HIGH QUALITY TRIANGULAR/QUADRILATERAL MESH GENERATION OF A 3D POLYGON MODEL VIA BUBBLE PACKING

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This paper describes a new computational method that takes a 3D polygon model as input and creates a well-shaped and graded triangular or quadrilateral mesh. Typical input to the method is a triangular mesh of inadequate quality and/or undesired density. However, the input is not limited to a triangular or quadrilateral mesh; it can take an arbitrary polygon model. The method creates a high quality mesh with the desired density by the bubble packing method [1, 2].

Although existing triangular/quadrilateral mesh generation techniques work well for a CAD model represented by a set of parametric curves and surfaces, these techniques often fail when a polygon model is given as input. For example, while STL triangular polygon models have become popular as a data exchange format between CAD systems, they typically include many thin triangles, which yield inaccurate results in finite element analysis and cause failure of tetrahedral/hexahedral mesh generators. Hence, a good quality surface mesh must be created from an STL model to apply finite element analysis or to create a volume mesh. Another example is remeshing of a triangular mesh obtained by a laser range scanner. A laser range scanner is a useful tool for reducing the burden of 3D geometric modeling. A designer can create a physical mockup, such as a clay model, and a laser range scanner digitizes the model. Such a digitized model is, however, typically a very dense triangular mesh, which requires large storage space and long time to display. Such a mesh must be decimated into a triangular mesh with a reasonable number of elements. In both cases, when creating a mesh of a STL model or when decimating a laser scanned model, existing methods typically fail or do not create a high quality mesh.

The goal of the proposed method is to provide a solution to the problem of surface triangular/quadrilateral mesh generation from arbitrary polygon models, such as an STL model from CAD data and a dense triangular mesh from a laser range scanner. The proposed method creates well-distributed node locations by the bubble packing method [1, 2]. Spherical bubbles for a triangular mesh, or rectangular solid bubbles for a quadrilateral mesh, are packed on the input polygon model, and the centers of the bubbles produce well-distributed node locations lying on the polygon model. The nodes are then blended in the polygon model, and the nodes of the original polygon model are decimated by a method similar to Turk's [3]. The quality of the triangles is improved by an edge swapping method. When a quadrilateral mesh is desired, some pairs of triangles are merged and converted to quadrilaterals. Each quadrilateral is then subdivided into four quadrilaterals, and each remaining triangle is subdivided into three quadrilaterals to yield an all-quad mesh.

References

[1] K. Shimada and D. C. Gossard, "Automatic Triangular Mesh Generation of Trimmed Parametric Surfaces for Finite Element Analysis," *Computer Aided Geometric Design*, vol. 15, pp. 199-222, 1998.

[2] K. Shimada, J.-H. Liao, and T. Itoh, "Quadrilateral Meshing with Directionality Control through the Packing of Square Cells," Proceedings of 7th International Meshing Roundtable, pp. 61-75, 1998.

[3] G. Turk, "Re-tiling Polygonal Surfaces," Proceedings of SIGGRAPH'92, pp. 55-64, 1992.