Rendering of 3D Meshes by Feature-Guided Convolution

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ABSTRACT

The author presents a feature-guided convolution method for rendering a 3D triangular mesh. In their work, they compute feature directions on the vertices of a mesh and generate noise on the faces of a mesh. After projecting the directions and noise into 2D image space, the author executes convolution to render the mesh. They used three feature directions: a principal direction, the tangent of an isocurve of view-dependent features, and the tangent of an isophote curve. By controlling the value of noise, the author can produce several non-photorealistic rendering effects such as pencil drawing and hatching. This rendering process is temporally coherent and can therefore be used to create artistic styled animations.

Keywords: Convolution, Feature, Hatching, Non-Photorealistic Rendering, Pencil Drawing

1. INTRODUCTION

Convolution on a 3D mesh or 3D volume data is an interesting method to visualize the shape. Some researchers used convolution to visualize 3D medical volume data (Interrante & Grosch, 1997; Interrante, 1997) or some researchers used convolution to produce painting effects on a 3D mesh (Lee, 2005). In the image space, the line integral convolution (LIC) is used to produce pencil drawing or line illustration effects on a photograph (Mao, Nagasaka, & Imamiya, 2002).

In this paper, we present a novel method that renders the salient features of a 3D mesh using LIC algorithm. Our expected result is illustrated in Figure 1. The LIC is an image space algorithm that visualizes the flow embedded in an image by integrating noise superimposed on the pixels of the image along the direction of the flow (Cabral & Leedom, 1993). The convolution is applied for producing pencil drawing effects from photographs (Mao, Nagasaka, & Imamiya, 2002) and for conveying the shape of a 3D volume data (Interrante & Grosch, 1997; Interrante, 1997; Lee, 2005) but has not been applied for conveying the features of a 3D mesh yet.

The overview of our algorithm is as follows:

- We compute the directions at the vertex of the mesh from three directions on a mesh: (i) the principal directions, (ii) tangent directions of isocurves of view-dependent features, and (iii) tangent directions of isophote curves. We smooth them to...
build the smooth direction required for the convolution.

- We extract features from triangular meshes and measure the strength of feature at each vertex of the meshes. We generate noise at each face of the meshes from the strength of feature.
- After projecting the noise and smooth direction, we apply an LIC algorithm that conveys the salient features on the mesh in pencil drawing style.

This overview is illustrated in Figure 2. Our technical contributions to computer graphics society are summarized as follows:

1. **Feature-conveying pencil drawing style on a 3D mesh:** The features conveying salient shape of objects are rendered in pencil drawing style to present visually pleasing pencil drawing images.

2. **Improved direction computation for producing pencil drawing effects:** Most of the existing schemes use only principal directions for generating strokes on a 3D mesh. In addition to the principal directions, we present the tangent directions of isocurves and isophote curves to compute the directions of LIC.

3. **Noise control on the meshes for temporal coherence:** The coherence of the animated pencil drawing images is preserved by managing the noise on the faces of the meshes.

This paper is organized as follows. In Section 2, we briefly review the existing works. In Section 3 and Section 4, we explain how we

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**Figure 1. Results of our algorithm: Rendering salient features of objects in pencil drawing style from a 3D mesh**

**Figure 2. The overview of the algorithm**
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