Load Simulation in Vehicle Engineering

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Nowadays, simulation of system loads plays an important role in the development cycle of a vehicle. In various stages of design, development and testing, the system under consdieration is simulated to get insight and a deeper understanding of the system's behaviour and durability. This is substantially important in the area of commercial vehicles, agricultural and construction machines, where one is faced with large variability in customer usage as well as in product variants. Thus, here it is crucial simulate and to predict the system's behaviour without being forced to early measure and test every product variant in any possible application scenario. The vehicles in this field are typically modelled as flexible multibody systems, i.e., mathematically described by the corresponding equations of motion as differential equantions (ODEs or DAEs).

In order to simulate different variants of a vehicle, it is necessary to have appropriate input quantities that are invariant with respect to the variants under consideration. An important example for such quantity is the road profile. In this contribution, we present an approach to compute (virtual) road profiles based on measurements of a specific vehicle that are not invariant - such as wheel forces - and a multibody system model of the measurement vehicle. The strategy is to consider this task as an optimal control problem, cf. [1], and to apply function space methods to analyze it and to solve it.

Second, we give a brief overview of other numerical simulation methods that we use and develop in our activitites in the automotive and commercial vehicle area for load simulation. For instance, real-time co-simulation schemes for coupled full-vehicle-tire simulation at our driving and operation simulator RODOS®, see [2].

References

[1] M. Burger, *Optimal Control of Dynamical Systems: Calculating Input Data for Multibody System Simulation*. Dissertation, TU Kaiserslautern 2011, Verlag Dr. Hut, München, 2011.

[2] A. Gallrein, M. Bäcker, M. Burger and A. Gizatullin, *An Advanced Flexible Realtime Tire Model and its Integration Into Fraunhofer's Driving Simulator*. SAE Technical Paper 2014-01-0861, 2014.