

## **EECE (COMP) 4/6731 Data Visualization**

Fall Semester 2005

**EECE (COMP) 4/6731 Data Visualization (3).** Introduction to the terminology, methodology, and applications of data visualization. Methods for visualizing data from a variety of engineering and scientific fields including both static and time varying data and methods for generating both surface and volume visualizations. **PREREQUISITE:** EECE 3221 or COMP 2150 or Permission of Instructor.

**Goals:** The purpose of this course is to provide an introduction to data visualization techniques and their applications for upper-division engineering, computer science, physics, and other scientific majors who have an interest in computational science and engineering. Students will work in teams to develop a custom software project for visualization applications.

### **Prerequisite by Topic (Guidelines):**

1. Mathematics consistent with Junior standing in Engineering, Physics, or Computer Science.
2. Experience in programming with at least one high-level language.
3. Exposure to Object-Oriented and Linear Algebra concepts is helpful but not required.

### **Textbook:**

1. *The Visualization Toolkit An Object Oriented Approach to 3D Graphics*, 3rd Edition, W. Schroeder, K. Martin, B. Lorensen, Kitware Inc., 2004.

### **Reference:**

1. *The Visualization Toolkit User's Guide*, Version 4.2 (with CDROM), Kitware Inc., 2004.
2. VTK documentation available online at <http://www.vtk.org/doc/release/4.0/html/>
3. *Practical Programming in Tcl and Tk*, B. Welch and K. Jones, Prentice-Hall, 2003.

### **Software:**

VTK software is freely available online at <http://www.vtk.org>

### **Instructor:**

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### **Topics:**

Visualization Introduction (4.5 hours)

- What is visualization?
- What are the likely benefits of visualization?
- Example applications from engineering, physics, chemistry, math, and computer science
- Tying analysis into visualization
- Evaluating the effectiveness of visualization applications

Computer Graphics Primer (2 hours)

- Lighting/Shading
- Cameras
- Coordinate Systems and Transformations
- Graphics Hardware
- Using VTK to Render a Scene
- Differences between Visualization and Computer Graphics

Visualization Implementation Language Options (3 hours)

- Object-Oriented Design Principles used in VTK
- Tcl/Tk and scripting language benefits
- VTK Documentation and Class Libraries

#### Example VTK Program (1.5 hours)

- Renderer and Interactor Initialization
- Surface Extraction and Mapper
- Specifying Actors
- Effects of parameter variations

#### VTK Visualization Pipeline Design and Use (6 hours)

- Data Objects
- Process Objects
- Pipeline Topology
- Pipeline Execution
- Data Interface Issues

#### Data Representation (1.5 hours)

- Structured versus Unstructured Data
- Cell Types Including: Vertex, Line, Polyline, Pixel, Polygon, Tetrahedron, Voxel
- Scalars, Vectors, Normals, Tensors
- Types of Data Sets

#### Fundamental Algorithms (15 hours)

- Implicit Functions
- Scalar-field visualization in 2D (color, height field, isovalue contours, glyphs, clustering, patterns)
- 3D (isosurface contours, direct volume rendering, slicing, glyphs)
- Vector-field visualization techniques in 2D and 3D
- Multivariate visualization (discrete data, glyphs, textures, dimensional reduction)
- Applications with domain-specific data

#### Advanced Techniques (6 hours)

- Combined visualization techniques
- Animation, haptic display of data, auditory display of data

#### **Grading\*:**

- Pop Quizzes 10%
- Midterm 20%
- Assignments (including final project) 50%
- Final 20%

\*Note: The graduate students' final project will be graded on a higher standard. Specifically, graduate students will be expected to have more originality in their application of data visualization techniques. For example, applying data visualization techniques to emerging research problems is important for graduate students.

#### **Disabilities Statement:**

Students with disabilities who require accommodations must inform the instructor as soon as possible to make appropriate arrangements. Any student with authorization from the [Office of Student Disability Services](#) at The University of Memphis will be provided reasonable accommodations. Please also read the following statement regarding policies on this matter: <http://www.people.memphis.edu/~sds/g-ap.htm>.