USING NATURALISTIC DRIVING DATA TO ANALYZE EFFECTS OF DRIVER AGE ON VEHICLE DECELERATION AND ITS IMPACTS ON SAFETY AND TRAVEL TIME

Angela E. Kitali, Kelvin S. Machumu, Thobias Sando
University of North Florida
Jacksonville, Florida

The Fifth International Naturalistic Driving Research Symposium
Blacksburg, Virginia
August, 30th 2016
Outline

• Introduction
• Objective of the study
• Data collection
• Descriptive Statistics
• Vissim modeling
• SSAM
• Results and Analysis
• Conclusions
• Recommendations and Opportunities
Introduction

Aging population in US


Aging population in Florida

- 32.5% of Florida’s population will be older (60+) by the year 2030
- An increase of 34% from 2012
Currently, 65+ occupy 11% of driver population in US

Florida - licensed drivers over the age 65 are almost 20%

Decline: sensory, cognitive or physical function

Florida traffic crash report -11.3% increase in crashes involving elderly in Florida (2008 to 2012)
Factors affecting vehicle deceleration

- Vehicle deceleration
  - Driver ability
    - Age
  - Vehicle characteristics
    - Speed
    - Braking system
    - Weight / load
  - Road characteristics
    - Terrain
    - Roadway surface
Vehicle deceleration is observed to be a function of driver’s age among other factors:

- Young drivers are more likely to engage in risky driving habits;
  - Speeding up
  - Tailgating
- Older drivers are more likely to be defensive;
  - Decelerating gently
Vehicle deceleration: Application

• Modeling
  ✓ Traffic simulation
  ✓ Instantaneous fuel consumption rate
  ✓ Vehicle emission

• Traffic elements
  ✓ Length of yellow light at Intersection
  ✓ SSD at intersection
  ✓ Sign position
  ✓ Clearance and change interval

• Geometric element design
  ✓ Auxiliary lanes
  ✓ Freeway ramps
Vehicle deceleration Cont...

Common deceleration maneuvers:

• At intersection, during onset of yellow phase
• Sharp corners
• Upgrades
• Congested traffic flow
• Pedestrians crossing
• Changing speed following the speed limit from one facility to the other
Objectives of Study

• To examine the effects of driver age on vehicle deceleration rate and how it affects
  ✓ Safety
  ✓ Travel time
• Comparing the existing traffic flow condition with vehicles having uniform smooth deceleration maneuvers
Data used to model the intersections are obtained from:
• Naturalistic driving study data: 2010-2013
  ✓ 401 to 646 participants
  ✓ 75,500 trips

The selected corridor has 4 signalized intersections
 I. Bruce B Downs Blvd & E Fletcher Avenue
 II. Bruce B Downs Blvd & USF Holly Drive
 III. Bruce B Downs Blvd & USF Pine Drive
 IV. Bruce B Downs Blvd & E Fowler Avenue

Bruce B Downs is a corridor with leading severe injury crash locations in Hillsborough County
(Source: Tindale-Oliver and Associates Incorporation, 2013)
Descriptive statistics

The data were categorized into three age groups:

- Young Drivers: 35%
- Middle-aged Drivers: 24%
- Old drivers: 41%

Chart showing the percentage distribution of drivers used in the study.
Descriptive statistics

Maximum deceleration and acceleration based on driver’s age group
**VISSIM modeling**

Layout of one of the intersection modeled in VISSIM taking into account all parameters; reduced speed area, no overtaking area, desired speed, detectors and lane width and configuration etc.
VISSIM modeling

Vehicle characteristics
- Deceleration
- Acceleration
- Speed profiles

Calibration based on FDOT simulation guidelines

Output parameters
- Travel times & delays
- Conflicts trajectory files (.trj)
- Results obtained are the average of 10 simulation run performed
- Percentage of older drivers
- Evening peak hour (4 – 5) pm
Simulation results

![Travel Time simulation results graph](image)

- **Travel Time, Seconds**
- **Older Drivers (%)**
- **Existing Vehicle composition**
Simulation results

Relation between total number of conflicts and proportion of young drivers
Conclusions

• Old drivers exercise lower deceleration rates than young drivers;
  ✓ Increase travel times & delays
• Young drivers tend to decelerate at higher rate than old drivers;
  ✓ Increased number and severity of conflicts
• Presence of drivers with differential deceleration maneuvers at intersections increase number and severity of conflicts
• Automated vehicles vehicles with automatic braking systems;
  ✓ Improves traffic flow travel time
  ✓ Reduce conflicts

Due to differential vehicle deceleration maneuvers
Travel Time simulation results: comparison between existing vehicle composition & automated vehicles
## Recommendations

### Conflict results-paired t-test

<table>
<thead>
<tr>
<th>SSAM Measurement</th>
<th>Mean (BV)</th>
<th>Var. (BV)</th>
<th>Replications (BV)</th>
<th>Mean (AV)</th>
<th>Var. (AV)</th>
<th>Replications (AV)</th>
<th>t value</th>
<th>t critical</th>
<th>Mean Difference</th>
<th>Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTC (second)</td>
<td>0.57</td>
<td>0.40</td>
<td>3280</td>
<td>0.55</td>
<td>0.42</td>
<td>1730</td>
<td>-0.47</td>
<td>1.66</td>
<td>-0.01</td>
<td>NO</td>
</tr>
<tr>
<td>PET (second)</td>
<td>0.59</td>
<td>0.96</td>
<td>3280</td>
<td>0.67</td>
<td>1.10</td>
<td>1730</td>
<td>1.99</td>
<td>1.66</td>
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<tr>
<td>MaxS (mph)</td>
<td>23.17</td>
<td>70.55</td>
<td>3280</td>
<td>17.47</td>
<td>44.86</td>
<td>1730</td>
<td>-8.60</td>
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<tr>
<td>DeltaS (mph)</td>
<td>11.28</td>
<td>21.44</td>
<td>3280</td>
<td>10.06</td>
<td>21.82</td>
<td>1730</td>
<td>-2.80</td>
<td>1.66</td>
<td>-1.22</td>
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<tr>
<td>DR (mph2)</td>
<td>-3.03</td>
<td>12.12</td>
<td>3280</td>
<td>-2.20</td>
<td>3.70</td>
<td>1730</td>
<td>2.54</td>
<td>1.66</td>
<td>0.83</td>
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<td>MaxD (mphs)</td>
<td>-6.85</td>
<td>32.33</td>
<td>3280</td>
<td>-4.45</td>
<td>6.37</td>
<td>1730</td>
<td>5.31</td>
<td>1.66</td>
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<td>MaxDeltaV (mph)</td>
<td>6.69</td>
<td>8.21</td>
<td>3280</td>
<td>5.30</td>
<td>1.84</td>
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<td>Conflicts</td>
<td>Mean (BV)</td>
<td>Var. (BV)</td>
<td>Replications (BV)</td>
<td>Mean (AV)</td>
<td>Var. (AV)</td>
<td>Replications (AV)</td>
<td>t value</td>
<td>t critical</td>
<td>Mean Difference</td>
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<tr>
<td>Total</td>
<td>656</td>
<td>324</td>
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<td>346</td>
<td>193</td>
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<td>-3.03</td>
<td>2.92</td>
<td>-310</td>
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</tbody>
</table>
**Recommendations**

- Conflict severity increase with line number, i.e. line 1 & 2 has the lowest severity

Overall severity score contour line equations

<table>
<thead>
<tr>
<th>Severity level</th>
<th>Equation (Maximum DeltaV=)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL-1</td>
<td>(120/7)(TTC)-(390/7)</td>
</tr>
<tr>
<td>SL-2</td>
<td>(55/3)(TTC)-(110/3)</td>
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<tr>
<td>SL-3</td>
<td>(280/15)(TTC)-14</td>
</tr>
<tr>
<td>SL-4</td>
<td>(240/13)(TTC)+10</td>
</tr>
<tr>
<td>SL-5</td>
<td>20(TTC)+30</td>
</tr>
</tbody>
</table>
Recommendations

Comparing conflicts severity level between normal condition and automated vehicles

Therefore automated vehicles saves a better way in both travel time and conflicts
THANKS FOR LISTENING 😊