EE 4700-2
Review

About the final exam

- Time and Location:
  - Thursday Dec. 10th , 12:30pm-1:30pm
  - @ this room
- 15~20 questions:
  - Most are "Multiple Choice" or "True&False"
  - Things covered in our slides or addressed in the class

- Course Project: due 8pm December 13th
- About the homework:
  - before midnight December 6th (upto 60%)

Review Outlines

- Basic Computer Graphics
  - Triangle Mesh and Half-Edge Data Structure
  - Transformation and 3D graphics pipeline
  - Some Basic OpenGL Programming
  - Texture Mapping
- Basic Geometric Modeling
  - Curves and Surfaces
  - Barycentric Coordinates
  - Spline
- Basic Geometric Processing
  - Progressive Mesh
  - Parameterization
  - Remeshing
  - Deformation

Triangle Mesh

- Two tables
  - Vertex table → geometric information
  - Facet table → topological information
- A piecewise linear approximation of the 3D shape
- Triangle mesh is one of the most popular representation method in computer graphics:
  - Triangulation can always be generated from discrete sampling points
  - Supporting local refinement
- Half-Edge data structure
  - Why? How?

Transformation

- Linear Transformation
  - Scaling
  - Rotation
  - Shear
  - Translation *
- Homogeneous Coordinates
- 3D Rotation
  - Matrix for rotating an angle about an axis
  - Matrix for rotating a vector to an axis
- Projection
  - Types: parallel projection and perspective projection

OpenGL Programing

- Commands format
- Primitives
- A state machine, states remains until changed
- Modeling and viewing transformations
- Rendering pipeline

Texture Mapping

- 2D Texture Mapping
- Bump and Normal Mapping

- Environment Mapping
- Light mapping
- 3D Procedural Texture

Curve and Surface

- Curves are different with Surfaces because of their topology
  - Topological equivalence

    = (intuitively) existing a non-degenerate, continuous deformation

    = (strictly) existing a bijective mapping that is continuous in both directions
  - Curve, surface, volumetric, … definition
    - Continuous definition
    - Discrete analogy using simplicial complex
- Topological classification of surfaces
  - # of connected components
  - # of boundaries
  - Genus
  - Orientability
  - How to compute them?

Barycentric Coordinates

- On Curve
- On Surface
- On higher dimensional simplicial complex (n-dimension)

Progressive Mesh

- Level of detail
- Multiresolutional modeling/processing
- Edge collapse, vertex split
- Progressive transmission
- Progressive tetrahedral meshes

Spline

- Piecewise linear, piecewise polynomial, and piecewise rationale
- Hermite Curve, Bezier Curve and B-Spline
- Parametric/Geometric Continuity
- From Bezier Curve to B-Spline to NURBS
- Tensor product surface
- Spline fitting
  - Interpolation
    - Parameterization
    - Knots vector
    - Fitting with a linear system
  - Approximation

Surface Parameterization

- Definition
- Mapping criteria: length-preserving, angle preserving, area preserving
- Spring model and the linear system for flattening the mesh
  - Graph embedding and cotangent weights
  - Bijectivity?
- Conformal mapping and harmonic mapping
- Relationship among length-, angle-, and area-preserving
  - Length preserving = angle preserving + area preserving

Remeshing

- Definition
- Motivation
- Three General approaches to remeshing
  - Subdivision + Simplification (Progressive Mesh)
    - Insert some vertices, then remove some vertices
  - Resampling
    - Directly conduct a sampling to generate all vertices as new
  - Mesh Optimization
    - Move vertices on the surface to optimize the mesh quality
- A method based on surface mapping
  - Sampling
  - Parameterization
  - Delaunay triangulation
  - Centroidal Voronoi Diagram to adjust the sample points positions

Deformation

- Definition
- General approach:
  - Define an energy that approximates the original shape
  - When some points move, resolve all other points position so that the energy is minimized and the change is meaningful