CSE 530:
TOPICS and
RELATED FIELDS for PROJECTS

Overview

- Geometric and solid modeling
- Mathematics and Geometry
- Deformable models
- Physics-based modeling
- Numerical Solutions
- Visual computing applications
  - Graphics
  - Vision
  - Computer Aided Geometric Design
  - Visualization
  - Virtual environments

Geometric and Solid Modeling

- Polygonal meshes
- Polynomials and splines
- Parametric curves and surfaces
- Bezier Splines
- B-splines and NURBS
- Triangular & irregular patches
- multisided surfaces
- Subdivision objects
- Manifold splines
- Implicit functions
- CSG and volumetric models

- Wavelets and hierarchical models
- Special shapes
  - ruled surface
  - developable surface
  - offset
  - sweepting
  - swung surface
  - surface of revolution
- Solid Models
  - Constructive solid geometry (CSG)
  - Boundary representation (B-rep)

Geometric Operations and Technique

- Trimming
- Intersection
- Approximation
- Interaction
  - control point
  - weight
  - knot vector
- Interpolation
  - scattered data
  - curve network
  - regular dataset
- Constraints
  - shape-preserving
  - convex-preserving

- Fitting
- Continuity
- Optimization
- Computation Geometry
- Differential Geometry
- Dynamic geometric design
- Forces — dynamic sculpting
- Efficient Algorithm
- Hierarchical techniques
- Level of Details
- Simplification

Physical Models

- Rigid & nonrigid models
- Articulated models
- Mass-spring lattices
- Parameterized models
- Elastic & inelastic bodies
- Dynamic B-splines & NURBS
- Dynamic subdivision models
- Particle systems & fluid models
- Superquadric geometry
- Snakes: dynamic contour models
- Symmetric models

- **Finite elements**
- **Constrained fractals**

Dynamic Modeling

- Mass, damping, elastic Energy
- Internal and external forces
- Geometric constraints
- Optimal control of physical models
- Lagrange mechanics
- mathematical physics
- Multi-body (rigid and nonrigid) simulation
- local and global deformations
- Viscoelasticity, plasticity, fracture
- Thermoelasticity, the heat heat transfer, Melting
- Fluid dynamics

Numerics

- Linear algebra & matrix computation
- Linear & nonlinear systems
- Static & dynamic problems
- Initial-value & boundary-value problems
- The finite difference method
- The finite element method
- Calculus of Variations
- Direct & iterative methods
- Differential equations of equilibrium
- Numerical analysis
- Multiresolution algorithms

- Optimization

Visual Computing Applications

- Morphing and image warping
- Surface blending and solid rounding
- Animation and simulation
- Freeform deformation
- Reverse engineering
- Shape reconstruction
- Sparse data fitting
- Interactive sculpting
- Model simplification
- Object motion tracking
- Feature extraction and segmentation

- **Visualization**
- **Variational design**
- **Shape interrogation and control**
- **Biomedical imaging**
- **Interface and virtual environments**
- **Texture mapping**
- **Artificial Life**
- **Plastic surgery**
- **Natural phenomenon**