

Constrained Structural Optimization of Dynamic Mechanical Systems

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The method of flexible multibody systems is a well-established way to model and analyze mechanical systems, whose components undergo both large rigid-body motions and deformations. The simulation models can be used not only to determine the dynamic loads on the components but also in simulation-based optimization. For instance, in structural optimization, the objective is often to find an optimal lightweight design of the components which shows no undesired vibrations or deformations under the dynamical loads. Considering the full dynamic system in the optimization, a large, nonlinear, and continuous optimization problem must be solved. It has been shown, that gradient-based optimization algorithms in combination with a dual method are an efficient way to tackle these optimization problems, as long as the number of constraints remains small. Stress and deformation constraints, however, have to be satisfied at each point of the body and, for dynamic systems, also at each time point. Therefore this talk aims to present two different aggregation strategies to consider time- and space-dependent constraints in the optimization of flexible multibody systems. On the one hand, an equivalent integral formulation is used to transform a set of inequality constraints into one equality constraint. On the other hand, a conservative approximation from all inequality constraints is derived using the Kreisselmeier-Steinhauser function. Both approaches are tested by means of a flexible slider-crank mechanism, whose piston rod is optimized using topology optimization.