Injury probability functions for pedestrians and bicyclists based on real-world accident data

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Abstract

The paper is focusing on the modelling of injury severity probabilities, often called as Injury Risk Functions (IRF). These are mathematical functions describing the probability for a defined population and for possible explanatory factors (variables) to sustain a certain injury severity. Injury risk functions are becoming more and more important as basis for the assessment of automotive safety systems. They contribute to the understanding of injury mechanisms, (prospective) evaluation of safety systems and definition of protection criteria or are used within regulation and/or consumer ratings. In all cases, knowledge about the correlation between mechanical behavior and injury severity is needed. IRFs are often based on biomechanical data. This paper is focusing on the derivation of injury probability models from real world accident data of the GIDAS database (German In-depth Accident Study).

In contrast to most academic terms there is no explicit term definition or definition of creation processes existing for injury probability models based on empirical data. Different approaches are existing for such kind of models in the field of accident research. There is a need for harmonization in terms of the used methods and data as well as the handling with the existing challenges. These are preparation of the dataset, model assumptions, censored/unknown data, evaluation of model accuracy, definition of dependent and independent variable, and others. In the presented study, several empirical, statistical and phenomenological approaches were analyzed regarding their advantages and disadvantages and also their applicability. Furthermore, the identification of appropriate prediction parameters for the injury severity of pedestrians has been considered. Due to its main effect on injuries of pedestrians and bicyclists, the importance of the secondary impact has also been analyzed. Finally, the model accuracy, evaluated by several criteria, is the rating factor that gives the quality and reliability for application of the resulting models.

After the investigation and evaluation of statistical approaches one method was chosen and appropriate prediction variables were examined. Finally, all findings were summarized and injury risk functions for pedestrians in real world accidents were created. Additionally, the paper gives instructions for the interpretation and usage of such functions. The presented results include IRFs for several injury severity levels and age groups.

The presented models are based on a high amount of real world accidents and describe very well the injury severity probability of pedestrians and bicyclists in frontal collisions with current vehicles. The functions can serve as basis for the evaluation of effectiveness of systems like Pedestrian-AEB or Bicycle-AEB.