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SIMPLE AND EFFICIENT MULTIBODY VEHICLE DYNAMICS USING MATLAB AND C++

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ABSTRACT

This article presents a simple and powerful simulation framework for the dynamic analysis of complex multibody vehicle models. The framework is based on an efficient semi-recursive multibody formulation which makes the most of the system's topology and achieves better computation times than those of commercial multibody tools. The implementation is mainly carried out in MATLAB™, though two of its core functions have been programmed as MEX-functions in C/C++ to improve its efficiency.

With this framework the development of programs is rapid and clean, and different algorithms can be easily compared. Moreover, this approach has all the advantages of in-house programmed models against other commercial programs, among which the main ones are the versatility, the capacity of configuration and the easiness of making advanced data pre and post-process. It includes realistic contact forces on the tyres and thread-independent 3D graphics for the visualization of the simulated manoeuvres, allowing a rapid generation of the parts which cannot be imported as CAD models.

As specific examples of complex models developed with this framework the authors present three vehicles with exact suspension geometry and realistic forces: a coach, a Formula SAE racing car and a semi-trailer truck. The chosen manoeuvre for the simulations has been a multiple slalom test along a flat road.

The integration, despite the big variation of some of the forces (like the contact forces), remains stable, and real-time computations are achieved in the coach and the racing car, and almost achieved in the truck. Then, a complete analysis of their efficiency, in terms of computation times, is carried out. The results prove that the specific implementation reduces the computation times between two and three orders of magnitude with respect to an entirely MATLAB-programmed program.

Summing up, the presented framework turns out to be an economic, versatile, rigorous and efficient multibody program which allows reliable vehicle dynamic simulations and which opens the door to other applications like onboard control devices or real-time highly accurate vehicle simulators.