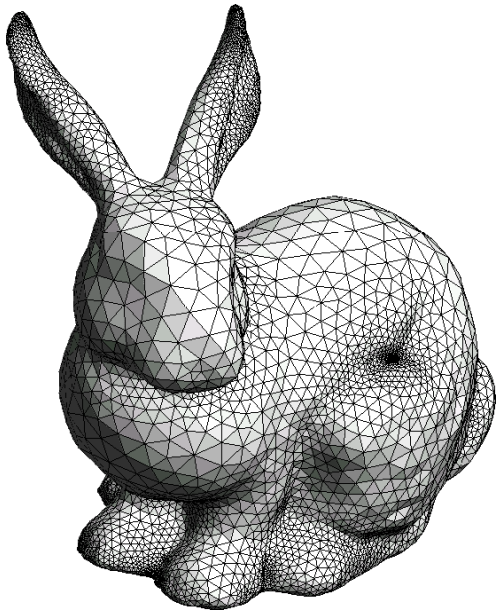

Geometric Modeling in Graphics

Part 0: Introduction

vis gravis
visualization, graphics & vision

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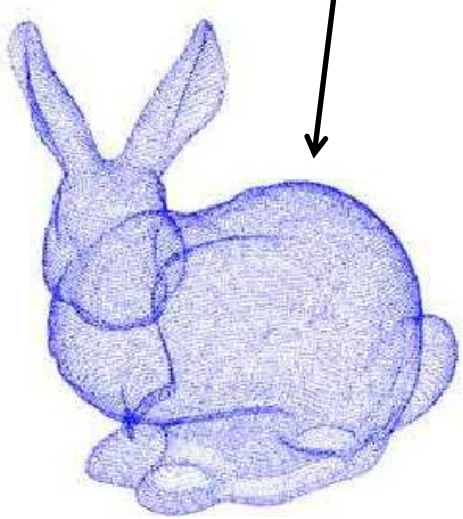
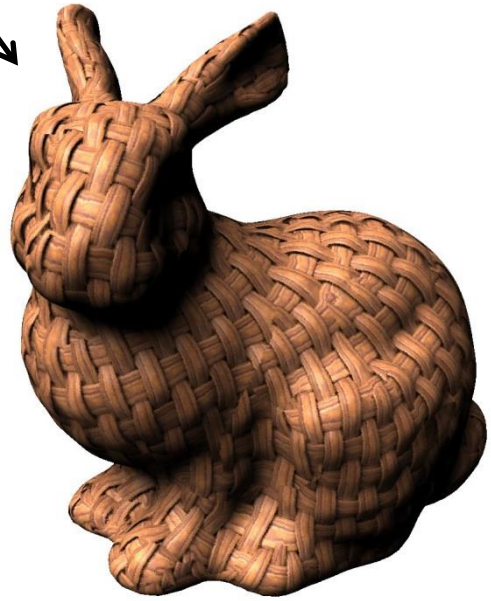
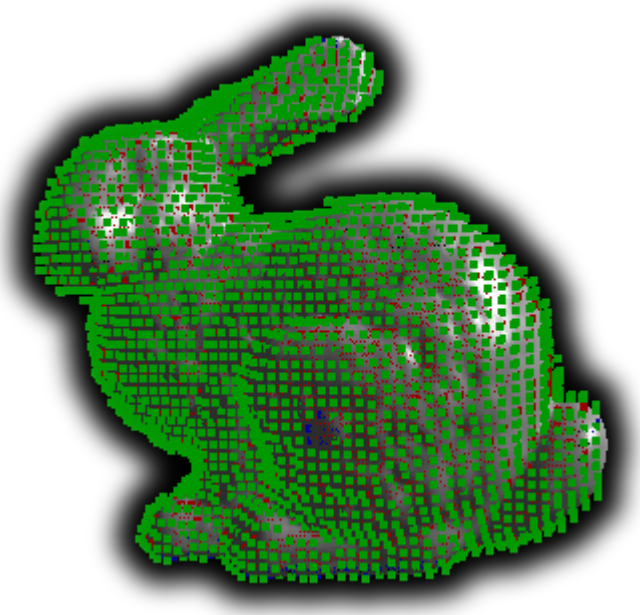
Modeling in Graphics

- Bringing geometry of real world object to virtual space
- Representing real world objects as virtual objects in computer memory
- Procedural and manual creation of virtual objects
- Boundary and volume representations of 1D, 2D or 3D objects
- Algorithms for changing properties or increasing quality of models in given representation
- Algorithms for conversions between representations
- Intersections and Boolean operations
- Compression, serialization and transfer of objects

Modeling in Graphics



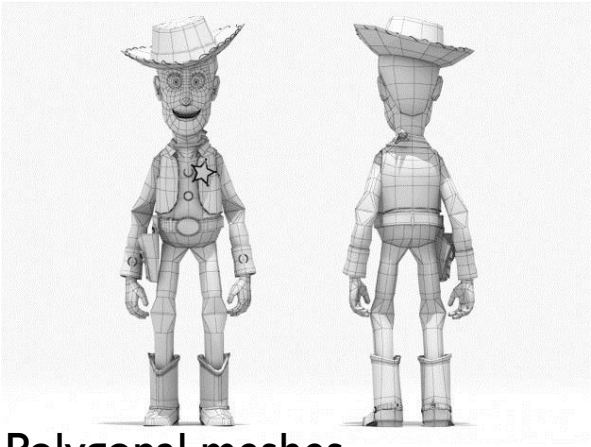




Representations of Object

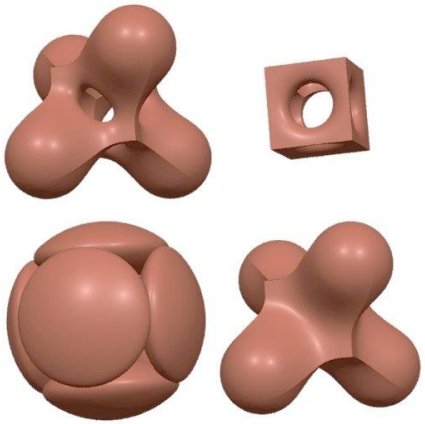
- Boundary representation
  - Only boundary of object is described
  - Polygonal meshes – set of vertices (geometrical information), edges and faces(topological information)
  - Parametric surfaces – smooth representation of boundary based on parametric formulas
  - Implicit surfaces – smooth representation of boundary based on parametric formulas
  - Point clouds – set of unorganized points, only geometric information
- Volume representation
  - Also interior of object is described
  - Discrete grids and distance fields
  - FREP – implicit volume representation
  - Parametric volumes

Representations of Objects

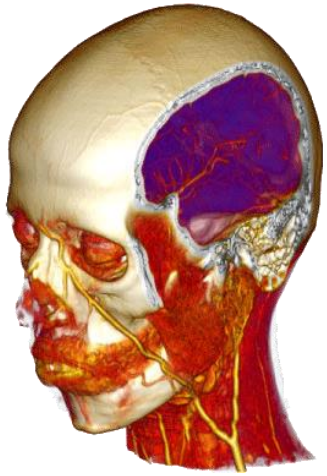


Polygonal meshes

Parametric surfaces

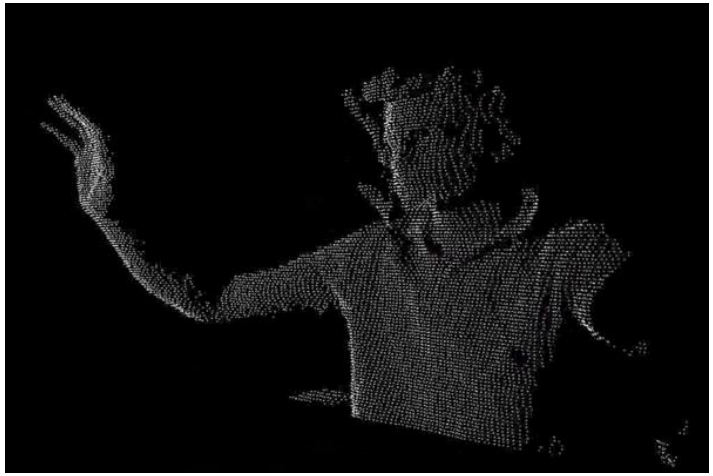


Implicit surfaces



Volumetric grid

Distance field



Point cloud

Lectures Syllabus

- Objects, manifolds, polygonal meshes, and representations, winged-edge, quad-edge, half-edge, visualization
- Mesh simplification, progressive meshes, compression
- Subdivision algorithms, mesh smoothing
- Parametrization, triangularization, normals, curvatures, skeletons
- Global and local solutions for mesh editing, mesh comparison and classification

Polygonal meshes

- Parametric interpolation and approximation curves, animation curves, polynomic curves in several forms
- Parametric surfaces, polynomial forms (Bezier, NURBS), algorithms, tessellation, basic objects

Parametric objects

- Volumetric representation, discrete grids, distance fields, marching cubes
- Implicit curves and surfaces, properties and algorithms, conversion to polygonal meshes, FREP

Implicit rep. & volumes

- Unorganized set of points, normals estimation, nearest neighbors search, registration, visualization
- Clasterization, surface reconstruction, point cloud comparison
- Review of API libraries and software solutions

Point clouds

Exercises

- Focused on boundary representation, polygonal meshes, half-edge data structure
- Conversion from other representations to half-edge
- Implementing one basic algorithm from previous lecture
- Multiple options for graphics engine and programming environment
  - Unity + C#
  - Unreal Engine + UnrealScript
  - Irrlicht + C++
  - OGRE + C++
  - Blender + Python
  - MeshLab + C
  - OpenGL + C,C#

Evaluation

- Programming assignments during semester as continuation of exercise tasks
  - 1. Half-edge structure, import from file, cube & sphere, neighborhood queries, visualization, deadline 15.3.2016, **15 points**
  - 2. Subdivision & simplification algorithms on half-edge structure, deadline 12.4.2016, **15 points**
  - 3. Marching cubes (half-edge from uniform volume grid), intersection of 2 volumes, conversion of implicit objects to volume representation, deadline 17.5.2016, **20 points**
- Assignments submitted after deadline – 50% points off
- Oral examination at the end of semester – **50 points**
- Final grade
  - A: 91-100 points
  - B: 81-90 points
  - C: 71-80 points
  - D: 61-70 points
  - E: 51-60 points
  - Fx: 00-50 points

The End