

constraints. When the latter ones are modeled as second-order cone constraints, the optimization problem falls into the SOCP category. Typically the constraints contain linear equalities and inequalities, as well as cone constraints. The objective function embodies the criterion used to select the "most desirable" force vector, among the feasible ones. We are currently collecting data from the literature and testing how well our approach works for this class of problems.

### **A New Algorithm for Identifying all Global Maxima Based on Simulated Annealing**

**4991**

**A. I. P. N. Pereira<sup>1</sup>, E. M. G. P. Fernandes<sup>2</sup>**

(1) Polytechnic Institute of Bragança, Bragança, Portugal  
(2) University of Minho, Braga, Portugal

In this paper we consider the problem of finding all the global maximizers of a given nonlinear optimization problem. This type of problem appears, for example, in the phase-shift analysis of experimental data on scattering in nuclear and elementary particle physics and in a local reduction method for solving semi-infinite programming problems.

The simulated annealing (SA) method is a stochastic method and it is well documented in the literature. Its most important property, as a global optimizer, is that asymptotic convergence to a global solution can be proven. However, in general, the SA algorithm finds just one global optimum. The function stretching technique carries out a two-step transformation of the objective function aiming to eliminate local optima while preserving the global ones. We propose a new algorithm which combines the SA algorithm with a function stretching, to generate a sequence of nonlinear maximization problems that are defined whenever a new maximizer is identified. To find all global maximizers, we apply the SA algorithm to this sequence of maximization problems.

Results of numerical experiments with a set of well-known test problems in the global optimization literature show that the proposed method is effective. We also compare the performance of our algorithm with other multi-local solvers.

### **An Augmented Lagrangian Relaxation for Analytical Target Cascading Using the Alternating Directions Method of Multipliers**

**5731**

**Simon Tosserams<sup>1</sup>, L.F. Pascal Etman<sup>1</sup>, Panos Y. Papalambros<sup>2</sup>, J.E. (Koos) Rooda<sup>1</sup>,**

(1) Department of Mechanical Engineering, Eindhoven University of Technology, Eindhoven, The Netherlands  
(2) Department of Mechanical Engineering, The University of Michigan, Ann Arbor, Michigan, USA

Analytical Target Cascading (ATC) is a method for design optimization of hierarchically decomposed multilevel systems. ATC subproblems are defined by introducing target and response variables that couple the subsystems of the original system. During the iterative solution inconsistencies between target and response variable values are minimized using a quadratic penalty function. Typically, a nested solution strategy is used consisting of an inner and an outer loop. In the inner loop subproblems are solved with fixed penalty weights while in the outer loop these weights are updated with information from the inner loop. Two sources of computational cost associated with solving the decomposed ATC problem are observed. First, accurate solutions can often be obtained only with large penalty weights, which can also introduce ill-conditioning of the subproblems. Second, subproblems are not independent and their solution has to be coordinated within the inner loop, meaning that subproblems may have to be solved many times before the algorithm can return to the outer loop. The article introduces the use of an augmented Lagrangian function to obtain accurate subproblem solutions for relatively small weights. To reduce the computational cost of coordination in the inner loop, an alternating directions method of multipliers is used. Instead of updating penalty parameters at convergence of the inner loop, the alternating direction method updates the penalty parameters after a single inner loop iteration. Inner loop coordination is reduced to solving subproblems only once. These new strategies are demonstrated on four example problems and compared to the quadratic penalty function currently used for ATC. Computational costs for the tested problems are decreased by orders of magnitude ranging between ten and one thousand.

### **Numerical Solution of Cohesive Crack Problems Through Optimization Method**

**5601**

**M. Bruggi, C. Cinquini, P. Venini**

Department of Structural Mechanics, University of Pavia, Pavia, Italy

A new approach for cohesive crack propagation in elastic media is presented. Once it is recognized that discontinuous displacements and continuous tractions are the basic ingredients of any approach for cohesive crack propagation, the distinctive feature behind our technique is the development of a novel and enriched version of the Hellinger-Reissner variational principle that induces inherently continuous tractions and discontinuous displacements. Interface softening laws between adjacent elements are added in a natural way wherever the crack is evolving.