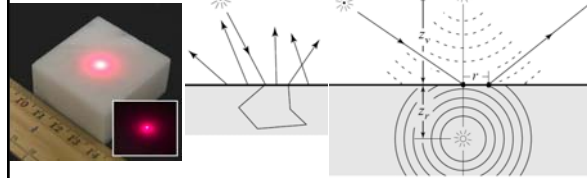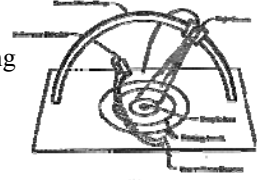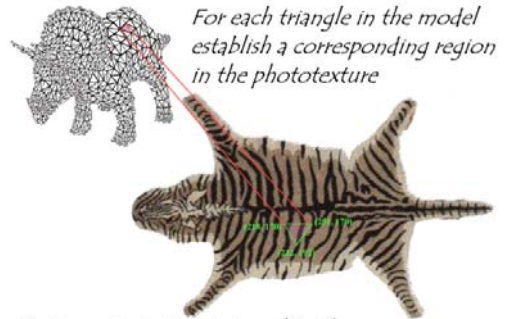# Procedural Modeling

Last Time?

- Measuring BRDFs
- 3D Digitizing & Scattering
- BSSRDFs
  - Monte Carlo Simulation
  - Dipole Approximation

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
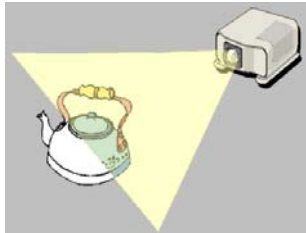 - Variations in reflectance and illumination
  - Tiling problems

Can't do this!

You can get around this problem for planar surfaces if you specify 4 points.
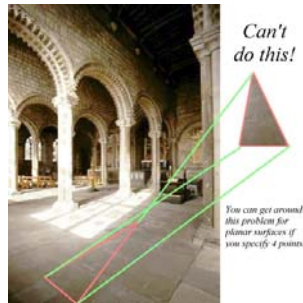
Common Texture Coordinate Mappings

- 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
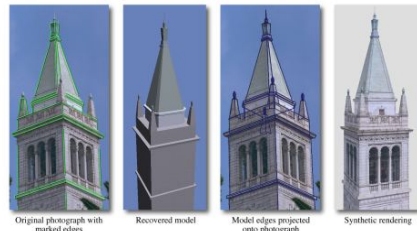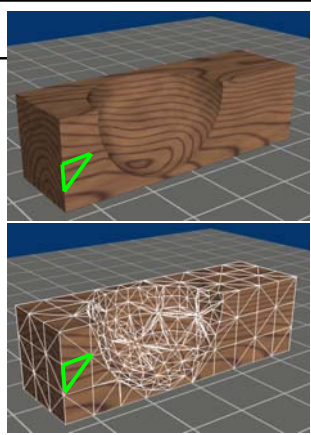- Using input photos as textures

Original photograph with marked edges Recovered model Model edges projected onto photograph Synthetic rendering

Figure from Debevec, Taylor & Malik
http://www.debevec.org/Research

Texture Chart
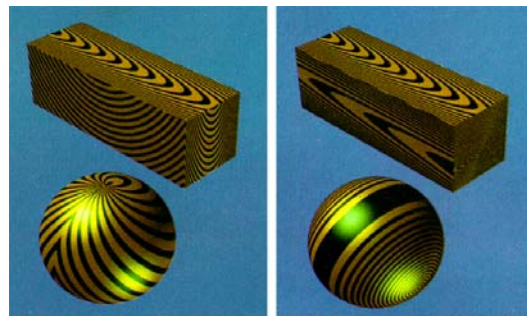
- Pack triangles into a single image

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",
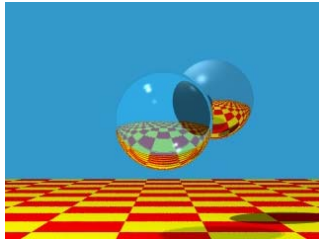Peachey, SIGGRAPH 1985

Procedural Textures
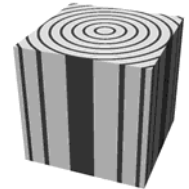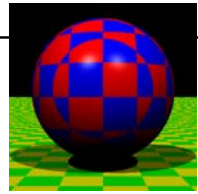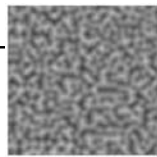
$f(x,y,z) \rightarrow$ color

Image by Turner Whitted

Procedural Textures

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

- Disadvantages
  - non-intuitive
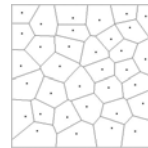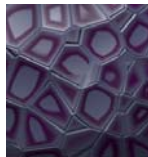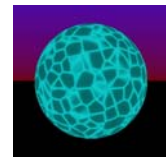 - difficult to match existing texture

Perlin Noise

Ken Perlin,
"An Image Synthesizer", SIGGRAPH 1985
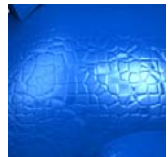"Improving Noise", SIGGRAPH 2002

Cellular Textures

Voronoi diagram

"A Cellular Texture Basis Function", Worley, SIGGRAPH 1996

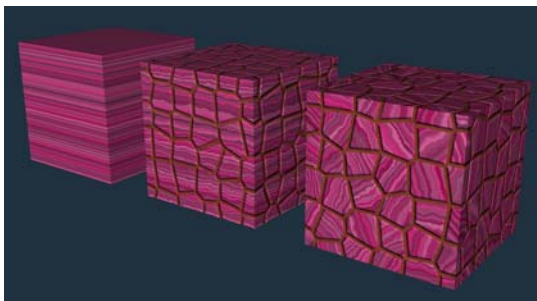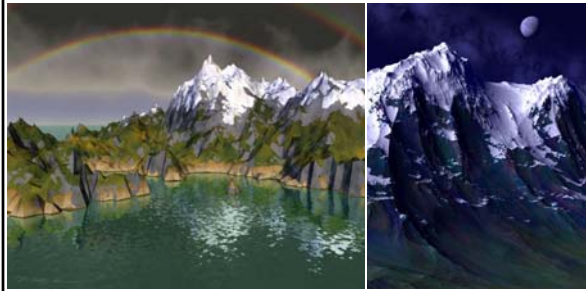www.worley.com

Questions?

Image by Justin Legakis

Today

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

Procedural Displacement Mapping
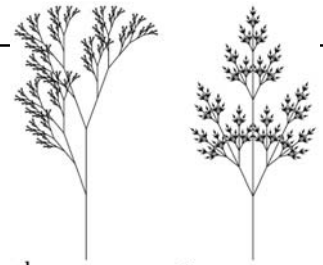

Ken Musgrave
www.kenmusgrave.com

L-Systems

alphabet: {a,b}
initiator: a
production rules:
    a -> b
    b -> ba

generations:
    a
    b
    ba
    bab
    babba
    babbabab
    babbababbabba
    babbababbabbababbabab

d
n=7 ,δ=20°
X
X $\rightarrow$ F[+X]F[-X]+X
F $\rightarrow$ FF

e
n=7 ,δ=25.7°
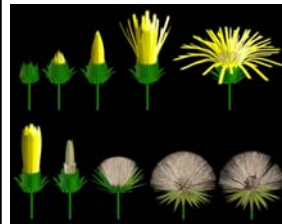X
X $\rightarrow$ F[+X][-X]FX
F $\rightarrow$ FF

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

L-Systems

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

Readings For Today

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

*Feature-Based Cellular Texturing
for Architectural Models*
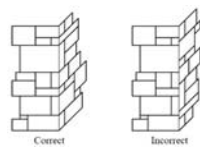Legakis et al.
SIGGRAPH 2001

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,
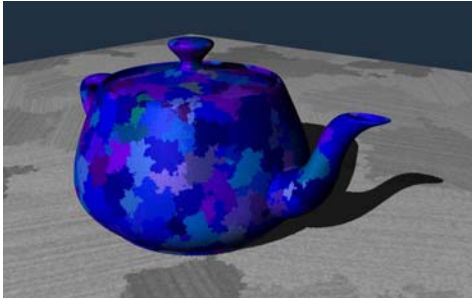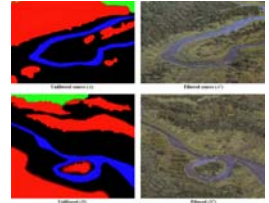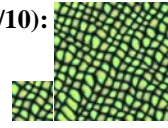& Gortler, SIGGRAPH 2001

Questions?

Image by Justin Legakis

Readings for Tuesday(4/10):

Efros & Leung, "Texture Synthesis by Non-parametric Sampling", *ICCV 1999*

"Image Analogies", Hertzmann et al., *SIGGRAPH 2001*

Readings for Friday(4/13):

"Interactive Pen-and-Ink Illustration", Salisbury et al., *SIGGRAPH 1994*

Hoiem, Efros, and Hebert, "Automatic Photo Pop-up", *SIGGRAPH 2005*