Level-of-Detail in Surface and Volume Modeling

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Outline

- Introduction
- Surface Approximation with Triangle Meshes
- Simplification Algorithms
- LOD Models
  - Part one: a comprehensive framework for multiresolution
  - Part two: overview of LOD models
- Applications
Motivations

- High complexity of 3D scenes
  - automatic acquisition of the surface of solid objects
    - range scanners -- 3D scanners
      - resolution supported: ~ 10 facets / mm²
  - standard solid modeling tools (CAD)
    - complex 3D object defined by # faces > 100K
  - digital terrain models
    - millions of faces
  - tessellation of implicit surfaces

...Motivations...

- 3D graphics is a limited, valuable resource
  - graphics throughput of low level ws / pc : ~100K faces/sec
  - interactivity requires multiple frames per second
  - web graphics (VRML) needs transmission of data on low bandwidth networks
    - scientific users: 300-500KB/sec local, 10 - 100KB/sec remote
    - commercial/home users: 56Kb/sec (in Italy)
  - graphics file size:
    - 24 byte/vertex (if binary, >> if ascii)
Reducing Graphics Costs

- **Visualization Stage:**
  - culling back faces
  - view frustum culling
  - visibility culling

- **Modeling Stage:**
  - tessellate surfaces with triangle meshes
  - simplify meshes
  - construct a LOD model

View Frustum Culling

- an example of **view frustum culling**
  (images by SGI, OpenGL Optimizer)

[Images showing view frustum culling in action]
Visibility Culling

- an example of **occlusion/visibility culling**
  (images by SGI, OpenGL Optimizer)

![Occlusion Culling Off](image1)
![Occlusion Culling On](image2)

Level of Detail:
Approximating surfaces with triangle meshes

- **Assumption:**
  - accuracy of the approximation is proportional to the number of triangles

- **Objective:**
  - always produce the simplest mesh that satisfies the accuracy required by the application
...Approximating Surfaces...

- **On-the-fly simplification**: extract from raw data a mesh of minimal size whose accuracy is sufficient for application needs
  - only raw data and the simplified mesh are stored
  - simplification is usually an expensive task

- **LOD / multiresolution model**: build a model off-line that encompasses many different representations and that can be queried efficiently
  - more expensive in terms of space
  - more efficient: support to real-time operations