Procedural Modeling

Last Time?
- Modern Graphics Hardware
- Cg Programming Language
- Gouraud Shading vs. Phong Normal Interpolation
- Bump, Displacement, & Environment Mapping

Today
- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems

Texture Mapping
- For each triangle in the model establish a corresponding region in the photo texture
- During rasterization interpolate the coordinate indices into the texture map

Texture Mapping Difficulties
- Tedious to specify texture coordinates
- Acquiring textures is surprisingly difficult
  - Photographs have projective distortions
  - Variations in reflectance and illumination
  - Tiling problems

Common Texture Coordinate Mappings
- Orthogonal
- Cylindrical
- Spherical
- Perspective Projection
- Texture Chart
Projective Textures

- Use the texture like a slide projector
- No need to specify texture coordinates explicitly

Projective Texture Example

- Modeling from photographs
- Using input photos as textures

Texture Chart

- Pack triangles into a single image

Text Map vs. Solid Texture

“Solid Texturing of Complex Surfaces”, Peachey, SIGGRAPH 1985

Questions?

Today

- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems
Procedural Textures

\[ f(x,y,z) \rightarrow \text{color} \]

Image by Turner Whitted

Advantages:
- easy to implement in ray tracer
- more compact than texture maps (especially for solid textures)
- infinite resolution

Disadvantages
- non-intuitive
- difficult to match existing texture

Readings for Today:
  & “Improving Noise”, SIGGRAPH 2002

Perlin Noise

Properties:
- Looks “random”, but is deterministic (always returns the same answer for a specific coordinate)
- Small memory footprint & fast to compute
- Known amplitude & frequency
- Smooth interpolation when zoomed in

Can be combined/layered:
- Add multiple noise functions w/ different frequencies and amplitudes
- Simple arithmetic operations (thresholding, sine waves, etc.)

Reading for Today:

Cellular Textures

www.worley.com

Voronoi diagram
Today

- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems

Procedural Displacement Mapping

- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems

L-Systems

- Alphabet: \{a, b\}
- Initiation: \[a\]
- Production rules:
  - \[a \rightarrow b\]
  - \[b \rightarrow ba\]
- Generations:
  - \[a\]
  - \[b\]
  - \[ba\]
  - \[bab\]
  - \[babab\]
  - \[bababab\]
  - \[babababab\]

- http://algorithmicbotany.org/

L-Systems

- Animation of Plant Development
- Prusinkiewicz et al., SIGGRAPH 1993

Cellular Texturing for Architecture

- “Feature-Based Cellular Texturing for Architectural Models”, Legakis, Dorsey, & Gortler, SIGGRAPH 2001
**L-Systems for Cities**

- "Procedural Modeling of Cities", Parish & Müller, SIGGRAPH 2001

**Procedural Modeling of Buildings**


**Image-based Procedural Modeling of Facades**


**Questions?**

Image by Justin Legakis

**Reading for Tuesday:**

- “Towards Artistic Minimal Rendering”, Rosin & Lai, NPAR 2010

*Figure 1: Mona Lisa rendered in different styles: (a) line drawing, (b) image abstraction, (c) addition of three styles of the proposed approach.*