New approximations for sequential optimization with discrete material interpolations

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Abstract

The Discrete Material Optimization (DMO) [1] is a novel technique employed in structural optimization problems, dealing with the choice of discrete candidate materials over a certain structural domain. It is based in the use of material interpolations, functions of design variables, which can be seen as weighted sums of the candidates. Its goal is to select the weights' values by means of optimization techniques, in a way that the material being represented by the interpolation can assume the constitutive characteristics of one and only one of the proposed candidates.

At the literature, the DMO was successfully employed in optimization problems of laminated composites, where it was desired to find orientation stacking sequence and material distribution in laminae of plates and shells. Such problems involve in their formulation compliance [1], natural frequencies [2], buckling loads [2,3], etc. The solutions of these problems were all obtained by the Method of Moving Asymptotes (MMA), which is grounded in Sequential Approximate Optimization (SAO) concepts (also known as Approximation Concepts in optimization) [4].

However, in many cases, such results do not provide final designs showing full convergence to well (uniquely) selected materials. This work presents a new solution strategy to DMO problems based on improvements in SAO techniques, by proposing a new class of second generation approximations [5] based on defining DMO weights as proper intermediate variables. The results obtained show that such approximations provide superior convergence to DMO problems in terms of better and uniquely selected materials, in cases of membrane structures where compliance is minimized, in comparison to previous results of the literature.

Keywords: discrete material optimization, sequential approximate optimization, second generation approximations

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