From aDRIVE Project to INTEGRATED Safety

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I. INTRODUCTION

aDrive is a first Polish national project that aims to develop integrated simulation environment comprising realistic traffic scenarios, vehicle driving automation ADA systems models, HMI /human-machine interfaces/ communications and control links, and HIL /Human in the loop/ simulator testing capabilities for the evaluation of the PRE-CRASH phase. It allows incorporating innovative ADAS algorithms, test their impact mitigation capabilities taking into account realistic human reactions and assess probability and conditions of near-misses or in some cases impact scenarios. Such dynamic information includes initial and/or boundary conditions for occupant/pedestrian safety evaluation. Hypothetically vivid linkage between the complex pre-crash phase and the impact instant should on one hand allow for a wider optimisation of passive safety systems that could be optimised and properly initiated in some cases already prior to impact by using specific information from sensors in ADA systems, and on the other hand it would serve as a realistic environment for injury recognition for personalised human models.

This paper outlines the proposed approach and results of the development of an integrated simulation environment and its first successful application on the basis of pedestrian impact case taking into account AEB and the potential of the effectiveness of the V2I system. Developed environment allows for ADAS effectiveness evaluation process and INTEGRATED Safety Approach links it directly to safety measures in case of impact. Pedestrian scenarios have been chosen due to the fact that statistically fatality and injury risk rate for pedestrians crossing the road is one of the highest scores in Europe [1-2] and a lot of national Polish efforts is currently directed to changing the trend. Secondly pedestrian impact scenarios do not introduce any problems in splitting the phase of PRE and IMPACT and allows for easy single direction parameters transfer between both phases.

II. METHODS

As a first step a realistic typical two lane street pedestrian crossing scenario has been built in PreScan environment (Fig. 1). The traffic situation of the scenario represents an incorrect behaviour of the driver, who ignores the must stop rule, while the other driver in the parallel lane stopped. The field of view of the sensor and driver is reduced, so it is impossible to detect pedestrian on time.

Fig. 1 Scenario overview.

Fig. 2 shows own model of AEB system together with programmed vehicle control concept. It was also linked with the mini-simulator stand [3] ready for further experimental tests (Fig. 3) evaluating human perception and reactions in case of AEB system application.

So far the pedestrian test scenario has been prepared in such that it was not possible to stop the car by normal driving. Applications of AEB system improved results lowering the impact speed from original 13.4 m/s up to 6.8 m/s.

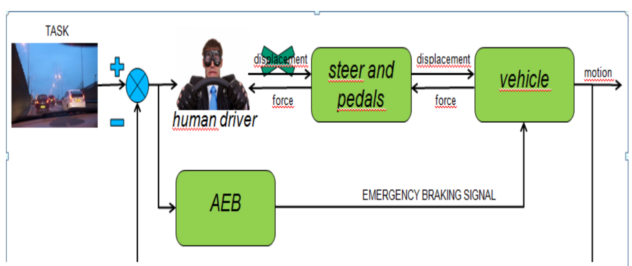

Fig. 2 Control system scheme including AEB.

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Additionally added V2I communication allowed stopping the car ahead of the crossing pedestrian. Gathered first pre-crash entry parameters were prepared to be directly transferred for further impact phase analyses.

III. INITIAL FINDINGS AND ROLE OF SUPLEMENTARY TOOLS AND MODELS

The mini-simulator stand is shown in Fig. 3. The station consists of five screens, steering wheel, driver's seat and pedals. It was built for verification and development of created tools and models. In addition, simulations with real drivers based on the experiment are planned in the mini-simulator station. The multi-tasking steering wheel can be used to teach drivers ADA systems with possibility of turning them on and off by them.

Fig. 3. Mini-simulator stand at WUT

In parallel also the fuzzy logic actor-driver has been developed to replace standard predictable algorithms of vehicles movement. Actors can represent different driver behaviours, i.e., aggressive, optimal or careful driver, with different workload like low (bored), optimal (focused on the road) and high (talking on the phone).

Applying entry PRE_CRASH conditions (scatter between impact velocity) we were able to investigate full body human – vehicle interaction. At the same time by applying two differently personalised (morphed) THUMS models we have received two different schemes of impact kinematics. The example on the THUMS pedestrian model is shown in Fig. 4. Furthermore it is planned to split the impact simulation phase into two sub-phases; First, optimisation sub-phase in which simple parametric human impact models are to be used to deliver most dangerous configurations and secondly an injury recognition stage for injury risk analyses based on personalised complex human model like THUMS or GHBMC.

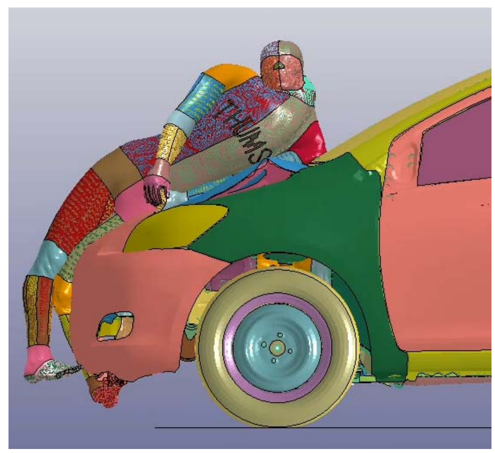

Fig. 4. 'Fat' THUMS pedestrian.

IV. DISCUSSION

Presented work illustrates how the developed in aDRIVE project pre-crash simulation methodology (including both tools and models) might serve as an input for further integrated human safety analyses. First the pedestrian impact case shows how chosen fraction of multidimensional pre-crash investigation of the AEB system effectiveness might be used for functional linkage between AEB and the injury pattern. Taking into account differences in human morphology and by applying parametrically scaled or morphed human models may directly introduce a new *personalization* dimension to any optimisation process that might have taken place for ADAS and/or passive restrained systems

ACKNOWLEDGEMENTS

Presented work has been financed and supported by the project aDrive - PBS3/B6/28/2015 project within the Polish National Applied Research Program of the National Centre for Research and Development.

V. REFERENCES

[1] Polish National Police Headquarters (System of evidence of accidents and collisions) –data set 2015, 2016.
[2] WHO Road Safety report 2015.
[3] D. Jastrzębski, et al., Autobusy,Spatium 2016.