CS559: Computer Graphics

Final Review

Li Zhang

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What’s not in the final

- OpenGL and FLTK syntax
- Image based Lighting
- 3D photography

Eyes and Cameras

- Why can we see color?
  - Light spectrum
  - Photoreceptors
- Camera obscura
  - Pinhole, lens
  - Different ways of capturing color
- Optical effect
  - Motion blur
  - Depth of Field

Images

- Representation
  - Sampled, vector, functional
- Minimum Sample requirement
  - Sampling theorem
- Re-sampling
  - Up-sampling, down-sampling
  - Anti-aliasing
- Compositing
  - Alpha channel

Image Filtering

- Convolution
  - Continuous and discrete
- Linear filter
  - Blur, shift, sharpen, edge detection…
- Painter algorithm
  - Iteratively apply strokes

Image warping

- 2D transformation
  - Scale, Rotate, affine, translate, …
  - Inverse transformation
- Properties of 2D transformations
  - Line to line, parallel to parallel, …
- Homogeneous transformation
- Forward warping
  - Splatting
- Inverse warping
  - Reconstruction

Image morphing

- What do we need?
  - Avoid ghosting
- How to do it?
  - Warping + blending

Dynamic Range and Color space

- What is dynamic range?
- Why do we care?
- Human perception of brightness.
- What is gamma?
- What is Trichromacy?
- Color space
  - RGB, HSV, LAB

3D transform

- Homogenous Coordinate
  - Point vs direction
  - Transforming normals
- 3D rotation
  - property
  - Different representation
  - Geometric interpretation
- Concatenation of transforms
  - Hierarchical modeling

Projection

- Graphics pipeline
- Orthographic vs perspective projection
  - Matrix representation
  - Vanishing point
- View frustum
  - Clipping plane, Field of view
  - Convert to projection matrix
- Canonical view volume
  - From perspective view volume

Scan conversion and visibility

- Draw lines and triangles
  - Tricks to make it fast
  - Anti-aliasing
- BSP
  - How to construct and how to use
- Z buffer vs A buffer
  - Pros and cons

Shading

- Phong shading model
  - Emission, diffuse, specular
- Types of light sources
  - Point, spot, directional
- Shading interpolation
  - Flat, Gouraud, and Phong

Curves

- Implicit vs Parametric Curves
- Polynomial Curves
  - How to evaluate polynomial
  - How to compute the curve
  - Problem
- Piecewise cubic polynomial
  - Continuity: C0,C1,C2
  - Local control
  - interpolation

Curves

- Natural, Hermite, Catmull-Rom, Cardinal, Bezier,
  - Commonality and differences
- Bezier curves
  - Subdivision
  - De Casteljau
  - Generalization
  - …

Texture

- Calculate texture coord
  - Perspective correct interpolation
- Texture resampling
  - Antialiasing: Mipmap, Ripmap, SAT
    - How do they work,
    - What can they do, limitation
- Other usages:
  - Bump Map, Displacement Map, 3D Texture, Environment Map, Shadow map
  - Projector texture (no requirement)

Shape

- Boundary vs Solid modeling
- Parametric, Implicit, Procedural
  - Pros and cons
- Polygon meshes
  - Why popular
  - Pros and cons
  - Data structure

Shape

- Sweep objects
- Spatial enumeration
  - Oct tree
- Bezier Patch
  - Bilinear, biquadric, bicubic
  - De Casteljau

Subdivision Curves and Surfaces

- Approximating vs Interpolating
- Regular vs Irregular vertices
- Continuity
- Loop, sqrt(3), Catmull-Clark
  - Commanality and difference
  - Piecewise smoothness (no requirement)
- Fractal Modeling
  - Terrains, trees, …

Animation

- Particle Systems
  - Euler method
  - Collision Detection and Response
- Principles of Cartoon

Raytracing

- Recursive procedure
  - Shadow, Transparency, Reflection, Refraction
  - Why inter-reflection is hard?
  - Anti-aliasing: jittered sampling, why
  - Soft shadow, glossy surface,
  - Depth of field, Motion blur
- Ray object intersection
  - Simple objects: triangle, polygons, …
- Spatial data structure for Acceleration
  - BSP, octtree, grid

Image based Rendering

- Why do we want it?
- How does it work?
- Pros and cons