DTHEX: AN IMPROVED ALL-HEXAHEDRAL MESHING SCHEME USING GENERAL COARSENING TOOLS

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Certain applications of the finite element method require hexahedral meshes for the underlying discretization. A procedure guaranteed to produce an all-hex mesh is to begin with a tetrahedral mesh and then subdivide each element into four hexahedra [1]. This presentation examines a procedure to effectively coarsen an initial tetrahedral mesh and then efficiently subdivide this mesh into a semi-structured all hexahedral mesh.

The first step of the procedure is to create a triangle surface mesh. The model must be watertight, and a coarsening tool is used to check to ensure that every edge is connected to two triangles. Coarsening is then performed using edge collapsing iteratively over the surface until no more edges can be collapsed. This edge-collapse scheme requires all resulting edges to be closer to their desired length than they were initially [2]. It also checks to ensure that boundary conditions are satisfied after the collapse. After each edge collapse, a Delaunay swap criteria is applied recursively to improve quality. Smoothing, using a centroid area pull method, will also improve element quality. Once a valid surface mesh has been created and smoothed the volume is easily meshed with a tetrahedral scheme. Each tetrahedron is then subdivided into four hexahedra. The procedure can then invoke dicing, resulting in a mesh corresponding to a desired hexahedra size.

Observed quality improvements were recorded on a limited number of models. One major application of this method is in faceted biological models. The advantage of this method over other methods is that it can guarantee an all-hex mesh with proper connectivity of nodes. Examples will be given in the presentation.

References

[1] D. Pelessone, and C.M. Charman, “Adaptive Finite Element Procedure For Non-Linear Structural Analysis”, American Society of Mechanical Engineers, Pressure Vessels and Piping Division (Publication) PVP, v 301, Developments in Pressure Vessels and Piping, p 191-198, 1995

[2] P.J. Frey, H. Borouchaki, “Unit Surface Mesh Simplification”, American Society of Mechanical Engineers, Applied Mechanics Division, AMD, v 220, Trends in Unstructured Mesh Generation, 1997, p 51-56