Hybrid human model for industrial applications

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In the transportation industry, safety of the occupant is an important issue of the research and development. Production and development of safety systems is based on experiments such as crash-tests in which the human body is represented with physical models such as standard dummies. However, numerical simulations become to play more and more important role in the process supporting and sometimes substituting the physical tests. For that purpose, development of the computational model of the human body is a challenging task. Two types of the models are usually distinguished. Articulated rigid body models (ARB) are based on the multi-body structure (MBS) consisting of rigid bodies connected via joints. Finite element models (FEM), on the other hand, are fully deformable.

In this work we present a development of the hybrid human model for the applications in transportation industry, namely for the safety assessment. It combines both multi-body structure and the deformable elements to profit from both approaches. For instance, it is easy to position, requires low computational time and still it allows for the deformations of individual body parts and evaluating of injury criteria. Due to the scaling algorithm implemented, it respects the variety of human population in mass, weight and age.

Important task of the model development is to ensure its biofidelity. Therefore, extensive validation has been done including impact scenarios with various impactors, impact energy levels and directions. Validation tests have been performed with individual body parts as well as whole body comparing the results with experimentally observed response of post-mortem human surrogates (PMHS).

Due to the variety of validation tests, the biofidelity of the model for the multi-purpose use is ensured. For instance, possible applications of the model in the transportation safety include accidents reconstruction, virtual prototyping and safety assessment of various transportation means.