Design of Planar Articulated Mechanisms Using Branch and Bound

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In this talk we present an optimization model and a solution method for optimal design of two-dimensional mechanical mechanisms. The mechanism design problem is modeled as a nonconvex mixed integer program which allows the optimal topology and geometry of the mechanism to be determined simultaneously. The underlying mechanical analysis model is based on a truss (pin jointed assembly of straight bars) representation allowing for large displacements. For mechanisms undergoing large displacement elastic stability is of major concern. We derive conditions, modeled by nonlinear matrix inequalities, that guarantee that a stable mechanism is found. The feasible set of the design problem is described by nonlinear constraints as well as nonlinear matrix inequalities.

To solve the mechanism design problem a branch and bound method based on convex relaxations is developed. The relaxations are strengthened by adding valid inequalities to the feasible set. Encouraging computational results, which will be presented, indicate that the branch and bound method can reliably solve mechanism design problems of realistic size to global optimality.