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 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?

Today

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

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

GLSL example: checkerboard.vs

```
// a shader for a black & white checkerboard

precision mediump float;
vec4 checkerboard(vec3 v) { return vec4(v.x % 2.0 < 0.5 ? 1.0 : 0.0, 1.0, 1.0, 1.0); }
```

Procedural Textures

• 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:

Ken Perlin,
“An Image Synthesizer”, SIGGRAPH 1985
“Improving Noise”, SIGGRAPH 2002

Another GLSL example: orange.vs

```
// a shader that looks like orange peel

// the farness shader responds with the world map position (FT)
// connectiion map mapping a normal map (LT)
// connection map mapping a diffuse map (LT)

// float nmap(FT) return normal(...)
// float dmap(FT) return diffuse(...)

float nmap(FT) { return normal(...); }
float dmap(FT) { return diffuse(...); }
```

GLSL example: checkerboard.fs

```
// a shader for a black & white checkerboard

precision mediump float;
vec2 checkerboard(vec3 v) { return vec2(v.x % 2.0 < 0.5 ? 1.0 : 0.0, 1.0); }
```
Another GLSL example: orange.fs

```cpp
#include <iostream>

int main() {
  return 0;
}
```

Cellular Textures

www.worley.com

Questions?

Today

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

Procedural Displacement Mapping

Ken Musgrave
www.kenmusgrave.com

L-Systems

alphabet: \(\{a,b\}\)

initiator: a

production rules:

\[ a \rightarrow b \]
\[ b \rightarrow ba \]

generations:

a
b
ba
bab
bababa
bababababa
bababababababa

Prusinkiewicz & Lindenmayer,
The Algorithmic Beauty of Plants, 1990
http://algorithmicbotany.org/
L-Systems

Animation of Plant Development
Prusinkiewicz et al., SIGGRAPH 1993

Prusinkiewicz & Lindenmayer,
The Algorithmic Beauty of Plants, 1990
http://algorithmicbotany.org/

Reading for Today:


L-Systems for Cities

“Procedural Modeling of Cities”, Parish & Müller, SIGGRAPH 2001

Cellular Texturing for Architecture

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

Questions?

Image by Justin Legakis

Reading for Tuesday:

- “Artistic Thresholding” Xu & Kaplan, NPAR 2008