Developing a V2I Motorcycle Warning Algorithm using Naturalistic Driving Data

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Outline

- Introduction to Motorcycle Hazards
- Connected Vehicle Technology
- Motorcycle Warning Algorithm - System Overview
- Framework for Algorithm Development
- Future Work
- Summary
- References
Background

- Road hazards such as gravel, potholes, and debris, may cause a rider to lose control of his or her bike.
- These conditions can occur on any roadway where activity has altered the quality of the existing pavement.
- Motorcyclists are more likely to be seriously injured or killed when interacting with pavement abnormalities than passenger vehicles.
A short list of hazards to motorcyclists

- Rough roads
- Gravel on pavement
- Edge breaks
- Slick surfaces
  - Leaves
  - Painted surfaces
  - Anti-freeze or oil
- Expansion joints
- Open bridge joints
- Railway tracks and crossings
- Debris or objects in the road
Roadway Design

- Transportation engineers design roadways to be forgiving to road users

- Breakaway Sign Posts
- Semi-rigid Barriers
- Clear Advanced Warning (with redundancy)
- Flexible Barriers
Motorcycle Warning Algorithm - Application
The Process

Crash Report Analysis → Motorcyclist Subjective Feedback → SHRP 2 Kinematic Data → Functional Detection Algorithm

- Strongly agree
- Agree
- Disagree
- Strongly disagree
Determining Events of Interest

- Crash Report Analysis
- Motorcyclist Survey Response

Events in SHRP2 Data
Why naturalistic data? Why passenger vehicles?

- Why naturalistic data?
  - Naturalistic data allows for a LARGE sample of real world conditions
  - VARIETY – Drivers traveling though work zones, striking pot holes, and animals in the road exist in the SHRP2 Database.

- Why passenger vehicles?
  - LARGE sample size
  - VARIETY of road types sampled.
  - MANY built in sensors
    - traction control, electronic stability control, and anti-lock braking systems
Getting into the data

- Variables of interest will be identified for different event types
- Some variables include:
  - Speed
  - Acceleration (x,y,z)
  - Braking/Steering input
  - Activation of integrated safety systems
Video Assessment to further algorithm development

- **Event Classification**
  - Transverse Surface Irregularities
  - Longitudinal Surface Irregularities
  - Low Traction Situations
  - Debris in Roads

- **Hazard Severity Assessment**
  - Low Level
  - Medium
  - High Level

- **Driver Response Classification**
  - Driver Strikes Surface Abnormality
  - Driver Takes Evasive Action
## Driver Response Classification

<table>
<thead>
<tr>
<th>Data Collected:</th>
<th>Driver Hits Deformation</th>
<th>Driver Takes Evasive Action</th>
</tr>
</thead>
</table>
| Vehicle Kinematic Data before, during, and after striking the deformation | Driver response data  
- Steering  
- Braking | Directional information for motorcyclist for hazard avoidance |
| How it will be used: | Deformation type and severity identification | |
Future Work

- Algorithm, false-positive and false-negative rates will be ascertained using a confusion matrix.
- After preliminary algorithm validation and refinement, a Field Operational Test will be deployed on a small set of passenger vehicles and motorcycles.

<table>
<thead>
<tr>
<th>Actual Value (Experiment)</th>
<th>Predicted Outcome</th>
</tr>
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<tbody>
<tr>
<td>Positive</td>
<td>Positive</td>
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<tr>
<td></td>
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<td>True Positive</td>
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<td></td>
<td>TN</td>
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<td></td>
<td>True Negative</td>
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</tbody>
</table>
In Summary

- Motorcyclists are a vulnerable group of road users
- Using naturalistic data with subjective feedback from motorcyclists allows this to be holistic and human based
- Implementation of a warning algorithm using advanced technology has the potential to reduce motorcyclist injuries and fatalities
References


Thank you!

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