Identification of Hazardous Road Locations on the basis of Floating Car Data
Agenda

- Brief intro to Hazardous Road Locations
- The Method briefly
- Floating Car Data
- Scientific background
- Data sources
- First results
- Next step
Hazardous Road Location: a definition

- Hazardous Road Location (HRL) is also known as Black Spot

A location which is more accident-prone than it it should be expected due to traffic level, road furniture and road design.
Hazardous Road Location: a definition

- Based on police-reported accidents
- 3-5 years periods normally
- Challenges:
  - Few accidents are reported
  - Biased reporting (soft road users under represented)
  - Significant black figure
  - Black figure is growing (at least in Denmark)
  - <14% of the injury accidents are reported (2007)
- HRL identification is highly uncertain
Hazardous Road Location: a definition

• Hazardous Road Location (HRL) is also known as Black Spot

A location which is more accident-prone than it should be expected due to traffic level, road furniture and road design.
The Method briefly

• In principle it is an area-based conflict study technique
• Based on Floating Car Data (FCD)
• The idea is that HRLs induce more abrupt hard decelerations than else
• Too many decelerations in one location indicates a HRL
• Small scale studies indicate that the jerk gives a more clear pattern (the derived of the deceleration)
• A Forward-looking approach (don’t wait until the accidents appear)
• Hence required for Vision Zero
In principle it is an area-based conflict study technique

Inspired by Svensson & Hydén 2006
Conflict indicator?

- Avoidance can be made in three ways:
  - Decelerate
  - Accelerate
  - Sideways
- Decelerations (and jerks) are selected:
  - Intuitively
  - Swerving data might be difficult to distinguish from quick turns (in an analytic perspective)
  - Support from literature: 72-98% of all accident avoidance activities (Horst 1984, Hydén 1987, Hantula 1994, Nygård 1999)
Floating Car Data

- Data from vehicles carrying out their ‘normal’ purpose on the road network
- Location can be detected by GPS or/and GPRS network (mobile phone network)
- Data can be collected by:
  - On board units (special developed for e.g. research)
  - Smartphones
  - Navigation units
  - Units made for fleet management
  - Etc.
### Data example

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**Note:** The table above contains example data with columns for year (yyyy), day (mm), hour (hh), speed (km/h), latitude (lat), longitude (lon), number of observations (no obs), and error terms (acc m/s² and sideways m/s²). The x and y columns represent additional parameters. The values are placeholders and should be replaced with actual data for analysis.
Decelerations and jerks (theoretical connection)

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Speed, Decelerations, and Jerks
Speed, Decelerations, and Jerks
Scientific background

• (Salusjärvi 1981)
• Nygård (1999)
• Svendsen et al. (2008)
• (Bagdadi & Várhelyi (2011))
Salusjärvi: on society level

- Finland 1981
- Studied the association between speed variation and accident risk
- Based on a number of Finnish experiments with speed limits in the period 1962 to 1978
- When average speed increases the speed variation increases significantly
- The higher speed variation the more serious accidents
Nygård

• Finland 1999
• To find serious conflicts on the basis of FCD
• 70 drivers
• Each drove a trip of 50 km with GPS registration and a trained conflict observer in the car
• Compared the size of decelerations and jerks with the observations of conflicts
• Found that jerks gave more clear results than decelerations
• Found that serious conflicts resulted in jerks that differed significant from jerks in case of voluntary braking
Svendsen et al.

- Denmark 2008
- Data from the Danish ISA trial Pay As You Speed
- Tested the HRL identification on a small scale
- Supported Nygård’s jerk-based approach
- 94 drivers, 1,097 jerks, and found 12 locations with \( \geq 4 \) jerks
- Used (relatively) low frequency data (1 Hz)
- He also found that the frequency of data affected the threshold values markedly
(Bagdadi & Várhelyi)

• Sweden 2011
• Based on FCD from the ISA trial in Lund (1999-2001)
• Data from 166 cars included
• Questionnaire data (among others about accident data)
• Found a connection between the number and seriousness of jerks and the accident risk
• Connections from jerks to risk, but no connection to locations!
Data sources (and results)

- Pay As You Speed (PAYS)
- ITS Platform
- TAC Safecar project (Melbourne)
Pay As You Speed (PAYS)

- North Jutland
- Intelligent Speed Adaptation
- Informative, warning and recording ISA + incentives (up to 30% discount on insurance rate)
- Field trial April 2006 to January 2009
  - 153 18 – 70-years-old car owners
  - 12 to 32 months
  - To test if economic incentive in combination with ISA can reduce the participating drivers’ speeding
Total FCD from PAYS

- 153 vehicles
- Distance driven: 2.8 million km
- 380 million records
- 1 Hz
- No acceleration data
Individual threshold

- Each driver had an individual threshold for jerks
- Jerks $>|$ the threshold were supposed to be included
- 93 drivers included
- 9,500 hours
- 1,097 jerks included
- 1 jerk/8.40 hours

One driver: distribution of jerks and threshold level
ITS Platform

- North Jutland
- 2010-2013
- On board Unit, Backend Server and a no. of applications
- 400 cars
- Driving for 1 – 1.5 years
- Is scheduled to continue on commercial basis after 2013
FCD from ITS Platform

- 10 Hz
- 500 cars
- Acceleration data included
- 8-12 billion records on accelerations are expected
- Simplification will be used
ITS Platform FCD: first results

- Challenge: long distance driven/serious jerk = very few jerks so far
- 6 cars in 3 months
- 2 million observations with 10 accelerations each
- 38,000 km driven
- Jerk types:
  - Jerk based on speeds
  - Jerk per 0.1 sec.
  - $|J_{\text{max}} - J_{\text{min}}|$
Examples of reliable jerks

- Significant jerk before AND after a deceleration
- Delays compared to change in speed
Examples of reliable jerks

- Significant jerk before AND after a deceleration
- Delays compared to change in speed
Examples of reliable jerks

- Significant jerk before AND after a deceleration
- Delays compared to change in speed
Pitfalls with FCD

- Speed bump
Pitfalls with FCD

- Bad GPS data
- City Canyons
Pitfalls with FCD

- Speed bumps again
Identification procedure (November 2012)

- Significant differences $|\text{Jerk}_{\text{max}} - \text{Jerk}_{\text{min}}|$  
  - Unique size or individual size?

- Explicit reduction in speed  
  - To avoid effects from vertical accelerations  
    - Bumps  
    - Railway crossings  
    - Bad road surface

- Speed before jerk > a threshold (4-5 m/s – has to be defined)  
  - Start-up and stop activities can cause significant jerks
Next step

• **Late 2012:**
  • 6 months of driving from +50 cars
  • Comparison of decelerations and jerks
  • Finding first HRL – hopefully 😊

• **Mid-2013:**
  • Full-scale study
  • Refind results
  • HRL identification
  • Reporting
Summary

- Identification of HRL on the basis of FCD
- Jerk seems to be the most reliable approach
- Also info about the speed and change in speed is required
- Few reliable jerks found so far
- Large-scale data study will be initiated in late November 2012
Aalborg University and traffic safety research

Two research projects with different approaches to find HRLs:
• Based on identification of jerks from FCD
• Based on road characteristics
Thank You

Niels Agerholm
Traffic Research Group
Aalborg University
+45 61 78 04 55
agerholm@plan.aau.dk