Design of functionally graded fully compliant mechanisms using topology optimization method with model order reduction

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Abstract

The idea behind multi-material structures is to take advantage of the continuous change of its property to design the hinge regions of compliant mechanisms. This allows the improvement of the output displacement and reduces the stress concentration by softening those regions. The Topology Optimization Method (TOM) is a strong technique to the design of those mechanisms.

To the best knowledge of the authors, previous works on design of fully compliant mechanisms using topology optimization didn’t address any technique to reduce the computational effort needed. Our approach herein is to apply the Model Order Reduction (MOR) to reduce the computational effort needed to solve the linear system.

The presented MOR is a Galerkin projection coupled with an adaptive strategy in the snapshot selection stage. The current equilibrium residual and convergence rate are compared between the full space and the reduced projection space. The reduced projection space is updated to reach the minimum error in displacement as well as the pseudo-density.

Results are presented to compare the proposed methodology with the traditional TOM methodology. The optimization problem is to find the configuration that has the maximum displacements when subject to a prescribed displacement, volume constraint and equilibrium. The material model used was the SIMP. The OC algorithm was used to impose the volume constraint.

Keywords: *topology optimization method, model order reduction, graded materials, compliant mechanisms