Procedural Modeling

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

Reading for Last Time:
- Chris Wyman, "An Approximate Image-Space Approach for Interactive Refraction", SIGGRAPH 2005

Final Project Progress Reports
- What do you plan to show for your progress report in 2 weeks?
- Each teammate should make a post outlining their contributions thus far
- Post image(s), e.g., bloopers
- Post revised task list

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 phototexture
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

Questions?
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Texture Map vs. Solid Texture

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

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

Procedural Textures

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.)
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L-Systems

- alphabet: {a,b}
- initiator: a
- production rules:
  a -> b
  b -> ba
- generations:
  a
  b
  ba
  bab
  babba
  babbahab
  babbahabhabhabhab

Procedural Displacement Mapping

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

L-Systems

- Animation of Plant Development
- Prusinkiewicz & Lindenmayer, The Algorithmic Beauty of Plants, 1990
- http://algorithmicbotany.org/
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?

Reading for Tuesday: