MEDICAL IMAGING VIRTUAL SYSTEM DESIGN WITH TABLET PC TECHNOLOGY

Course to be developed/improved: ECE497 Medical Imaging Systems
Ideas for implementation: To develop a series of virtual system design experiences based on five medical imaging modalities

How this implementation would improve the course:

- promote active and collaborative learning,
- provide project-based learning (PBL) design experience among cross-disciplined teams, and
- teach fundamental principles of Medical Imaging Systems

Submitted by: Deborah Walter, Assistant Professor, ECE

Motivation

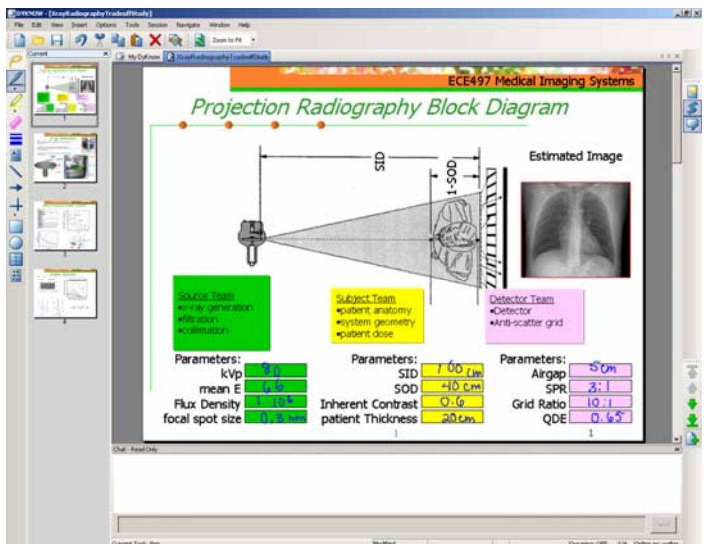
This project is focused on the development of a virtual system design experience to promote project based learning to teach fundamental principles of medical imaging systems. Medical Imaging Systems (ECE497) is a newly developed special topic class which is offered as a senior level technical elective in the ECE department and as a bioinstrumentation track elective. The technical core of the class is the presentation of the underlying physics of five medical imaging modalities: X-ray, Computed Tomography, Nuclear imaging, Magnetic Resonance Imaging(MRI), and Ultrasound. Roughly six lectures are spent for each modality, so the topics are not deeply covered. To encourage deeper understanding, students are also required to complete an independent research project. Discussion of engineering tradeoffs are included in the lecture material and the importance of some sub-system requirements can be learned in the research project, but neither the lecture experience or the research project prepare students to <u>design</u> complex medical imaging systems.

In industry the development of complex systems, like medical imaging systems, require large teams that are focused on the design of specific components. It is not cost effective for every team member to be expert in every area. The system design tradeoffs are made by careful description of sub-system specifications, and the interrelated links between sub-systems. It is required that cross-disciplined teams effectively communicate. It's not reasonable to build a prototype of an expensive and complicated system, such as an MRI, but we can provide project based learning through simulation and create a virtual design experience. The introduction of Tablet PCs in the classroom will allow the instructor to guide students through a virtual design experience in real-time, and will be a more effective way to teach fundamental engineering tradeoffs in medical imaging systems.

Why Tablet PCs

The Tablet PCs ability to write equations, sketch drawings, display high quality medical images, and make electronic annotations, are needed to enable real-time collaboration and expand classroom interaction. Laptop PCs could be used to share images and demonstrate design tradeoffs, but the communication path is typically limited to one way interactions: instructor-to-student.   Tablet PCs will be used to allow students interact with each other and the instructor to iterate design changes in real-time. Communication is expected to mimic large-scale system design tradeoffs, where cross-disciplined teams share technical information on multiple levels: instructor-to-student, student-to-student, and student-to-instructor. The results of the design choices will be demonstrated instantaneously, by generating and displaying a simulated image. Furthermore the process can be documented and saved with individual class notes appended. The image based nature of medical imaging makes this class a natural fit with the Tablet PC interface, cut the virtual system design experience could be expanded to other classes or disciplines.

A mock-up



An example is described to demonstrate how one might use tablet PCs in a virtual design classroom experience. The figure at right shows a block diagram of a Projection X-ray system. The class is broken down into three teams: *Source*, *Subject*, and *Detector*. Each team is responsible for some key parameters. The parameters are interrelated, e.g., the scatter-to-Primary Ratio (SPR) depends on the patient thickness. The problem is introduced with some parameters chosen by the instructor (purposely designed to be a sub-optimal system). The image is simulated to represent the image quality resulting from the design point. The class goes through the next three panels together which describe the sub-systems. This part of the class is no different from the current lecture format. Then students break up into teams and brainstorm improvements to the design, focusing on their particular component. They keep notes on their design process using the private note area in DyKnow. When a change is accepted by the instructor, the other teams have to recalculate the parameters that they are responsible for and submit the updated parameters to the instructor. The instructor can initiate a simulation that will estimate the new image which can be evaluated qualitatively or quantitatively and compared to the earlier image. Then the teams iterate. Teams should submit their notes describing how proposed parameters where estimated or how they reacted to different design constraints and they are graded on their performance. The class as a whole tries to get the best image possible.