Graph Matching with Subdivision Surfaces for Texture Synthesis on Surfaces

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Figure 1: Texture synthesis on surfaces.

Abstract

Existing texture synthesis-from-example strategies for polygon meshes typically make use of three components: a multi-resolution mesh hierarchy that allows the overall nature of the pattern to be reproduced before filling in detail; a matching strategy that extends the synthesized texture using the best fit from a texture sample; and a transfer mechanism that copies the selected portion of the texture sample to the target surface. We introduce novel alternatives for each of these components. Use of $\sqrt{2}$-subdivision surfaces provides the mesh hierarchy and allows fine control over the surface complexity. Adaptive subdivision is used to create an even vertex distribution over the surface. Use of the graph defined by a surface region for matching, rather than a regular texture neighbourhood, provides for flexible control over the scale of the texture and allows simultaneous matching against multiple levels of an image pyramid created from the texture sample. We use graph cuts for texture transfer, adapting this scheme to the context of surface synthesis. The resulting surface textures are realistic, tolerant of local mesh detail and are comparable to results produced by texture neighbourhood sampling approaches.

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1 Introduction

Texture synthesis techniques are used to reproduce the pattern contained in a sample image onto either a larger 2D image or a surface in 3D. A variety of techniques have been employed for 2D image texture synthesis. The repertoire used for synthesis onto polygonal meshes is more restricted. In this paper we investigate the use of alternative strategies to those commonly used for texture synthesis on surfaces.

Neighbourhood matching is a fundamental component of many texture synthesis algorithms. This relies on textures having the Markov Random Field property, whereby the value at any point in the texture is dependant on the values of the neighbouring points. Therefore finding matching regions about two points is sufficient to allow transfer of texture attributes from one point to the other. Square neighbourhoods within the example texture have become the de-facto standard for neighbourhood matching. We show that a region based on local surface connectivity is a viable alternative for matching and has benefits with respect to controlling texture scale and anti-aliasing.

Considerable success has been achieved using an image pyramid for texture synthesis. Lower resolution versions of the sample texture are used first during synthesis, covering the target with a coarse outline of the desired pattern. This provides a guide for later iterations to use higher resolution versions of the sample image to fill in details. Surface meshes at corresponding levels of detail are also required, and we demonstrate the use of $\sqrt{2}$-subdivision surfaces for providing these.

Some synthesis strategies work one point at a time. Others copy larger patches of the texture sample at each step, which is faster. We apply the graph cut mechanism to allow transfer of large areas while minimising seams. This has previously been applied to texture synthesis on 2D images. We show how it can be adapted to surface synthesis.

The terminology used in the remainder of the paper is as follows. We use the term *colour* as an intuitive term to refer to the attribute