Non Uniform Rational B-Splines

- Piecewise-polynomial tensor product surfaces
- Most general spline surface
  - De facto surface representation for CAD
  - Can be used to represent Bezier and b-spline surfaces
- Compact definition
  - Control points
  - Knot vectors for u and v parametric directions

\[
S(u,v) = \sum_{i=0}^{m} \sum_{j=0}^{n} N_i(u)N_j(v)w_{ij}P_{ij}
\]

Basis Function Evaluation

- First-order basis function is the step function
- Calculate higher order basis functions from lower order basis functions in parallel
- Compute \(k^{th}\)-order basis function in \(k-1\) parallel passes

\[
N_i^1(u) = \begin{cases} 1 & \text{if } u < u_i \\ 0 & \text{otherwise} \end{cases}
\]

Surface Evaluation

- Locate the sub-mesh of control points that influence the evaluation point coordinates
- Compute basis functions along u and v directions
- Multiply the basis functions with their corresponding control points from the sub-mesh

Crack Elimination by Thick Edges

- Process each edge in parallel
- Draw quads around edges, parallel to view plane
- Detect cracks by comparing surface IDs
- Render only “crack” pixels

Algorithm
1. Calculate edge quad location and dimension
2. Invoke fragment program on the edge quad
3. GPU based comparison
   - Pixels other than crack “discarded”; cracks filled iff present

Sample Model Renderings

- 3D models have multiple surfaces
- Neighbor vertices may not match
  - Parameterization mismatch
  - High curvature surfaces
- Cracks form around the edges
  - Changes with view direction/zoom
  - Have to be eliminated each rendering pass

Preliminary Timing Results