An Automatic Topology Recovery Method Based on T-Spline Surfaces Reconstruction in BFM

Baotao Chi[1], Jianming Zhang[1*]

[1]State Key Laboratory of Advanced Design and Manufacturing for Vehicle Body, College of Mechanical and Vehicle Engineering, Hunan University, Changsha, 410082 China

ABSTRACT

An automatic topology recovery method based on T-Splines, a novel and automatic topology recovery method is presented to reconstruct surfaces by virtual topology for handling geometry noises and facilitating mesh generation without modifying the original input CAD model. In solid modeling and Computer Aided Geometry Design (CAGD), Non-uniform rational B-spline (NURBS) is a standard for free-form curves and surfaces sculpting in commercial modeling software. But as we know, the problems associating with the fundamental limitations of NURBS are still kept unresolved in traditional NURBS-based design. The control points of NURBS must lie topologically in a rectangular grid and a complicated engineering model design using Boolean operations often requires hundreds, if not thousands, of NURBS patches which are usually discontinuous across patch boundaries. More specially, geometry noises usually lead to mesh generation with poor quality or even fail to generate mesh.In traditional methods, only by modifying the original analysis CAD models, the CAE model can meet the requirement of mesh generation and the further geometry computations. However, the CAE model (approximate grid model) is completely different from the CAD model (continuous parametric model), not only in geometry and topology, but also in representation data structure. This makes the interaction between CAE and CAD extremely difficult. A truly seamless interaction is determinatively impossible.

T-splines were first introduced by Thomas W. Sederberg in the CAGD community to address the intrinsic drawbacks of NURBS. Any trimmed NURBS model can be represented by a watertight trimless T-spline and multiple NURBS patches can be merged into a single watertight T-spline. Compared with these methods, we propose an automatic, arbitrary and adaptive method to repair CAD models without any manual operations. Our method includes the following steps. Firstly, automatic detection of smooth facets, sharp corner and short edges that need to be repaired is of great importance. Secondly, global parameterization using delaunay triangulation and LSCM. And then, some unordered points should be sampled from the NURBS and perform T-spline reconstruction adaptively. And in order to approximate surface better, we also proposed an algorithm, which combined the scattered points interpolation with T-spline surface interpolation. Finally, T-spline local refinement algorithm is performed subsequently with the given error tolerance without changing the T-spline surface shape. Importantly, in the proposed defeaturing algorithm, we take virtual topology without modifying the original CAD model, which introduces more virtual operations to suppress features.During BFM analysis, the BFM requires only boundary mesh, advances of our automatic topology recovery method on T-spline relieve the burden of mesh generation to some extent.Several examples of CAD models with automatic topology recovery and corresponding mesh generation are presented to validate the proposed method.

Key words: *automatic topology recovery; T-spline surface reconstruction; mesh generation; geometry noises; virtual topology*