NATURALISTIC OBSERVATIONS TO INVESTIGATE CONFLICTS BETWEEN DRIVERS AND VRUS IN THE PROSPECT PROJECT

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ABSTRACT

PROSPECT aims at developing a new generation of proactive safety systems to protect Vulnerable Road Users (VRUs), with an emphasis on pedestrians and cyclists. To improve sensor effectiveness, PROSPECT will expand the scope of scenarios addressed by sensors already on the market, enhancing their overall performance.
Interactions between vehicles and VRUs were investigated in real traffic situations to better understand critical situations and identify factors that lead to conflicts. As a result, VRU and vehicle modelling will be more effective, allowing safety systems to react earlier, without increasing false activation rates.
Accident studies highlighted the most relevant use cases, and further naturalistic observations provided information that could not be inferred from accident databases regarding these use cases, such as trajectories and kinematic data (speed, acceleration, TTC or PET) throughout the conflict evolution. Data was also collected on VRU's behaviors which forecast their intent in the near future (i.e. positional data, gestures). Lastly, naturalistic observations were used to look for correctly managed situations by the road users that could lead to false alarms in existing sensors.
Two kinds of naturalistic observations were undertaken in three countries. A first data set (France and Hungary) was collected from on-site observations by infrastructure-mounted cameras. A second data set was collected by cars equipped with sensors and cameras (Hungary and Spain) to observe interactions with surrounding VRUs.
Only situations of conflict with close proximity between road users both in space and time were studied. This important criterion qualified an encounter as a conflict. Low speed conflicts were excluded.
Several hundred conflicts were collected, each classified according to use cases and annotated using a common grid. Different categories of parameters were investigated to describe: environmental conditions (light, precipitation, road surface, traffic density, etc.), infrastructure (layout, dedicated lanes, speed limit,

etc.), VRU characteristics (type, equipment, etc.), encounter (visibility, right of way, yielding, conflict management, estimated impact point, etc.), intent (head/torso orientation, gesture, flashing indicator), kinematics and trajectories.
Start and end timestamps were recorded for time dependent parameters such as yielding, head movements, etc.
Finally, variants of use cases were obtained to describe potential conflict evolutions and determinant factors of this evolution.
As annotations of conflicts were based on subjective evaluation of observers, training was required. Although training sessions were organized, materials differed between observations which could lead to some distortion. However, including objective data such as kinematics and trajectories mitigated data validity concerns. Severity of conflicts, for example, was first assessed by subjective measure (as filtering process), then revised by taking into account kinematic data as a more objective measure. We also considered inconsistent accuracy level of video processing algorithms for spatial data (trajectories and kinematics).

INTRODUCTION

Accidents involving Vulnerable Road Users are a significant issue for road safety. According to the World Health Organization, pedestrian and cyclist deaths account for more than 25% of all road traffic deaths worldwide. The PROSPECT project is a collaborative research which aims to address this problem by developing the next generation active safety systems for protecting Vulnerable Road Users (VRUs), with an emphasis on two groups with large shares of fatalities: cyclists and pedestrians. The project focuses specially on urban environments, where the large majority of VRU accidents occur. Know-how about VRU accidents and VRU behavior is a pre-requisite for the specification of the relevant real-life conditions in which the safety functions developed in the project need to be tested.

Accident data bases provide a lot of information useful to understand the causation chain of the accidents. However they generally lack information about behavioral aspects in the seconds before the accident and then cannot fully explain the process that lead to an accident. In complementary, naturalistic observations facilitate a better understanding of potentially dangerous traffic situations with VRUs. In particular, it includes the identification of motions, behaviors and interactions that lead to such situations, from both VRU and driver perspective. They may also allow for identifying the parameters that signal VRU intent in order to enable earlier and more precise reactions by safety systems. Results from naturalistic observations appear therefore crucial for the development of advanced algorithms integrated in next generation PROSPECT-like systems, and can be also taken into account as relevant factors for the definition of test scenarios.

Naturalistic observation campaigns make available a large amount of data where lots of situations can be extracted. This part focuses on conflict situations between vehicles and VRUs. According to Kraay et al.'s 2013 literature review (Doctor Technique manual [1]), the notion of conflict has been evolving since the late 1960's. These authors report several definitions ranging from Perkins & Harris [2] to their own one. The first characteristics evoked in the definitions of conflict are related to "sudden" and "uncontrolled actions" of the road users in order to avoid the crash. Another important aspect of these definitions is the "close proximity" between road users on both space and time dimension. The fact that a crash will occur if none of the involved road users rapidly attempt an action to mitigate the situation appears to be particularly relevant to qualify an encounter as a conflict.

Other important aspects are also evoked by Laureshyn et al. [3] to define a conflict. Indeed, they emphasize the continuous relationship between normal encounters and crashes, revealing here the ideas of frequency of occurrence and severity of the encounters. They present a pyramidal / diamond shaped representation of both frequency and severity of conflicts in the global frame of encounters ranging from common ones to accidents. This way of representing conflicts shows the relationship between the severity and the frequency of problematic encounters. The notion of severity is reported by both Kraay et al. [1] and Laureshyn et al.[3] as a very important aspect of what makes an encounter a conflict. The latter indicates that severity is related to various factors namely: "Type of road users", "collision angle", "collision speed" and "potential damages". These questions have been reviewed within the InDev project D2.1 Appendix 6 [4].

Evaluating the severity of conflict is an important issue and a key point of conflict identification and analysis. Different parameters are generally considered. Initially the notion of severity was described as being related to "both the probability of collision and the extent of the consequences if a collision would have occurred" [5]. The type of involved road users is also described as influencing the conflict severity through the potential consequences in case of collision [3]. The probability of collision can be related to objective values such as TTC, speed and proximity. Involved road users evasive manoeuvers and control over it may also influence the severity criteria.

METHODOLOGY

Two kinds of naturalistic observations have been carried out in 3 different countries: France, Hungary and Spain in order to collect conflicts between vehicles and VRUs. Only conflicting interactions between VRU(s) and vehicle(s) are presented here.

On-site observations A first data set has been collected from on-site observation. These observations were conducted in Lyon and Budapest. In this case, test sites are equipped with cameras that continuously record traffic data during long periods of time. Such road traffic observations have been used for decades to evaluate road safety of the infrastructure. Different protocols have been designed such as the Doctor technique [1] or the Swedish technique [6] which are based on observer judgements. For this reason, protocols are designed to also train the observers to recognize conflicts. This is also the reason why caution is required when being used as they rely mainly on human subjective evaluation. However, the possibility to include video analysis to the subjective data brings back interest to the approach. Such observations can provide very useful information like location, distance, speed of surrounding traffic, time to collision, post encroachment time, etc.

In-vehicle observations A second data set was collected from in-vehicle to observe interactions from an equipped vehicle with surrounding VRU(s). These observations were conducted in Budapest and in Barcelona.
The approach followed here differs from the so-called NDS, as the study is not intended to observe totally free driving by different drivers. Even if drivers drive in a natural setting, without the presence of an experimenter, they are asked to drive in hotspot areas, where conflicts have a high probability to occur. Recorded data focuses on the road environment rather than on the driver himself.

Test sites have been selected regarding different criteria such as high concentration of bikes and pedestrians, accident fatalities reported in maps of accidents, investigation among neighborhood…

Data collection

Data collection in France Two campaigns of data collection were undertaken (September-October 2015 & April-May 2016) in two areas in Lyon, cameras that targeted the roadway being installed in private premises (Fig. 1). In each area, two cameras filmed continuously the same scene from two points of view in order first to enable an optimized image processing and then to allow for 3D reconstitution (necessary to obtain vehicle and VRU's trajectories). The video recording systems consisted in Axis IP camera plugged on a Synology server to store the video data. The camera provided 8.3 MP/4K Ultra HD resolution image at 25 frames per second. The recording systems were monitored through secured internet connection to check the recording status. The video sequences represent about 1,440 hours of acquisition.

Figure 1. Site 1 – View from one camera

An automatic pre-selection tool has been designed to provide a quite large set of relevant situations. This tool first extracts foreground objects - car and VRUs – (Fig. 2) by modelling the urban background (image of the empty scene), then classifies the detected objects in two classes that include respectively the VRUs and the cars, based on the size and the geometry of the detected shape (Fig. 3). Finally, conflicts are identified based on the distance between VRU and car objects to the condition that they remain close for a certain period.

Figure 2. Object detection results

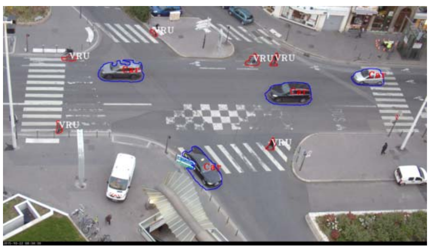


Figure 3. VRU / car classification results

1,400 potential conflictual situations have been manually reviewed for validation and 126 have been retained as of interest. The conflicts have been then encoded using an annotating sheet that is common to all T2.2 partners (see data annotation). To help at filling all the required information for each retained sub-sequence, a software has been developed to compute the trajectory of each actor of the conflicts. Tracking is achieved by an expert that chooses the better part of the objects to track. Because 3D raw points obtained from the 2D tracking and after a 3D re-projection are noisy, a filtering step is applied to yield smoothed trajectory curves.

Data collection in Hungary 25 locations with different infrastructure layout, traffic control, etc. were selected in Budapest, to ensure the diversity of conflict situations (Fig. 4). Approximately 1-1.5 hours of data was recorded in each session, where the time and length depended on expected conflict frequency. Recordings were carried out between mid-October 2015 and end of August 2016, therefore VRU and driver behavior in different weather conditions have been analyzed.
Two or three cameras were used in every location, which were mounted to infrastructure elements (lamp post, back of traffic sign, etc.). The resolution of the videos is 720p (1280x720 pixel), with 30 FPS (30 Hz) image capture frequency, to ensure adequate detailing with optimal data size (100 hours of recordings on 700 GB).

Figure 4. Camera position on-site

Video processing was carried out manually with dedicated software developed at BME, which allows synchronized scrolling of videos, tracking of road users, and describing situations (Fig. 5). The software is connected with a dedicated database which stores the different types of data (see data annotation).
The labelling process starts with the recording of base data of transport users and continues with the drawing of trajectory boxes (rectangle) frame by frame for all transport users involved in coded situations. Time-dependent activities are added manually with a start and an end time-stamp.

The 2D trajectories of road users were calculated from videos by dedicated software that uses the pinhole camera model as it is widely used in photogrammetric engineering. Firstly the calibration of the cameras was solved to eliminate the distortion of the fish-eye lens. Secondly the position of the camera was calculated with defining multiple control points on each camera-picture. The last step is the projection of trajectory points (the middle of the trajectory rectangles) onto the road surface level to get the path of transport user in 2D. The result of this calculation is an X-Y dataset with 30 Hz for each transport user, which allows calculating velocity and acceleration as well (see Koppányi et al. [7]).

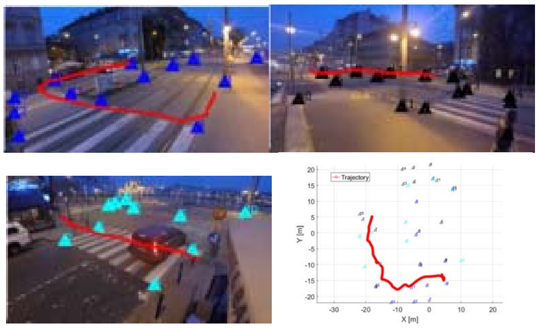


Figure 5. Trajectories and control points

For in-vehicle data collection in Hungary, three cameras (GoPro Hero 3+/GoPro Hero 4 Silver/ GoPro Hero 4 Black) and special CAN data acquisition software (WeCAN) have been used, CAN data being synchronized with events appearing in videos (Fig. 6).
The three cameras recorded front, back/side and the driver. The resolution of the videos is 720p (1280x720 pixel), with 30 FPS (30 Hz) image capture frequency, to ensure adequate detailing with optimal data size (50 hours of recordings on 700 GB).

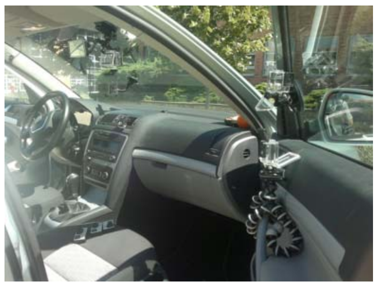


Figure 6. Camera position on-board

Recordings were carried out on 7-10 kilometers long (25-80 min) routes through accident hot-spots according to accident analysis heat-maps and previous experience of traffic conflicts – covering as many hot-spots as possible. The survey was taken between the middle of October 2015 to the end of August 2016, therefore VRU and driver behavior in different weather conditions were analyzed as well, total distance covered is 964 km. Video processing was also carried out manually with dedicated software connected with a dedicated database. The labelling process started with the recording of base data of transport users and continues with the drawing of trajectory boxes (rectangle) frame by frame for all road users involved.

Data collection in Spain The in-car observations were conducted in Barcelona in some reference areas based on interesting hotspots for pedestrians and cyclists between the 7th of April and the 12th of August 2016. Around 1,000 hours have been recorded, around 8 TB were collected. The daily work consisted on 12 hours of driving and 2 shifts (6 hours per shift). Professional drivers were initially trained for the purposes of the activity. They were requested to drive normally and to activate a trigger whenever a conflict was identified. On the event of trigger activation, synchronized data from the different sensors (LIDAR, camera, vehicle CAN BUS, GPS) was extracted.
The equipment used by IDIADA (Fig. 7) consists of a data fusion and object detection system based on one LIDAR sensor, a GPS data logger, a laptop and two cameras. Together with this, a keypad device has been mounted for manual registration of interesting cases by a triggering event. The rest of equipment is formed by Laptop, Vector CAN, Ethernet box, synchronization box, battery switch and feeding box.

- LIDAR IBEO Lux 4: The laser scanner detects the surroundings and the objects located within its field of view allowing the measurement of the distance, velocity and direction of the detected bodies.
- Camera Logitech Webcam C930 (FOV: 90º and 30 fps): Two cameras have been continuously recording the whole field test. One has been pointing towards the front view and another one placed inside the vehicle pointed towards the driver to record his reactions and/or his interactions with pedestrians.
- GPS data logger Video VBOX from Racelogic: To record the vehicle’s current position.
- vADASDeveloper: Data fusion and object detection. This software combines the information from the laser and CAN data from the vehicle and builds a virtual representation of the scenes.

At the end, researchers viewed all extracted potential conflict situations and made a final selection of the conflicts to be considered within the study. Finally selected situations were later analyzed and annotated using a common coding grid.

Figure 7. Equipment on the test vehicle

IDIADA’s in-car observations allow the calculation of kinematic data by the use of kinematics of test vehicle provided by the CAN bus, and kinematics of the VRU provided by the LIDAR. For all conflicts, precise VRU trajectories were derived to compute all kinematic parameters - relative position and speed of VRU with respect to vehicle, TTC and or PET, vehicle acceleration – (Fig. 8).

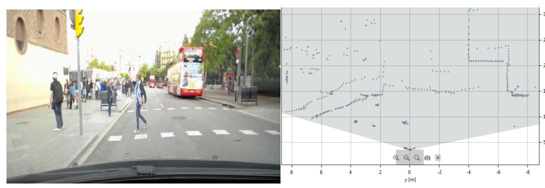


Figure 8. Video data from LIDAR

Data annotation
An annotating grid has been elaborated by all partners to provide information on how to encode parameters for analyzing the conflicts. It is composed of six sub-groups of parameters validated for annotation. They describe (1) the general

environmental conditions of the conflict (lighting, precipitation, road surface, traffic density, etc.), (2) the infrastructure (layout, number of lanes, dedicated lanes for VRUs, speed limit, type of traffic control etc.), (3) the characteristics of the VRU (type, gender, age, equipment, etc.), (4) the encounter characteristics (visibility of VRU, right of way, yielding behavior, conflict management, estimated impact point, etc.), (5) the intents of the VRU (head/torso orientation, gesture, flashing indicator), (6) kinematics and trajectories of both car and VRU. Start and end timestamps are recorded for time dependent parameters such as yielding, head movements, kinematics etc. Conflicts are classified according to their severity levels. Severity is first assessed by subjective measure (as filtering process), then revised by taking into account kinematic data as a more objective measure, in order to mitigate data validity concerns.

Training session has been organized in order to finalize the data collection and to ensure coding homogenization.

Conflict clusters All conflicts have been clustered according the use cases defined in the Prospect project, which cover different encounter configuration. Aggregations of use cases have been done, as from a sensor perception viewpoint only the relative positions between car and bicycles are of main interest. Infrastructural conditions, road geometry and right of way rules are only secondary and mainly influence the vehicle control and HMI behavior. Among all use cases, 12 have been more deeply considered as they are selected to be implemented in the demonstrators: 9 for cyclists and 3 for pedestrians. Even reduced, this number still addresses around 80% of all cyclist accidents investigated in the project.

For each use case, a detailed description of all conflicts that have been extracted has been made. This large amount of information contributes to specify the use cases that will be utilized further in the project, as it includes a battery of VRUs' behavior when involved in a specific configuration and allows for identifying the most important features of influence in the investigated scenario. At the end, this work will not only contribute to define clues that could predict VRUs' behavior in the near future, but can also be used to calibrate the most representative cases that will be utilized for the test development.

Kinematic data
Each conflict has been described in terms of kinematics to evaluate criticality and severity of a potential collision. Kinematics data contains the detailed trajectories (with timeline) of VRUs and car and describe the conflict with calculated indicators. Two measures have been more specifically computed:

- **Time To Collision** (TTC) as "the time required for two vehicles to collide if they continue at their present speed and along the same path" (Hayward [8], 1971). The smaller a TTC value is, the more dangerous a situation is.
- **Post-encroachment Time** (PET) as "the time between the first road user leaving the common spatial zone and the second arriving at it" (Laureshyn et al. [3]. 2010).

Based on actual (on-site observations) or relative (in-car observations) positions and speeds of car and VRU(s), these measures are calculated at each time step (see TTCi, TTCe and TTCx on Fig. 9). From these times it can be decided whether the VRU or the car will reach the conflict zone first (TTCi is larger or TTCx).

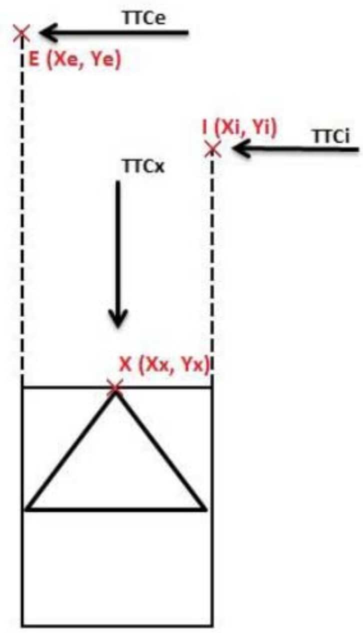


Figure 9. Key points and times of TTC calculation

Positions are also calculated where the VRU will cross the borders of vehicle's path (see Xi, and Xe on Fig. 9) and the front line (Yx) of the vehicle.

From these points it can be decide whether they may collide or not. When the relevant coordinate (if the vehicle arrives first then Xi; if the VRU arrives first then Yx) is smaller than the vehicle's size, car and VRU are in collision course and TTC is calculated, otherwise PET is calculated.

Another method has also been further used with French data to compute TTC and PET indicators. From the current car and VRU trajectories predictions of the situation evolution are computed at each time step based on kinematic data. Thanks to these predictions, behavioral adaptations from both car and VRU are taken into account.
From the extrapolated trajectories, shapes of vehicles and VRU are reconstructed according to theirs dimensions. Separating axis theorem is used to test the possibility of a collision at each time step. Then TTC and PET indicators are directly computed on collision predictions.

Other parameters have been discussed such as:
- **Time To Conflict Zone** (TTCZ) which is the maximum of TTCi and TTCx, i.e. the time when the second road user arrives to the conflict zone. When car and VRU are in collision course, TTC=TTCZ. The interest of such a value is that it can also be given even in case of PET calculation. TTCZ is continuous for both situations.
- **Time Difference To Collision** (TDTC) defined by Zhang et al. [9] (2012), corresponds to "the time difference for a pedestrian and a vehicle to travel to the potential conflict point if their speed keeps constant". Considering pedestrian behavior as a way more flexible than the vehicle one, Zhang and al. proposed this new parameter that better takes into account pedestrian mobility. "TTC and PET are not able to individually capture all the dangerous interactions." (i.e. a vehicle may induce pedestrian to fall when passing by too close, even if they never collide). TDTC innovative dimension deserves to be further studied.

RESULTS

From the 1,080 hours of videos recorded at IFSTTAR, 1,000 hours recorded at IDIADA and 150 hours at BME, naturalistic observations allow for extracting 602 conflicts analyzed in terms of severity (Table 1). Each of them was annotated using the common annotating grid using all parameters.

Most of the conflicts extracted from the videos are at a low level of severity. Only 2 or 3 have been found by each team at a high level of severity.

Table 1. Summary of analysed conflicts

Severity	France			Spain			Hungary		
	Low	Med	High	Low	Med	High	Low	Med	High
Cyclists	23	15	0	22	4	0	33	**17**	3
Pedestrians	66	18	2	260	20	1	105	13	0
Total	89	33	2	282	24	1	138	30	3
Total	**124**			**307**			**171**		

The number of time a pedestrian or a cyclist makes sign or hand gesture toward the car in conflict was investigated. Unfortunately very few are registered. Such gesture has different meaning according to when it occurs:
- Generally before T0, a hand gesture corresponds to a request for yielding or on the contrary to give the way.
- At T0, a hand sign expresses either a thank or a reprimand (in French data) or a request for yielding or to give the way (Hungarian data).
- After T0, most of the signs express either a thank or a reprimand in both French and Hungarian data.

EXAMPLES OF CONFLICT ANALYSES

Car turning left (Fig. 10) A car intends to turn left at the junction, a pedestrian comes from the right at a crosswalk. Generally, the pedestrian has an absolute right of way while the driver has only a conditional one as they have to yield in the presence of a pedestrian.

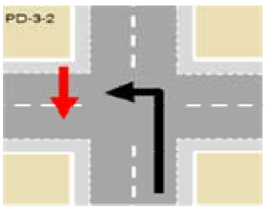


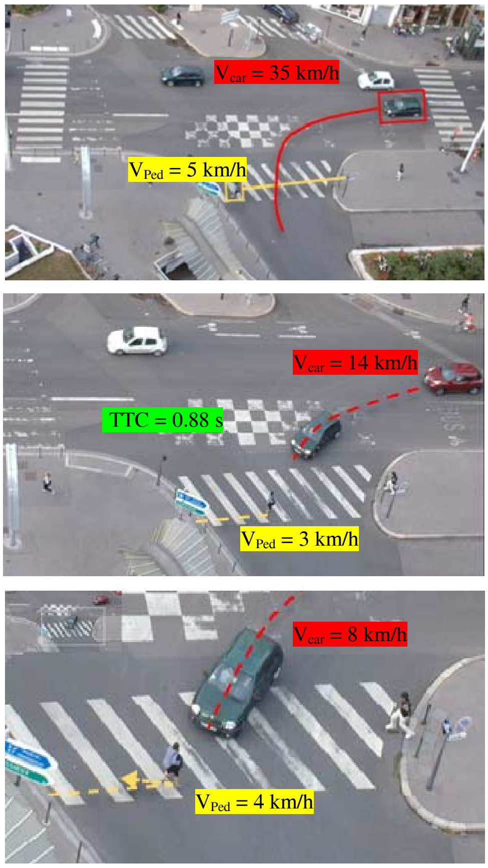
Figure 10. An example of use case

24 such conflicts have been analyzed in terms of how pedestrians check the environment before or while crossing (from French data). Three types of pedestrian behavior have been observed:
- In most cases (18 cases), the pedestrians clearly look around and towards the car before crossing, which seems to show they have taken into account the presence of the car and expect the drivers to adapt their behavior accordingly.

However, if the driver actually adopts his/her speed in some cases, in small half cases, pedestrians have to slow down or speed, or to deviate or even to jump, in order to avoid being hit. In these last 7 cases, lack of reaction from the driver is noticed, pointing out the interest of Prospect-like systems.
Among these 18 cases, pedestrian’s gesture has also been observed (gesture of irritation after the car passes and gesture to ask for yielding before the car passes).

- In 3 cases, the pedestrians look around later while being crossing, and realize the presence of a fast car. In these situations, the pedestrian either forces the vehicle to brake making a sign or not, or deviates to avoid the vehicle.
- In the last 3 cases, the pedestrians adopt a risky behavior without taking into account ambient traffic: don’t look around before crossing and force cars to brake.

The following pictures illustrate the evolution of three conflicts between cars and pedestrians.



Full line = expected trajectory /Dotted line = real trajectory
VVRU = VRU speed / VCAR = Car speed

Figure 11. Example of a conflict in Lyon

In the pictures of Fig. 11, a car intends to turn left at the junction while a pedestrian crosses the road from the right on a crosswalk, in the city of Lyon. The driver seems not to look toward the pedestrian, obviously diverted by a skater arriving from his left. He only realizes at the last moment the presence of the pedestrian. The speed of the car was quite high at the beginning, which forces 1) the driver to break hard to avoid the pedestrian and 2) the pedestrian to steps back to protext herself from the car. The criticality is assessed first by the need for an evasive maneuver from both driver and pedestrian and then by the TTC value which is quite low (TTC = 0.88s) at the most critical time of the conflict.

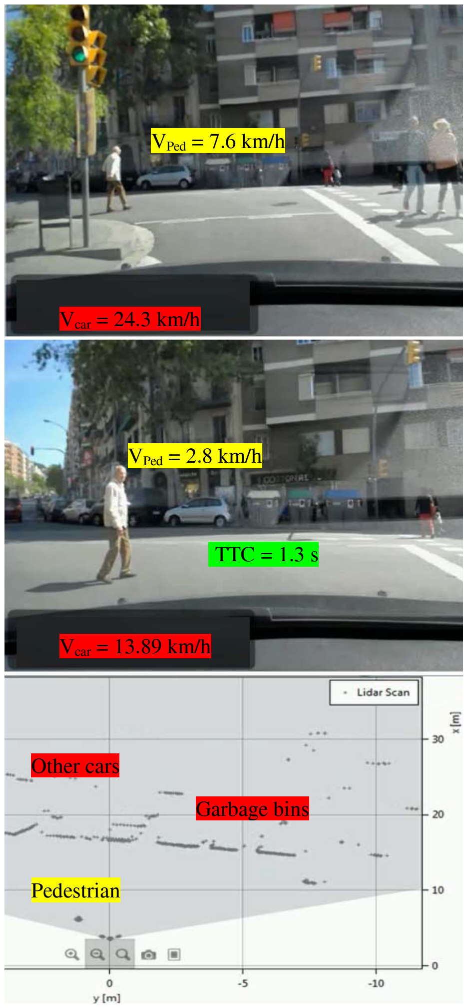


Figure 12. Example of a conflict in Barcelona

Pictures in Fig 12 illustrate the evolution of another conflict between a car and a pedestrian, in the city of Barcelona. In this situation, the driver approaches a junction with car absolute priority over pedestrians. When the driver decides to turn

left, he unexpectedly notices a pedestrian crossing in a place where he is not allowed to. The driver breaks to avoid a collision and gives the pedestrian a safe place to have enough time to finish crossing safely (TTC = 1,3sec.).
In this case, TTC is computed thanks to the lidar system (120° angle) using laser beams. The distribution of dots allow for determining the position and distance of potential obstacles (pedestrians, other cars or garbage bins).

The last example (Fig. 13) takes place at a complex, un-signalized intersection, where the car crosses a zebra crossing, a tramway and then turns right and crosses another zebra crossing – on which the pedestrian arrives. The driver realizes the situation quite late, therefore needs a high deceleration. Although vehicle speed is not high, this conflict is relatively severe, as TTC is very low, 0.33 s. (Right after this situation, the pedestrian gets into another conflict with a car arriving in the next parallel lane. But the latter one is less critical as the driver starts to brake earlier thus we focus on the first case.)

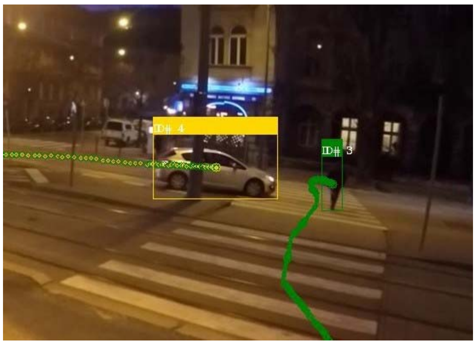


Figure 13. Example of a conflict in Budapest

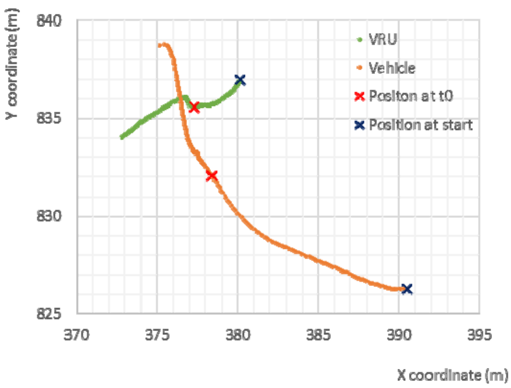


Figure 14. Trajectories of pedestrian and car (Budapest)

Figures 14 to 16 show the situation in a frame from camera recordings, the trajectories of the participants in an absolute and in a vehicle-based coordinate-system and finally the values of some key parameters by time.

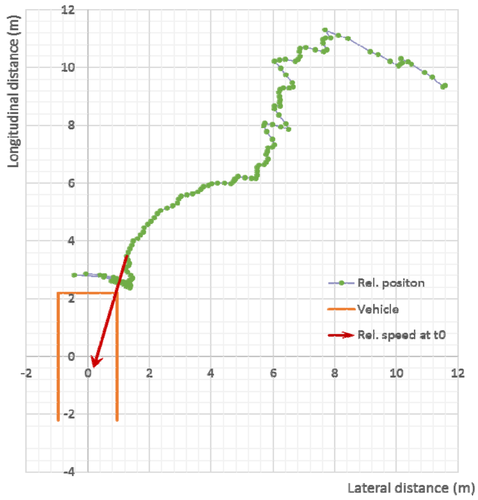


Figure 15. Relative position of VRU (Budapest)

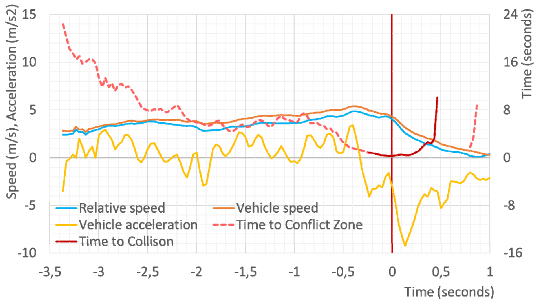


Figure 16. Speeds, acceleration and TTC, TTCZ (Budapest)

CONCLUSION

Conducting naturalistic observations in limited time is challenging, as these studies are time consuming at each step of the work.

The first objective of this study was to collect and to analyze a large amount of relevant conflicts between vehicles and VRU (pedestrians and cyclists). More than 2,000 hours of videos were recorded in Lyon, Barcelona and Budapest and allowed for extracting 602 conflicts. Nearly half of them belong to the use cases that have been identified to be implemented in the Prospect demonstrators.
Each of these conflicts was then fully annotated according to six sub-groups of parameters which describe the general environmental conditions of

the conflict, the infrastructure, the characteristics of the VRU (type, equipment, etc.), the encounter characteristics, the intents of the VRU and kinematics and trajectories of both car and VRU.

Analyses performed on each use case provide descriptions of a battery of VRUs' behavior when involved in a specific conflict that will help to identify the clues that can predict VRUs' behaviour in the near future.
Finally, the naturalist observation campaigns made available videos where lots of more situations could be extracted. This part of the project focused on conflict situations between vehicles and VRUs. New analyses are planned to provide information about typical situations. Kinematic data will be computed for example regarding cruise speeds for VRUs (pedestrians, cyclists) under normal traffic situations.

The development of these studies will contribute to the improvement of the state-of-art knowledge about accident causation and facilitate a better understanding of potentially dangerous traffic situations with VRUs. In particular, it includes the identification of behavioral patterns that lead to such situations, from both VRU and driver perspective.
Additional to the accident analysis data on national and European level, Naturalistic studies will enable realistic modelling of VRU behavior, including the identification of indicators that signal VRU intent. These results will provide important input to safety system development, to testing methodologies and tools in the PROSPECT project, but as well as to future research projects.

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