Texture Synthesis

Last Time?

- Architectural Rendering
- Reading for Today
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Painterly Rendering

Final Project Presentations

- Presenters:
  - Summarize prior work as necessary
  - Be technical: What were the challenges? How did you solve them?
  - Live demo / video / lots of images
  - Teams of 2: All should present & make it clear who did what
  - Practice! & time yourself!
- Rest of Class:
  - Attendance mandatory, start at 2pm sharp (please don’t be late)
  - No laptops allowed during your classmates’ presentations
  - Ask good questions (participation grade)
- Final Project Grade:
  - Report: 20 pts
  - Presentation: 10 pts (instructor: 5 pts, peer average: 5 pts)

Final Presentation Schedule

<table>
<thead>
<tr>
<th>Tues. April 21</th>
<th>Fri. April 24</th>
<th>Tues. April 28</th>
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Total time (including setup & questions):
14 min (individual), 24 min (team of 2)

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

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.”

Alternate Synthesis Order

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

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Template


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Neighborhood Size

Figure 2. Results: given a sample image (left), the algorithm synthesized four new images with neighborhood windows of widths 3, 15, 15, and 2 pixels respectively. Notice how perceptually intuitively the window size corresponds to the degree of randomness in the resulting textures. Input images are: (a) synthetic ramp, (b) Brodatz texture (D), (c) brick wall.
Failure Examples

from Efros & Leung

from Wei & Levoy

Questions?

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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
Today

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Wang Tiles

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


Wang Tile Texture Synthesis

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

Input texture sample
Automatically generated set of Wang tiles
Synthesized textures using Wang tiling


Reading For Today:

“Image Analogies”, Hertzmann et al., SIGGRAPH 2001
Objective

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

Given a 2D slice through an aggregate material, create a 3D volume with a comparable appearance.

Slide from Rob Jagnow

Recovering Sphere Distributions

\[ N_A = \text{Profile density} \]
\[ N_p = \text{Particle density} \]
\[ \overline{H} = \text{Mean caliper particle diameter} \]

The fundamental relationship of stereology:

\[ N_A = \overline{H} N_p \]

Slide from Rob Jagnow

Recovering Sphere Distributions

\[ \begin{bmatrix} N_A \\ N_p \end{bmatrix} = \begin{bmatrix} K \end{bmatrix} \]

Slide from Rob Jagnow

Profile Statistics

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

Input
Segmentation

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

Slide from Rob Jagnow

Recovering Color

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

Input
Mean Colors
Synthetic Volume

Slide from Rob Jagnow

Recovering Noise

How can we replicate the noisy appearance of the input?

Input
Mean Colors
Residual

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

Synthesized Residual

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