Naturalistic observations to investigate conflicts between drivers and VRU in the PROSPECT project

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Objective: to develop a new generation of proactive system to protect VRU(s) with focus on

- Pedestrians.
- Cyclists.

To improve effectiveness of active VRU safety systems by

- Expanding the scope of scenarios addressed by sensors on the market.
- Enhancing overall performance of the systems.
Conflict analysis: Naturalistic Observations

• Complementary to accident database analysis.

• Objectives:
  ➢ To collect qualitative/quantitative data of VRU-vehicle behaviour.
  ➢ To investigate how vehicles and VRU interact in real traffic:
    • To better understand critical situations.
    • To identify factors that lead to conflicts.
    • To provide qualitative/quantitative description of VRU-vehicle motion, behaviours and interactions.
    • To identify indicators that signal VRU intent.
    • To address correctly managed situations that could lead to sensor false alarms.

• Make VRU and vehicle modelling more effective:
  ➢ Allowing safety systems to react taking into account VRU intent.
  ➢ Without increasing false activation rates.
Data acquisition: two types of Naturalistic Observations

- On-site observations (Lyon and Budapest)
  - Cameras on infrastructure
  - Accident hotspots / high frequency of vehicle-VRU

- In-vehicle observations (Budapest and Barcelona)
  - Vehicle-mounted sensors
  - Cameras and laser scanners covering vehicle environment and observing the driver

Only conflict situations are collected
• 2 sites, 1 month/site continuously recorded
• Automatic extraction
  ➢ Object detection.
  ➢ Object classification.
  ➢ Tracking.

• Conflicts identified based on the distance of car-VRU
  ➢ 1440 hours of data collection.
  ➢ 1400 potential conflict situations manually reviewed.
  ➢ 126 situations identified as conflicts (low speed conflict excluded).
Data collection in Budapest: on-site and in-vehicle observations

- 25 locations, 1h to 1h30 each (total 100h (infra.) + 50h (in-vehicle, 964 km)
- In different weather conditions.
- Conflict extracted manually and software for kinematics (2D trajectories).
- Video processing done manually.
- Software (BME) for road users tracking.
Data collection in Barcelona: in-vehicle observations

- Video from in-vehicle equipped with sensors and data acquisition devices
  - VRU trajectories from laser scanner: accuracy in cm.
  - Vehicle speed, acceleration and deceleration from GPS / CAN.
  - Vehicle position from GPS.
  - LIDAR for points map graphic.

- 4 months recording, about 1,000 hours
  - Manual coding and annotating.
  - Kinematic data: from CAN bus and Lidar of the test vehicle.
  - 304 Conflicts extracted.
Data annotation

- 6 categories of items (manual coding)
  - Global analysis:
    - Lighting, precipitation, road surface, traffic density, etc.
    - Road infrastructure characteristics: layout, lanes, speed limit, traffic control etc.
  - VRU characteristics:
    - Type, gender, age, equipment, etc.
  - Encounter characteristics:
    - Visibility of VRU, right of way, yielding behavior, conflict management, estimated impact point, etc.
  - Intents:
    - Head/torso orientation, gesture, flashing indicator.
  - Kinematics and trajectories.
Data annotation

- Differences by country to take into account:
  - Variability in the annotation.
  - Accuracy level of video processing algorithms for spatial data.
  - On-site & in-vehicle data not mixed.

- Conflict severity:
  - First assessed by subjective measures (as filtering process),
  - Then revised by taking into account kinematic data (objective measurement).

- Conflicts clustered according to PROSPECT use cases:

Examples for pedestrian: car turning left/right, pedestrian comes from the right /left
For each use case under study:
- Detailed description of all conflicts.
- Battery of VRUs’ behavior when involved in a specific configuration.
- Identification of most important features of influence.
- Definition of clues that could predict VRUs’ behavior in a near future.

It will be useful:
- To specify use cases to utilize further in the project.
- To calibrate the most representative cases for test development.
Data analysis: kinematics

- Criticality and severity of a potential collision assessed by kinematics and trajectories (with timeline).

- Two measures used: TTC and PET
  - Based on actual (on-site observations) or relative (in-car observations) positions and speeds of car and VRU(s).
  - Calculated at each time step
    - Positions of VRU and front line of the vehicle used to determine collision course.
    - Collision course => TTC, otherwise PET.
Use case: Pedestrian left turning

- 36 cases: 24 in Lyon, 7 in Barcelona and 5 in Budapest
- Generally, conditional right of way for driver
- Factor of influence: Visual behaviour of the pedestrian (don’t look at all, look before, during)
- 2 conflicts (IFSTTAR data) estimated at a high level of severity
Data analysis - example

Use case: Pedestrian with obstruction

- 159 cases: 33 in Lyon, 89 in Barcelona & 37 in Budapest.
- Generally, absolute right of way for driver.
- Factor of interest: obstruction.
Conclusion

- To collect and analyze relevant conflicts:
  - More than 2,000 hours of videos recorded (Lyon, Barcelona & Budapest).
  - More than 600 conflicts extracted and annotated.
  - Nearly half belongs to use cases implemented in PROSPECT demonstrators.
  - Description of a battery of VRUs’ behavior for each use case.
- Made available a large amount of other situations that can be extracted
  - New analyses planned on typical situations.
  - Kinematic data for cruise speeds of VRUs under normal traffic situations.
  - Analysis of aberrant behavior of VRU.
  - Collection of gesture and their meaning.
  - Etc.
- Important input for safety system development.
- Limitations:
  - Time consuming at each step of the work.
  - Subjective assessment of situations.
  - Study should be extended to more cities and areas.
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