Testing and modelling a car-driver system in the situation of a road accident

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Abstract

One of the current, not fully recognised, issues is with testing the parameters that describe a driver's behaviour in a critical situation. Results of such tests are required to design and improve active computer-aided safety systems in vehicles that can predict the driver's behaviour in a critical situation. Findings of these tests could be also useful in the driver training process. The problem is particularly valid for professional drivers, for whom a vehicle is also their workplace. In addition, their response to road conditions may be different than in the case of amateur drivers. A driving simulator that can realistically reproduce a wide range of situations with accidents and record drivers' behaviour is a good and modern tool for carrying out such tests.

The aim of the work was to develop mathematical models describing human response (operator in the car-driver system) to an accident-risk situation.

As part of this work, experiments were conducted with the use of a car simulator placed on a Stewart platform to record drivers' behaviour in accident-risk situations and during normal driving. The test session was a key part of the study programme and was the same for each subject. It ended with an accident situation where a pedestrian ran onto the road in front of the subject's car from the right side. Before the accident, various potentially dangerous situations were arranged and the driver's responses to them were recorded. These situations included: following an "awkward" vehicle, turning left into traffic and driving on a curve. The tests were carried out with participation of professional drivers (n=60) and amateur drivers (n=59), in order to compare these two groups.

In addition, each driver was examined according to their intellectual capacity, cognitive processes and psychomotor capacity with the use of tests selected from the Vienna Test System – a set of tests recognised as an international standard for the evaluation of drivers in terms of their capabilities and capacity to drive a car.

The results were used to develop mathematical models describing human response (operator in the car-driver system) both in an accident-risk situation and in a variety of other situations. The models are based on the knowledge of control theory.

The test has demonstrated that it is possible to define models describing the driver's responses to changing road conditions during normal driving. The models are defined by parameters that can be determined in real-life conditions by measuring such values as speed and distance to the preceding vehicle. In addition, parameters specific for these models were linked with parameters of accident situation models. Therefore, they can serve as predictors of behaviours in a road accident situation. Such information may be useful for designers of automotive active safety systems that help mitigate consequences of collisions with pedestrians; with particular consideration for the differences between the results recorded for professional drivers and amateur drivers. Another conclusion that can be drawn from the test is that psychological test results can be used as predictors of behaviour in a road accident, as accurate, reliable and objective indicators of the driver's capacities and capabilities.

The thesis is concluded with a summary of key findings and the identification of needs and perspectives for further research.

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