Evaluating Road Departure Crashes Using Naturalistic Driving Study Data

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Scope of the problem

- Nationally, SVROR account for 28.9% of fatalities (Neumann et al, 2003)
- 52% of Iowa’s fatalities are related to lane departure
- 39% of Iowa’s fatal crashes are single-vehicle ROR crashes
Research Objectives

- Analyze ROR crashes using data from existing naturalistic driving studies and other sources.
- Develop analytical tools for use in full scale in-vehicle driving study to answer research questions related to road departure.
- Provide feedback to improve full scale naturalistic driving study data collection and analysis and mobile mapping data collection so that road departures can be fully addressed.
Datasets

- **VTTI 100-Car Naturalistic Study**
  - Virginia road database
  - Virginia crash database
  - Aerial imagery

- **UMTRI Field Tests**
  - Michigan road database
  - Michigan crash database
  - Aerial imagery

- **University of Iowa Naturalistic Study of Teenage Drivers**

- **Iowa DOT Crash Database**

- **Iowa DOT Geographic Information Management System (GIMS) Roadway Database**

- **FARS**

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8 Research Questions (Summarized)

Evaluate and quantify relationship between driver behavior, roadway, environmental, and vehicle factors for pre- and post-road departures

- What roadway, environmental, driver, and vehicle factors lead to road departures

Rural single vehicle run-off-road crashes in Iowa by pavement surface condition (2005 crash data)

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Summarized Research Questions

- Once a vehicle initially leaves the roadway, how do roadway, environmental, vehicle, and driver factors influence subsequent events and outcomes after a vehicle initially leaves the roadway?
- What factors led to positive rather than negative outcomes?
Summarized Research Questions

- Can a meaningful relationship between crash surrogates and crashes/near crashes be developed?
Analysis Plan

Define crash surrogates

- Non-departure lateral drift
- Non-conflict road departure
- Road departure conflict
- Road departure crash

Surrogate depends on potential hazard:
- Time to collision
- Time to lane departure
- Time to hazard (on-coming vehicle, adverse slope, fixed object)

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Define kinematic signatures for each surrogate

- Lateral acceleration, forward acceleration, speed, brake,
- Develop algorithm to flag incidents

Vehicle trace of non-departure lateral drift (Data source: UMTRI)

Vehicle trace of Non-conflict road departure (Data source: UMTRI)

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Distribution of Vehicle Activity (Data source: UMTRI)

Distance to right lane edge (m)

Lateral acceleration (m/s²)

Lateral speed (m/s)

Yaw rate (degrees/second)

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Select exposure-based risk variables

- AADT
- Driver VMT
- Induced exposure
- Traffic operation from naturalistic driving study data
  - Level of service
  - Headway
  - Traffic density

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Develop Analytical Tool to Extract Variables

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Extract independent variables

**Driver**

- Driver distraction
  - Conversation, grooming, cell phone use, eating, drinking, smoking
  - Time into trip
  - % of time or number of times driver glances away, amount of time or number of times driver engages in non-driving behaviors
- Aggressiveness
  - % of time driver exceeds speed limit by a certain threshold
  - Number of hard braking or hard acceleration
  - Headway—example: percent time spent following at certain distance
  - Aggressiveness indices

**Environmental**

- Source of information
  - Naturalistic driving study video
  - Meteorological data
- Potential variables
  - Presence of lighting
  - Roadway surface condition
  - Weather

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Extract independent variables

Roadway

- Source of information
  - Roadway data files
  - Naturalistic driving study video

- Potential variables
  - Characteristics of horizontal curves (degree of curve, length of curve, etc)
  - Shoulder characteristics (type, width, condition)
  - Roadway cross-section (lane width, type and presence of medians, etc)
  - Pavement markings and signings
  - Rumble strips
  - Sight distance
  - Number of access points
Event begin | Event end

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Develop statistical models of relationships

For each specific research question

- Determine feasibility of extracting data
- Determine sample size needed to answer question
- Address limitations in data
- Address sample size limitations
- make recommendations for full-scale in-vehicle field study
Example: What is the relationship between vehicle speed and safe curve speed (posted/advisory curve speed) and crash risk?

1. How feasible is it to measure curve radius and estimate safe curve speed if posted/advisory speed is not available? Other related variables?

2. How many “normal” events are necessary?

3. How many conflict/near-crash/crash events are necessary?
Develop statistical models of relationships

- Statistical model to assess probability associated with each possible category as a function of driver, vehicle, road and environment attributes.
  - Generalized linear model, Bayesian, etc
  - Account for correlations between observations on the same subject
  - Account for confounders that can obscure the effect of a driver, vehicle, road or environmental factor on the probability of an event.
  - Apply model diagnostics

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Develop statistical models of relationships

Develop tools that they can be applied to full-scale
Questions?