Engineering Faculty Document No. 51-07
1/25/2008

TO: The Engineering Faculty
FROM: The Faculty of the School of Electrical and Computer Engineering
RE: New Dual Level Course: ECE 517

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 517 **Visualization Techniques**
Sem: Fall, even years. Class: 3; Credit: 3.
Prerequisite: EE368, EE369

This course covers topics in and algorithms for visualization: scientific visualization, medical visualization, information visualization, and volume rendering techniques. Fundamental algorithms, advanced techniques, design criteria, and application specific issues will be explored.

Reason: Visualization has become a fundamental tool for engineering and science. This course will prepare computer engineering students, as well as engineering and science students to effectively use, evaluate, design, and develop visualizations and visualization software. Computer graphics and visualization are important, fundamental components of modern computer engineering. Therefore, we need this course to educate our students on the basic algorithms, techniques, and tools of this field.

Mark J. T. Smith
Professor and Head

Supporting Documentation

Required Text: Schroeder, W., Martin, M., Lorenson, W., The Visualization Toolkit, 2nd Edition, 1997, Prentice Hall Computer Books, ISBN: 0139546944.

Recommended References: None:

Course Outcomes: A student who successfully fulfills the course requirements will have demonstrated:

i. an understanding of the design issues for creating effective visualizations (1,4, b, c, j, k)
ii. an ability to apply visualization techniques to an actual visualization problem and associated dataset. (1,3,4, a, c,e, k)
iii. an ability to read, evaluate, and present technical papers (3,6, a, g)
iv. an understanding of scalar, volume, and surface-based visualization techniques (1,3,4, a)
v. an understanding of the issues and techniques for applying visualization to one of the following visualization problems: medical, flow, scientific, and information (abstract data) (1,3, 7,a, b, j)
vi. an ability to design an effective visualization solution for a problem (2,3,4, a, c, e, k)
vii. an ability to present their design and resulting system (6, g)

Assessment of Outcomes: The course outcomes will be assessed through student demonstration of a completed visualization project, submission of working program(s), homework assignments, oral and written presentation of results (literature survey, alpha release report, beta release report, regular meetings of project teams with the instructor, and the final project report). The overall knowledge acquisition of visualization techniques will be assessed by student oral presentations of papers, through the completion of a literature review, several homework assignments, and through several initial project assignments.

Engineering Design Content: The semester visualization project involves a project proposal, review, and revised project proposal. The proposal generation process involves the analysis of a problem, review of design alternatives for the solution, and choice of solution approach. The project then involved the construction of a software solution, testing, evaluation, and assessment of the final results.

Engineering Design Considerations: This course covers topics in the implications of the use of images for making engineering decisions, medical diagnoses, etc. Topics also cover accuracy, reproducibility, and general accepted use of techniques. Students learn to appreciate these issues through the class topics and discussions such as “Would you want a doctor deciding to perform surgery on you based on using your software to reconstruct the MR data?”

Course Outline

- Week 1: Organization and Introduction to visualization
  goals, data sources, data representation, history, rendering review
- Week 2: Introduction to graphics programming
  graphics hardware
- Week 3: Scalar visualization and OpenGL
  color, geometry, texture, OpenGL
- Week 4-5: Isosurfaces
  isosurface generation, large data issues, interactive isosurface construction, Initial project presentations
- Week 5-6: Volume Visualization
  volume ray casting, splatting, transfer functions, acceleration, interactive PC-based volume rendering
- Week 7 : Visualization Design and Illustrative Visualization
  system design, effectiveness, illustration and artistic principles, advanced system design and interaction, alpha project release presentations
- Week 8-9: Flow Visualization
  experimental flow visualization techniques; glyphs, particles, line-based techniques; texture-based techniques, Line Integral Convolution (LIC)
- Week 9-10: Medical Visualization
  goals, data sources, issue, pipeline; MIP, isosurfaces, transfer functions and accuracy; clinical validation and assessment; latest techniques and applications,
- Week 11-12: Perception & Beta Release Presentation
  visual mechanisms and characteristics, perception of pattern, color, depth, and motion; Beta release presentation
- Week 8: Review of Latest Work in Volume Rendering and Flow Visualization
  (review of papers from this past year's visualization conferences)
- Week 13-14: Information Visualization
  Infovis goals and problems, glyph-based visualization,
  visualization of text, databases, visualization of networks, relationships, high-dimensional data, dynamic infovis, web-based infovis, distortion viewing; visual analytics; analysis exercise
- Week 15: Project Presentations