Texture Synthesis

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 \((0,0) \rightarrow (1,1)\)

Tiles with visible seams

Seamless tiling (repeating)

Texture Synthesis Challenge

input    tiled    synthesis

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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.”

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

Template


Questions?
Today

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Image Inpainting

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

Reading for Today:

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

Constrained Texture Synthesis

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

Reading for Today:

- Coarse to fine completion
- Confidence & traversal order
- Search for best match over different scales, rotations, & resolutions (texture frequency)
- Compositing fragments

- “Fragment-based image completion”, Drori, Cohen-Or, Yeshurun, SIGGRAPH 2003
"Image Analogies", Hertzmann et al., *SIGGRAPH 2001*

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

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**Wang Tiles**

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


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**Wang Tile Texture Synthesis**
- As a precomputation, fill the tiles with texture
- Then create infinite amounts of non-periodic texture!


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**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.

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**Recovering Sphere Distributions**

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

The fundamental relationship of stereology:

\[ N_A = \bar{H}N_P \]

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**Profile Statistics**

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

Input
Segmentation

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

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**Recovering Color**

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

Input → Mean Colors → Synthetic Volume

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**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
Putting It All Together

Slide from Rob Jagnow

Results

Slide from Rob Jagnow

Reading for Tuesday:

“Coded Rolling Shutter Photography: Flexible Space-Time Sampling” Ciu, Minomi, Miananza, & Nayar, ICIP 2010

(a) Conventional rolling shutter  (b) Input: interlaced readout ($K=2$)

(c) Interpolated sub-image $I_1$  (d) Interpolated sub-image $I_2$