Single level confidence structural robust optimization with stiffness uncertainties

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Keywords: *Robust design and optimization; Parameter uncertainty; Nonlinear semi-definite program; Confidence robust optimal solution.*

Abstract

Most of the structural behavior constraints involved in structural robust design and optimization are *non-convex* functions of design variables. Therefore if local optimality criteria based optimization algorithms are employed to find the worst case structural responses that are used for examining the feasibility of a given design, it is highly possible that the optimization process will get stuck in a local optimum. If this is the case, the reliability of a “robust” design cannot be guaranteed, at least theoretically. Moreover, Bi-level formulation is often used to solve the structural robust optimization problems. This often involves large computational efforts and sometimes the convergence behavior is not so good because of the non-smooth nature of the Bi-level formulation.

In order to overcome the above-mentioned difficulties, a single-level nonlinear semi-definite programming (NSDP) formulation for confidence structural robust optimization is proposed. This is achieved by using some technical tools such as S-procedure and quadratic embedding in convex analysis. The resulting NSDP problem is then solved with the Augmented Lagrange multiplier method with sound mathematical properties. Furthermore, the deficiencies of the naive single level formulation in literatures are also analyzed. Numerical examples show that confidence robust optimal solutions can be obtained with the proposed approach effectively.