Texture Synthesis

Final Project Status Report:
- Each student should post on LMS by Monday
- Including at least 1 screenshot or other data (project dependent)
- Team Projects:
  - Each member should post and describe their contributions to the project

Last Time?
- Non-Photorealistic Rendering
  - Line Drawing
  - Pen & Ink / Hatching
  - Technical Illustration
  - Painterly Rendering
- Architectural Rendering

Today
- Texture Tiling
- Texture Synthesis Challenge
- Markov Model
- Constrained Texture Synthesis
- Image Completion
- Wang Tiles for Texture Synthesis
- Volumetric Texture Synthesis

Texture Tiling
- Specify a texture coordinate (u,v) at each vertex
- Canonical texture coordinates (0,0) → (1,1)

Texture Synthesis Challenge
- input
- tiled
- synthesis
Today

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Markov Random Field

- English words and sentences can be modeled as a Markov Random Field:

  "I spent an interesting evening recently with a grain of salt."

Template


Alternate Synthesis Order

"Texture Synthesis by Non-parametric Sampling", Efros & Leung, ICCV 1999

Neighborhood Size

Image from Efros & Leung

Failure Examples

from Efros & Leung

from Wei & Levoy

Figure 2. Results: given a single image (left), the algorithm synthesized four new images with neighborhood windows of width 3, 5, 11, and 23 pixels, respectively. Notice how perceptually intuitively the window size corresponds to the degree of randomness in the resulting textures. Input images are: (a) synthetic rugs, (b) indoor texture D1, (c) brick wall.
Questions?

Today

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Constrained Texture Synthesis

Examples from Efros & Leung
http://graphics.cs.cmu.edu/people/efros/research/EfrosLeung.html

Image Inpainting

"Image Inpainting”, Bertalmio, Sapiro, Caselles & Ballester, SIGGRAPH 2000

Image Completion

“Fragment-based image completion”, Drori, Cohen-Or, Yeshurun, SIGGRAPH 2003

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Wang Tiles

Align tiles to match edge color to create non-periodic tilings

“Wang Tiles for Image and Texture Generation”,
Cohen, Shade, Hiller, Deussen, SIGGRAPH 2003

Wang Tile Texture Synthesis

- As a precomputation, fill the tiles with texture
- Then create infinite amounts of non-periodic texture!

“Wang Tiles for Image and Texture Generation”,
Cohen, Shade, Hiller, Deussen, SIGGRAPH 2003

Reading for Today:

"Image Analogies", Hertzmann et al., SIGGRAPH 2001

"PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing",
Barnes, Shechtman, Finkelstein, & Goldman, SIGGRAPH 2009

“Wang Tiles for Image and Texture Generation”,
Cohen, Shade, Hiller, Deussen, SIGGRAPH 2003
Given a 2D slice through an aggregate material, create a 3D volume with a comparable appearance.

**Objective**

"Stereological Techniques for Solid Textures"
Jagnow, Dorsey, & Rushmeier, SIGGRAPH 2004

**Recovering Sphere Distributions**

\[ N_A = \text{Profile density} \]
\[ N_V = \text{Particle density} \]
\[ \bar{d} = \text{Mean caliper particle diameter} \]

The fundamental relationship of stereology:

\[ N_A = \bar{d} N_V \]

**Profile Statistics**

Segment input image to obtain profile densities \( N_A \).

Bin profiles according to their area, \( \sqrt{A/A_{\text{max}}} \).

**Recovering Color**

Select mean particle colors from segmented regions in the input image.

**Recovering Noise**

How can we replicate the noisy appearance of the input?

The noise residual is less structured and responds well to Heeger & Bergen’s method.

*Slide from Rob Jagnow*
Putting It All Together

Input

Synthetic volume without noise

Synthetic volume with noise

Slide from Rob Jagnow

Results

Input

Result

Slide from Rob Jagnow

Reading for Tuesday: pick one

“Photographing long scenes with multi-viewpoint panoramas”, Agarwala, Agrawala, Cohen, Salesin, & Szeliski, SIGGRAPH 2006

“Environment Matting and Compositing”  
Zongker, Werner, Curless, & Salesin, SIGGRAPH 1999