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Can the prognosis of the results of the crash be the basis to steering the autonomic vehicle with the trailer in the critical situation?

LEON PROCHOWSKI[1], PATRYK SZWAJKOWSKI[2*], MATEUSZ ZIUBIŃSKI[3]

1. Military University of Technology (WAT), Institute of Vehicles and Transportation, ul. gen. Sylwestra Kaliskiego 2, 00-908 Warsaw, Poland; Łukasiewicz Research Network – Automotive Industry Institute (Łukasiewicz-PIMOT), ul. Jagiellońska 55, 03-301 Warsaw, Poland, leon.prochowski@wat.edu.pl [0000-0003-2093-1585]
2. Łukasiewicz Research Network – Automotive Industry Institute (Łukasiewicz-PIMOT), Electromobility Department, ul. Jagiellońska 55, 03-301 Warsaw, Poland, patryk.szwajkowski@pimot.lukasiewicz.gov.pl [0000-0003-4832-826X]
3. Military University of Technology (WAT), Institute of Vehicles and Transportation, ul. gen. Sylwestra Kaliskiego 2, 00-908 Warsaw, Poland, mateusz.ziubinski@wat.edu.pl [0000-0003-4955-2095]

* Presenting Author

Abstract: The autonomous vehicles move to follow up a pre-planned trajectory, which is generated by the trajectory planning model of the control system. The same situation is observed during obstacle avoidance maneuvers. Autonomous vehicle (A) (without occupants onboard) with a cargo trailer (CT unit) movement has been considered in this paper. During the CT unit motion at high speed on a road intersection, the car (driven by the driver, D) entered the lane of the CT unit and thus to become an obstacle. It was affirmed that in some cases of considered road critical situation, there is a lack of the safe obstacle' avoidance maneuvers. In such cases, planning of the CT unit trajectory is also necessary. Among all of the trajectories, some of them consider the possibility of the collision (impact). The aim of this study is to show the possibility of movement trajectory selection, based on assessments to risk associated with possible vehicle D occupants injury. The basis for this selection are the results of the numerical modelling of the vehicles' collision effects. The research carried out have shown the relations between the selected driving trajectory and possible consequences of the vehicles' collision. Set of these relations from the model research, can be stored in the autonomous vehicle controller memory and be used by for selection the movement trajectory in an obstacle avoidance maneuver. This would help to plan the trajectory to reduce injuries risk of the vehicle D occupants to lowest possible level in investigated critical road situation.

Keywords: autonomous vehicle with cargo trailer, road accidents, occupants injuries.

1. Introduction

The autonomous vehicles move to follow up a ongoing planned and generated movement trajectory. The same situation is observed during obstacle avoidance maneuvers. Autonomous vehicle (A) (without occupants onboard) with a cargo trailer (CT unit) movement has been considered in this paper. During the CT unit motion at high speed on a road intersection, the car (driven by the driver, D) entered the lane of the CT unit and thus to become an obstacle blocking one of the road lane along a driving trajectory in relation to the car A. The method of selecting a defensive maneuver by the system controller in a critical situations has been considered.

The result of the research presented in [1] was to determine the method of generating the planned driving trajectory to safely avoid the obstacle. The results of these research provide grounds for a statement that several possibilities of the considered road critical situation lack a safe driving trajectory. How to proceed in such a situation? One way is to select a trajectory taking into account a collision (impact) with the least severe consequences (the strategy of the lesser evil).

The aim of this study is to show the possibility of movement trajectory selection, based on assessments to risk associated with possible vehicle D occupants injury (the strategy of the lesser evil). In autonomous vehicle (A) there are no people. The basis for this selection of the driving strategy in analyzed critical situation are the results of the numerical modelling of the vehicles' collision effects. This paper is an extension of [1].

2. Research methods

The research carried out (example in fig. 1) have shown the relations between the selected CT set driving trajectory and possible consequences of the vehicles' collision. Set of these relations from the model research, can be stored in the autonomous vehicle controller memory and be used by for selection the movement trajectory in an obstacle avoidance maneuver.

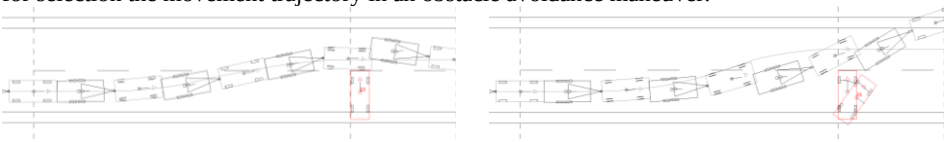

Fig. 1. Road traffic situation, depending on the selection of draiving trajectory

In this study, short-term vehicles collision proces is analyzed (various variants of road collisions) in order to determine the risk indicators for occupants (research results example in fig. 2). The 10 degree of freedom (DOF) model of CT set was developed. The vehicle D has 6 DOF and occupant/driver dummy (Hybrid III) has 19 DOF.

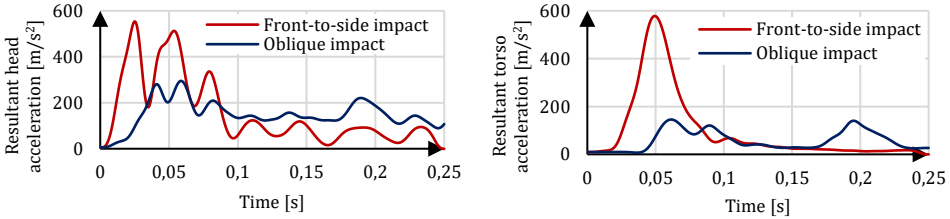

Fig. 2. The course of the vehicle D occupant head acceleration (left figure) and torso (right figure) during a front-to-side and oblique impact

During assessment of the injury risk was used so-called risk curves in the AIS scale (Abbreviated Injury Scale). The total risk of injury (P_{Joint}) for a side impacts in percent is calculating:

$$P_{Joint} = 1 - (1 - P_{head})x(1 - P_{chest})x(1 - P_{abdomen})x(1 - P_{pelvis})\ 100\%$$

where: P_{head} *=f(HIC);* P_{chest} *=f(chest displacement);* $P_{abdomen}$ *=f(the resultant force acting on the abdomen);* P_{pelvis} *=f(force acting on the pelvis).*

Mentioned above risk indicators are determined for the set of collision variants in the range of driving speeds 40-90 km/h for the CT set and the impact angle 0-90 deg of the vehicle D. This has made it possible to further planning of the trajectories, which would decrease injuries risk indicators of he vehicle D occupants to lowest possible level in investigated critical road situation.

References

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