Lecture 25a – Subdivision

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November, 2006
Used as notes, not projected as lecture

Last Time

• Triangle Subdivision Schemes
• Today: Quad subdivision schemes
• And move on to next topic (rendering)

Catmull-Clark Subdivision

• Regular Case is quads
• Same rules apply to non-quads
• Only have non-quads at first iteration
• Generalization of cubic B-Splines
  – On uniform mesh, gives same things
  – But works on non-uniform meshes

Catmull-Clark Rules

• Face point = center of polygon (1/n times each)
• Edge points = average of 4 neighbors
  – (2 old points, 2 adjacent face points)
• Move old points
  – (n-2)/n times itself
  – 1/n² average of N adjacent edges
  – 1/n² average of N adjacent faces
• Edges
  – New point = midpoint
  – Old point = 1/8 \( \frac{3}{4} \) 1/8
• Corners – stationary points

Making Creases

• Hard edge subdivision
  – Pretend that it is an edge of the surface
  – Put edge points at midpoint
• Semi-hard edge subdivision
  – Use hard edge rules for first few iterations
  – Then use the regular rules

Exact Evaluation

• For regular points on Catmull-Clark – it’s just a B-Spline!
• There are methods for extraordinary points (1998)
• For all types, “Masks” exist
  – Final answer depends on points in the neighborhood
  – Look them up in a book
Modeling with subdivision

- Any mesh can be subdivided
- Cut holes, create unusual topology, stitch pieces together
- No matter how complicated the mesh, it will lead to a smooth surface!

Why Subdivision

- B-Splines are Smooth
- B-Splines must be Tessellated
  - Sampling issues
  - How to decide triangle size
  - Need to worry about cracking
- B-Splines have uniform resolution
- Detail must be global

Why Subdivision (2)

- B-Splines require regular grid
  - No corners, holes, ...
- Trimming is hard
- Stitching is hard
- Get a (u,v) parameterization
  - Not controllable
- Hard to make creases and sharp edges

- Subdivision of any mesh
- Any topology can be handled
  - Easy to make corners, holes, ...
- Trimming is easy
- Stitching is easy
- (u,v) parameterization by subdivision of points
  - Controllable
- Easy to make creases and sharp edges

- Limit surfaces are smooth
- Subdivision gives meshes
  - Subdivide as needed
  - Always gives connected mesh
  - Get as many polys as you need
- Subdivision – put detail where you want it
- Detail is multi-resolution