EXPERIENCES WITH AN ELECTRONIC WHITEBOARD TEACHING LABORATORY AND TABLET PC BASED LECTURE PRESENTATIONS

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ABSTRACT

This paper presents our experience in setting up an electronic whiteboard based computer laboratory for teaching Digital Signal Processing (DSP) courses in Australian undergraduate and postgraduate programs. In addition, student interaction with the electronic whiteboard based tutorial class environment is also reported. The DSP lectures, outside the laboratory, were presented using a Tablet PC as a digital whiteboard, which allowed annotation of lecture slides to support high quality handwriting capability over the slides and overcame the limited flexibility currently present in the normal PowerPoint delivery of lectures. For selected tutorial questions, solutions were electronically provided by the lecturer’s interactive handwritten explanation on a blank slide on the Tablet PC along with audio commentary. An evaluation of student opinions towards this multi-mode of teaching DSP was illuminating and the overall experience with this set-up was that signal processing could be effectively and naturally taught in this mode with high student attention span.

1. INTRODUCTION

The traditional ‘lecture only’ classroom environment has been enhanced recently by the use of educational software tools and online tools for opening up different interactions among the participants in a classroom environment [1], [2]. These enhancements have been shown to promote faster learning an environment where student expectations of mixed-mode delivery methods are increasing.

Presentation tools are also increasing in popularity. An interactive electronic whiteboard is an excellent tool for distance learning where users can be at more than one site concurrently. It has been demonstrated that the use of the electronic whiteboard in a virtual classroom environment, via tele-lectures from a remote location, can provide an appropriate visual and contextual realism as it adequately allows for natural and spontaneous interaction between the lecturer and the students [3].

Teaching with Tablet PCs have recently attracted attention as a potential tool for educational use and a “Classroom Presenter” system has been developed [4] for delivering computer science courses. Their surveys indicated that students paid more attention and had a better understanding of the material. This system was further extended for collaboration and active learning within the classroom where students can submit digital ink-based material to the lecturer, within a Tablet PCs based classroom, to display on the projector [5]. Signal processing education relies strongly on keeping up to date with the technologies constantly being generated by new research in the field [2].

This paper describes the methodology and technology used in developing an interactive whiteboard DSP laboratory that was established at the School of Electrical Engineering and Telecommunications, University of New South Wales to aid teaching. The significant features of this laboratory are the mixed modes of delivery, that include the broadcast of a lecturer’s desktop onto student monitors to demonstrate a lesson or simulation using MATLAB. The lecturer can select a student’s monitor or their own console and project it onto the whiteboard for annotation and explanation. Students can use the electronic whiteboard by and interact with the lecturer and their peers in tutorial discussion sessions in the laboratory. These interactions are saved as pdf files at the end of the session and emailed to all students for future reference.

Another key feature of the laboratory is that the solutions of tutorials are electronically provided by the
lecturer’s interactive handwritten explanation on blank slides, that were prepared outside the classroom using the Tablet PC, along with audio commentary and can be accessed by all students in and outside the laboratory.

2. ELECTRONIC WHITEBOARD BASED TEACHING LABORATORY DESIGN

2.1. Virtual Teaching Laboratory (VTL) Design

In 2003, we reported the design and operation of a VTL [3] at our School for multiple site/two-site mode configurations, allowing students to receive fully interactive, real time lectures delivered from a remote international location. We presented the methodology and technology used to develop a complete set of tele-lectures and online tools for a course entitled ‘Signal Processing and Applications’. An evaluation of student opinions towards the virtual teaching laboratory revealed that 90% of students rapidly became comfortable with the use of this new educational facility, among other results [3]. Extensive use of the Internet-based electronic whiteboard was made for projecting lectures, viewing diagrams or text transmitted from the remote location, and full two-way interaction using an electronic pen for completing examples, drawing diagrams and writing questions intended for the remote lecturer.

2.2. Signal Processing Teaching Laboratory (SPTL) Design

Using the above experience gained in designing a VTL, we then designed a teaching laboratory for signal processing education. The key aspect of the design is the use of a wall mounted SMART Board, which is an interactive electronic whiteboard, along with 30 student workstations.

The significant feature of this laboratory is the use of SMART Technology based “SynchronEyes software” that include the broadcast of a lecturer’s desktop onto student monitors to demonstrate a lesson or simulation using MATLAB, as well as displaying the lecturer’s desktop on the electronic whiteboard. This further allows the lecturer to write over top of the whiteboard using an electronic pen and all students can see the annotations on their monitors. This is a useful feature to have when the lecturer is demonstrating and explaining a MATLAB simulation results. On the other hand, the lecturer can select a student’s monitor and project it onto the whiteboard for annotation and explanation.

A sample screenshot taken from the Signal Processing course is shown in Figure 1. A common technique employed by the lecturer was to use “attention marks” (in this case a red circle) to draw the student’s attention to a specific item.

We have used this laboratory very intensively for teaching Signal Processing courses for undergraduate and postgraduate classes. The interaction between the students and the lecturer/tutors are extremely positive and very high as compared to our experience with previous Signal Processing courses that have been taught over the years in similar laboratories without an interactive electronic whiteboard.

Fig. 1. Screen capture of a powerpoint slide on the electronic whiteboard

2.2. Interactive Tutorial Sessions in SPTL

It was not our original intention to use the SPTL for tutorial discussions. When we tried it out, we found the students started to use the electronic whiteboard more often and interacted with the lecturer and their peers in tutorial discussion sessions in the SPTL laboratory. The discussion annotations on the electronic whiteboard were automatically captured and saved (see right column on Figure 2) as we opened new blank sheets for discussions.

It was also possible to switch between the saved annotated sheets by simply touching the icon. At the end of the class, these interactions were saved as pdf files and were emailed to all students for future reference. During the sessions, interaction via the electronic whiteboard became very productive and student attention was very high.

Figure 2 shows a snap shot of a tutorial discussion session where many sheets have been used in the discussions (see right column). In all of the seven sheets as seen in Figure 2, many students have contributed to a particular problem discussion.
Figure 2 shows a snapshot of a tutorial discussion session using an electronic whiteboard.

2.3. Tablet PC as a Digital Whiteboard

The Tablet PCs have recently attracted attention as a useful tool for educational use. We first used a tablet PC in a first-year class of 250 students in April 2003 as a presentation device that replaces a laptop and a whiteboard in a lecture theatre. We are now regularly using Tablet PCs for teaching Signal Processing courses, in particular postgraduate classes. In our experience, the Tablet PC provides another form of interactive electronic whiteboard teaching in a classroom environment. We found that there are many advantages of using a Tablet PC instead of a laptop:

- The lecture can be prepared as normal using PowerPoint slides and annotated during the lecture or the lecture can be conducted entirely using an electronic pen without preparing material in advance;
- The lecturer will maintain eye contact with the class and there is no need to turn to the board as one would do if you are using a laser pointer when using a laptop;
- There is easy access to multiple pens with widths and colours and the lecturer can re-visit previously discussed material during the class;
- It is easy to switch to applications, such as a real time simulation of a digital filter using MATLAB, and display the results and then use the digital pen to draw attention to a specific item, for example by drawing a circle;
- Any important discussions can be saved and emailed to all students outside the class time.

- Animated PowerPoint lecture notes can be avoided as the Tablet PC allows annotation with natural handwriting.

Student feedback regarding the use of Tablet PC based lectures has been extremely positive. This is due to the fact that the use of the Tablet PC as a digital whiteboard allows annotation of lecture slides to support high quality handwriting capability, thus in turn allow them to pay more attention to the lectures.

2.3. Tutorials Solutions Using a Tablet PC with Audio Commentary

We have used “HyperCam” software to capture the text annotations on the Tablet PC screen and audio (lecturer’s voice) to save it as a standard and easily edited AVI file. “HyperCam” lets us define the precise area of the screen that we want to capture, unlike camcorders that record the entire screen. These AVI files can be useful as teaching tools, for students to review any illustrative material at their convenience in and out of the class environment. Since the video is not recorded, the AVI files are reasonably small in size. However, we can get further compression by inserting the AVI file into a read only PowerPoint slide.

We have utilized this capability to provide tutorial solutions for selected tutorials where AVI files consisting of the lecturer’s interactive handwritten explanation on blank slides, that were prepared outside the classroom using the Tablet PC, along with audio commentary were made available for student access.

We have developed approximately 200 multiple choice questions, including many thought provoking questions, for the undergraduate course entitled “Digital Signal Processing” covering the major topics in Digital Signal Processing and for selected questions we have provided AVI files as explained above. These were well received by the students and their comments regarding this approach were highly illuminating. A sample snapshot of a recorded AVI file (audio + screen capture) is shown in Figure 3.
Figure 3: Snapshot of the final frame of the AVI file

In the recordings, the lecturer highlighted that the pole and zero are real, and ruled out the incorrect options in a particular order. Student feedback showed that they liked this explanation and the AVI files helped their understanding.

3. EVALUATION

For this project, the course ‘Digital Signal Processing and Applications’ was offered from Athlone Institute of Technology, Ireland to 30 postgraduate students of the University of New South Wales, Australia, in tele-lecture mode. The course was delivered in 3-hour lectures weekly over twelve weeks during session 1, 2002. The course content covered digital filter design, frequency domain analysis, multi-rate signal processing, adaptive filtering, time-frequency analysis and speech processing applications.

A major objective of this project was to evaluate the experiences of the staff and students with the virtual teaching laboratory-based tele-lectures. At the completion of the course, a survey was conducted among the students to gauge their responses to this new mode of delivery. The survey comprised 21 questions, covering the technology, including the electronic whiteboard, the pedagogy, the learning process, interaction with the lecturer, ability to concentrate on the lecture material, the signal quality and the time delay between audio, video and electronic whiteboard signals. Out of the 30 members of the class, 28 responded to this survey.

5. RESULTS

5.1. Student experiences

The students were asked about the naturalness of delivery. As seen in Fig. 2, 61% of the students were in favor of this mode of delivery.

Fig. 2. Student responses to the statement “Interaction with the lecturer was straightforward in this mode of delivery”.

As regards to their opinion on how essential it was to have a lecturer physically present in class rather than at a remote location, 68% of students thought that delivery from a remote location was acceptable.

Other highlights of student responses include (percent agree):

- The audio signal quality was satisfactory (100%)
- The delay between the arrival of the audio signal and the appearance of writing on the electronic whiteboard was acceptable (96%)
- Video presence is necessary, but poorer video quality can be tolerated (52%)
- It is not more difficult to concentrate in a lecture given from a remote location than one received when the lecturer is present in the classroom (59%)
- The use of colorful PowerPoint slides and colored electronic pens is important in helping to maintain concentration (96%)
- It is easy to follow PowerPoint slide progression on the electronic whiteboard (89%)
- Receiving lectures from a remote location does not take significant time to get used to (85%)
- It is useful to have local academic support in the classroom (96%)
- Overall this method of receiving lectures is just as good as the normal method, where the lecturer is present in the classroom (68%)

Almost all of the students (90%) felt that the virtual classroom-based modules did not take a significant time to get used to, and that this mode of teaching should be made available in the future, as illustrated in Fig. 3.
Additional comments from the students indicated that digital signal processing lent itself to this mode of delivery due to the ease of presenting effective practical examples and the opportunities for receiving lectures from experts from in the field from around the world.

CONCLUSION

We have developed an electronic whiteboard based Digital Signal Processing Laboratory and have demonstrated that the use of “SynchronEyes” software allows interaction between the lecturer and students via their monitors and the whiteboard. This laboratory was used for interactive tutorial sessions and it was found that the key advantage of this system is that the interaction between students and lecturers catered for a greater understanding of the material taught, in comparison to the traditional methods of teaching. At the end of the interactive tutorial sessions, the annotations of discussions captured on the electronic whiteboard in the class were saved as pdf files and forwarded to all students for future reference. Student participation and attention in the laboratory sessions were very high. Capturing AVI files using a Tablet PC for tutorial solutions have also enhanced student learning. The use of the Tablet PC as an electronic whiteboard in a lecture environment has provided many advantages for a lecturer compared to the traditional use of a laptop. This integrated system were have demonstrated, opens up various avenues for teaching and enhances student learning.

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REFERENCES


