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Design Optimization Procedures for the Validation of Generic Road Vehicles

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ABSTRACT

The introduction and broad application of modern high performance computing during the past two decades has dramatically transformed the automotive design and engineering process. Auto manufacturers now simulate collisions on high performance computers, reducing development costs and substantially shortening design cycle times. Design of automotive structures for passenger safety during crash uses an iterative process where design changes are made and the structure is re-analyzed for its response. An evaluation of any design change requires simulation of the system, which is a nonlinear dynamic problem. New materials and structural design do not allow a design based in intuition or in re-evaluation of older models. Numerical methods for simulation of automotive crash events have been developed, and many finite elements programs have become available, greatly enhancing the state of the art for simulation of the various crash events. But on the other hand, finite element models are usually very large having tens of thousands of degrees of freedom. As a result, the number of calculations for a realistic simulation is extremely large requiring enormous computing time. Therefore it is desirable to develop models that can be used at the conceptual design development stage for quick analysis and redesign [1].

Another important difficulty for all those want to use realistic model of road vehicles in crash environments is the fact that generally the vehicle manufacturers are unable to release the detailed data for their models, even for older models, due to commercial and legal restrictions. A solution to this problem is the development of virtual vehicle models that have the same response of the detailed models for selected crash scenarios studies. Such response can be measured in terms of accelerations of given points in the vehicle structure or dummy component, energy absorption characteristics of subsystems, intrusion measures or by any other measurable characteristic of the crash. As an example of application of this virtual model, a developer would be able to tackle the task of devising a subcomponent or protective system for a selected part of the vehicle being assured that the overall behavior of such vehicle is indeed correct [2].

The development of a complete multibody vehicle model to be used in front and side

impact crash scenarios is presented here. After devising the topological structure of the multibody system that represents the structural vehicle components and that is able to describe the most relevant mechanisms of deformation it is necessary to identify the constitutive behaviour of the plastic hinges so that the vehicle response is that of a reference vehicle. This task is undertaken by using an optimization procedure based on the minimization of deviation between the observed response of the vehicle model and the reference response. The vehicle model obtained is said to be validated and constitutes a virtual model of the reference vehicle.

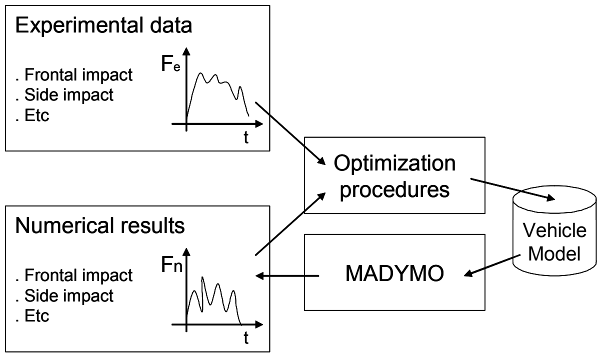

Figure 1. Scheme of the methodology used for validation of Multibody vehicle models based on optimization procedures

This work presents the methodology and example applications of the validation of a generic car vehicle for crash impact, in terms of some interesting defined objectives, for example accelerations, velocities, intrusion deformations.

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