New Unstructured Tetrahedra Octree-Based Mesher

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Nowadays large part of the time needed to perform a numerical simulation is spent in preprocessing, especially in the geometry cleaning operations and mesh generation. Furthermore, these operations are not easy to automatize because they depend strongly on each geometrical model and they often need human interaction. Many of these operations are needed to obtain a watertight geometry. Even with a clean geometry, classical unstructured meshing methods (like Delaunay or Advancing Front based ones) present critical weak points like the need of a given quality in the boundary mesh or a relatively smooth size transition. These aspects decrease their robustness and imply an extra effort in order to reach the final mesh. Octree based meshers try to relax some of these requirements.

A new octree based mesher for unstructured tetrahedral has been implemented inside GiD. The proposed mesher ensures the mesh generation avoiding most of the geometry cleaning operations. It is based in the following steps: fit an octree onto the model, refine it following given criteria, apply a tetrahedra pattern to the octree cells and adapt the tetrahedra close to the contours in order to represent accurately the boundary shape. An important and innovative aspect of the proposed algorithm is it ensures the final mesh preserves the topology and the geometric features of the original model, which are typical weak points of other octree-based meshers.

The method uses a Ray Casting based algorithm for the identification of the inner and outer parts of the volumes involved in the model. This technique allows the mesh generation of volumes even with non-watertight boundaries.

The main advantages of the presented mesher are: robustness, no need for watertight boundaries, independent on the contour mesh quality, preservation of geometrical features (corners and ridges), original geometric topology guaranteed, accurate representation of the contours, valid for immersed methods, and fast performance.

A shared memory parallel implementation of the algorithm has been done. The effectiveness of the algorithm and its implementation has been verified by some validation examples.

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