Digital Geometry Processing

Instructor: Ligang Liu

lgliu@ustc.edu.cn
http://staff.ustc.edu.cn/~lgliu
About This Course

• Prerequisite
  – Computer Graphics
  – CAGD
  – C/C++, Matlab

• State-of-the-art of geometry modeling and processing
  – Hot topics
  – Future trend
Digital Media

75 80 85 90 95 00 05 10

Sound

Image

Video

Geometry

Dynamic Geometry
Digital Media

• Sound
• Image
• Video
• Geometry
  – Computer animation
  – Visualization
  – Computer game
  – Entertainment
Geometry Representations

- Constructive Solid Geometry (CSG)
  - Cube, cylinder, cone…
  - Boolean operations

- Boundary Representation
  - B-spline, NURBS
  - Triangular mesh
    - Rendering engine
Mesh Surfaces

• Demo: Examples of mesh surfaces
Geometry Examples

- Meshes
- Point clouds
- Implicit surfaces
- Volumetric data
- CSG
Geometry Processing

• 3D Geometry is based data for
  – CAD/CAM, Engineering
  – Visualization and simulation - medical, physics, etc...
    – Graphics, multimedia

• Geometry processing
  – Computerized modeling of 3D geometry

• Digital Geometry ≈ Mesh Processing
Digital Geometry Processing (DGP)

• Processing of discrete models
  – Polygonal mesh (Typically triangular)
• Why discrete?
  – Simplicity - ease of description
  – Based data for rendering software/hardware
  – Input to most simulation/analysis tools
  – Output of most acquisition tools
    • laser scanner, CT, MRI, etc...
Applications

Medical Engineering Topography Simulation

Game Movies E-commerce Art history

Demo
Geometry Data Processing

• Data acquisition and reconstruction
• Data storage and compression
• Data representation
• Data editing
• Data rendering
• Data retrieval
Course Syllabus

• Model acquisition
• Surface reconstruction
• Mesh simplification and Remeshing
• Geometry compression
• Mesh parameterization
• Mesh editing, deformation and morphing
• Subdivision surfaces
• Discrete differential geometry
Data Acquisition
Surface Reconstruction
Differential Geometry
Smoothing/Fairing
Mesh Simplification
Geometry Coding

![Image of a sculpted head with binary code]

010011110010101100010101...
Parameterization
Remeshing
Subdivision Surfaces
Mesh Editing and Morphing
Segmentation
Point Based Surfaces
Others

• Matching
• Deformation transfer
• Connectivity shape
• Statistical learning
• …
Course Requirements

• Programming exercises (30%)
  – Mesh library
  – Parameterization
  – Deformation

• Final projects (40%)
  – Develop an algorithm for interesting problem
  – Or implement existing paper

• Survey report (30%)
  – Literature survey on an interesting topic
Expectations

• DGP
  – Many interesting topics
  – Wide applications
• Do something interesting
• Learn something
  – Coding, writing, demo, presentation
• Hard work!

Have fun! 😊
Resources

• Course website:
  – http://staff.ustc.edu.cn/~lgliu → “Teaching” → “Digital geometry processing”
• http://www.math.zju.edu.cn/ligangliu/Resources/Graphics/resourse_graphics.htm
Q&A