Lapped Textures

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Goal

Little user effort
No apparent seams
No obvious periodicity
Low distortion
Local texture control
Anisotropy

Previous 2D Texture Synthesis

Histogram equalization [Heeger ’96]
Laplacian block shuffling [de Bonet ’97]
Pixel template matching [Efros ’99] [Wei ’00]

Previous 3D Texturing

Volumetric textures:
- Noise functions [Perlin ’85, Worley ’96]
- Solid textures by example [Ghazanfarpour ’96]

Synthesizing texture on a surface:
- Reaction-diffusion [Turk ’91, Witkin ’91]
- Cellular textures [Fleischer ’95]
- Covering surface with triangular tiles [Neyret ’99]
Lapped textures

Approach

Key Idea: Patch Pasting

PROCESS

Algorithm

Algorithm

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Algorithm

Issues

1. Texture patch creation
2. Specifying direction field
3. Surface patch growth
4. Patch parametrization
5. Face coverage estimation
6. Texture storage and rendering

Texture Patch Creation

Less Structure → Splotch

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Tangential Vector Field

Optimizing the Parametrization

Least squares best match to unit axes
Sparse linear system. No explicit fairness functional

Result of Optimization

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Coverage estimation

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Render patch triangles
Flag covered triangles
Remember 1 pixel per uncovered triangle
off-screen buffer

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Texture Storage and Rendering

Method 1: Texture Atlas
- Pre-composite into a global texture map.

-- OR --

Method 2: Runtime pasting
- Composite at run-time using hardware

Method 2: Runtime Pasting

Store vertex coordinates for each patch
Composite at run-time using hardware
May render triangles several times

Atlas vs. Runtime Pasting

Atlas
+ Faster rendering, more portable
+ Easy to paint unique details (eyes, nose on bunny)
- Sampling artifacts; user effort

Pasting
- Increases model complexity (×1.6 –3)
+ Huge effective resolution
+ Reuse splotch parameterization for many textures
RESULTS

Results: Splotches

(Completely automatic: no direction field)

Results: Anisotropic

Controlling Direction and Scale

Limitations

- Low-frequency components
- Boundary mismatches
- Direction field singularities
Timings
Texture patch creation: 1 min \{ Human effort
Specifying direction field: 15 min
Surface patch growth
Patch parameterization
Face coverage estimation
Preprocessing: 20 sec – 6 min
Rendering: 25fps @ 1024^2

Conclusions
Effective texture-by-example through:
• Overlapping texture patches
• Minimal edge blending
Aligning to direction field → fast optimization
Runtime pasting → high effective resolution

Future Work
Other texture types:
• Animated
• “Thick” (volumetric) textures → fur
• NPR rendering
Greater automation
Fine-tuning patch placement

Real-Time Fur [Lengyel 2001]
Real-Time Fur [Lengyel 2001]

Real-Time Hatching [Praun 2001]
Stroke-based rendering of 3D models
Strokes convey:
• tone
• material
• shape

Texture Synthesis over Arbitrary Manifold Surfaces
[Wei 2001]
Synthesize a surface texture by coloring mesh vertices

Texture synthesis on surfaces [Turk 2001]