A Feasible Direction Algorithm for Structural Optimization with Semidefinite Constraints

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ABSTRACT

Nonlinear Semidefinite Programming (SDP) deals with nonlinear optimization problems that include semidefinite constraints on symmetric matrix-valued functions. We employ a finite element based formulation for structural optimization that considers local mechanical constraints, like stresses or nodal displacements, and SDP constraints. SDP constraints are employed to impose structural stability or bounds on the fundamental frequencies. In free material optimization, the elastic material tensors of elements are design variables and positive definiteness constraints on these matrices have to be considered.

A numerical solution of this problem is obtained with FAIPA_SDP, a feasible directions interior point algorithm for nonlinear optimization with vector and matrix constraints, [1]. FAIPA_SDP is based on the iterative solution in the primal and dual variables of Karush-Kuhn-Tucker optimality conditions and generates a feasible decreasing sequence.

At each iteration, to compute a feasible descent direction, FAIPA_SDP solves two linear systems with the same matrix. An inexact line search is then performed in order to determinate the new iterate. Feasible iterates are essential in applications where feasibility of some of the constraints is required to be able to compute the objective functions or some of the remaining constraints.

This is the case in free material optimization where positive definite material matrices are required to make possible the structural analysis. A particular formulation of FAIPA_SDP that takes advantage of the stiffness matrix structure is presented. We describe and discuss some numerical results with some test problems.

REFERENCES

[1] Aroztegui, Miguel; Herskovits, José; Roche, Jean Rodolphe and Bazán, Elmer. A feasible direction interior point algorithm for nonlinear semidefinite programming. Structural and Multidisciplinary Optimization (Internet DOI 10.1007/s00158-014-1090-2) (2014)