On the application of IGA to the inverse homogenization problem

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ABSTRACT

The design of periodic microstructures has become a fundamental research area in structural optimization. Finding the topology of such structures, having optimized or prescribed properties is refered to as the inverse homogenization problem. This problem is usually tackled by coupling topology optimization approaches and numerical homogenization using periodic boundary conditions and multiple design depended load cases [1]. The representative volume element (RVE) is usually discretized by a regular, highly resolved mesh and the optimization is parametrized using material penalization approaches. This procedure has been applied successfully to many different demands [2].

However, this problem is highly non-convex and the solution is affected by the starting guess of the optimization. Träff et. al. [3] investigated the influence of different starting guesses for the inverse homogenization problem, minimizing the complementary work of the RVE. One of the starting guesses was created in a systematic way, inspired by non-physical rank-n materials [4], which are projected to non-optimal single scale microstructures, resulting in only two different and simple topologies for all possible loading scenarios. It was also shown that this starting guess does not change in terms of topology during the optimization and that the resulting performance is close to theoretical bounds given by rank-n materials, which often outperforms the competing starting guesses.

This finding is reasoning the application of shape optimization using IGA resulting in computational less expensive parameterization, utilizing the benefits of a smooth boundary and resulting in CAD compatible data. Similar studies have been performed on RVEs for different applications [5, 6]. This contribution aims to discuss some aspects, advantages and disadvantages of the application of IG shape optimization to the inverse homogenization problem.

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