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TETRAHEDRAL MESH OPTIMIZATION COMBINING BOUNDARY AND INNER NODE RELOCATION AND ADAPTIVE LOCAL REFINEMENT

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This work introduces a new technique for tetrahedral mesh optimization. The procedure relocates boundary and inner nodes without changing the mesh topology. In order to maintain the boundary approximation while boundary nodes are moved, a local refinement of tetrahedra with faces on the solid boundary is necessary in some cases. New nodes are projected on the boundary by using a surface parameterization.

In this work, the proposed method is applied to tetrahedral meshes of genus-zero solids that are generated by the meccano method [1, 2]. In this case, the solid boundary is automatically decomposed into six surface patches which are parameterized into the six faces of a cube with the Floater parameterization. The cube is meshed by using the Kossaczky local refinement method. The parameterization is used to map the cube boundary nodes, while the inner nodes are initially relocated using the Coons patches and finally optimized by using a simultaneous untangling and smoothing technique [3].

As the boundary nodes are located only using the parameterization of the solid surface, without considering the tetrahedral mesh quality, problems could appear. This work

develops an innovative way to relocate boundary nodes in order to improve the overall quality of the generated mesh. The main idea is to perform a constrained optimization of the boundary nodes in the parametric space while computing the value of the mesh quality in the physical space. Additional restrictions are used in order to have a valid volumetric parametrization between the physical and parametric mesh. The volumetric parameterization quality is a crucial aspect in several simulation methods. Specifically, it has a great influence in isogeometric analysis [4, 5].

The mesh quality improvement will be shown in several examples. Finally, it is important to remark that the proposed technique can be extended to any mesh-generation method that uses surface parameterization.

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