Geometric Modeling in Graphics

Part 0: Introduction

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vis gravis
visualization, graphics & vision

Modeling in Graphics

▸ Bringing <u>geometry</u> of real world object to virtual space

▸ <u>Representing</u> real world objects as virtual objects in computer memory

▸ Procedural and manual <u>creation</u> of virtual objects

▸ Boundary and volume representations of 1D, 2D or 3D objects

▸ Algorithms for <u>changing</u> properties or <u>increasing</u> quality of models in given representation

▸ Algorithms for <u>conversions</u> between representations

▸ Intersections and <u>Boolean operations</u>

▸ <u>Compression</u>, serialization and transfer of objects
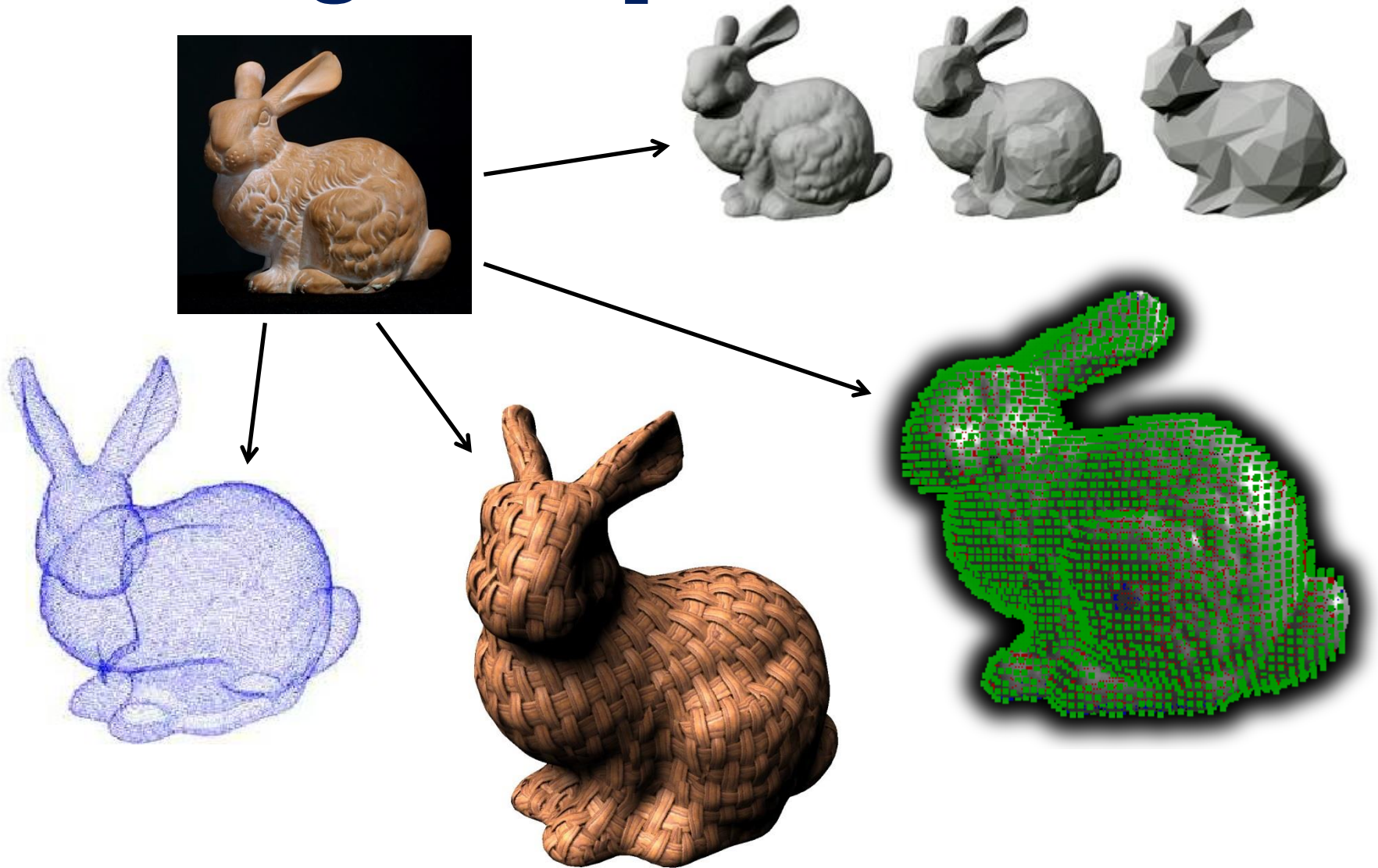
Modeling in Graphics

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
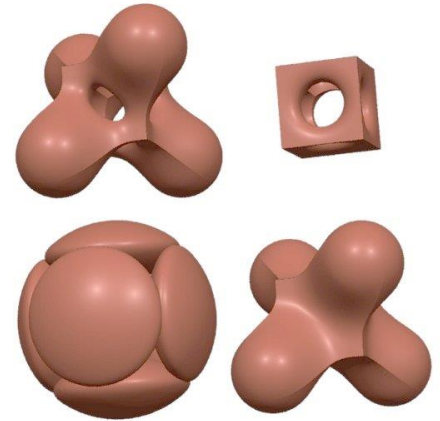
Representations of Objects
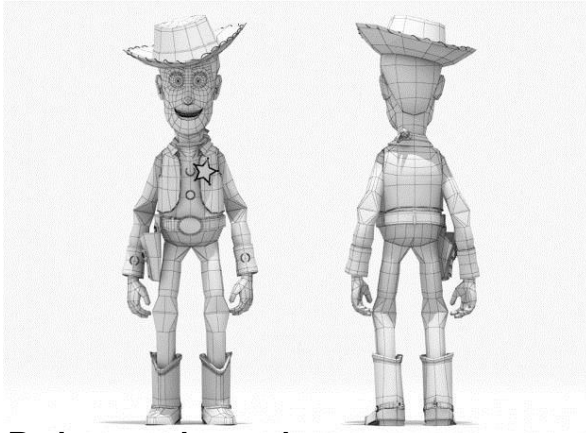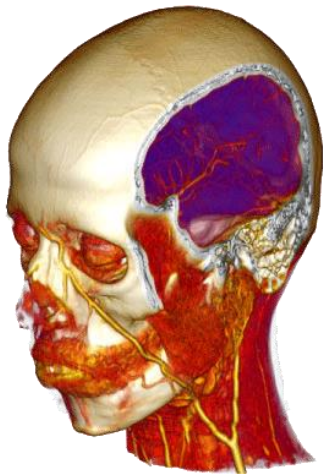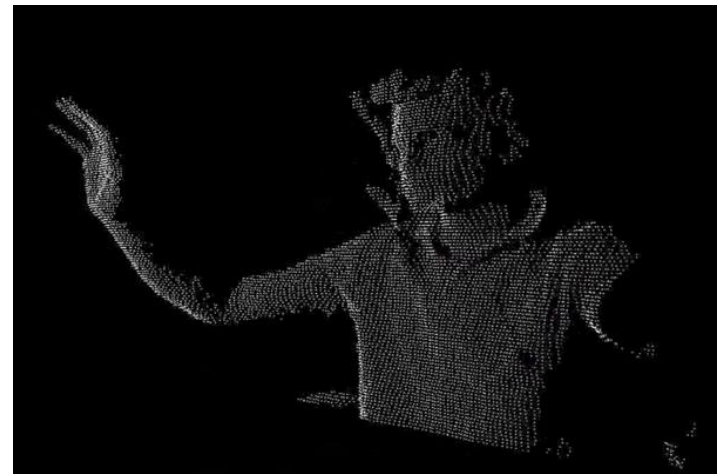

Polygonal meshes

Parametric surfaces

Implicit surfaces

Volumetric grid

Distance field

Point cloud

Lectures Syllabus

Polygonal meshes

- 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

Parametric objects

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

Implicit rep. & volumes

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

Point clouds

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

Geometric Modeling in Graphics

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#

The End