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CHANGE THE WORLD FROM HERE

Mesh Simplification

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Decimation of Triangle Meshes

- Reduce the total number of triangles in a triangle mesh
- Preserve the original topology and a good approximation of the original geometry

Overview

A multiple-pass algorithm

- During each pass, perform the following three basic steps on every vertex:
  - Classify the local geometry and topology for this given vertex
  - Use the decimation criterion to decide if the vertex can be deleted.
  - If the point is deleted, re-triangulate the resulting hole.
  - This vertex removal process repeats, with possible adjustment of the decimation criteria, until some termination condition is met.

Steps

Basically for each vertex, three steps are involved:

- **Characterize the local vertex geometry and topology**
- **Evaluate the decimation criteria**
- **Triangulate the resulting hole.**

Characterize Local Geometry and Topology

Each vertex is assigned one of five possible classifications:

Simple vertex

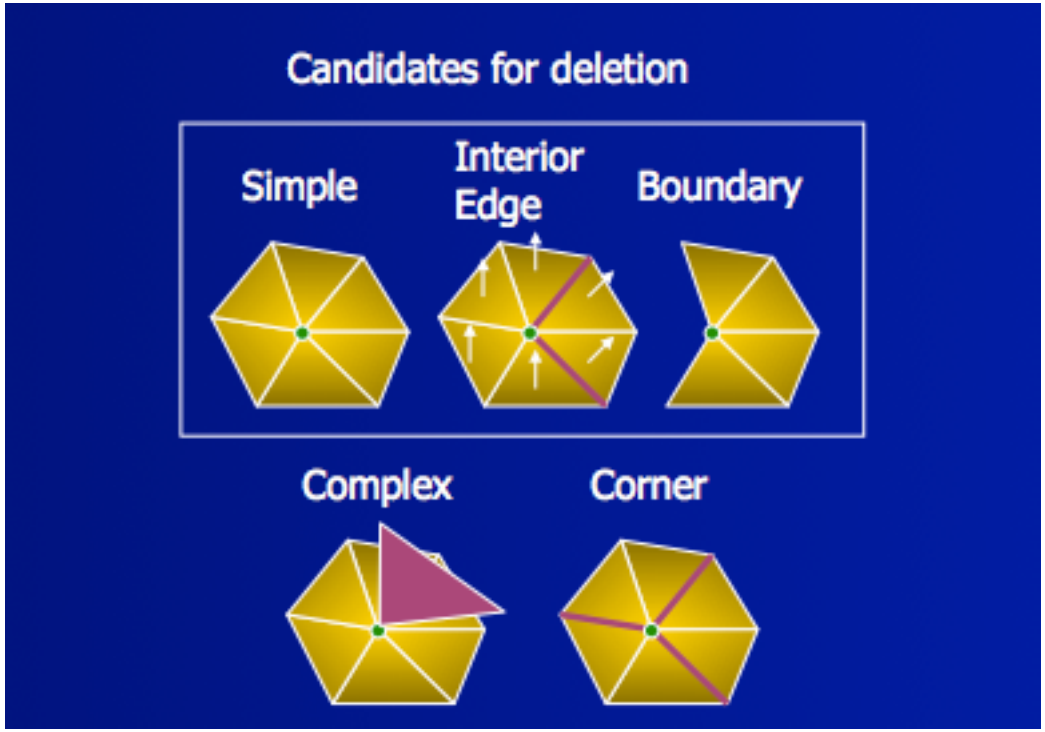
Complex vertex

Boundary vertex

Interior edge vertex

Corner vertex

Classification of edges

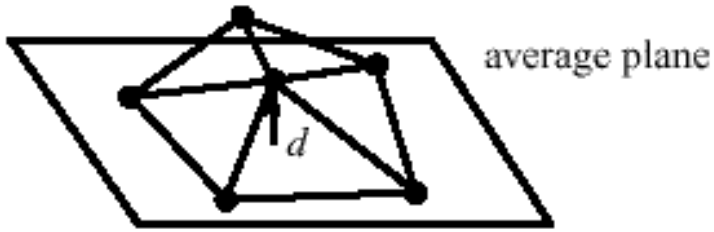


Evaluate the Decimation Criteria

- Complex vertices are not deleted from the mesh.
- Use the distance to plane criterion for simple vertices.
- Use the distance to edge criterion for boundary and interior edge vertices.

Decimation Criterion for Simple Vertices

Use the distance to plane criterion.
If the vertex is within the specified distance to the average plane, it can be deleted. Otherwise, it is retained.



Challenges We Have

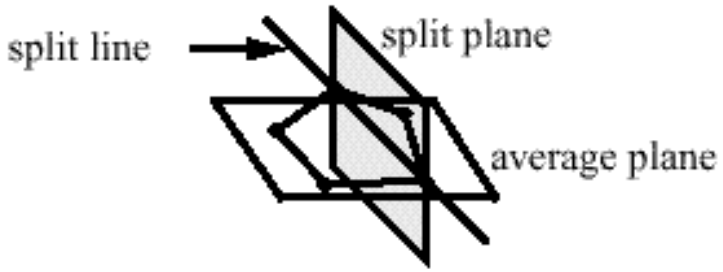
- **Dynamically storing the primitives after each pass.**
- **Triangulation**
- **Calculating the normals on the new set of primitives after each pass.**

Triangulation

Deleting a vertex and its associated triangles creates one(simple or boundary vertex) or two loops(interior edge vertex).

Future Works(Recursive Splitting Method)

- Divided the loop into two halves along a line defined from two non-neighboring vertices in the loop.
- Each new loop is divided until only three vertices remain in each loop.



Vertex Clustering

- Grading
- Clustering
- Synthesis
- Recalculating normals

Grading

A weight value is computed for each vertex according to its visual importance (e.g. number of the faces bounded by the vertex and the inverse of the maximum angle between all pairs of incident edges on the vertex).

Clustering

Create clustering-cell for vertices synthesis

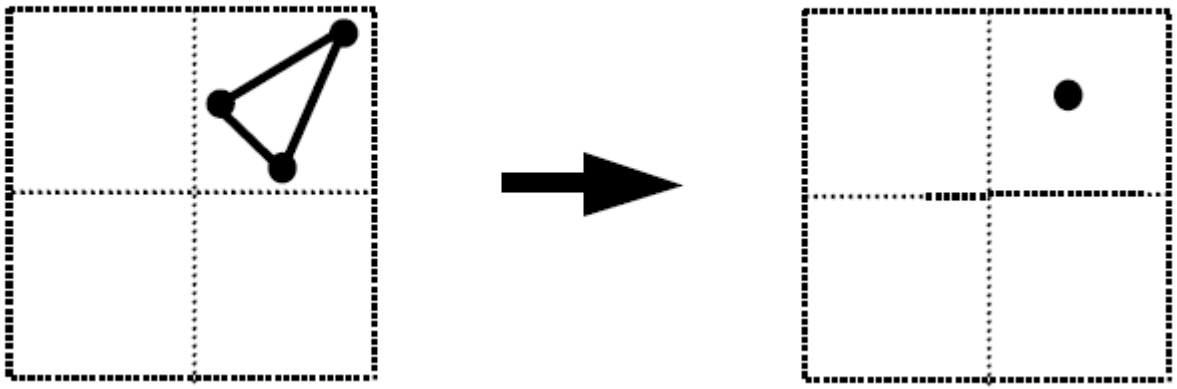
Keep a vertex representative per cell

Clusters $p \leftrightarrow \{p_0,\ldots,p_n\}$, $q \leftrightarrow \{q_0,\ldots,q_m\}$
Connect (p,q) if there was an edge (p_i,q_j)

Synthesis

The representative of P_1, P_2, …, P_k in the same cell is their weighted average:

$$\mathbf{P} = \frac{w_1\mathbf{P}_1 + w_2\mathbf{P}_2 + \ldots + w_k\mathbf{P}_k}{w_1 + w_2 + \ldots + w_k}$$



Recalculate normals

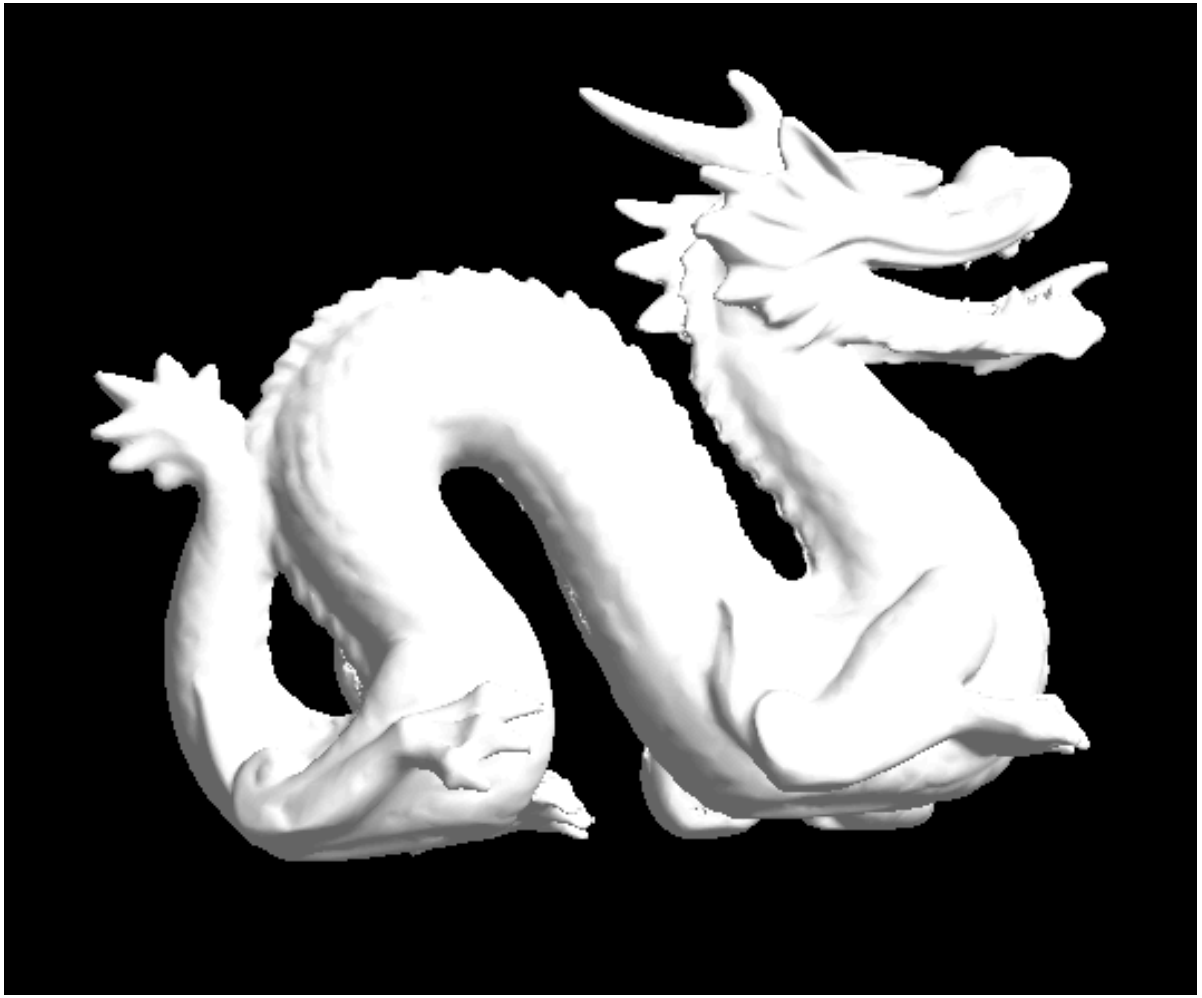
Normals of resulting vertices and triangles should be reconstructed

Challenges

Adjustment of normals

Filling holes

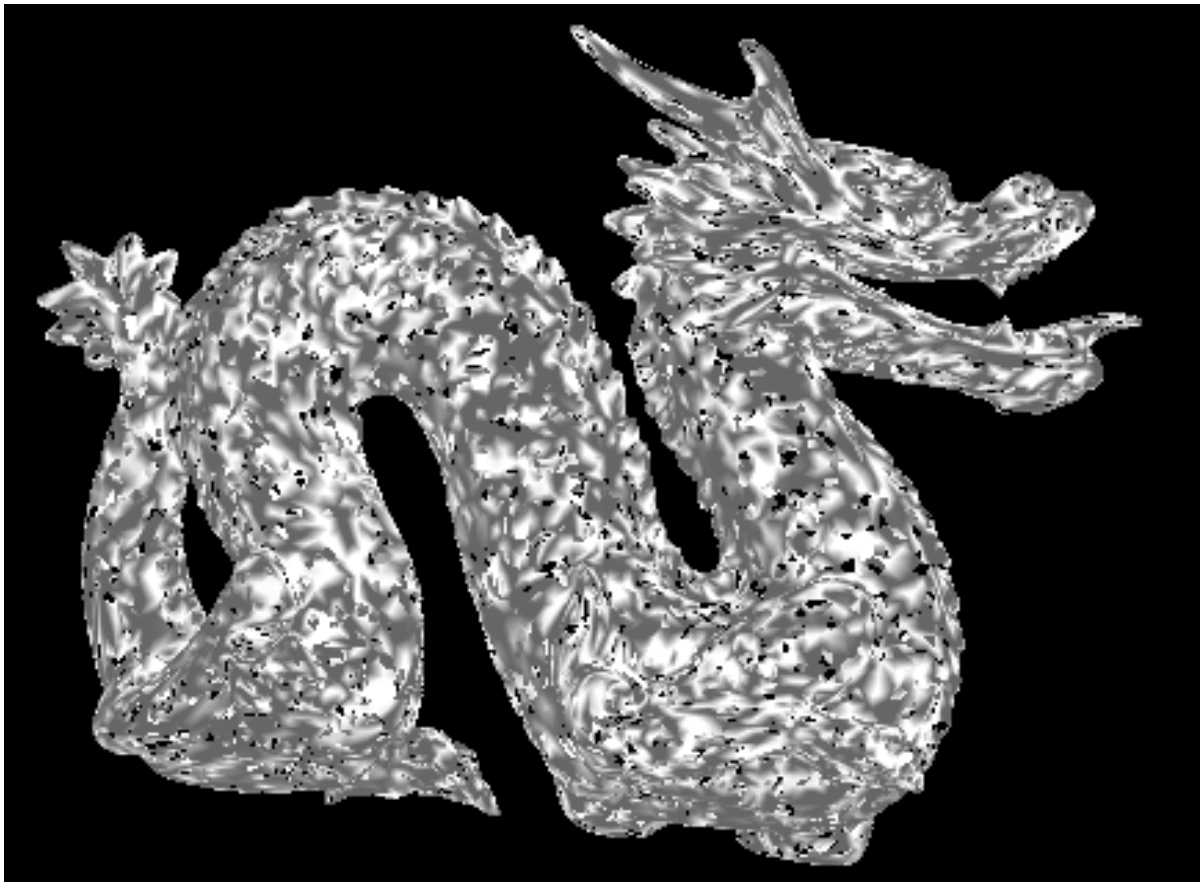
Result



Original mesh

Faces: 100,000
Vertices: 50,000

Result



Simplified mesh

Faces: 52,987
Vertices: 31,232

References

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Mesh Simplification Viewer

http://www.jsomers.com/vipm_demo/meshsimp.html

Thank you!