The Meccano Method for Simultaneous Volume Parametrization and Mesh Generation of Complex Solids

Introduction

We have recently introduced the meccano technique for constructing adaptive tetrahedral meshes of solids (Montenegro, R 2009, Cascón, JM 2009). 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.

Methods

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 present significant advances in the method. Specifically, we describe the procedure for a solid whose boundary is a surface of genus 0; i.e. a surface that is homeomorphic to the surface of a sphere. In this case, the meccano is a single cube, and we define an automatic parametrization of a solid surface triangulation to the meccano boundary such that the global mapping is the combination of six patch-mapping. A crucial consequence of our technique is the volume parametrization of a complex solid to a cube.

Results

The efficiency of the proposed technique is shown with several applications: Stanford Bunny, Armadillo, Screwdriver, etc.

Conclusion

The meccano technique is a novel and promising mesh generation method for creating adaptive tetrahedral meshes and volume parametrizations of a complex solid. We highlight the fact that the method requires minimum user intervention and has a low computational cost. At present, the procedure is fully automatic for genus-zero solids.

Acknowledgments

Authors are grateful for Spanish Government and FEDER support, grant contract: CGL2008-06003-C03-00, http://www.dca.iusiani.ulpgc.es/proyecto2008-2011.