H-adaptive mesh refinement process for structural optimization processes based on sensitivity analysis

O. Marco*, J.J. Ródenas*, E. Nadal*, J. Albelda*, M. Tur*, F.J. Fuenmayor*

* Research Centre in Mechanical Engineering (CIIM)
Universitat Politècnica de València
Camino de Vera s/n (Edificio 5E), 46022 Valencia, Spain
e-mail: onmaral@upvnet.upv.es, jjrodena@mcm.upv.es, ennaso@upvnet.upv.es,
jalbelda@mcm.upv.es, matuva@mcm.upv.es, ffuenmay@mcm.upv.es

ABSTRACT

Strucutral optimization processes pretend to find an optimal shape by finding the optimal parameters of a parametric geometric model. In this process, standard optimization processes such as evolutionary algorithms or gradient-based algorithms, among others, are used. This involves an iterative process to find the optimal parameters. This process makes a gradual evolution of the initial geometry (i.e. initial set of parameters) to a final geometry. During this process a Finite Element (FE) problem is solved for each set of parameters, requiring, in general, a *h*-adaptive process to guarantee a certain level of accuracy. This *h*-adaptive process implies evaluating the same geometry with different levels of mesh refinement, as prescribed by the refinement algorithm based on the error estimation of the solution. This makes the global optimization process highly time consuming, being the performance of the FE algorithm crucial in the performance of the method.

Due to the similarity of the geometries, particularly near the optimal geometry, the meshes which produces a certain error level are also similar. One solution to increase the performance of the optimization process for standard mesh generators was presented in [1], where the sensitivity analysis of the error estimation, with respect to the design variables, performed only once using a geometry of reference, allowed generating 2D *h*-adapted meshes for a set of designs without the necessity of performing a full adaptive remeshing procedure for each geometry. From this starting point, in order to reduce the computational cost of the optimization process, we propose an strategy based on the use of 3D Cartesian grids independent of the geometry[2] whose unique hierarchical properties will be used to project the results of the sensitivity analysis to all other designs to be analysed, greatly reducing the computational cost compared with standard strategies.[1]

REFERENCES

[1] G. Bugeda, J. J. Ródenas, E. Oñate, An integration of a low cost adaptive remeshing strategy in the solution of structural shape optimization problems using evolutionary methods, Computers & Structures, 86 (2008), pp. 1563-1578.

[2] O. Marco, R. Sevilla, Y. Zhang, J. J. Ródenas, M. Tur, Exact 3D boundary representation in finite element analysis based on Cartesian grids independent of the geometry, International Journal for Numerical Methods in Engineering 103 (2015), pp. 445-468.

[1] With the support of the Generalitat Valenciana (PROMETEO/2016/007) and the Ministerio de Educación y Ciencia through the project "Personalización de implantes mediante modelos de elementos finitos a partir de imágenes médicas 3D. FEM4u". DPI2013-46317-R.