

Geometric Meshing of Discrete Surfaces

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Most computer-aided design (CAD) systems include a boundary representation (B-rep) where a surface is modeled by a collection of patches, each patch being defined by a function σ from a parametric domain in R^2 to a face in R^3 . To generate a mesh of such a surface, an indirect approach can be used [1]. In this case, the size and shape of the elements to be generated on the surface are specified by metrics M_3 , which are converted into metrics M_2 in the parametric domain using the first partial derivatives of σ in order to control meshing in two dimensions. The initial metrics M_3 on the surface are either isotropic or anisotropic, and can depend from geometric features to generate a "geometric mesh". To obtain an isotropic geometric mesh, the prescribed size is proportional to the minimum radius of curvature at any point of the surface. For an anisotropic geometric mesh, the prescribed size depends on the two principal curvatures and the two corresponding principal directions. All these geometric features are based on the first and second partial derivatives of σ . To summarize, the indirect approach for surface meshing needs the evaluation of σ , its first partial derivatives and possibly its second partial derivatives. In practice, these computations are realized by CAD queries, which in some cases may be time-consuming, non-parallelizable, or return degenerate values.

To overcome these problems, a discrete model made up of triangles can be built from the continuous CAD model. Then, an approximation of σ and its first partial derivatives can be computed efficiently; since the first derivatives are constant on each triangle, they can even be stored to increase speed. The second partial derivatives are null but curvatures can be approximated at each vertex and then interpolated in order to generate an isotropic geometric mesh [2]. We now propose a new approach where the first and second derivatives of σ are computed at the vertices of the discrete model, based on Taylor expansions. This approach improves efficiency to generate isotropic geometric meshes, and makes it possible to generate anisotropic geometric meshes.

[1] H. Borouchaki, P. Laug, P.L. George, Parametric Surface Meshing using a Combined Advancing-Front / Generalized-Delaunay Approach, *Int. J. Numer. Meth. Eng.* (49)1-2:233-259, 2000.

[2] P. Laug, H. Borouchaki, Discrete CAD Model for Visualization and Meshing, 25th International Meshing Roundtable, *Procedia Engineering* (163)149–161, 2016.