Multiresolution Mesh Generation using Combined Simplification / Refinement

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Abstract:

We present a method for constructing a multiresolution mesh with nice properties for two-dimensional manifold surfaces in the Euclidean tridimensional space.

The input surface can be specified in various forms, such as parametric, implicit or even volumetric descriptions.

The method employs a combination of simplification and refinement to obtain a multiresolution mesh structure with the following desirable properties: (1) bounded aspect ratio of triangles in the mesh; (2) underlying semi-regular 4-8 hierarchical structure; (3) geometric approximation within a prescribed tolerance.

The strategy adopted by the method consists of using simplification to obtain a base mesh with good aspect ratio, followed by adaptive 4-8 refinement to produce a multiresolution mesh that approximates the surface and possesses an underlying regular structure.

The base mesh construction uses topological simplification of discrete neighborhoods. The input surface is processed in order to compute a volumetric distance function. Then, a polygonization algorithm of the isosurface produces a connectivity graph. A restricted disk covering is generated along with the corresponding Voronoi diagram. The base mesh is the Delaunay triangulation of this disk covering.

The multiresolution structure is produced by applying adaptive 4-8 refinement to the base mesh. At each step, the current mesh is adjusted by three types of warping forces that respectively improve: geometry;‘ parametrization and smoothness.

Distance functions are used throughout the method. Intrinsic distance over the connectivity graph is used to compute the disk covering. Extrinsic distance over the ambient space is used to compute the adaptive approximation.

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