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A family of MMA approximations for structural optimization

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This paper deals with the approximation concepts approach applied to structural optimization. In 1987, Svanberg proposed the method of moving asymptotes for solving structural optimization problems. This approximation is monotonous and can efficiently treat problems characterized by such a behavior. Svanberg (1995) proposed a modification of the MMA approximation by making it non monotonous. This property is based on an heuristically updated parameter. The resulting approximation is called GCMMA. In Bruyneel et al. (1999), it is shown that it is possible to generate non monotonous GCMMA based approximations, called GBMMA, by using the gradient and/or the function values from previous iteration. It was shown that such approximations improve the convergence speed of the optimization process.

In many optimization problems (for example composite structures optimization or simultaneous sizing and optimal configuration of truss structures), the structural responses present both monotonous and non monotonous behaviors. A mixed monotonous/non monotonous approximation scheme has to be used for approximating in the best way the optimization problem (Zhang et al., 1998 and Bruyneel and Fleury, 2000).

In this paper, we propose to show that it is possible to derive a very general approximation of the MMA family based on gradients and/or functions values at two successive design step, that present a mixed monotonous/non monotonous behavior. This approximation scheme is based on the GMMA approximation of Dusyinx et al. (1995) and on the non monotonous GBMMA approximations of Bruyneel and Fleury (1999).

As the approximation scheme proposed in this paper is general, it contains all the approximations of the MMA family described above, that is MMA, GCMMA, GBMMA and GMMA. According to the characteristics of the problem under consideration, one of those approximations or of a mix of them is used to solve the optimization problem. This selection can be automatic or based on the designer's knowledge.

Numerical applications will show that the derived GMMA/GBMMA approximation scheme is efficient for solving structural optimization problems. Results will be compared with the ones obtained with the other approximations of the MMA family.

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