Driver’s deceleration behaviour according to infrastructure

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Introduction

SURCA project

• GOAL: identify the conditions that will allow autonomous vehicles (AVs) to perform as well as drivers in normal driving conditions, and above all, better than them in accident-prone situations

First results from the field

• Detailed US accidents involving AV’s (>150 cases)
  • Mostly rear-end collisions (freq>50%)
  • AV’s not at fault, mostly braking situations within an intersection at low speeds

• Biever (2020):
  • Conflicts may be caused by differences between AVs and human driving behavior.
  • Conservative ADS behavior may violate the expectations of other nearby human road users.


Figure 2. Crash typology distribution.
Hypothesis

The stopping manoeuvres carried out by light-vehicle drivers produce different deceleration profiles depending on the reason for stopping (priority scheme or road design)

Variable of interest: Reason for stopping

- Priority scheme (traffic light, stop sign, give-way);
- Road design (roundabout, pedestrian crossing, bus stop)

Covariate

- Speed limit (30, 50, 70, 90)
Material

Driving data sets (deceleration)
- Data gathered from 5 previous naturalistic driving studies
- Driving data collected from OBD and GPS
- Drivers were asked to drive several times the same route
- Experiments were designed to observe different behaviors:
  - General driving style
  - Ecodriving style
  - Intersection management

Map data
- Posted speed limit from public map (OSM)
- Infrastructure: on-site data collection (GPS positions of infrastructure candidates)
Methods

Deceleration profiles extraction process
• Detect stops (Speed<5km/h during at least 3 secs)
• Extract the last 20 secs
• Identify the first instant of deceleration & extract the resulting profile
• Do some cleaning

Context enrichment
• For each deceleration profile:
  • Get the posted speed limit
  • Get the reasons to stop candidates
  • Select the most likely following a selection rule

PI’s
• Deceleration distance
• Deceleration duration
• Maximum deceleration
• Average deceleration
• Initial speed
• Std speed
## Results

### Deceleration profiles distribution

<table>
<thead>
<tr>
<th>Reason to stop</th>
<th>30 km/h</th>
<th>50 km/h</th>
<th>70 km/h</th>
<th>90 km/h</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Stop</td>
<td>3</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>Give Way</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>91</td>
<td>100</td>
</tr>
<tr>
<td>Traffic Light</td>
<td>80</td>
<td><strong>505</strong></td>
<td>12</td>
<td>0</td>
<td>597</td>
</tr>
<tr>
<td>NA</td>
<td>139</td>
<td><strong>1875</strong></td>
<td>177</td>
<td><strong>312</strong></td>
<td>2503</td>
</tr>
<tr>
<td>Pedestrian Crossing</td>
<td>10</td>
<td><strong>235</strong></td>
<td>17</td>
<td>1</td>
<td>263</td>
</tr>
<tr>
<td>Roundabout</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>16</td>
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<tr>
<td>Stop Sign</td>
<td>3</td>
<td><strong>66</strong></td>
<td>0</td>
<td><strong>83</strong></td>
<td>152</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>236</td>
<td>2738</td>
<td>213</td>
<td>487</td>
<td>3674</td>
</tr>
</tbody>
</table>
Performance indicators according to infrastructure

Max deceleration
- Stop: 50 km/h = 90 km/h (Wang et al. (2005))
- 50 km/h: Stop > Traffic light = Pedestrian crossing
- 90 km/h: Stop > Give way

Initial speed
- Stop: 50 km/h < 90 km/h (Wang et al. (2005))
- 50 km/h: Stop > Traffic light = Pedestrian crossing
- 90 km/h: Stop > Give way

F(6; 1438) = 31.64; p < 0.001
F(6; 1438) = 96.61; p < 0.001

Results: Average curves

Stop signs are associated with higher approach speeds, followed by a late but harder deceleration phase, for the both available speed limits.
Conclusion

Human driver’s deceleration differs according to the reason to stop

Is it the case for AV’s?

Recommendations:
• AV’s should mimic the human deceleration behaviour according to the reason to stop
• AV’s should be better identified
• Human drivers should be familiarized with AV’s behaviour specificities

A complete list of recommendations will soon be available from the Surca project.
Thank you!

Smart and Sustainable Mobility for all.