OPTIMIZING TETERAHEDRAL SUBDIVISION SCHEMES FOR FINITE-ELEMENT APPLICATIONS

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Abstract

Existing tetrahedral subdivision schemes do not support adaptive refinement and have traditionally been driven by the need to generate smooth three-dimensional deformations of solids. These schemes use edge bisections to subdivide tetrahedra, which generates octahedra in addition to tetrahedra. To split octahedra into tetrahedra one routinely chooses a direction for the diagonals for the subdivision step. For FE applications it is more convenient to use a refinement operator that generates only tetrahedra and supports adaptive refinement. An example for such a scheme is an adaptive subdivision scheme for unstructured tetrahedral meshes inspired by the $\sqrt{3}$-subdivision scheme for triangular meshes.

Such a tetrahedral subdivision algorithm is motivated primarily by the need to generate high-quality adaptive tetrahedral meshes for numerical simulations and visualization of scientific phenomena. Thus, the optimization in the subdivision algorithm design emphasizes on geometric quality of a refined tetrahedral mesh, efficiency of the refinement operations, adaptive refinement, and preservation of sharp geometric features on the boundary and in the interior of the physical domain.