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INVESTIGATION OF INITIAL DESIGN INFLUENCE IN TOPOLOGY OPTIMIZATION

Jimmy Schoubroeck, Matthijs Langelaar, Deepak Gupta

TU Delft, Netherlands
jimmy@vanschoubroeck.com, m.langelaar@tudelft.nl, d.k.gupta@tudelft.nl

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Abstract: Topology optimization problems are large-scale and non-convex, in which the initial design plays an important role. Functioning as the starting point for the optimization algorithm, it influences the quality and the computational cost of the final design. Although this is well known in the topology optimization community, a homogeneous density distribution is traditionally chosen. As topology optimization problems contain an abundant amount of local minima, problem specific initial designs potentially yield better results. Soild-void designs results in slowly occurring and only slight modifications by the optimizer. Generating an initial design using an evolutionary approach [1] proves initial designs that outperform a homogeneous distribution exist, at a high computational cost. Thus far, the influence of the initial design on the quality and total cost of the final design has not been studied systematically. Furthermore, problem dependent initial designs are hardly used. A reason for this might be the lack of a common, systematic method to investigate the relative initial design quality differences. In this contribution, we present three novel ideas to address this gap. First, we define a method to compare and rank the performance of different initial designs in a quantitative manner, inspired on a method previously proposed for ranking optimization algorithms [2]. Second, we compare two new initial design types that require little computational effort to generate, with the conventional homogeneous distribution. The first consists of optimizing the unpenalized problem on a coarsened grid. The second is physics-based, originating from Constructal Theory [3] Third, we investigate the robustness of optimizers by initiating them with an explicitly chosen poor initial design. The comparison of initial designs is performed using three standard optimizers (OC, MMA, IPOPT) using a large set of established mechanical and thermal problems. However, the method can also be extended to other problem types. As the initial designs are tested using a large problem set, their performance ratio can be compared in great detail. One practical result is that for the IPOPT optimizer, initial designs that outperform the homogeneous distribution in the objective exist for all investigated problem cases. Another result is that OC performs poorly when starting from a poor initial design.

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