Automated video analysis and behavioural studies based on individual speed profiles

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Power model \([\text{Nilsson, 2004}]\):

\[
\frac{\text{Number}_\text{i}_\text{njury}_\text{a}_\text{ccidents}_{\text{a}}\text{fter}}{\text{Number}_\text{i}_\text{njury}_\text{a}_\text{ccidents}_{\text{b}}\text{efore}} = \left(\frac{v_{\text{a}}}{v_{\text{b}}}\right)^2
\]

\[
\frac{\text{Number}_\text{f}_\text{atal}_\text{a}_\text{ccidents}_{\text{a}}\text{fter}}{\text{Number}_\text{f}_\text{atal}_\text{a}_\text{ccidents}_{\text{b}}\text{efore}} = \left(\frac{v_{\text{a}}}{v_{\text{b}}}\right)^4
\]
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[Lee, Hellinga & Saccomanno, 2003]:

A model for real time identification of potential crash conditions. Crash precursors:
- Variation of speed on each lane;
- Variation of speed between the lanes;
- Traffic density.

[Golob & Recker, 2004]:

Crash type and location are related to certain combination of traffic parameters:
- flow & flow variation for each lane;
- flow/occupancy ratio (i.e. surrogate for speed) for each lane and its variation.
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Swedish Traffic Conflict Technique [Hydén, 1987]

[Graph showing the relationship between entering speed (km/h) and time to accident (sec). The graph illustrates the distinction between serious and non-serious conflicts.]
Decceleration (i.e. 1st derivative of speed) is a valid indicator for a conflict.

- > 3.0 m/s² - potential conflicts;
- > 4.5 m/s² - slight conflicts;
- > 6.0 m/s² - serious conflicts.
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[Nygård, 1999]:

The derivative of deceleration, “jerk” (i.e. 2nd derivative of speed) is a much better indicator for serious conflicts compared to deceleration.

“Jerk” describes the “suddenness” of the braking.
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Video analysis as a researcher’s tool

Automated analysis

- $x, y, t$
- other parameters

Description, Analysis, Conclusions

Reality
How do we analyse video?

Step I – rectify the image
How do we analyse video?

**Step II** – detect the changed pixels
How do we analyse video?

**Step III** – filter the pixels, forming large areas
How do we analyse video?

**Step IV** – follow each area’s travelling path
How to deal with speed profile data?

**Speed profile** - the dataset, describing road users’ speed over a certain continuous period of time.
How to deal with speed profile data?

Data aggregation is necessary.

Example:
- 25 frames/second;
- 40 km/h;
- 150 m.
- 1200 veh/h.

⇒ \(150 \times \frac{40}{3.6} \times 150 = 338 \text{ data points per vehicle.}\)

⇒ \(338 \times 1200 = 405600 \text{ points per hour of observations.}\)
How to deal with speed profile data?

Individuality is preserved, but spatial dimension is lost.
How to deal with speed profile data?

Spatial dimension is preserved, but individuality is lost.
Practical test

Sölvegatan-Tornavägen, Lund

102 veh/h
heavy 12%
turning 37%

252 veh/h
heavy 7%
turning 10%

264 veh/h
heavy 11%
turning 12%

138 veh/h
heavy 4%
turning 46%
Practical test
Practical test

No pedestrian (15 profiles)
Practical test

No pedestrian
Practical test

No pedestrian
Practical test

No pedestrian
Practical test

Pedestrian present (19 profiles):
Practical test

Pedestrian present

Distance to zebra, m

Speed, m/s
Practical test

Pedestrian present
Practical test

Pedestrian present

![Graph showing speed and distance to zebra](attachment:image.png)
Practical test

Pedestrian present
Practical test

How a pedestrian affects the drivers?

![Graph showing speed vs. distance from zebra with lines for 'No pedestrian' and 'Pedestrian present' categories. The graph compares the speed at different distances from the zebra, indicating a change in driver behavior with the presence of a pedestrian.](image)
Practical test

Speed distribution 5 m before the zebra

No pedestrian

Pedestrian present
Discussion

The test shows that it is practically possible to perform all the steps in a typical study of road users’ behaviour;

Speed profiles from automated video analysis system provide additional information which cannot (or is quite difficult) to obtain by conventional methods (e.g. a visually distinguished “characters” of the profiles);

The system allows to have much longer observation periods, thus collect much more data for analysis;
Discussion

On the other hand, intensive data flow from the system requires development of special routines for data management and analysis;

Automation of data filtering procedures opens new possibilities for studying of rare events in traffic process, e.g. conflicts.