C^1 Modeling with Hybrid Multiple-sided A-patches

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Abstract

We propose a new scheme for modeling a smooth interpolatory surface, from a surface discretization consisting of triangles, quadrilaterals and pentagons, by algebraic surface patches which are subsets of real zero contours of trivariate rational functions defined on a collection of tetrahedra and pyramids. The rational form of the modeling function provides enough degrees of freedom so that the number of the surface patches is significantly reduced, and the surface has quadratic recover property.

Key words: Implicit surface; rational A-patch; surface fit; tetrahedra; pyramids

1 Introduction

The problem considered in the present paper is to construct a smooth interpolatory surface from a surface discretization $\mathcal{L}$ by piecewise implicit surface patches. The discretization $\mathcal{L}$ of the surface consists of triangles, quadrilaterals and pentagons. The constructed surface passes through the vertices of the discretization and has the given normals at the vertices. This solution uses piecewise rational functions defined on a hull that consists of tetrahedra and pyramids (see Fig 1.1).

Several approaches to using implicit surface representation in modeling geometric objects have been proposed in papers (see for examples, ([1], [3], [6], [9], [11], [14]). Most of the schemes use various simplicial hulls over surface triangulation and polynomial functions (see [2], [3], [6], [9], [10]). They in general consist of the following three steps: **a**. Generate a normal for each vertex of $\mathcal{L}$ which will also be the normal of the constructed smooth surface at the vertex. **b**. Build a surrounding simplicial hull $\sum$ (consisting of a series of tetrahedra) of the triangulation. **c**. Construct a piecewise trivariate polynomial F within that simplicial hull, and use the zero contour of F to represent the surface. Dahmen [5] first

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