Radar
- Controller
- User Interface
- Communications (Radio)
- Battery

Warning Node
- Solar
- Fault Indicator
- SIGN
- Controller
- Communications (Radio)
- Battery
Driver Behavior Evaluation System Concept

• Need to know exactly what the problem is:
  – System to provide reliable data
  – Driver behavior underlying the problem
  – At rural intersection stop signs
    • Behavior of driver approaching stop sign
    • Behavior of driver on through road
    • Speed profiles
  – At horizontal curve
    • Behavior of driver approaching curve
    • Speed profile
Driver Behavior Evaluation System

• **Hardware**
  – Doppler radar
  – GPS receiver
  – Data logger
  – Battery powered with life of 3 weeks
  – Up to 4 devices to cover 4-way intersection
  – Single device to cover each approach to a curve

• **Software**
  – Analysis and reporting strategies
Driver Behavior Evaluation System
Olmsted County, MN
TH 42/CSAH 9
DBES Data Report

Side Road at Stop Sign

Day, Date
Location:

<table>
<thead>
<tr>
<th>Start Time</th>
<th>Total # of Vehicles</th>
<th># of Vehicles</th>
<th>Declaration &gt; 14.8 fps²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 - 10 mph</td>
<td>&gt; 10 mph</td>
</tr>
<tr>
<td>12:00 AM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00 AM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00 PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
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</table>

Point Speed (Main Road or at Curve)

Day, Date
Location:

<table>
<thead>
<tr>
<th>Start Time</th>
<th>Total # of Vehicles</th>
<th>Speed</th>
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</thead>
<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
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</tbody>
</table>

10 mph pace =
% in pace =
85th Percentile Speed =
Stop Sign Warning System
Concept

- Radar-based detection to monitor speed profile of vehicle approaching a stop sign
- Provide a flashing warning of the stop based on speed
  - Within normal stop profile – No warning
  - Excessive speed detected – flashing lights to alert driver
Stop Sign Warning System

• Hardware
  – Doppler radar
  – Wireless link
  – Controller
  – Flasher stop sign
  – Fault notification

• Software
  – Speed/distance data algorithm to set parameters
  – Determine spatial position of the vehicle
  – Activate flashers
Stop Sign Warning System Design

- Deceleration Rate = 14.8 ft/s²
- Maximum Approach Speed Design = 80 mph
- Duration of Flash = Detection Speed / 14.8 ft/s²
- Enhance Border of Near Right Stop Sign
Stop Sign Warning System
Washington County, MN
CR 64 (McKusik Rd)/ CSAH 15 (Manning Ave)
Stop Sign Warning System
Washington County, MN
CR 64 (McKusik Rd)/ CSAH 15 (Manning Ave)
Average Vehicle Speed Approaching Stop Sign

Distance from stop sign (ft)

Sensor 1

Sensor 2

Average Distance from Stop Sign Activation

- 753.00', 48.36 mph
- 488.00', 45.64 mph
- 308.27', 45.73 mph
Stop Sign Warning System Performance

<table>
<thead>
<tr>
<th>Number of Activations During Field Operational Test</th>
<th>Successful Activations (Unambiguous)</th>
<th>Number of Activations Requiring Deceleration Outside Target (14.8 fps)</th>
</tr>
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<tr>
<td>621</td>
<td>486</td>
<td>135</td>
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<tr>
<td></td>
<td>78.3%</td>
<td>21.7%</td>
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Curve Warning System
Concept

- Radar-based detection to monitor speed profile of vehicle approaching a horizontal curve
- Provide a flashing warning of the curve ahead based on speed
  - Within normal stop profile – No warning
  - Excessive speed detected – flashing lights to alert driver
Curve Warning System
Line of Sight
Curve Warning System
Wright County, MN
CSAH 37
Curve Warning System
Wright County, MN
CSAH 37
Curve Warning System Design

- Deceleration Rate = 14.8 ft/s²
- Design for Curve Entry Speed = 47 mph
- Maximum Approach Speed Design = 75 mph
- Enhance Chevron Signs 3, 4, and 5
- Duration of Flash = 4 seconds from curve entry (50 mph to Sign 5 from Curve Entry)
Drivers View at Night
System at Night
## Curve Warning System Performance

<table>
<thead>
<tr>
<th></th>
<th>Number of Activations During Field Operational Test</th>
<th>Successful Activations (Unambiguous)</th>
<th>False Activations (vehicles approaching curve below target speed of 47 mph)</th>
<th>Activations at Distance Requiring Deceleration Rate Greater than Target (14.8 fps)</th>
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<td>452</td>
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<td>78.9%</td>
<td>16.4%</td>
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<td>4.7%</td>
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Current Status

• DBES Testing – May 2011
• Final Evaluation and Report – July 2011
Questions?

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