CREATING ON-LINE MATERIALS FOR COMPUTER ENGINEERING COURSES

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Abstract

Recent fast growing computer techniques have made tremendous change to the way we live. Educational methods are also influenced by computers and computer networks. Educators have adopted all kinds of tools to enhance course curricula and teaching materials. As a result, computer based courseware development has been dominated for the past decades. Popular teaching environments range from virtualization, gaming style, online courses, and etc. Those new teaching and learning modules improved the teaching quality by breaking traditional class setting and encouraging more students' interaction. Nowadays on-line courses are offered in many art and science subjects while it is challenging to extend it to engineering territory because most of the engineering courses have hands-on experiments. In this paper, authors shared their experiences on on-line course development with a focus on Computer Engineering related subjects.

Background

The 21st century entered a real computer era. Besides, internet broadened people's vision by a means to provide information beyond physical location barrier. As a result, the learning tools and environment changed with it. Microsoft Powerpoint slides show enabled the digitalized class notes; released instructors from writing and erasing on the board; and expedited the class pace. Other similar software also prepared for future education evolution. Ever since spring of 2001, Massachusetts Institute of Technology (MIT) announced its open courseware [1] where course materials such as syllabus, class notes, homework and projects are accessible through internet, the piloted on-line courses came into being. After the first group of 50 courses being published in 2002, over 2000 courses are put on-line. There was a discussion one decade ago that whether teachers will soon be replaced by the on-line courses. Finally this replacement wasn't happen since teacher-students interaction can not be omitted for most of the courses.
Recently, one of the important advancement is the widely used YouTube which enables full lecture recording. The other is internet based video conference like Webinars and Skype. Real

time interaction and discussion can be added to on-line courses. A new wave of on-line courses development is emerging. Another critical issue for teach courses on-line is subject dependent. Some subjects, like math, English, history, and etc. classified as art and science, are relatively easier to be developed on-line because the course contests can be 100% delivered through videos and tests and quizzes are enough to check the learning results. While engineering courses are of a little difficult to be shifted to on-line setting since the practical laboratories or projects are difficult to be checked remotely. But there are educators working on it for the past decade and several achievements have been made. When computer graphics technique became mature, virtual reality was introduced into classroom [2, 3]. Students can view the 3D environment created by instructor using their computer to solve course problem. Difficult science problems can be explained vividly using virtual objects. When National Instruments (NI) published the idea of hardware in the loop, faculty developed laboratories to utilize the new tools [4]. Electrical and computer problems can be included in a virtual world. Students can get access to the NI equipment located in the university lab through remote access. So they can stay at home to utilize lab equipment for hands-on experiments as long as they have a computer connected to internet [5]. Several other examples are also successfully advancing the on-line courses to a new height. One is organized by Extreme Science and Engineering Discovery Environment (XSEDE) on an "Application of Parallel Computers" course [6]. A group of universities participate together. All the lecture slides, quizzes, data, and tools are put on-line. Students are encouraged to post questions and employ the forums to share ideas and get assistance. Faculty meetings among participating universities are scheduled regularly to discuss the process. Necessary changes are made based on feedback. In this example, major research university is leading the course and would like to share the resources with other peer educators. And an auto grading system is deployed to help with the evaluation. Of course a group of teaching assistants from leading university are critical to the success of this online course. For some universities which do not have that many resources, put course materials online to assist regular class is a popular approach. For instance, in Mississippi State University, the class of ECE3724 Microprocessors has all the slides and videos on-line, so instructors don't have to go over those basics in class. The class time is for solving real problems which is essential for engineering students [7].

Course Materials

As the authors are in computing disciplines, here the focus is on computer related courses. Based on authors' research, successful engineering on-line courses not only developed interactive lecture materials, but also figured out a tool to implement hands-on labs. Among all the engineering majors, computer engineering could pilot the on-line procedure because computer is not only used as a tool, but also the subject to teach. As most of engineering lecture courses are

either accompanied by a lab course as a co-requisite, or the three hour lab is included in the course already, here authors category the course materials to lecture and lab.

1. Lecture online

   If instructors deliver lecture to the class, materials usually include slides, class notes, quizzes, tests, homework assignments and projects. It is a common approach that slides are provided to students before class for them to preview the summary of class contents. By selecting textbook or reference books and tailor the slides provided by the authors, instructors can generate their slides and put them on-line for students to download. Some universities have renovated classrooms equipped with interactive white board, SMART Sync software and clickers [8]. Instructors can send students electronic version of the class notes right after class.

   Nowadays it is very convenient to generate lecture videos and make them available either through class website or YouTube. Students can pause and replay the video which is better for them to understand the concepts. Some YouTube videos are also very helpful and can be used in class. Instructors don't need to re-invent the wheel. For example, when authors were generating teaching materials on Microprocessors Systems Design course which focus on Intel microprocessor, there are many good YouTube videos to introduce Intel processor starting from 4004 to most current multicore processor [9]. Instructors can choose the feasible ones to enhance their class. Fig. 1 illustrates a screen shot of a YouTube video where the 4004 was compared with current Intel Xeon processor.

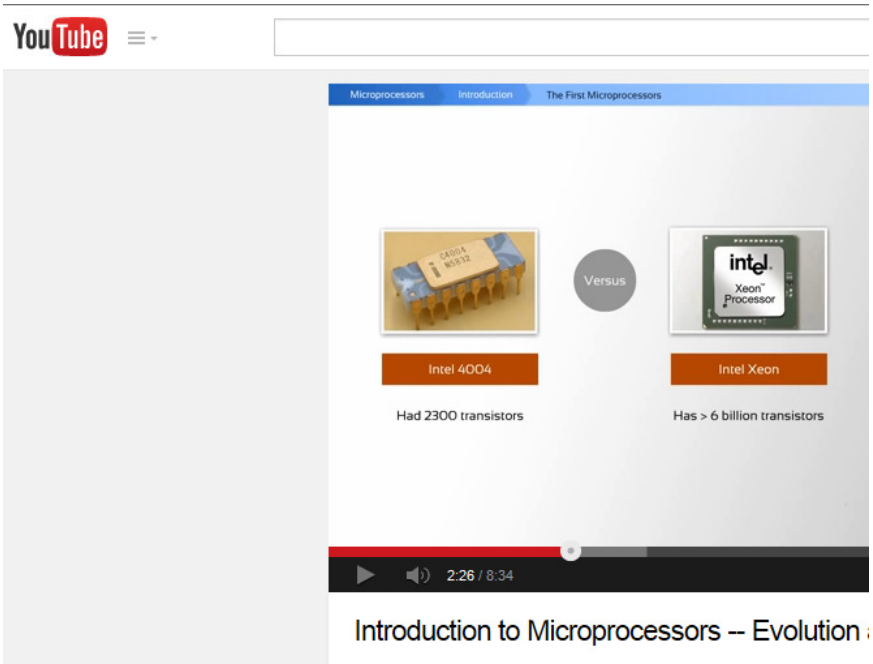

Fig. 1 Sample YouTube introduction on Intel microprocessors

Multiple choices quizzes and tests can be done online easily, but other assignments vary based on the nature of the requirements. An auto grading system as mentioned in [6] works well for the software evaluation, since there are existing benchmarks to be chosen. It would be convenient if assignments can be to be auto graded, but each subject will have to develop its own capable grading scheme.

2. Lab online

To have lab materials online, first, step by step procedures are videotaped and put on-line. Second, proper trainers need to be selected. Authors are working on two computer engineering labs: one is Microprocessors Systems Design, and the other is Embedded Systems Design. The first one use an 8086 trainer by Global Specialties, which is of big size and relatively expensive. So it is not capable to ask each student have one by themselves. The lab is limited to be completed in university lab room. For Embedded Systems Design, TI ARM technique is taught. The Stellaris LM3S1968 Evaluation Kits is chosen to conduct the lab experiments. This trainer is of pocket size and costs less than a hundred dollars, so students can purchase their own or check out from school.

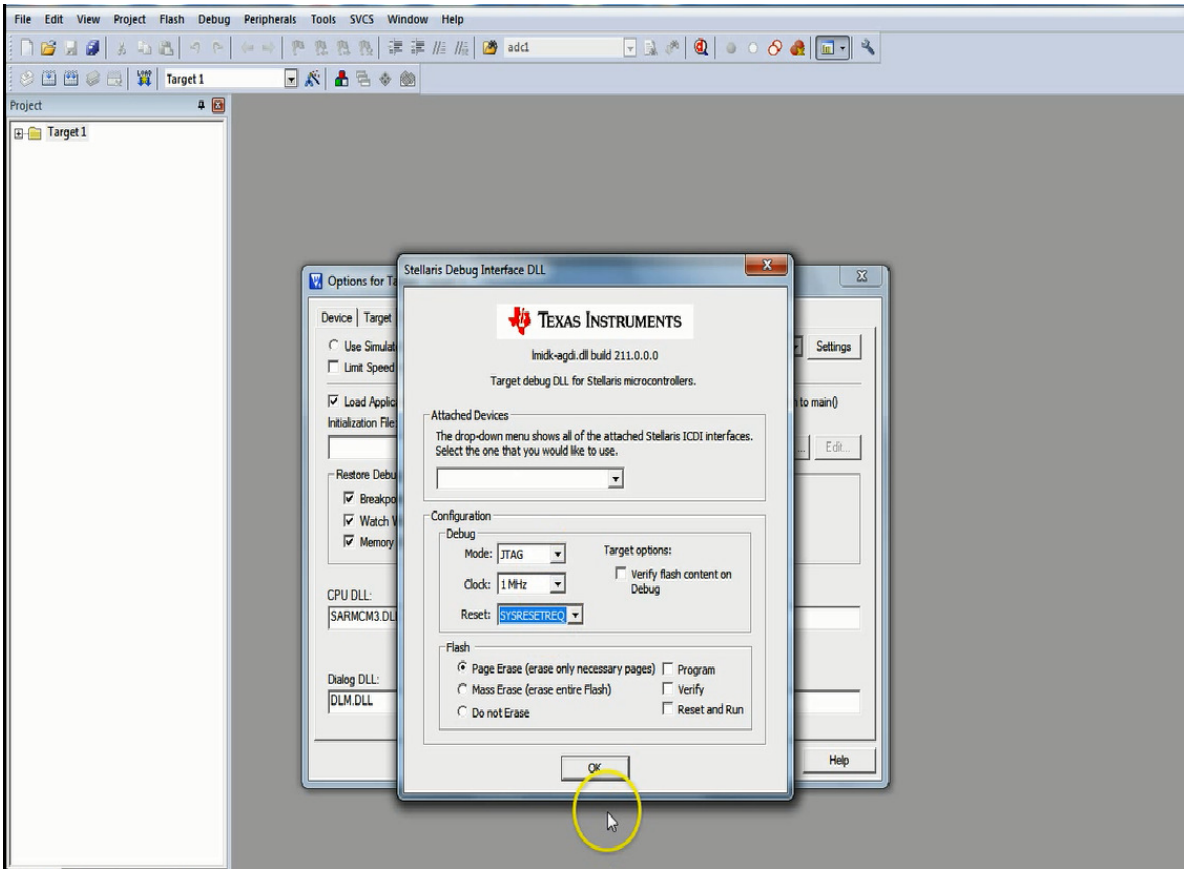

Fig. 2 Screenshot of lab instruction video

The lab videos are developed by free software from Screencast-O-Matic. One of the video screenshot is shown in Fig. 2. Students can follow the instruction from the video to complete the lab, videotape the results and submit to instructor or teaching assistant with their report. Fig. 3 illustrates one of the labs with the trainer and a simple circuit on breadboard. All the designed labs will have similar hardware setting.

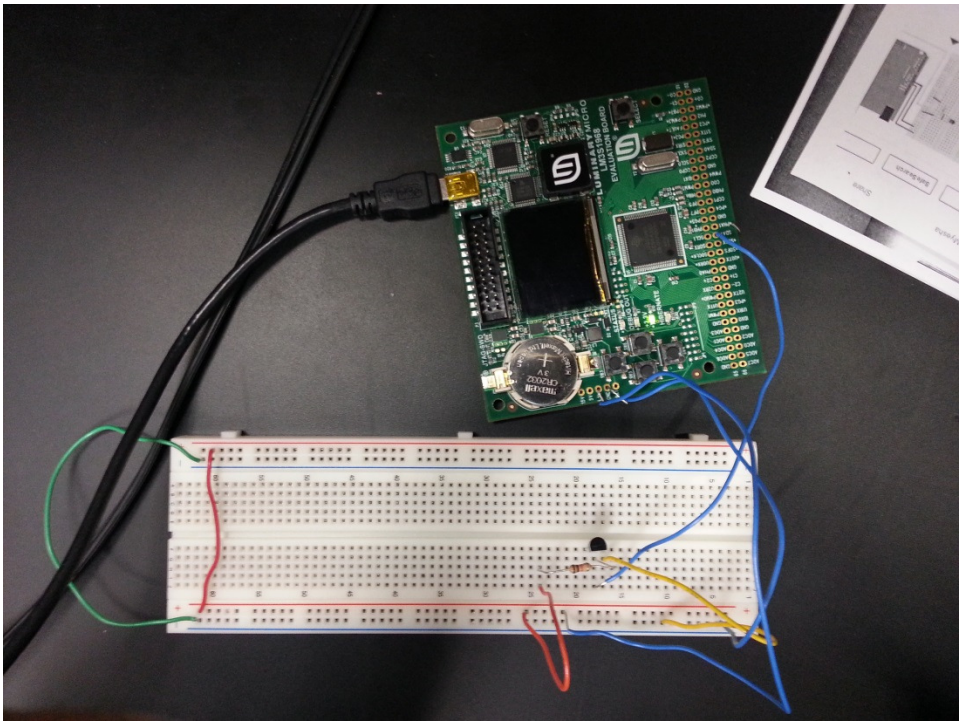

Fig. 3 Sample lab hardware setting

As of now, the labs can take advantage of current digital media techniques to assist the advising and grading procedures, but regular class meeting and face to face instruction are still provided. In the future, the labs are capable to be taught on-line.

Discussions

As on-line course is still new to many universities, computer engineering program can be the pilot for all engineering programs. Authors would like to share their experience for developing computer engineering on-line teaching and experimental materials. Some features leads to successful on-line engineering course materials include:

1. A very detailed digitalized course contents must be generated which include lecture videos, quizzes, assignments and etc. Those materials focus fundamental knowledge that students can acquire through viewing the videos. Quizzes must be designed to help

students grab the gist of the technical points. View and review the videos offer a more convenient way to enhance learning.

2. Besides lecture videos, quizzes and tests to evaluate knowledge from textbooks, engineering courses must have hands-on projects or labs which are capable for students to practice outside of the class room. It is essential to choose proper trainers. Portable and low cost trainers are of the choice. The reason is each student won't have the problem to own his/her trainer. So they don't depend on the physical lab opening schedule, and they'll have more time practice real life experiments.
3. An effective communication strategy needs to be in place. On-line forums are a popular way for instructors and teaching assistant to answer questions raised by students. Teleconferences will help if the class size is not very big. Skype and other tools can be used for this purpose.
4. If the course and/or lab are offered on-line, an effective assessment procedure must be implemented. Especially at the very beginning of shifting to an on-line setting, not only the capability of course contents, but also the instructor, department and students readiness need to be taken into account. The assessment should contain both objective and subjective feedbacks. A pilot course period or section needs to be created for comparison. Both quantitative assessment from students' major exam questions and digital audiovisual content assessment from online materials should be collected. Based on the statistic data, decision will be made on to what extent the on-line materials can be of benefit. Educators must be very careful to avoid students getting lost in on-line courses.
5. It is observed that to purely adopt on-line course materials from one university to another might not work well. In this scene, the "cultural sensitivity" for each institution plays an important role. To answer this call, authors decided to have local students to act in some of the course or lab videos. As it is the local "culture" here in the university to have study groups after school, students felt more comfortable viewing videos from peer students and were motivated to see all of them.

Conclusion and Future Work

With the advanced digital media and internet techniques, people become more and more familiar with obtaining online information than decades ago. Educators need to make good use of the new communication resources we have now. On-line capability is the trend for the future university courses. At one hand, it will save university resources since faculty don't have to repeat same contents again and again for multiple sections. On the other hand, online courses break the physical location barrier for students to attend a certain university, so it will increase the enrollment in a long run. At last, put detail teaching materials accessible helps students to

acquire knowledge wherever and whenever they want. That is a more realistic environment for life-long learning.

As of now, authors started to generate computer engineering related course and lab materials and put them on-line. The home university is not a major research institution and available resources are limited, so currently the courses are still taught at regular meeting time with assistant from on-line materials. But as more and more online materials become mature, they will be assessed and evaluated, then can be offered online in the near future.

Acknowledgements

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