

Work in Progress - Video-based Lab Tutorials in an Undergraduate Electrical Circuit Course

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Abstract - The Electrical Engineering curriculum is often coupled with extensive laboratory practice. The primary objectives of these laboratory experiences are to develop measurement and testing skills, draw relationships between classroom theory and real world applications and increase students' interest in the practice of the engineering profession. Traditionally, laboratory exercises that instruct students on the operation of instruments and basic measurement techniques are presented in a written format. For a novice student unfamiliar with the equipment, these written instructions can be confusing and frustrating. In this project, we are creating a web-based repository of video tutorials for electrical circuit laboratory exercises in a sophomore-level Introduction to Electrical Circuits class. We will study the effectiveness of the video-based lab tutorials on improving students' lab skills. In addition, this study will examine the students' preference between the video-based lab tutorials and text-based lab tutorials.

Index Terms – Video-based lab tutorials, Student learning, Electrical circuits

INTRODUCTION

Today transmitting lectures live or from pre-recorded archives over the internet is a mainstay of distance education. Producing and transmitting live content has become very easy and cost effective in recent years with the emergence of screen capture software tools such as TechSmith's Camtasia [1] and Macromedia Captivate [2], making it feasible for an individual faculty member to produce all of the needed materials with little or no support from other university staff. At the receiving end, most students have high-speed internet access on or off campus, and standard video software such as Microsoft Media Player or Shockwave Flash require no specialized hardware. In addition to capturing a complete lecture, other types of web-delivered visual aids abound for circuit analysis. Interactive tools such as "6.002x Circuits Tutor" [3] and "Electric Circuit Study Applets" [4] present a circuit and problem statement to the student, who in turn solves the problem and submits the numerical answer. The interactive module grades the problem and provides feedback. The CyberProf project [5] which evolved into the Mallard web-based tool

[6] is also well-known as automatic graders for circuit problems.

To improve the students' lab skills, we will create a web-based repository of video-based tutorials for electrical circuit laboratory exercises. The functionality of the tablet PC will be extended by connecting it to a video camera. The settings and outputs of the lab equipment will be displayed on the camera window of a computer screen and the schematic of the circuit will be shown on another window simultaneously. To explain the measurement system, the instructors will explain the test circuit by drawing and writing on a computer-hosted digitizing tablet while the results of the measurements will be displayed on the camera window. A screen capture program captures video frames and audio of the content instructor's commentary.

In the first stage of this study, the instructors developed 10 audio-video based lab tutorials in the fall of 2008 and these tutorials were used by the students in the winter of 2009. Self-evaluation questionnaires were collected from the students to assess the students' preference between the video-based lab tutorials versus the text-based tutorials. In the second stage of this study, the instructors will refine the video tutorials based on the students' feedback and develop more video-based lab tutorials in the spring of 2009. All the lab tutorials will be used by the students in the fall of 2009. During every quarter, all sections of Introduction to Electrical Circuits are/will be taught by the instructors using a common syllabus and lab projects. Students will be given a standard practical lab skills inventory test. The results of the standard lab practical test will be compared and analyzed to assess the students' lab skills. At the end of each quarter, questionnaires will be collected from the students to measure their preference versus other media and the usefulness of the video-based lab tutorials. The results from the students' survey will be used to measure students' preference for the video or text based lab tutorials.

PRELIMINARY RESULTS

The study was started in the fall of 2008. At the end of the quarter, 10 audio-video based lab tutorials were developed and used by the students who were enrolled in the Introduction to Electrical Circuits class in the winter of 2008. The topics or the tutorials are listed below¹:

¹ The video-based tutorials can be viewed at <http://www.rose-hulman.edu/~walter/labTutorials.htm>

1. How to use a bread board
2. How to read the resistance of small resistors
3. Examples -- How to read a resistor
4. Build your first electrical circuit!
5. How to use the DMM
6. How to measure Resistance with DMM
7. How to measure Voltage with DMM
8. How to measure Current with DMM
9. How to use function generator
10. How to adjust scope display

A pilot study was conducted to determine the effectiveness of the video tutorials. Two sections of students who were enrolled in a sophomore electrical circuits' class participated in this study. The students in section 1 had the access to the video-tutorials before and in the lab. The students in the second section didn't have the access to the tutorials. In the first lab, the students in section 1 were asked to watch the tutorials before they came to the class. During the lab, the instructor spent only 15 minutes reviewing the important points of the video tutorials. The instructor in the second section spent 45 minutes lecturing at the beginning of the lab. The average time that the students spent working on the lab project is similar for the two sections. The video-based lab tutorials did save the instructor's time lecturing in the lab and as a result the students had more time to work on their lab project. In the second lab, the students in the first section watched the video-based tutorials before they came to the lab and the students in the second section didn't have access to the tutorials. The instructors of both sections spent 15 minutes lecturing. The average time that the students of the first section spent working on the lab project is 15 minutes less than that of the second section. Table I summarized the lab time for the first two labs.

TABLE I
AVERAGE TIME OF THE TWO SECTIONS ELECTRICAL CIRCUITS CLASS

labs	Section	Lecture Time	Lab time	Total Time (hours : mins)
Lab 1	Section1	0:15	1:24	1:39
	Section 2	0:45	1:20	2:05
Lab 2	Section1	0:15	1:02	1:17
	Section 2	0:15	1:17	1:32

The advantage of the video tutorial over the pre-lab lecture is that:

1. Students can watch the video before lab, thereby saving lab time.
2. Students can re-watch the video many times at their own speed and they don't have to wait for the instructor to come around to their bench.
3. The students can watch the video on their PC which can be placed right next to their instrument and it's easier to see small details on the video compared to

a physical demonstration set up at the front of the classroom.

A questionnaire was given to the students who had the access to the video-based tutorials. Twelve students completed a questionnaire that was used to measure their preference between the video-based lab tutorials and text-based lab tutorials. Table II shows the average students' ratings on the video-based lab tutorials. The result of the survey showed that the students preferred the video-based lab tutorials.

TABLE II
SURVEY QUESTIONS AND THE AVERAGE SCORES
(5-Strongly Agree, 4-Agree, 3-Neutral, 2- Disagree, 1- Strongly Disagree.)

	Ratings
The video tutorials helped me to make efficient use of my lab time.	4.00
The video tutorials improved my understanding more than the written material.	4.16
The video tutorials are more clear than the text-based instructions.	4.25
I like the video-tutorials better than the text-based material.	4.33

FUTURE STUDY

The study will continue in the spring quarter of 2009. The instructors will refine the video tutorials based on the students' feedback and develop more video-based lab tutorials in spring 2009. The effectiveness of the video-based lab tutorials will be studied further.

REFERENCES

- [1] TechSmith website; <http://www.techsmith.com/>
- [2] Macromedia website; <http://www.macromedia.com/>
- [3]. MIT 6.002x Circuits Tutor website; <http://six002x.csail.mit.edu/classes/6.002x/>
- [4] Svoboda, James A., "Electric Circuit Study Applets" website; <http://people.clarkson.edu/~svoboda/eta/ecsa.html>
- [5] McCreanor, P.T. (2000). "Developing a Web-Enhanced Course: A Case Study." *Frontiers in Education Conference 2000*, pp. S1B/18 – 1B/22 vol. 2.
- [6] Swafford, M.L., C.R. Graham, D.J. Brown, and T.N. Trick (1996). "MallardTM: Asynchronous Learning In Two Engineering Courses," *Frontiers in Education Conference*, 1996. Pp. 1023 – 1026 vol.3.