Conference Paper

Digital Laboratory Experiences: Creating Videos for Undergraduate Engineering Practical Sessions

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Abstract

This paper will go over the method used to record and present practical sessions to students studying undergraduate engineering as 'digital laboratory experiences'. The aim of the practical sessions was to give students exposure to simple electrical engineering concepts to supplement their project based learning in a two credit point unit.

Outlined are the goals the practical sessions, the process of capturing footage and editing a video file for the students; and finally a discussion on student attendance to in person practical sessions once the videos were made available. After this, future work to be completed is discussed, mentioning possible improvements that could be made.

Keywords: digital laboratory, practical experiments, online learning

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Academic Editor: Paul K. Collins

Received: 28 November 2016
Accepted: 4 December 2016
Published: 9 February 2017

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the DesTech Conference Committee.

1 Introduction

Electronics practical sessions for first year engineering students are often used as a way to demonstrate basic information such as how circuits operate and to gain hands on practical skills. Analysis on student engagement levels in different delivery methods has been undertaken (Horan, Joordens *et al.* 2013) with results indicating preference on either system depending on factors such as the students' chosen engineering discipline.

Within a project oriented approach to learning, the specific requirements for students change, and the delivery of educational content must therefore adapt to the changing educational landscape. Students are also showing they are willing to learn content through technology enabled learning practices (Joordens, Chandran *et al.* 2012). In recent years, the School of Engineering has transitioned to the Lab-Volt Fault Assisted Circuits for Electronics Training (FACET) board equipment (Lab-Volt Systems 2013) and its associated Mind-Sight software.

This allows for a more structured approach to students learning, but now with a shift of curriculum into project oriented design based learning (Chandrasekaran, Stojcevski *et al.* 2013), and having students perceptions be that design based learning will be beneficial (Chandrasekaran, Stojcevski *et al.* 2013, Chandrasekaran, Stojcevski *et al.* 2013) the structure of the laboratories must too change.

Focusing on the electrical engineering subject, with a transition into two credit point, project based assessment tasks, the practical content delivery needed to be addressed as to not lag behind the new educational philosophy. It was decided to film an instructor completing the practical sessions and allow students to remotely view practical content, while still being able to attend practical content in person. With internet speeds increasing, the use of video has become a dynamic learning tool that can be used to assist in the online engineering education process (Jackson, Quinn *et al.* 2013), and has been used previously to film lecture content (Al-Nashash and Gunn 2013) with positive results.

This paper outlines background on the subject practical delivery method, the method used to film practical sessions, and discusses possible future additions.

2 Subject background

The unit that this methodology applies to is a first year electrical unit offered to students studying undergraduate engineering. The unit follows a project based learning philosophy and requires a large amount of group work on electrical projects for students. To accommodate this, the unit incorporated both online learning tools with the option of attending practical sessions, such that students would be able to watch pre-recorded videos of the practical sessions, but would also be able to attend the practical sessions as per usual in a more traditional setting, that being in a workshop with a lab instructor present. This gave students the electrical groundwork to be able to handle the project work required of them for this unit.

The unit was offered both to students studying on campus as well as those studying remotely, and therefore content such as practical sessions needed to be designed to accommodate for this.

2.1 Practical session overview

The practical sessions were run with the assistance of the Mind-Sight software and the Lab-Volt equipment and FACET board. The strength of this equipment is that it allows for a computer program to communicate with physical hardware to prompt users to take measurements and observations while walking them through the required steps and offering them extra information if incorrect attempts were made.

The topics covered in the practical sessions for students include both AC and DC circuit concepts as well as electrical safety, from DC circuits some topics included Ohm's Law, series resistors, as well as phase angle and capacitive reactance from AC circuits.

Week released	Videos Released	Total time to watch all content (min)
2	3	51
3	2	48
4	4	82
5	2	45
6	3	88

Table 1: Release schedule and total time of practical videos

This was aimed to reflect the content covered in other areas of the subject, therefore allowing students to easily gain relevant information.

In previous years, often two or three practical sessions were completed in one sitting, allowing students to complete these sessions in a three hour block. However, the delivery method changed with the updated practical delivery session, allowing students to complete practical content in their own time. Starting week 2, between two and four videos were produced. More detail is presented in table 1 below:

2.2 Student access to practical content

The method used to allow student access to the laboratory involved posting video files online in order to give all students, those studying on campus and remotely, access to all content at all times. This differs from previous years where for the practical content, remote students were required to attend a full day to do practical sessions. Now that they can view the content online, this day is instead utilised for other work, such as project work with their team, having access to all required university facilities.

It is still possible for students to attend practical sessions if that is what they require to learn, or if they want hands on experience with the equipment before completing their project work for the class. Both methods were made available to the students. Since videos were made available week 2 of the teaching period, this was the time that students were able to attend the practical teaching sessions.

3 Recording the sessions

Each practical session was filmed over roughly an hour per practical, with each video being refined to last between ten and forty minutes. Camtasia Studio was selected as a video editing software as well as for screen capture. Practical sessions needed to be able to observe the Mind-Sight software program, as well as view any physical hardware being completed. Due to this, multiple cameras, a desktop microphone and a computer capable of screen capture were required in addition to the Mind-Sight software and hardware requirements for the practical session.

Figure 1: VIEW OF FACET BOARD DURING THE SERIES RESISTIVE CIRCUITS PRACTICAL SESSION.

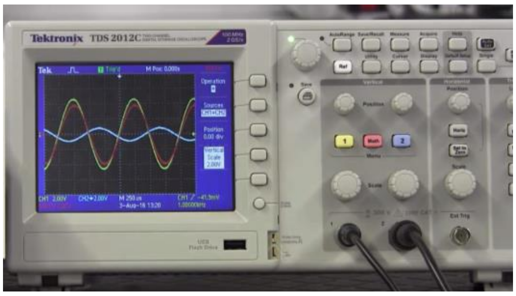

Figure 2: VIEW OSCILLOSCOPE DURING THE AC MEASUREMENTS PRACTICAL SESSION.

3.1 Camera Setup

Setting up the camera was done with the idea of having three separate viewpoints. One being a screen capture to allow students to read the instructions presented by the Mind-Sight software and to view any calculations being completed with an on screen calculator, the second view was of the FACET board and any cable/measuring equipment required for that shot, such as multi-meters and two-post connectors. This was handles with a camera mounted above the board looking directly down. The third view was only used in required practical's, and was of the function generator and oscilloscope if it was used for that practical session. A single camera was set up to show these two devices, and therefore the instructor was required to pan the camera either left or right to be able to view this equipment. The process having the instructor move the camera was taken out of the final video to save time, however some of the panning motion was kept in the video to establish the position of the equipment.

The above figures, Figure 1 and Figure 2, show the outputs of the two cameras used in the filming process. The camera used to capture Figure 2 was also able to view a function generator which was sitting to the left of the oscilloscope. Figure 3 shows the screen capture, with the calculator being used as required. During normal operation the calculator was not open, allowing for all text and diagrams to be visible.

DOI 10.18502/keg.v2i2.610

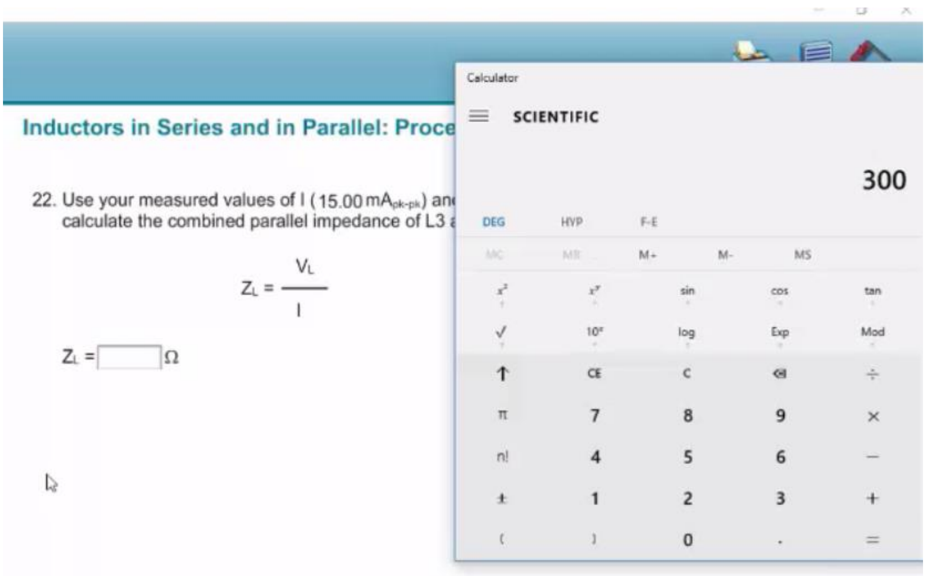

Figure 3: VIEW OF SOFTWARE AND CALCULATOR DURING THE INDUCTORS PRACTICAL SESSION.

3.2 Editing

Editing the videos was done in Camtasia Studio. While it would have been possible to use other software, Camtasia Studio also allowed for screen capture to assist in recording the practical session, it was decided that this would be the best solution.

4 Student behaviour with extra content

An interesting outcome of presenting students with practical sessions in a video format is the subsequent drop in attendance to in person sessions. During the very first week of practical sessions a single student came to gain hands on experience with the lab equipment, however since that time attendance has not exceeded one student.

This could be due to the way the subject is structured, with assessment being project based, so students are using the videos to learn knowledge specific to the challenges they face in their project work. It will be important (and a requirement in future years) to ensure competency in electrical components, and while students are not attending the formal practical sessions, by being able to complete the other assessment tasks for this unit they will be required to prove this competency.

An important competency for an engineering student to be able to display are skills such as use of a multi-meter, oscilloscope and function generator. While these skills are often unexamined, they are requirements as an undergraduate engineer progresses through their education. It is important to remember that these skills are utilized in other areas of the unit being discussed, and therefore these skills are still being developed.

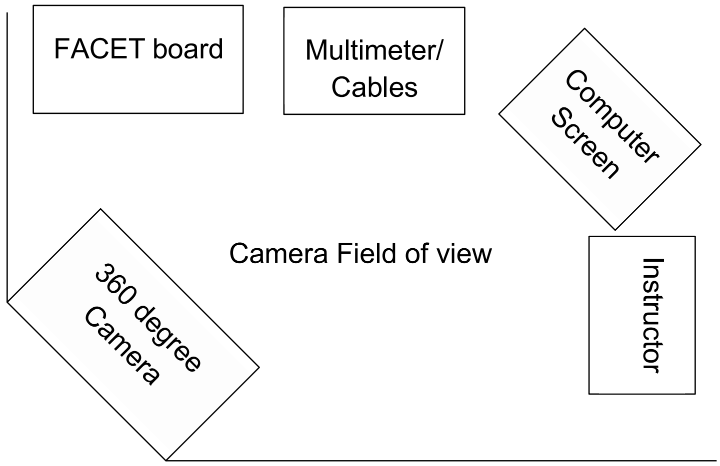

Figure 4: LAYOUT OF 360 DEGREE CAMERA SHOWING FIELD OF VIEW OF OBJECTS.

5 Future work/improvements

With the aim of improving student immersion in a virtual environment, the idea of using a 360 degree video was planned. A single practical session was filmed in this manner, containing enough footage to create three practical videos, however the editing time and extra time/staff required to set up this extra feature meant that it was ultimately decided to wait until future classes to film in this manner. The basic premise of the practical session was to have all content (FACET board, electrical monitoring equipment, screen and practical demonstrator) set up in such a way as to allow the camera to have full view of the entire practical session, allowing the user to either wear a VR headset and look around in the virtual world created from the video content, or use a traditional screen with the assistance of a mouse to drag the perspective, or even using augmented reality tools to assist student immersion (Borrero and Márquez 2012). This aims to increase immersion by creating a virtual environment, with research in this area ongoing (Callaghan, McCusker *et al.* 2013).

6 Summary and Conclusion

This paper has outlined how practical sessions were filmed and presented to students studying undergraduate engineering. A total of 14 videos were recorded and presented to the students, which led to a significant drop in attendance to the in person laboratory sessions mad available to the students. Students are still required to show competencies in their electrical engineering skills however. An interesting future study will be the abilities of these students as they progress through their undergraduate degrees. Allowing students to focus their skills solely on project work while supplementing these skills with video content of foundation knowledge allows for much more efficient presentation of content.

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