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# AUTOMATIC GENERATION AND DIRECT EDITING OF HEXAHEDRAL MESH

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Hexahedral mesh is imperative for finite element analysis, and it is usually better than tetrahedral mesh. However, it is still too difficult to automatically generate high quality hexahedral meshes of complex CAD models up to now. In this talk, three of our recent research works on hexahedral mesh generation and editing will be introduced, including automatic swept volume decomposition based on sweep directions extraction, direct editing of hexahedral mesh through dual operations, and effective hexahedral mesh matching.

In order to guarantee the quality of the generated hexahedral mesh, current commercial software normally require users to manually decompose a complex solid model into a set of simple geometry like swept volume whose high quality hexahedral mesh can be easily generated. However, the manual decomposition is a time-consuming process, and its effect heavily depends on the user's experience. To solve this problem, we propose an automatic swept volume decomposition approach based on sweep directions extraction. The approach first extracts all the potential local sweep directions (PLSDs) of a given solid model using heuristic rules, then generates a relevant face set (RFS) for each PLSD, and incrementally determines all the swept volumes including heavily interacting ones based on PLSDs. Furthermore, to make the decomposition good for high quality hexahedral meshing, the approach constructs optimal cutting face sets (CFSs) to split the interacting swept volumes.

In order to make hexahedral mesh editing a more powerful hexahedral mesh regeneration means, we put forward a direct editing method for hexahedral mesh. When users carrying out direct editing on the CAD model, effective mesh deformation is conducted on the associated hexahedral mesh model. Then we perform automated mesh quality optimization on the deformed mesh, firstly, simplified fundamental sheet configuration conversions are applied to improve the boundary mesh quality; secondly, dual operations are carried out to insert/extract entire sheets; thirdly, according to the measurement of the hexahedron deformation, those mesh regions whose mesh sizes become not reasonable due to the deformation are coarsened

and refined through localized dual operations. The method can not only effectively support high quality and adaptive hexahedral mesh regeneration, but also facilitate the interoperation of CAD model and mesh model.

Mesh matching is an effective way to convert the non-conforming interfaces between two hexahedral meshes into conforming ones, which is necessary for mesh editing operations like mesh merging. In order to make the existing mesh matching algorithm more robust and efficient, we improve the algorithm in three aspects: by introducing a more precise criteria for chord matching and the concept of partition chord set enables the complex interfaces with internal loops to be handled; put forward a mesh quality evaluation method to speed up the sheet extraction operation during mesh matching; bring up a solution to make it possible to locally inflate self-intersecting sheet.