ECE209A
Rendering Techniques for Biomedical Imaging

Spring Quarter 2003

Catalog Data: ECE209A Rendering Techniques for Biomedical Imaging (Credit Units: 4.0) Image Acquisition techniques (overview), combining different modalities (CT/MRI/fMRI/PET), 2-D image enhancement techniques, image storage (wavelet compression), feature detection, 3-D surface reconstruction, volume rendering, scalability, final project (hands-on experience). Computer literacy, but no programming skills required.

Prerequisite by Topics: None

Textbook: Class Notes (online).

Reference: Research Articles, Handouts.

Coordinator: Joerg Meyer, Assistant Professor

Course Objectives: Students should be familiar and comfortable with using imaging and rendering technology for their work in research and industry. To accomplish this, they will learn about fundamental and state-of-the-art techniques in biomedical image processing, feature extraction, efficient data storage, and rendering.

Relationship to Objectives: The course is specifically designed for students that do not necessarily have the programming skills required for biomedical imaging, but want to learn about state-of-the-art methods in digital image acquisition, processing and rendering. The motivation for this course is driven by the call from industry and research lab for qualified personnel with an interdisciplinary background in visualization and biomedicine. The course fits within the goals of the department to foster and facilitate interdisciplinary research, and it will provide students with the necessary qualification to do research in biomedical imaging. The course will be taught primarily by faculty that hold a shared position and have a research program in the ECE department and another academic engineering department.
**Course outcomes:**

1. The students will learn about current techniques in image acquisition (overview).
2. The students will learn how to combine different imaging modalities (CT/MRI/fMRI/PET) and what the implications of image distortions are.
3. The students will learn how to enhance images that have poor quality and how to extract features in 2-D images.
4. The students will learn how to store image data efficiently (wavelet compression).
5. The students will be familiar with 3-D surface extraction and rendering techniques.
6. The students will know about the techniques, the possibilities, and the advantages and disadvantages of volume rendering.
7. The students will be aware of scalability issues which are important when dealing with large data sets.
8. The students will get hands-on experience and visual feedback by working one hour per week in the lab using different biomedical imaging techniques and algorithms.

**Professional Component:** n/a

**Course Topics:**

**Week 1**
Image acquisition techniques (overview)

**Week 2**
Combining different modalities (CT/MRI/fMRI/PET)

**Week 3**
2-D image enhancement techniques (contrast, gamma correction, contour enhancement)

**Week 4**
Image storage (lossy vs. lossless compression, wavelets)

**Week 5**
Feature detection in 2-D images (Sobel, Marr-Hildreth)

**Week 6**
3-D surface reconstruction

**Week 7**
Volume rendering (raytracing, texture-based rendering)
Week 8
Scalability (large-scale data management)

Week 9
Final project

Week 10
Project review (Dr. Meyer)

Class Schedule:  Class meets 3 hours per week + 1 lab hour.

Computer Usage:  Yes (computer instruction lab).

Laboratory Projects:  One hour per week (lab session).

Design Content Description:

Approach
The students will learn about state-of-the-art techniques in the lecture, and experiment with selected methods during the lab sessions. The computer lab session is an essential part of this course as it is supposed to lower the barrier and the reservations that some students might have towards using computer-based biomedical imaging technology for their own work.

Lecture
Presentation of material by the instructor, interactive discussion of possible approaches, guided discussion of existing and possible future solutions.

Lab
Hands-on experience using existing algorithms and simple programming or program extension tasks (scripting, batch processing). No explicit programming skills required.

Grading Criteria:
Midterm Exam 30%
Lab Projects: 40%
Final Exam/Final Project: 30%

Estimated ABET Category Content:

Engineering Science: 3.0 credit units or 75%
Engineering Design: 1.0 credit units or 25%

The mathematical background of the course and the effort required to complete the lab sessions along with the course material presented in the lectures justifies 4.0 credit units. The course is also to be cross-listed as ECE209A in the Department of Electrical & Computer Engineering, where it also receives 4.0 credit units.

Prepared by: Joerg Meyer  Date: October 17, 2002