New technologies for collecting surrogate safety measure data on the road

Richard van der Horst

Content

• Traffic safety assessment

• Background site-based video observations in real traffic

• Expert meetings Automated video analysis
  • Lund 2006
  • Soesterberg, 2010

• Examples of behavioural studies (Signalised turbo roundabouts, Level railway crossings, PROLOGUE)

• Examples of automated video analysis
  • Lund
  • TNO
Introduction

Traffic Safety Assessment

- Traffic Accidents
  - limited reflection of traffic (un)safety
- Police reports
  - limited sample of all accidents
  - limited for behavioral research purposes?
  - Subjective interviews?
- Accident Analyses
  - many methods
  - validated?

- Traffic Safety Assessment
  - Do the thing right
  - Do the right thing

Traffic Safety Assessment

Traffic (un)safety

Traffic Accident

Police report

Accident Analyses

Behavioural Analysis

Traffic Safety Assessment

Introduction (2)

Traffic Safety Assessment

Traffic (un)safety

Accident Analysis

Behavioural Analysis

Traffic Safety Assessment
Integrated Approach of Accident Analysis,
TNO project 2004-2007

Video observations

Road-scene analyses

Interviews

Accident Causation

In-depth analyses

Long term effects

Relational database

Long-term video observations

- Observation of 4 blackspots in 2-yr period
  - Pijnacker (T-junction) + Delft (3 signalized intersections)
- Rough data: 8 years of video material
- Selection: Collisions (# police-reported?) whole period
  Incidents when observed
  Conflicts (analyses ala ‘DOCTOR’ method) one day
- Methodology to determine driver behavior in the pre-crash phase
- Insight in the chain of elements of human behavior that either is resulting in, or avoiding an accident
Traffic observations
T-junction - Pijnacker

Video recordings

- At each location 1 or 2 CCD cameras
- PC + 3 hard discs (750 Gb) (> 2 weeks, 2 cameras)
- Separate jpeg pictures in a time-directory structure (date, hour, min, 60x 12.5 fields)
- Motion detection on the spot + specific areas excluded

Video analysis

- Manual selection of collisions by specially developed fast Windows viewer (at high speed still good interpretable images)
- Windows application for quantitative analysis (semi-automatic), (basically the same as 30 years ago) of collisions and conflicts (speed, distance, TTC, PET, etc.)
- Still urgent need for automated procedure!!
Pijnacker P1 T-junction

4 collisions
1 rear-end C-C
1 right-angle C-C
1 ‘right-angle’ C-B (injury)
1 single-bicyclist B

- Left turn from minor road
- Crossing bicyclists
- Interaction

Delft D1

7 collisions
4 left-turn –opposing
C-C minor road
2 rear end C-C
1 right-angle C-Moped

- Left turn from minor roads
- Left turn from below into wrong carriageway
**Delft D2**

1 collision
1 single-vehicle C

- Frequently U-turns -> conflicts (C-B-P-tram)
- Difficult path choice
  (straight-on -> right turn)
  Left turn -> wrong carriageway
  -> Tram/bus lane

**Delft D3**

4 collisions
2 rear-end C-C
1 single-vehicle C
1 single-scootmobiel

- Conflicts BU-B/P
- Many Bs own path-choice
- C straight-on -> left-turn
- Left-turn -> wrong carriageway
Delft D1 Left-turn opposing minor road

Pijnacker T-junction rear-end + conflict C-C
Analysis

- VIDARTS (VIDeo-based Analysis of Road Traffic Scenes)
- collisions and conflicts

Transformation from video to street
Semi-automatic procedure
-\( V, \text{DIST}, \text{TTC}, \text{TTCmin}, \text{PET}, \text{etc.} \)

- DOCTOR (Dutch Objective Conflict Technique for Operation and Research)

Overall severity (scale 1-5)
- probability of collision (TTC or PET)
- extent of consequences if collision had occurred

Conclusions (1)

- Traffic conflicts and analysing deviant behaviour together with road scene analyses give good insight in potential traffic safety problems at intersections. Good resemblance with results analysis of collisions from video.

- Remarkably, frequently, another road user (in)directly involved in pre-crash process

- Observing and scoring conflicts according to DOCTOR method from video feasible

- Time-related measures such as TTC and PET promising surrogate safety measures for predicting accident risks by microscopic traffic simulation models (EU proposal SIMPAC)
Conclusions (2)

- We do not have to wait for accidents for improving road environment and traffic management
- Systematic observation of behaviour already gives you lots of clues for improving road safety at intersections
- Video observations rich source of information for natural traffic behaviour of road users (interactions mutually or in relation with road environment), in future additional to integral approach? -> Naturalistic driving studies (also on-site)

Background Expert meeting Soesterberg

- Development of semi-automatic video analysis technique (1978-1984)
  - Evaluation of several intersection solutions (placement of speed humps)
- Development of time-related measures TTC, TTI, TTS, etc.
- ICTCT Conflict studies
  - Malmö Calibration Study (1983)
  - Trautenfels (1985)
- Strong need for joint effort for developing objective road user behaviour analysis tools
  - CARUSO (Cognitive vision for Assessment of Road Users Safety and Operational efficiency), EU-proposal 2003
  - Joint Workshop Lund 2006 (27 participants)
Expert meeting Soesterberg 15-16 November 2010

- Aim the expert meeting on automated video analysis of road traffic scenes (Soesterberg, 15-16 November 2010):
  - Exchange newest developments in automated video analysis techniques and applications and discuss future plans and activities
- 23 participants, 10 countries (Sweden, Netherlands, Finland, Denmark, Israel, Spain, Germany, Canada, USA, Belgium)
- Applications:
  - Motorway traffic (same direction, etc.) TNO
  - Intersections: Lund, UBC, TNO
  - Pedestrian crossings: Lund, UBC
- Future developments:
  - Data fusion with Stereo Radar, Laser scanner, Lidar
  - Observations from helicopter (Helsinki, TUD-NL)
  - Site-based and in-car observations combined (naturalistic driving studies)
Evaluation of signalised turbo roundabouts

- Province of Zuid-Holland has two operational: Doenkadeplein and Tolhekplein

- Aim of study:
  Better insight in functioning with respect to traffic flow and road users’ behaviour and experience

  - (Traffic flow)
  - Road Scene Analyses
  - **Behavioural observations by video**
  - Road user surveys
Lay-out Tolhekplein

Traffic flow
- Comparison Doenkadeplein with conventional signalised intersection
- Two-phase control -> reduction in:
  - Cycle time (-47%)
  - Waiting time (-41%)
  - Waiting queue length (-39%)
- Better traffic throughput, higher capacity
Video behavioural observations

• Doenkadeplein

Video behavioural observations

• Tolhekplein
Video behavioural observations

- 15-19 oktober 2007
- Three video-camera’s each, 1 looking backwards filtering lanes, 1 central area, 1 zoomed in furthest away area
- Selection:
  - Rush hours: 07:30-9:30, 16:30-18:30
  - Non-rush hours: 09:30-16:30
  - Total 11 hours each
- Error manoeuvres and deviant behaviour

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>% total</th>
<th>Non/Rush Fraction left turn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doenkadeplein</td>
<td>173</td>
<td>0.55</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80.4%</td>
</tr>
<tr>
<td>Tolhekplein</td>
<td>153</td>
<td>1.07</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>52.3%</td>
</tr>
</tbody>
</table>

Video behavioural observations

- Error manoeuvres by type

<table>
<thead>
<tr>
<th></th>
<th>Left turn inside-out</th>
<th>U-turn</th>
<th>Complex</th>
<th>SC-LT/LT-SO/ST-RT</th>
<th>Filtering</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doenkadeplein</td>
<td>80</td>
<td>37</td>
<td>32</td>
<td>8</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>46.2%</td>
<td>21.4%</td>
<td>18.5%</td>
<td>4.6%</td>
<td>2.9%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Tolhekplein</td>
<td>36</td>
<td>27</td>
<td>18</td>
<td>42</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>23.2%</td>
<td>17.4%</td>
<td>11.6%</td>
<td>27.2%</td>
<td>10.3%</td>
<td>10.3%</td>
</tr>
</tbody>
</table>
Doenkaadeplein: Left turn inside out

Doenkaadeplein: Complex 2 rounds
Conclusions behavioural observations

• Route choice
  - Tolhekplein more problematic than Doenkadeplein
    - (before roundabout 10 vs. 3% error manoeuvres, At roundabout 22 vs. 5%)

• Path choice
  - Left turn manoeuvre most problematic
    - Tolhekplein -> ghost riding, directly turning left at 1\textsuperscript{st} light
    - Both roundabouts -> turning left at 2\textsuperscript{nd} light

• Conflicts
  - Number limited

Conclusions signalised turbo roundabouts

• Traffic flow much better compared with conventional signalised intersection
• Road Scene Analyses
  - Route signing before roundabout okay, on and after roundabout missing -> hesitant/uncertain behaviour?
• Behavioural observations
  - Route choice: issue at Tolhekplein (temporary?)
  - Path choice: Left turn manoeuvre problematic (ghost riding 1\textsuperscript{st} light Tolhekplein, left turn at 2nd light, U-turns)
  - Conflicts and running red: limited
• Road user survey
  - After habituation reasonably positive (truck drivers more, incidental users less positive)
  - Mistakes/errors (when new), also by others
Recommendations

• Approaching and negotiating signalised turbo roundabout appears to be a complicated manoeuvre, especially for the less familiar road user and result in errors/mistakes

• Several detailed improvements possible, but these will not exclude all errors

• Only consider application if traffic capacity for heavy crossing flows requires so
Video observations before and after design

Deurne, after
Oisterwijk
Oisterwijk 23:10
PROLOGUE in-car plus site-based, see separate presentation, Jasper Pauwelussen

Conclusions

• A lot of progress has been made, several excellent examples of new applications (datafusion, sit-based + in-car, multisensor, etc.)
• But still a lot of pre-knowledge has to be put into site-based observation and analysis
• Strong need for further cooperation for both developers (computer scientists) and users (road designers, traffic engineers, and behavioural scientists)

• We will explore further possibilities for this:
  • ICTCT
  • EU-proposal
  • COST action