

Level of Detail: Generating LODs



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(with help from David Luebke)



Generating LODs

- Simplification operator
- Measuring Error



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Generating LODs

- Simplification operator:
 - Cell collapse
 - Vertex removal
 - Edge collapse

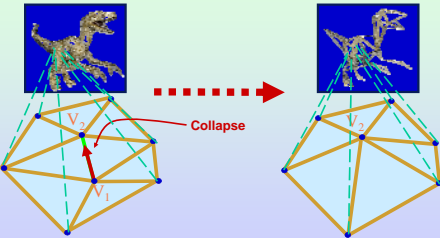


Generating LODs

- Simplification operator:
 - Cell collapse
 - Vertex removal
 - Edge collapse
 - Full edge collapse
 - + Better fidelity
 - Half edge collapse
 - + Less memory
 - - Quality
 - Vertex-pair merge a.k.a. "virtual edge collapse"
 - - Merges separate objects




Edge Collapse Algorithm



Edge Collapse Benefits

- Edge collapse operation is simple
- Supports non-manifold topology:



Edge Collapse vs. Vertex-Pair Merging

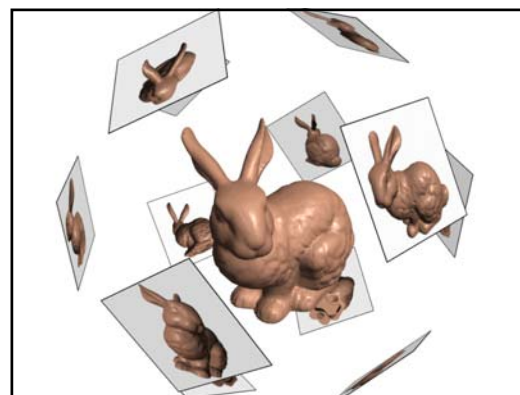
- Even better: *vertex-pair merging* merges two vertices that:
 - Share an edge, or
 - Are within some threshold distance t
- Q: *What does vertex-pair merging enable over edge collapse?*

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Measuring Error

- Most LOD algorithms measure error geometrically
 - What is the *distance* between the original and simplified surface?
 - What is the *volume* between the surfaces?
- Really this is just an approximation to the actual *visual* error, which includes:
 - Color, normal, & texture distortion
 - Importance of silhouettes, background illumination, semantic importance, etc.



Measuring Geometric Error

- Measuring error
 - Hausdorff distance
 - One-sided: $h(A, B) = \max_{a \in A} \min_{b \in B} \|a - b\|$
 - Two-sided: $H(A, B) = \max(h(A, B), h(B, A))$
 - Common approximations:
 - Measure vertex-vertex distance, vertex-plane distance
 - METRO: Sample $H(A, B)$ by sprinkling points on triangles
 - *Quadric Error Metrics*: a variation of vertex-plane distance that works well in practice



Measuring Perceptual Error

- Idea:
 - Measure local simplification operations against a perceptual model to predict whether the user can see the effect of simplification
- Model
 - Use a *contrast sensitivity function*



Perception 101: Contrast Sensitivity Function

- Contrast grating tests produce a contrast sensitivity function
 - Threshold contrast vs. spatial frequency
 - CSF predicts the minimum detectable static stimuli

