Low Operational Order Analytic Sensitivity Analysis for Tree-type Multibody Dynamic Systems

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Abstract

Computing first-order sensitivity information is crucial for many gradient-base optimization strategies, where the algorithms employed play a key role in determining the computational efficiency of an optimization process. For complex multibody system optimization problems, the numerical accuracy, stability, convergence characteristics, and computational order of the underlying formulations all contribute to the overall cost of the optimization process. The computational efficiency of the underlying forward problem, and the associated sensitivity analysis must each be considered if one is to properly manage these design problems under time and computational resource constraints. This paper presents an algorithm which determines the key state derivatives, central to first order sensitivity analysis, in a fully recursive manner. The algorithm significantly reduces the cost of determining analytic first-order sensitivity information for large-scale, tree-type multi-rigid-body dynamic systems. Qualitative and quantitative validation on the operational requirement of the present method are made through analytical means and empirical studies.

Key words: multibody optimization, sensitivity analysis, recursive algorithm, Order-n

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