# A level set approach for the structural optimization of flexible mechanisms

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## Abstract

With the evolution of virtual prototyping, mechanical systems are commonly analyzed using a multibody system (MBS) approach to study the behavior of the entire system and notably the dynamic interactions between the components.

Modern structural optimization of mechanical systems considers the dynamic loading exerted on the individual flexible components. The consideration is an essential feature and can be implemented in two ways. Firstly, one can consider a strong coupling wherein the component's optimization is performed using the time dependent loading conditions coming directly from the MBS simulation. Secondly, one can consider a weak coupling wherein the component's optimization is performed using a series of static load cases that do not fully account for the interactions between the components of the MBS. Rather this approach performs a MBS simulation to evaluate the loads for the initial design and then optimizes the component assuming the loads do not change. The process of evaluating the loads and then performing the optimization is repeated until suitable convergence criteria is satisfied, assuming convergence is possible.

The present paper focuses on the strong coupling method wherein the flexible MBS dynamic analysis is based on a nonlinear finite element formalism [1]. A level set (LS) description of the component geometry is used to enable a generalized shape optimization. The LS approach combines the advantages of shape and topology optimizations. Moreover, since the component boundaries are defined by CAD features, the manufacturing process is facilitated as no post-processing step of a rasterized design is required. The design sensitivity analysis for MBS is revisited in order to facilitate its implementation. The optimization of a slider-crank mechanism and a 2-dof robot is provided to exemplify the procedure.

References

[1] Géradin M., Cardona A. (2001) Flexible Multibody Dynamics: A Finite Element Approach. John Wiley & Sons, New York.