The Meccano Method for Automatic 3-D Triangulation and Volume Parametrization of Complex Solids

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We have recently introduced the meccano method for constructing adaptive tetrahedral meshes of solids [1,2]. The method requires a surface triangulation of the solid, a meccano and a tolerance that fixes the desired approximation of the solid surface. The name of the method stems from the fact that the process starts from an outline of the solid, i.e. a meccano composed by connected polyhedral pieces. The method builds a 3-D triangulation of the solid as a deformation of an appropriate tetrahedral mesh of the meccano. The main idea of the new mesh generator is to combine an automatic parametrization of surface triangulations, a local refinement algorithm for 3-D nested triangulations and a simultaneous untangling and smoothing procedure.

In this paper, we review the novel meccano method and we present significant advances in the method. Specifically, we describe the procedure for a solid whose boundary is a surface of genus 0. In this case, the meccano can be a single cube. We introduce an automatic partition of the given solid surface triangulation for fixing an admissible mapping between the cube faces and the solid surface patches, such that each cube face is the parametric space of its corresponding patch.

A crucial consequence of our technique is the volume parametrization of a complex solid to a cube. Another interesting property of the new mesh generation strategy is that it automatically achieves a good mesh adaption to the geometrical characteristics of the solid. In addition, the quality of the resulting meshes is high. The volume parametrization has applications in other fields different from tetrahedral mesh generation. Particularly, in this paper we use the method to construct a volume T-mesh for isogeometric analysis.

References

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