High-order Mesh Untangling and Smoothing Using the Hierarchical Smoother

- ADMOS 2015 -

Eloi Ruiz-Gironés*, Xevi Roca† and Jose Sarrate*

*Laboratori de Càlcul Numèric (LaCàN)
Universitat Politècnica de Catalunya
Campus Nort UPC, 08034 Barcelona, Spain
web page: http://www.lacan.upc.es
†Aerospace Computational Design Laboratory,
Department of Aeronautics and Astronautics
Massachusetts Institute of Technology
Cambridge, MA 02139, USA.

ABSTRACT

In the last years, high-order methods are emerging to simulate physical phenomena in applied sciences and engineering. However, these kind of methods rely on a high-order discretization. One of the most used methods to generate a high-order mesh is the *a posteriori* approach. First, a linear mesh that contains the required features for the simulation is generated. Then, the interpolation degree of the mesh is increased, and the additional nodes are inserted. However, when the high-order nodes are inserted, low-quality or inverted elements may appear if high-curved surfaces are present in the geometry. Thus, mesh untangling and smoothing is a key step of the meshing process to obtain valid high-order discretizations. Usually, the smoothing process is performed in two steps, as shown in [1,2]. First, the boundary nodes are moved by taking into account the quality of the boundary elements. Then, the quality of the maximal dimension elements is optimized by moving the position of the inner nodes. However, the boundary nodes position may constrain the quality of the whole mesh. Thus, we propose a novel framework in which we only consider the quality of the maximal dimension elements [3]. To this end, we minimize an objective function defined as the distortion of the maximal dimension elements, by moving the position of the inner nodes, as well as the position in the parametric space of the face and edge nodes. Although the objective function is defined globally, for implementation purposes, we propose to perform a node-by-node relocation process by using a non-linear Gauss-Seidel approach. That is, we first move the edge nodes, then the face nodes, and finally the inner nodes, until convergence is achieved.

REFERENCES

[1] P. M. Knupp, "Algebraic mesh quality metrics", *SIAM J. Sci. Comput.*, Vol. **23**(1), pp. 193–218, (2001).

[2] A. Gargallo-Peiró, X. Roca, J. Peraire and J. Sarrate, "Optimization of a regularized distortion measure to generate curved high-order unstructured tetrahedral meshes", *Int. J. Numer. Meth. Engng*, in press.

[3] E. Ruiz-Gironés, X. Roca, J. Sarrate, "Optimizing mesh distortion by hierarchical iteration relocation of the nodes on the CAD entities", *Proceedings of the 23rd International Meshing Roundtable*, (2014).