Compliant Mechanism Design with Stress constraint using Topology and Shape Optimization

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ABSTRACT

In the present study, we use a combination of topology and shape optimization to design a compliant mechanism with stress constraints. A compliant mechanism obtained using topology optimization usually contains hinges subject to very high stress. One way to avoid hinges with high stress is by introducing stress constraints.

To this end, in our approach, a sequential density-based topology and node-based shape optimization are used to address this problem. To start with, in the topology optimization phase, the objective is to maximize the output displacement with a volume constraint by updating the density variable. Next, we post-process the result of topology optimization to obtain the geometry of the compliant mechanism. Finally, in the shape optimization phase, we use the geometry from the previous step and introduce an additional p-norm stress constraint to the optimization problem. We then update the node variable to obtain a design with a lower stress concentration.

The sequential topology and shape optimization with the consideration of stress constraint in the shape optimization phase is the novelty of the present work. This allows us to get the best of both techniques: (1) consideration of the topology optimization techniques to obtain the mechanism layout (2) use of the shape optimization techniques to consider stress constraint.