

Large-Scale Gradient Computation in Flexible Multibody Systems

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In the analysis and optimization of flexible multibody systems, the gradient computation is often a necessary step. Considering a gradient-based optimization of a flexible multibody system, the sensitivity of an objective function with respect to the design variables is required. The gradient computation is based on the complete time-dependent solution of the flexible multibody system, and is a computationally expensive step. Therefore, in many of the previous works on optimization of multibody systems, only low dimensional optimization problems have been considered. For systems where the number of design variables is high, for instance, in topology optimization, the computational cost becomes unfeasible in the sense of time and resources. As a result, the size of dynamic topology optimization problems has been strongly limited. This work addresses the efficient and fast gradient computation for systems with a high number of design variables. In this framework, first the automatic detection and elimination of negligibly small derivation terms are introduced, which increases the computational efficiency without deteriorating the accuracy of gradients. Second, the parallelization of the gradient computation is discussed. Both approaches are tested on the application example of a flexible 3D slider-crank mechanism which is optimized using a gradient-based topology optimization method. With the parallelization and the introduced elimination of negligible terms in the gradients, it is shown that the gradient computation can be carried out in a feasible time with respect to more than 100000 design variables.