Feature-Based Subdivision Surface Fitting (sap_0032)

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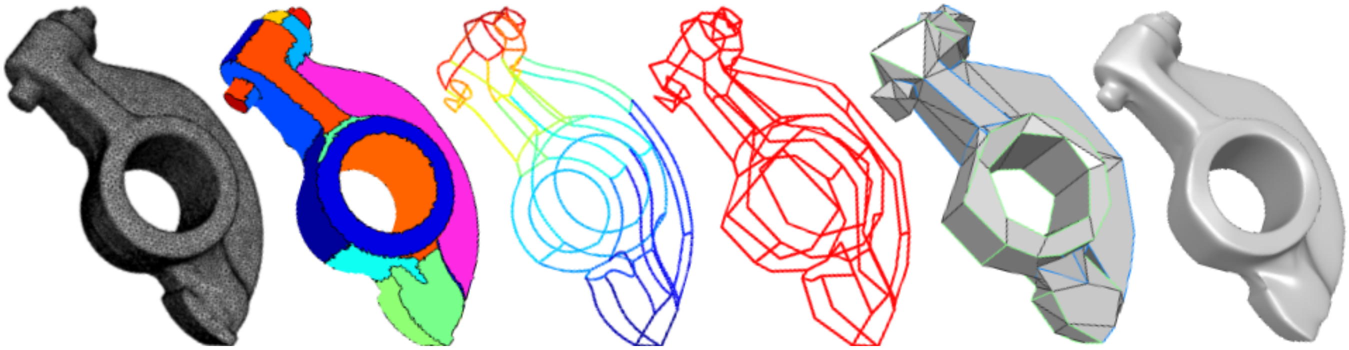

Figure 1: Overview of our subdivision surface fitting algorithm. *From left to right:* The input *RockerArm* mesh (15K vertices), result of the segmentation (35 regions), feature line network, control polygon network created from subdivision curve approximation, subdivision control mesh (160 vertices) with different sharpness degrees (Black: 0, Blue: 1, Green: 2), associated limit surface.

1 Introduction

Obtaining optimal and succinct representations for 3D models, usually defined as *redundant* dense polygonal meshes, is particularly of interest for many applications: animation, compression, recognition or understanding. Subdivision surfaces combine a lot of properties particularly relevant for this task: this model is very *compact*, can represent an *arbitrary topology*, authorizes a *local control* while being intrinsically *multi-resolution*. For these reasons, subdivision surfaces are increasingly popular in computer graphics and have been integrated to the MPEG4 standard. In this context, approximating a dense verbose polygonal mesh with this model becomes even more relevant.

Hence, we present an algorithm for subdivision surface fitting from arbitrary polygonal mesh; it follows our previous algorithm [Lavoué et al. 2007] which was specifically dedicated to piecewise smooth CAD models. Our main objective is not to focus on approximation error but rather to preserve the relevant features of the object while searching the coarsest possible control mesh.

2 Subdivision Surface Fitting Framework

Our surface fitting algorithm involves three main parts:

Feature lines extraction: Given an input polygonal mesh, we process a segmentation using a modified version of the VSA algorithm [Cohen-Steiner et al. 2004]. We then extract the network of corresponding boundaries and apply a smoothing mask to obtain a smooth feature lines network (see figure 1, 3^{rd} picture).

Base control mesh construction: We consider that a *correct* approximating subdivision surface has to respect/approximate the main feature lines of the object, and thus has to contain at least the number of control vertices necessary to approximate these feature lines. Hence our process is the following: we first approximate the feature line network with subdivision curves (see figure 1, 4^{th} picture) and then edges and facets of the base control mesh are created by linking only these *feature control points* with respect to the lines of curvature of the object.

Semi-Sharp control mesh construction: In order to reproduce precisely the shape aspect of the target mesh while maintaining a low control points number, we associate to each edge of the base control mesh, an integer sharpness degree from 0 (smooth) to 3 (rather sharp) according to the rules introduced by DeRose et al. [DeRose et al. 1998]. An automatic process determines the appropriate degree so as to reproduce the curvature radius of the corresponding fillet or blend on the target mesh. Finally a geometric optimization is conducted by iteratively moving control points in order to minimize a global quadratic distance to the input surface (see figure 1, 5^{th} picture).

3 Comparison with other algorithms

We have compared our results with two algorithms: (1) Simplification then geometric optimization (e.g [Marinov and Kobbelt 2005]) and (2) the approach from [Kanai 2001]. Figure 2 illustrates the results. Our semi-sharp control mesh provides better results than others in terms of visual and geometric similarities.

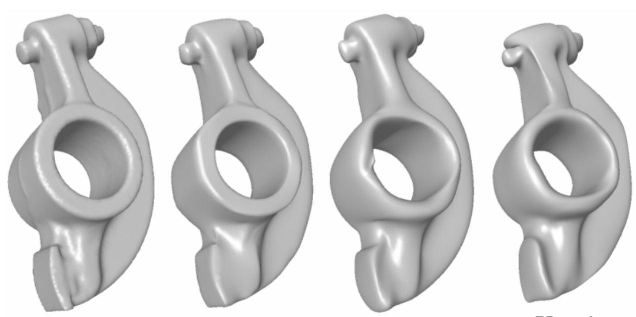

Figure 2: Approximation of *RockerArm* with different algorithms.

References

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