Digital Geometry Processing

Many possible surface representations
- Polygonal meshes
- Parametric surfaces
- Subdivision surfaces
- Implicit surfaces
- etc.

3D Polygonal Meshes

Set of polygonal faces representing a 2D surface embedded in 3D

Digital Geometry Processing

Processing of 3D surfaces
- Creation, acquisition
- Storage, transmission
- Editing, animation, simulation
- Manufacture

Applications
- Movies, games
- Computer-aided design
- Medicine, biology
- Art, history

3D Polygonal Meshes

Set of polygonal faces representing a 2D surface embedded in 3D

Polygonal Meshes

Adam Finkelstein
Princeton University
COS 526, Fall 2008

Acknowledge: slides from Funkhouser

Digital Geometry Processing

Let’s focus on 3D polygonal meshes
- Simple, common representation
- Rendering with hardware support
- Output of many acquisition tools
- Input to many simulation/analysis tools

3D Polygonal Meshes

Face
Edge
Vertex

Zorin & Schroeder, SIGGRAPH 99, Course Notes
Outline
Acquisition
Processing
Representation

Polygonal Mesh Acquisition
Interactive modeling
- Polygon editors
- Interchange formats

Scanners
- Laser range scanners
- CAT, MRI, etc. (isosurfaces)

Simulations
- Physical processes

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Simulations
- Physical processes
Polygonal Mesh Processing

- **Storage**
  - Compression
  - Transmission
- **Analysis**
  - Parameterization
  - Differential geometry
  - Feature detection
  - Segmentation
- **Editing**
  - Smoothing, sharpening, etc.
  - Deformation
  - Completion

Outline

Acquisition
Processing
Representation

Polygon Mesh Representation

Data structures determine algorithms
- Data structure must support key operations of algorithm efficiently

Examples:
- Drawing a mesh
- Removing a vertex
- Computing per-vertex normals

Important properties of mesh representation?

- Efficient traversal of topology
- Efficient use of memory

Possible data structures
- List of independent faces
- Vertex and face tables
- Adjacency lists
- Winged edge
- Half edge
- etc.
Independent Faces
Each face lists vertex coordinates
- Redundant vertices
- No topology information

Vertex and Face Tables
Each face lists vertex references
- Shared vertices
- Still no topology information

Adjacency Lists
Store all vertex, edge, and face adjacencies
- Efficient topology traversal
- Extra storage

Partial Adjacency Lists
Can we store only some adjacency relationships and derive others?

Winged Edge
Adjacency encoded in edges
- All adjacencies in O(1) time
- Little extra storage (fixed records)
- Arbitrary polygons

Winged Edge
Example:
**Half Edge**

Adjacency encoded in edges
- All adjacencies in $O(1)$ time
- Little extra storage (fixed records)
- Arbitrary polygons

Similar to winged-edge, except adjacency encoded in half-edges

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**Summary**

Polygonal mesh overview
- Acquisition
- Processing
- Representation

Next time: Laplacian Surface Editing