Automatic Triangular Surface Grid Generation on 3-D Surfaces Described in the Triangulated STL Format

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Abstract

In this paper an automatic triangular surface grid generation method on general 3-D surfaces is proposed, where the 3-D surfaces are approximately defined in the STL format. The STL format is one of standard formats for the exchange of surface shape data, especially in rapid prototyping field, which replaces the original surface with a collection of triangulated surface segments. Triangulated surface data described in the STL format, which can be easily exported by most of CAD systems or 3-D modeling programs, replace the exact surface definition with air-tight triangular cells with some degree of approximation. The STL surface data, however, keeps the curvature information by putting a large number of smaller cells near the highly-curved region while using rather bigger cells near the relatively flat area.

The proposed algorithm for automatic surface grid generation is based on Delaunay triangulation method. Starting with the surface data given in the STL format, target cell size distribution is first determined by checking the curvature distribution along the surface which can be estimated by the initial surface cell size distribution of the STL file. Once the target cell size distribution is decided, the node insertion followed by cell division is performed and edge-swapping is applied for high-aspect-ratio cells so that Delaunay criteria are satisfied. One of difficulties in applying Delaunay triangulation for 3-D surface grid generation is keeping triangular cells to stay on the given surface data, and the idea to overcome this issue is also introduced.

In this paper detailed description of the current approach is given, and results of automatic surface grid generation are demonstrated by using general 3-D surface shapes defined by CAD system and imported in the STL format.