

Methodologies in the use of Human Body Models for passive safety of vehicles

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Vehicles for transport of people have become safer since their birth, in particular in the last years. However, the safety level of vehicles is far from satisfying the EU plans to reach zero road deaths by 2050, the so called "Vision Zero" global strategy. The Finite Element (FE) simulation of accidents is a key instrument for the design of safer new vehicles, allowing faster and more detailed investigation. Moreover, Human Body Models (HBMs) allow more detailed injury analysis in several conditions, not carried out with expensive and time demanding experimental tests.

In this framework, the target of this work is to analyze different methodologies in the use of HBMs. The main challenges are in the pre-processing phase, during the positioning of the body inside the vehicles and in the post-processing phase. In the analysis of the results, it is necessary to obtain clear results, easy to read and accessible to people with different expertise. Moreover, the post-processing phase can be highly time-consuming, considering the complexity of the HBMs and the amount of information that can be examined. Therefore, in detail, the target of this work is the comparison between some methodologies that can be used for the positioning of the HBMs, in the pre-processing phase, and in the analysis and visualization of the results, in the post-processing phase.

For the positioning, two different methodologies were tested, simulating a small rotation of the head. The movement was defined with reference to postures that the occupants can have during autonomous driving. The simulations were repeated using two different HBMs, namely THUMS and VIVA.

For the injury evaluation in the post-processing phase, after defining the injuries to be evaluated and how to measure them, a procedure was developed to get the strain of the neck muscles, cervical ligaments and intervertebral discs in automatic way. Injuries on these three anatomical components are the main cause of pain generation following an accident, according to the literature. The results of the previous simulations on the two HBMs were used for this task.

The comparison of the positioning methodologies, confirmed as the simulation-based methods are more time-consuming but more accurate, ensuring more affordable FE models.

The analysis of the strain of the neck muscles, cervical ligaments and intervertebral discs, showed the difference between the two HBMs models and the influence of a small movement of a body region in the injury evaluation.

The work provides guidelines for researchers and FE analysts who want to use HBMs in an efficient way, reducing the time for the set-up of the FE analysis and obtaining clear results with a short time post-processing phase.

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