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A QUALITY-BASED FRAMEWORK TO GENERATE AND VALIDATE CURVED MESHES FOR UNSTRUCTURED HIGH-ORDER METHODS

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In the last years, high-order methods have attracted a remarkable attention from the community of computational methods. For problems with smooth solutions, high-order methods can deliver high accuracy with a lower computational cost than low-order methods [1]. However, their application has been hampered because the generation of such meshes is not straightforward. The main goal of this work is to propose a robust procedure to validate and generate curved high-order meshes. The resulting meshes are composed by valid and high-quality elements with the boundary nodes on the surfaces of a CAD model. To this end, we use an a posteriori approach. First, a linear mesh that prescribes the geometrical features desired for the high-order mesh is generated. Second, the linear mesh is converted to a high-order mesh by increasing the interpolation degree. Third, a valid high-order surface mesh is generated by moving the nodes on the CAD surfaces in order to minimize the distortion of the boundary mesh. Next, we curve the faces of the boundary elements to match the surface mesh. In this step, non-valid and low-quality elements can appear close to the curved boundaries. Finally, the mesh is untangled and smoothed to obtain a mesh composed by valid and high-quality elements.

Our method is composed of two main ingredients. First, we propose a mesh quality measure to validate nodal high-order triangle and tetrahedral elements of any interpolation degree by extending any Jacobian based distortion measure for linear elements [1,2]. Second, we propose a robust smoothing and untangling method to obtain the desired curved and high-order mesh.

[1] A. Gargallo-Peiró, Validation and Generation of Curved Meshes for High-Order Unstructured Methods, PhD Thesis, UPC, 2014.

[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.