Automatic detection of vehicle interactions in a signalized intersection,

Nicolas Saunier, Sophie Midenet, Alain Grumbach

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1. The problem

■ Purpose ?
  • Comparison of traffic light control strategies and their influence on the behavior and safety of road users.

■ How ?
  • Automatic detection of interactions between road users.
  • Based on video sensors.
  • A real experiment, yielding a large database:
    → 1 intersection, with 4 traffic lights control strategies, over a period of 8 months.
2. Our approach

■ Intersection: critical zone, especially the conflict zone,
  • role of the traffic lights,
  • study traffic events occurring in the conflict zone.

■ Traffic events relevant to safety?
  • Accidents,
  • Traffic conflicts,

■ Interactions, with or without a collision course.
2. Our approach: the severity

- Detect interactions and quantify their severity:
  - the distance between the interaction and the potential accident,
  - calculated in function of the features of the data,
  - interpretation: the distribution of the severity of the interactions.

- Previous work on vehicle-actuated strategies (R. van der Horst 88),
  - but no comparison with real time strategies (INRETS CRONOS).
2. A categorization of interactions

- A mobile = a road user + his vehicle.

- Categorization: *detection on the level of the zones*,
  - presence of mobiles,
  - collision course: mobiles in upstream storing zones have to cross the conflict zone,
  - not all interactions (no interactions within groups).
2. The categories to be detected

- Conflict zone
- Stationary mobile
- Stop line with traffic lights
- Moving mobile
- Storing zones
- Stationary mobile

- Downstream category
- Moving mobile
- Stationary cross traffic category
- Moving cross traffic category
3. The intersection

- An urban intersection, near Paris.
3. The data

- Surface data from video sensors: robust image processing tool.
- Basic discrete occupancy information: emptiness, presence of moving mobiles, and presence of stationary mobiles (no type of vehicle).

- A mobile or group of mobiles stopped behind a stop line.
- A mobile or a group of mobiles in the conflict zone, coming from an upstream storing zone.
- A mobile or group of mobiles arriving at the stop line (lane 1).

- Presence at time t
- Presence at time t-1
- Trace of presence between t-1 and t
- Lane 1
- Lane 2
- Emptiness
- Stop line
- Direction of traffic flow
3. The image of the intersection

- Processed several times a second, combined every second in an image of the occupancy of the intersection.

These two zones are directly linked in reality: the distances are distorted in the images.

Occupy information:
- emptiness
- trace
- head
- queue
- presence of moving vehicle
- presence of stationary vehicle
- stop line
- right direction of traffic flow
3. Interactions in the data

- Configurations of connected sets of units of presence, called blobs.

  - Interaction of the stationary cross traffic category
  - Interaction of the downstream category
  - Interaction of the moving cross traffic category

  Direction of traffic flow
3. Severity indicators

- Information in the data: *speed and distance*.

- No complex indicator, no evasive actions.

- 2 indicators:
  - extrapolated proximity: minimal extrapolated distance between the protagonists,
  - speed differential: norm of the difference of the speed-vectors of the protagonists.

- Severity: the closer the protagonists, the higher the speed differential, the more severe the interaction.
4. Development

- Rough data, but automatic detection for the treatment of large databases.
- No kinematics: work on images separately with pattern recognition methods.

**Image at time t**

**Detection of interactions**
*rule-based system*

**Set of interactions**
classified by context
location/category

**Interaction in image at time t**

**Evaluation of severity indicators**
*explicit computation & supervised learning*

**Severity indicators:**
extrapolated proximity, speed differential
4. Evaluating the severity indicators

- Multi-sensor data, disaggregation of the analysis:
  - compare interactions per location and category (context).

- Severity indicators: different difficulty in the tasks
  - extrapolated proximity: computed explicitly,
  - speed differential: supervised learning, which is more robust as the information is spread over the image.

- Goal: compare distributions (per context).
4. Focus on interactions

- More than one interaction can be detected in the same image and context:
  - ambiguity in the output.

- The *focusing* problem: how to weigh the relative usefulness of the parts of the input?
  - different techniques.
5. Current results and validation

- Validation of the detection of interactions with respect to the reality (video) (10 minutes):
  - about 90 % of correct detections.

- Learning of the speed differential with a focusing technique and an artificial neural network:
  - 88% in generalization.
6. Conclusion

■ No implementation of a Traffic Conflict Technique.
■ Treat large databases automatically.
■ Compare traffic light control strategies.
■ General purpose video data (control, AID, safety diagnosis...).
■ New safety diagnosis tool for traffic management at intersections.
■ Work in progress.