Motivation

- given a set of points in 3D
- create a surface representation

Outline

- Motivation
- Algorithm: Points $\rightarrow$ Multires Surface
- Results
- Future Work

Design - Review Cycle

1. designer creates physical prototype
2. 3D scanning
3. point cloud
4. numerical analysis
5. engineering
6. approved
7. digital model
8. manufacturing
9. surface reconstruction
10. suggested changes
11. Reverse Engineering
Why Multiresolution

- view-dependent rendering
- compression
- progressive transmission
- hierarchical editing

Level-of-detail Methods

- mesh simplification / progressive meshes
- subdivision-surface wavelets

Idea

- hybrid representation
  - adaptive voxel grid (octree)
  - subdivision + topology adaption

We use Hybrid Meshes

- alternating subdivision and local topology adaption [Guskov et al. 2002]
  - (S) Catmull/Clark-style subdivision
  - (T) topological modification
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Algorithm (3 steps)

1. hierarchical space partitioning (octree)
2. hybrid mesh wrapping (connecting levels)
3. vertex mapping

(1) Hierarchical Space Partitioning
- start with bounding box of point cloud
- recursively subdivide into 8 subvoxels
- erase empty voxels
- extract outer boundary of voxel complex

(2) Hybrid Mesh Wrapping
- construct subdivision connectivity
Hybrid Mesh Wrapping

1. Identify and connect new faces.

Hybrid Mesh Wrapping

- Mesh hierarchy stored as forest
  - Quadtree structure for subdivision
  - New roots introduced at topology changes
- Face adjacency found by looking at adjacent voxels in octree.

(3) Vertex Mapping

- For each vertex identify set of scattered points within adjacent voxels
- Construct linear surface approximation by least-squares fitting
- Project vertex onto this plane.
Vertex Mapping

- principal component analysis (PCA) provides least-squares fit

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Results

Stanford Bunny, 15K faces, 1.4 sec

rocker arm, 30K faces, 5.6 sec

Stanford Dragon, 43K faces, 12.0 sec

Stanford Buddah, 33K faces, 10.1 sec
Robustness

- manifold property
- correct topology
- water tight surface

\[ \text{Robustness} \]

Boundary Treatment

- stop at voxel backfaces (wanted holes)
- close small gaps (unwanted holes)

\[ \text{Boundary Treatment} \]

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\[ \text{Outline} \]

Future Work

- subdivision wavelets
  - provide smoother representation
  - do not support topological changes
- can we combine wavelets and hybrid meshes?

\[ \text{Future Work} \]