Project Year
2004

Project Team
Russell Taylor, Professor, Department of Computer Science/Radiology, Whiting School of Engineering/School of Medicine; Andy LaMora, Graduate Student, Department of Computer Science, Whiting School of Engineering

Project Title
Virtual Workshop for Computer-Integrated Surgery

Audience
Undergraduate students in the Computer-Integrated Surgery courses, 600.445 and 600.446

Pedagogical Issue
Few students arrive for these courses fully conversant in the fundamental skills required to succeed. Consequently, there is a need to provide students with material to review fundamentals or address knowledge gaps, and to help visualize the relationship between theory and a physical system.

Solution
This team proposes to create a personalized, web-based workshop of fundamental skills from linear algebra, computer programming and robotics, including a series of simulations that will bring the surgical experience to life.

Technologies Used
JAVA, JavaScript

Project Abstract
Computer-integrated surgery is a triumph of interdisciplinary cooperation. A typical solution draws from advanced concepts in calculus, linear algebra, physics, image processing, computer algorithms, robotics, and, of course, surgery. This diversity attracts students from an equally diverse blend of science and engineering backgrounds, which means that students are often required to master techniques beyond the scope of their studies. The Computer-Integrated Surgery courses attempt to acknowledge varied backgrounds through incremental, team-based programming projects, but the difficulty of quickly mastering techniques without the benefit of a formal treatment remains a perennial challenge. Although background material is currently provided, through web links to online texts and lectures, a self-study virtual workshop and simulation of the critical concepts could address this challenge more effectively.

Our proposal is to create a personalized, web-based workshop that presents students with an organized treatment of fundamental skills from linear algebra, computer programming and robotics within the scope and context of the course. We intend to illustrate the impact of these techniques by providing a simulation of an empty model of a digitizer, a typical surgical navigation system comprised of a simple

robot, x-ray images, and a phantom patient. As students progress through the workshop, they will add modules to the simulation that first bring it to life, and then refine its behavior in pursuit of better accuracy and precision.

We expect the material developed for this program to be used both for self-study and for TA sessions. We intend to implement a two-tiered content system based on XML, JavaScript and a PostGreSQL database, featuring an animated simulator built in Java or Macromedia Flash technology. The proposed Technology Fellow, Andy LaMora, is an experienced database and online systems developer. His skills will permit us to very quickly build the complicated backbone of the system, freeing us to address content and presentation issues. Andy and Dr. Taylor will work together to develop a mini-curriculum, drawing from our recent experience in the course. Dr. Taylor will also provide content and new exercises. We expect to meet weekly to review content and progress, and for Andy to spend 20 to 30 hours a week on the project.

This project will be a success if it is modular and gradually implements the following elements: an animated simulation; a series of incremental lessons on the fundamental mathematics, mostly linear algebra and calculus, required to understand and design computer-integrated surgical procedures; an tutorial on scientific programming; and an example on error estimation. Dr. Taylor expects additional material to be added to the workshop by TAs and himself as the course progresses; adding new modules will be made possible and easy by XML document support. Although the system will be designed for the CIS course, it could also provide a very effective platform for demonstrating the application of linear algebra, and even give robotics students a case study for registering a robot workspace to image data.