Project Year
2005

Project Team
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Project Title
Visualize Physical Principles with Virtual Lab Modules

Audience
Undergraduate students in 171.301-302: Introduction to Electromagnetic Theory/Advanced Topics in Electromagnetic Theory. After piloting the content in this course sequence, the lab modules will be used in other courses dealing with electromagnetism, including General Physics.

Pedagogical Issue
Digital-era students are strong in computer skills but weaker in their intuitions about physical objects. Mice and keyboards provide easy access to digital information, but don't provide experience with right-hand screws, electric fields, resisters in series, or other concepts that used to be part of the cultural background of the last generation of physics students. The result is that today's students don't have an intuitive understanding of tenets of basic electromagnetism.

Solution
This team proposes developing virtual lab modules to help students gain a better understanding of physical concepts through virtual labs. The modules will be used for an important sophomore-junior course involving concepts in electromagnetism (E&M) unfamiliar to most students these days. Virtual lab modules on electric fields, the Lorentz Force, magnetic fields, and capacitors and the displacement current will be developed first.

Technologies Used
Graphic Design, HTML/Web Design, PowerPoint/Presentation, Adobe PDF, Animation, C/C++, JAVA, JavaScript, MatLab

Project Abstract
We will develop a course website with both lecture material and with virtual lab modules, to help the students understand the physical principles taught in the lectures in greater depth. Dr. Chien plans to use these online materials in the course sequence 171.301-302 (Introduction to Electromagnetic Theory/Advanced Topics in Electromagnetic Theory). We will develop virtual lab modules on electric fields, the Lorentz Force, magnetic fields, and capacitors and the displacement current. After students have been introduced to, for example, the idea of electric fields in lectures and readings, but are still learning, they can review the lectures online and take a diagnostic test on their understanding of the

concept. Then, they can begin to play with the electric field virtual lab module, where they will be able to experiment with different charge distributions and experience the electric fields and potentials. They will take another test afterwards. The site will include built-in evaluation and feedback portions. Comparisons of the results of the two tests and online feedback from the students will help the team to evaluate the effectiveness of the modules. Rather than wait till the end to assess the impact, Dr. Chien would like to get feedback as early as possible, so as to continue developing the modules and better meeting student needs. Once we learn how to best use these modules, the approach can be applied, later, to other courses, and, hopefully, to the most difficult one to teach: General Physics. The faculty member will provide project structure and contents, and lead the discussions toward implementation. The two fellows will provide insights from their own recent learning and teaching experiences, and expertise in computer software development and with the Internet. Java Script, C++, and other commonly available software technologies will be used in the project. The budget pays for stipends: no special hardware is required beyond computer and Internet access. The opportunity to use virtual labs to illustrate abstract concepts will help students understand the materials more intuitively, and progress more confidently to further studies in physics.