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Automatic Fast Tetrahedral Mesh Generation of Isosurfaces

We present a method for generating 3-D unstructured tetrahedral meshes of solids whose boundary is a smooth surface. The method uses a background grid (body-centered-cubic (BCC) lattice) from which to build the final conforming 3-D mesh. The algorithm is fast, robust, and provides *useful* guaranteed dihedral angle bounds for the output tetrahedra. The method is simple to implement and performs *no* extra refinement of the background grid. The most complicated mesh transformations are 4-4 edge flips. Moreover, the only parameter in the method is the BCC lattice spacing.

If the surface has bounded curvature, and if the background grid is sufficiently fine, then the boundary of the output mesh is guaranteed to be a geometrically and topologically accurate approximation of the solid surface. Furthermore, if the lattice spacing is smaller than the “local feature size,” then the dihedral angle bounds are better than those for the method in (Labelle, Shewchuk 2007). Applications of the method range from free boundary flows, to modeling deformations, shape optimization, and to anything that requires dynamic meshing (e.g. virtual surgery).