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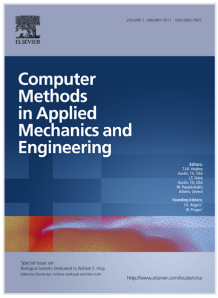

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An Isogeometrical Approach to Structural Level Set Topology Optimization

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Abstract:

This paper aims to utilize the Isogeometric Analysis (IGA) for the level set structural topology optimization. The level set function is parametrized using the Non-Uniform Rational B-Spline (NURBS) basis functions in a higher dimension. The same basis functions are employed for approximating the unknown deformations, geometry modeling of the design domain and the level set function. In this research, three optimization problems including minimization of the mean compliance considering a certain amount of material, minimization of weight with avoiding local stress concentration as well as minimization of weight and strain energy under local stress constraints are dealt with. The sensitivity analyses for the optimization problems are carried out to obtain velocity functions on the boundaries. In order to move the boundaries towards optimum the Hamilton-Jacobi (H-J) equation is solved using the forward Euler scheme. In order to illustrate the performance of the method to obtain reasonable results with smooth boundaries, several numerical examples are presented and compared with well-known problems in literature.

Key words: Isogeometric Analysis, Level Set Method, Topology Optimization

1. Introduction

In order to describe topology of a structure, several methods have been introduced in topology optimization literature. In pioneering works by Bendsøe and Kikuchi in 1988 [1], the optimization problem is parametrized by introducing microstructures model of materials such as square cells with centrally-placed rectangular void, where dimensions of voids are considered as design variables of the problem. Afterwards, the homogenization method gives the macroscopic properties of materials [2]. Also, an artificial material, called Solid Isotropic Material with Penalization (SIMP), was proposed to prevent the complexity of using homogenization and to eliminate gray areas in optimum layouts [3–6]. Since the microstructures are individually defined in each finite element of the domain discretization, these methods are called element based topology optimization. Therefore, a difficulty is that the obtained layouts are not independent from the employed finite element mesh. In addition, the instability of checkerboard pattern is occurred when lower order finite elements are used [7].

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