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AN ALGORITHM FOR CONSTRAINED OPTIMIZATION WITH APPLICATIONS TO THE DESIGN OF MECHANICAL STRUCTURES

Cristian Barbarosie[1], Sérgio Lopes[2], Anca-Maria Toader[1]

[1]CMAF-CIO, Lisbon University, Portugal
cabarbarosie@fc.ul.pt, atoader@fc.ul.pt

[2]CMAF-CIO, Lisbon University and ISEL, Instituto Politécnico de Lisboa, Portugal
slopes@adm.isel.pt

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Abstract: We propose an algorithm for minimization of a functional under constraints. First, an algorithm for minimization under equality constraints is devised. It uses first-order derivatives of both the objective function and the constraints. The step is computed as a sum between a steepest-descent step (which minimizes the objective functional) and a correction step related to the Newton method (which aims to solve the equality constraints). The linear combination between these two steps involves coefficients similar to Lagrange multipliers which are computed in a natural way based on the Newton condition. The algorithm uses no projection and thus the iterates are not feasible; the constraints are satisfied only in the limit (after convergence). A local convergence result is proven for a general non-linear setting, where both the objective functional and the constraints are not necessarily convex functions. In a second stage, this algorithm is extended, by means of an active set strategy, to the case of inequality constraints. Active constraints are treated as equality constraints. Inequality constraints are activated as soon as they are violated. However, they are not deactivated as soon as they become fullfilled. Instead, a deactivation criterion is used, based on the sign of the associated Lagrange multiplier. As a (trivial) third step, the algorithm is generalized in order to deal with minimax problems, which are relevant for structural optimization. An example of worst case design is discussed in the framework of optimization of mechanical structures with multiple load cases. Numerical results are presented.