Empirically-Based Performance Assessment and Simulation of Pedestrian Behavior at Unsignalized Crossings

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Project Overview

- STRIDE Project 2012-016S

- Research Team
  - ITRE at N.C. State University
  - University of Florida
  - University of Alabama at Birmingham

- Anticipated completion December 2013
Objectives

1. Develop new and improved pedestrian modeling algorithms for unsignalized crosswalks

2. Generate behavioral models from empirical field observations

3. Implement models in microsimulation
Two Principal Behavioral Models

• Pedestrian Behavior (Gap Acceptance)
  – Pedestrian GO Decision [GO] – The pedestrian decides that there is sufficient time for a safe crossing
  – Pedestrian NO-GO Decision [NOGO] – The pedestrian decides to reject the lag or gap.

• Driver Behavior (Yielding)
  – Driver Non-Yield Decision [NY] – The driver decides that it is either physically impossible to yield, or is unwilling to yield.
  – Driver Yield Decision [Y] – The approaching driver decelerates and creates a crossing opportunity for the pedestrian
Explanatory Variables

- Vehicle Speed,
- Distance from Crosswalk,
- Time-to-Contact,
- Necessary Deceleration Rate,
- Vehicle Type,
- Platooning,
- Pedestrian Attributes,
- Pedestrian Assertiveness,
- Lane Position,
- Crossing Geometry,
- Adjacent Yield,
- Downstream Conflict,
- Ped waiting time,
- Crossing width
Sample Events

Pedestrian Crossing in a Gap

Platooned Vehicle Not Yielding
Three Data Collection Approaches

1. **Observational Study of Driver Behavior:**
   - Observation of pedestrian crossings at the crosswalk
   - Combining real-time and video data collection of explanatory variables

2. **Pedestrian Intercept Survey**
   - Pedestrian feedback after crossing

3. **In-Vehicle Study of Driver Behavior**
   - Instrumented vehicle driving a pre-defined course
   - Recording driver behavior and reaction to pedestrians
Equipment Set up.

Data Collection Sheet
Analysis Approach

• Outcomes is binary in nature (yield/non-yield and GO/NoGO).

• Develop binary logit models

\[
\text{Logit} \left[ P(Y = 1) \right] = \log \left( \frac{P(Y = 1)}{1 - P(Y = 1)} \right) = \beta_0 + \sum_{i=1}^{m} \beta_i x_i
\]

• Intercept \( \beta_0 \) and parameters \( \beta_i \) describe the effects of \( m \) explanatory variables \( x_i \) on the yield response.

• Get probability estimates of response

\[
P(Y = 1) = \frac{e^{\alpha + \sum_{i=1}^{m} \beta_i x_i}}{1 + e^{\alpha + \sum_{i=1}^{m} \beta_i x_i}} = \frac{1}{1 + e^{-\left(\alpha + \sum_{i=1}^{m} \beta_i x_i\right)}}
\]
Sample Results (Logit Models)

Pedestrian Assertiveness: OR = 5.6
Activate Flashing Beacon: OR = 3.3
Vehicle in Platoon: OR = 0.4
Decel. Rate (per ft/sec^2): OR = 0.7

Sample Results (Source: Schroeder and Rouphail, 2011)
Application of Sample Results

(a) $P(\text{Yield})$ for Site A

- $\text{FLASH}=0, \text{AST}=0$
- $\text{FLASH}=1, \text{AST}=0$
- $\text{FLASH}=0, \text{AST}=1$
- $\text{FLASH}=1, \text{AST}=1$

Yield Probability

Deceleration Rate, $\text{DECEL} (\text{Ft/s}^2)$

- $\sim 65\%$
- $\sim 38\%$
- $\sim 10\%$

Sample Results (Source: Schroeder and Rouphail, 2011)
Next Steps

• Observational Study Data Collection
  – 3 States (North Carolina, Florida, Alabama)
  – 10 midblock crosswalks per state
• Pedestrian Intercept Surveys
  – Same sites as above
• In-Vehicle Driver Studies
  – Three routes in Florida
• Data Analysis
• Model Implementation in Simulation
Questions and Discussions