

Level-of-Detail in Surface and Volume Modeling

Leila De Floriani, Enrico Puppo

University of Genova
Genova (Italy)

Paolo Cignoni, Roberto Scopigno

National Research Council
Pisa (Italy)

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 trasmission 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

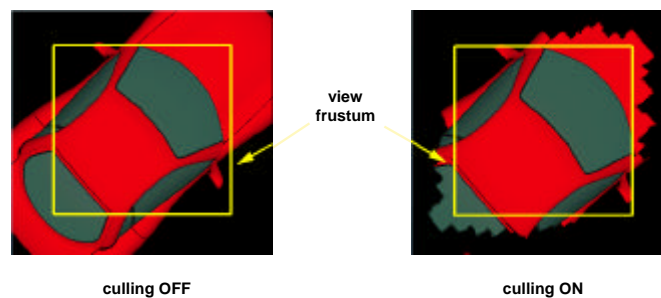
I
N
T
R
O
D
U
C
T
I
O
N

- ❑ **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)

I
N
T
R
O
D
U
C
T
I
O
N



Visibility Culling

- an example of **occlusion/visibility culling**

(images by SGI, OpenGL Optimizer)

I
N
T
R
O
D
U
C
T
I
O
N



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

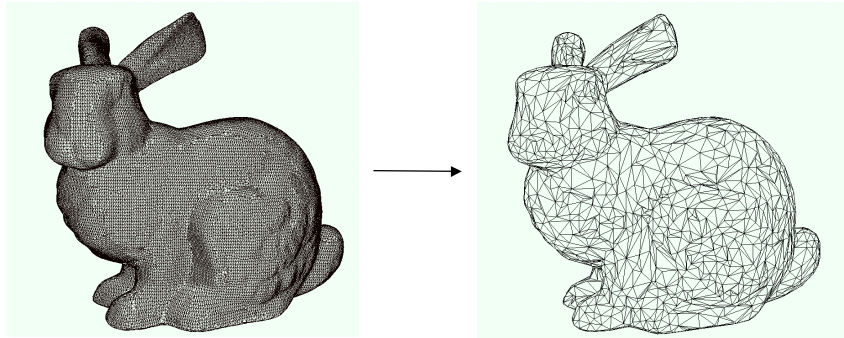
I
N
T
R
O
D
U
C
T
I
O
N

...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

I
N
T
R
O
D
U
C
T
I
O
N



EG99 Tutorial

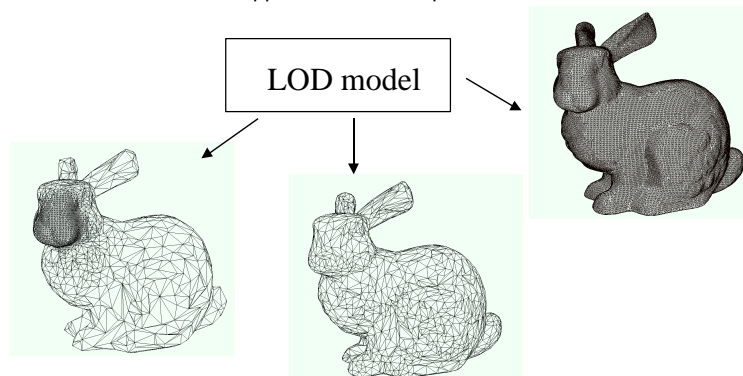
9

...Approximating Surfaces...

- **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

I
N
T
R
O
D
U
C
T
I
O
N



EG99 Tutorial

10