Improvement in 3D Topology Optimization with *h*-adaptive refinement using Cartesian Grids Finite Element Method (*cg*FEM)

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ABSTRACT

Topology Optimization is a well-known iterative procedure where the Finite Element Method (FEM) is required to obtain the objective functions and constraints. In case of structural optimization, the compliance, which represents the strain energy, is used as objective function [1], and volume is stablish as constraint.

A higher performance of the FEM could be achieved if the elements that conform the mesh have the same shape. Usually, this is impossible in traditional FEM solvers. In this work, we propose the Cartesian Grid Finite Element Method (*cg*FEM [2]) as an alternative to traditional FEM solvers. The main features of this method are: 1) the use of Cartesian element meshes and, 2) an efficient hierarchical data structure.

In addition, we propose to implement and *h*-adaptive refinement procedure [3] in the main loop of optimization in order to improve the accuracy of the contour definition. Starting from a uniform distribution of densities, in each step of the iterative process, the algorithm generates a new layout of material. Before convergence, those elements whose densities didn't reach one of the prescribed limits, will be refined. The optimization process continues until convergence or the need of a new refinement.

As a result of this implementation, the geometry obtained is quite similar to those with a coarser mesh, but with a better definition of the contour. Usually, this feature of the optimized components eases their manufacturing.

The main improvement carried out in the current work is the use of a single subdivision of the analysis mesh to compute some local calculations such as the filtering or the updating scheme. As a result, greater geometric definition is achieve without increasing the computational cost. In addition, some information of the internal behaviour of the elements is gathered.

Keywords: Topology Optimization, *cg*FEM, *h*-adaptivity

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