Developing a V2I Motorcycle Warning Algorithm using Naturalistic Driving Data

Alexandria M. Noble
Shane B. McLaughlin
Zachary R. Doerzaph
Thomas A. Dingus

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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.

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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

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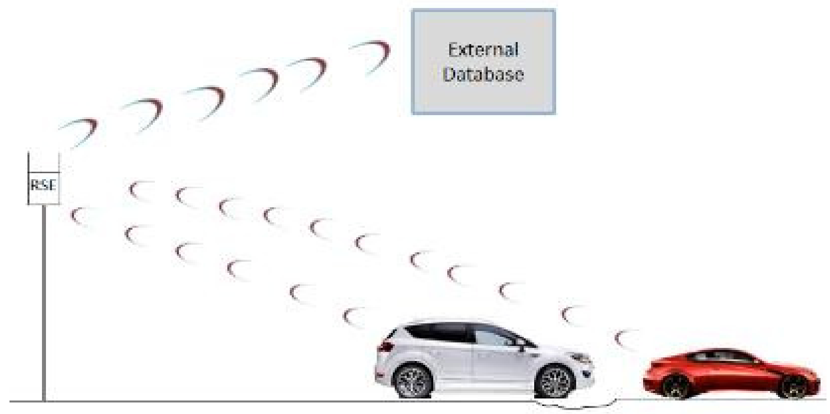
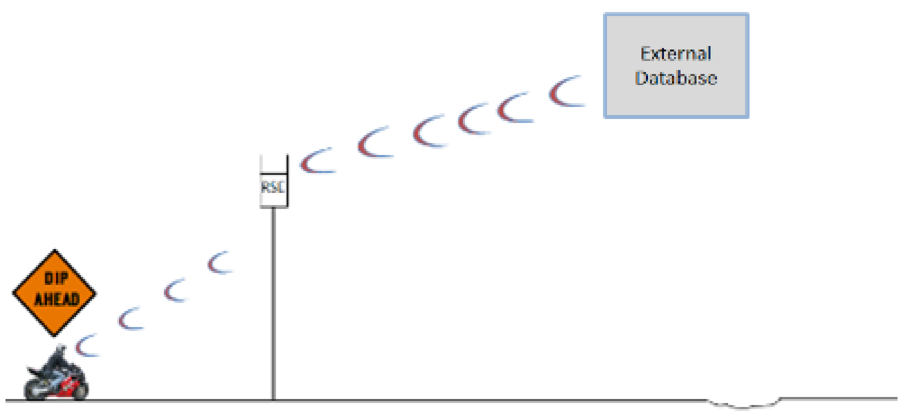
Connected-Vehicle Technology

Motorcycle Warning Algorithm- Application





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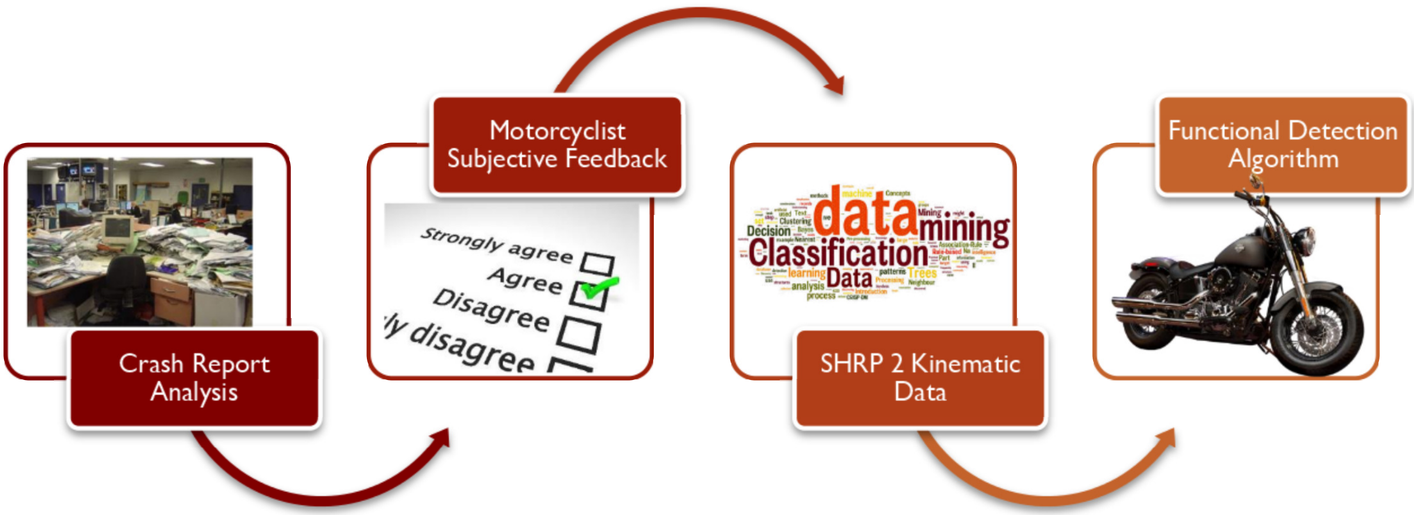
The Process


Crash Report Analysis
Motorcyclist Subjective Feedback
Strongly agree
Agree
Disagree
SHRP 2 Kinematic Data
data mining
Classification
Data
Functional Detection Algorithm

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

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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

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Video Assessment to further algorithm development

Event Classification

- Transverse Surface Irregularities
- Longitudinal Surface Irregularities
- Low Traction Situations
- Debris in Roads

Hazard Severity Assessment

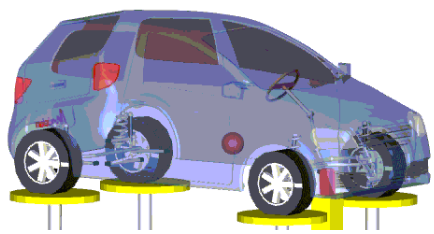
- Low Level
- Medium
- High Level

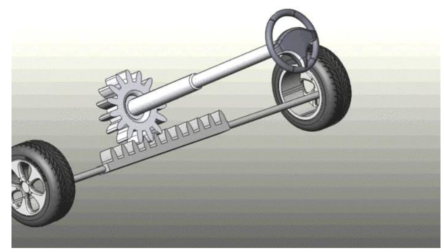
Driver Response Classification

- Driver Strikes Surface Abnormality
- Driver Takes Evasive Action

Driver Response Classification

	Driver Hits Deformation	Driver Takes Evasive Action
Data Collected:	Vehicle Kinematic Data before, during, and after striking the deformation	Driver response data - Steering - Braking
How it will be used:	Deformation type and severity identification	Directional information for motorcyclist for hazard avoidance





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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

		Predicted Outcome	
		Positive	Negative
Actual Value (Experiment)	Positive	TP True Positive	FN False Negative
	Negative	FP False Positive	TN True Negative

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

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References

NHTSA. (2011). Motorcycles. Traffic Safety Facts 2011 Data.

Science, Transportation Research Board of the National Academies of. (2013). The Second Strategic Highway Research Program Naturalistic Driving Study Dataset.

Haworth, N., Smith, R., Brumen, I., & Pronk, N. (1997). Case-Control Study of Motorcycle Crashes. Clayton, Victoria: Federal Office of Road Safety.

Katicha, S. W., Flintsch, G. W., & Fuentes, L. G. (2013, August 1). Use of Probe Vehicles to Measure Road Ride Quality. Washington, DC.

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Thank you!

Alexandria M. Noble
Graduate Research Assistant
Virginia Tech Transportation Institute
anoble@vtti.vt.edu