Final Topics

**CPSC 314**

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Final Topics (1)

**Rendering Pipeline**
- Structure, purpose, individual stages

**Transformations**
- Homogeneous coordinates in 2D and 3D
- Affine transformations
- Perspective and orthographic transformations

**Lighting and shading**
- Individual lighting models, interaction of lighting with flat, Gouraud, and Phong shading
Final Topics (2)

**Clipping**
- Line and polygon clipping

**Scan Conversion**
- Bresenham, DDA for lines
- Scanline-order scan conversion for polygons
- Edge/plane equations for polygons

Final Topics (3)

**Texture Mapping**
- Texture coordinate interpolation
- Texture minification/magnification, mip-mapping
- Bump-mapping, environment mapping

**Sampling**
- Nyquist limit, aliasing

**Depth Test/Visibility**
- Z-buffer, BSP trees

**Blending**
- Alpha blending
## Final Topics (4)

**Color**
- Black-body radiation, color temperature,
- CIE horseshoe diagram
- Color gamut of a device

**Ray Tracing**
- Ray tree, ray-object intersections, acceleration data structures

**Monte Carlo/Global Illumination**
- Basic MC sampling approach
- Examples of global illumination effects

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**Remember:**

*One more office hour tomorrow, 2-3*
Current Research in CG/Advanced CG Courses at UBC

**CPSC 314**

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3D Graphics

*Modeling:*
- Representing object properties
  - Geometry: polygons, smooth surfaces etc.
  - Materials: reflection models etc.

*Rendering:*
- Generation of images from models
  - Interactive rendering
  - Off-line rendering

*Animation:*
- Making geometric models move and deform
- Fluids and cloth

*Visualization*
- Use graphics to present abstract data
1) Geometric Modeling Topics

**Smooth Geometry**
- Use polynomials for object representations
  - One polynomial for whole object: Bezier curves (previous lecture)
  - More interesting: how to join multiple polynomial pieces such that there are no seams
    - Splines, NURBS

**Discrete Geometry**

*Modeling w/ points and triangles*
- How do we represent geometry as points or triangles?
- What are good user interfaces that let people quickly create the shape they want
- Can we refine triangle or quadrilateral meshes so that they approximate smooth geometry?
  - Subdivision surfaces
- How do we assign texture coordinates to each vertex to map an image onto triangle geometry?
  - Finding a parameterization for the mesh
Subdivision Surfaces - Octahedron

Subdivision Surfaces - Bunny
Subdivision Surfaces - Bunny

Parameterizing Geometry
Parameterization

- How do we get from here to here?

Venus bust  Venus bust with Britney Spears texture
© Wolfgang Heidrich

Parameterization

© Wolfgang Heidrich
Geometric Modeling Courses at UBC

Undergraduate
- CPSC 424: geometric Modeling
  - Mostly deals with smooth curves and surfaces, some topics on meshes
  - Will be taught in January by Alla Sheffer

Graduate
- CPSC 524: Digital geometry Processing
  - Focus on triangle meshes, parameterization, mesh morphing etc.

2) Rendering and Acquisition Topics

Rendering:
- Take scene description and create image

Acquisition:
- Take real-world environment, and extract scene description
  - Geometry
  - Reflection properties
  - Light sources, etc.
Rendering

**Problems for offline rendering:**
- Efficient sampling strategies for global illumination
- Efficient algorithms for animations
- Simulate new optical effects for which there are no efficient algorithms at the moment

**Problems for interactive rendering:**
- How can we use global illumination algorithms such as Monte Carlo ray-tracing on GPUs?
- What new features should next generation GPUs have?

Rendering Example:
New Monte Carlo Strategies
Acquisition

Problems:
• How do we scan the geometry of objects?
  – *When material properties are difficult*
    ▪ Glass, other transparent and specular objects
  – *When the geometry is moving/deforming*
    ▪ Cloth, smoke, etc.
• How do we measure the reflection properties of objects?
  – *More realistic representation than just diffuse+Phong*
• Lights? Camera?

Acquisition - Tomography
Rendering & Acquisition Courses

Grad course:

- CPSC 514: Computer Graphics - Rendering
  - Deals with both advanced rendering, and acquisition
  - Won’t be offered next year, but in 2 years
3) Animation Topics

Two sub-areas:

- Character animation
  - Movements of humans, animals
  - Both a question of the physics, and of user interface (how do you specify an animation?)
- Fluids etc.
  - Movement of deforming objects, including fluids, smoke, sand, cloth…
  - Heavy on the numerical analysis side
Fluid Animation

Animation Courses

Undergraduate:
- CPSC 426: Computer animation
  - Overview of animation techniques
  - Not taught next year (it alternates with CPSC424)

Graduate:
- CPSC 526: Computer Graphics: Animation
  - Focus on character animation
  - Not taught this year
- CPSC 533D: Animation Physics (topics course)
  - Also not taught this year
  - INSTEAD: Robert Bridson is teaching a scientific computing course 542G (with heavy graphics applications)
Information Visualization

Problem:
• Map abstract data to visual representations that help people understand the data

Visualization Courses

Graduate:
• CPSC 533C: Information Visualization
  – Taught next year by Tamara Munzner
  – But I don't know which term
Upcoming Lectures

Friday:

- Final