Texturing of Multi-Resolution Meshes with Basis Meshes

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ABSTRACT

A well known problem in the field of multi-resolution meshes is attribute preservation. To simplify mesh geometry while surface attributes, like texture information, remain stable, the textures have to cover several parameterized triangles (mesh patches). In such cases we have to simplify the surface parameterization along with the geometrical simplification. To minimize visible deviation while simplifying, we need a suitable parameterization and must avoid drastic changes along the patch borders.

In this paper we present an algorithm that creates surface patches for multi-resolution meshes. These patches are parameterized to share textures and normal-maps for all possible mesh approximations. To create the patches, we simplify the mesh to a low resolution triangle mesh (basis mesh) whose triangle structure is projected to the original surface in an refinement step. The projected basis triangles are used to build the surface patches. These patches are finally parameterized with shape-preserving weights.

Keywords

surface parametrization, texture, meshes, multi-resolution.

1. Introduction

In order to increase the visible details of polygonal meshes, 2-d texture maps and normal-maps are used. These maps are normally applied to single triangles, mesh patches or the triangle mesh. To apply texture and normal-maps to triangle meshes, we need to parameterize the surface. Whenever several connected triangles of the mesh share the same texture, we have to map them into the 2-d space. We get their mapped coordinates and thus a local parameterization. When all triangles of a mesh are mapped into the same parameter space, we get a global parameterization. Our aim is to divide the mesh surface into triangular parameterized patches which are suitable for multi-resolution meshes.

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2. Related Work

The creation of patch-based parameterizations for meshes has been investigated by a number of researchers. In [1] a hierarchical simplification was used to map the original surface vertices to a simplified version of the mesh. During the simplification the mapping process can cause triangle flips in the parameter space which must be treated separately. The resulting parameter spaces must finally be smoothed to obtain good results.

Another approach [2] creates so called "charts" from a mesh surface with an algorithm which iteratively merges two charts until a cost function stops the process. The borders of the resulting polygonal charts must be smoothed to be useable for multi-resolution meshes, but still limits the obtainable simplification ratio. The parameterizations of the final charts are optimized by means of the triangle stretch. This results in angle distortion for large patches and limits its usage with multi-resolution meshes.

Methods for global parameterizations where presented in [3,4,5]. But they are either limited to meshes of genus 0 [3] or limit the multi-resolution hierarchy with uneven mesh cuts [4,5].

3. Basis Domain Creation

In this section we will describe the creation of mesh patches, which can easily be parameterized with known techniques [6]. First of all we create an error based half-edge collapse [7] simplification hierarchy from the original mesh which leads to the basis domain mesh (coarsest level). The collapses are only allowed when the changed triangles can be projected into the exponential mapping of the former vertex star, without normal flips. For our tests we limited the number of triangles for the coarsest level but other stop conditions are possible too. During the mesh refinement, we iteratively map the domain mesh borders to the refined mesh. Due to the local influence of a vertex split (single vertex star) only few triangles have to be taken into account. Figure 1 shows the local mapping process.

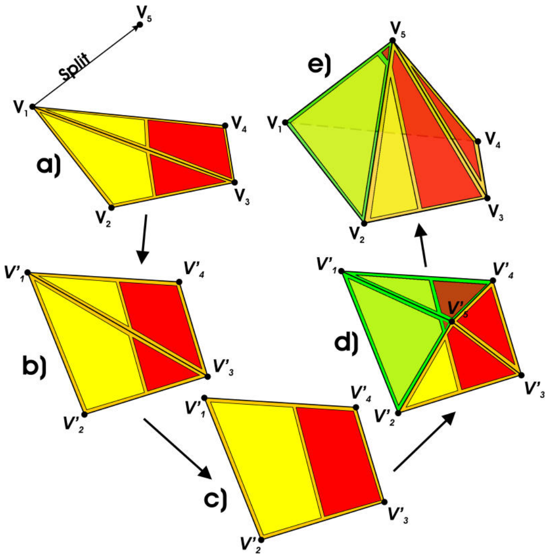

Figure 1: local split process

Fig.1a shows a vertex split, where $\mathbf{v_1}$ is split to a copy of itself and $\mathbf{v_5}$. The basis mesh structure mapped to the triangles ($\mathbf{v'_1}$, $\mathbf{v_2}$, $\mathbf{v_3}$) and ($\mathbf{v_3}$, $\mathbf{v_4}$, $\mathbf{v_1}$) is colored yellow and red. In the first step the border vertices are mapped to a plane with exponential mapping around $\mathbf{v_5}$ (Fig.1b). Then the basis domain edges are joined within the resulting polygon (1c). And finally we cut these connected base edges against the new triangles (1d) and store them in these. After the refinement, we triangulate the original mesh along the edges of the domain mesh to create smooth domain borders. Finally the domain borders and the inner points are parameterized to the domain triangles with the shape-preserving method [8].

The obtained parameterized mesh can now be simplified again to create the final simplification hierarchy. In this case we only allow edge collapses within the domain or along the domain borders, which must also be applied to the parameter space. The result is a parameterized multi-resolution mesh.

4. Results

The algorithm in Section 3 has been applied to several meshes to prove it. Every domain mesh could be mapped to the original mesh without problems and produced smooth parameterizations. Together with these parameter spaces we produced textured multi-resolution models. Figure 2 shows the parameterized "Stanford Bunny" in different approximations. The checker-box texture shows the smoothness of the parameterization, while the colors indicate the different domain triangles.

Figure 2: Bunny with 16000(u.l), 2000 (u.r), 500 (b.l.) and 50 (b.r.) triangles

5. References

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