Towards robust handling of complex geometries with multiple regions and baffles in cfMesh

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Mesh generation is still an important challenge many CFD teams face when performing flow simulations in complex geometries of industrial interest. This is further exaggerated by the problems often present in the input geometries, such as cracks, gaps, holes and overlaps. In addition, the problems faced by various industries require different meshing solutions to achieve a high-quality meshing process that does not require much manual intervention from the end user. Over the last years the trend is to include more-and-more details into the simulation and to gain more information how different components interact together. In order to meet these challenges, the current work focuses on development of a robust and parallelizable methodology for multi-physics meshing. The method detects interfaces between various domains in the input geometry by finding the intersections of mesh dual with the input geometry. The intersected dual lines correspond to the faces in the mesh that are later projected to the input geometry. This procedure is massively parallelizable and snapping of the vertices of the selected faces imposes minimum deformation to the mesh. However, the procedure requires additional models for filtering out of false non-manifold interface connections that may arise during the selection process. In order to achieve robust detection and classification of interface connections, the mesh structure and the handler of the mesh surface are extended to provide information about: domains attached to a vertex or an edge, manifold for each boundary face needed to increase the robustness of the whole meshing process. The boundary layer technology in cfMesh is further extended to allow the layers to cross the boundaries of internal domain in order to generate layer with maximum orthogonality, wherever possible. The methodology has reduced the necessity to collapse layers only in case of corners where it is not possible to fit prismatic elements and boundary edges of baffles, because the extrusion front does not exist. By default, the method generates a mesh in all domains present in the input geometry, and it is also possible to select the domains that shall be meshed either by specifying patches present in the volume of interest or by selecting a point in the domain. The method has been applied to a set of cases ranging from simple ones to the ones of industrial interest and show promise in terms of mesh quality and speed.