2006-1614: A COLLABORATIVE PROJECT ON JAVA-DSP INVOLVING FIVE UNIVERSITIES

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Abstract - This collaborative effort involves five universities, namely, Arizona State University, the University of Washington-Bothell , the University of Texas at Dallas, the University of Rhode Island, and the University of Central Florida. The paper describes educational technology innovations and software extensions that enable the on-line software Java-DSP to be used in three courses at five different universities. Assessment from use at ASU is presented in this paper. Preliminary assessment from the other institutions is also available. A new concept for concurrent collaborative laboratories is also presented.

INTRODUCTION

Java-DSP (J-DSP) (http://jdsp.asu.edu) is an educational program that enables on-line simulations and web-based computer laboratories. J-DSP is based on an object-oriented programming environment that enables students to establish and run DSP simulations on the internet. The initial version of J-DSP has been developed in the ASU MIDL lab and tested in a senior-level Electrical Engineering Digital Signal Processing (DSP) course (EEE 407). The J-DSP Version 1 (CD-ROM ISBN 0-9724984-0-0) is approximately 42,000 lines of Java code. Papers on J-DSP addressing several DSP related areas have been published previously in archival conference proceedings and journals [1-15].

This paper presents sponsored work aimed at developing, disseminating, and assessing several new J-DSP capabilities. The project involves five universities and includes significant educational technology innovations that enable Java-DSP (J-DSP) [1] to be used in 4 courses at 5 different universities. The project tasks consist of the following:

a) educational innovation that upgrades the J-DSP GUI,
b) a software development task to extend the mathematical and signal processing functionality of J-DSP,
c) a comprehensive on-line laboratory exercise development task engaging all the Co-PIs at the different universities,
d) a dissemination and assessment plan that involves five universities which committed to testing and providing feedback on the new J-DSP GUI and all exercises and content,
e) a comprehensive pilot test of a new multi-site laboratory concept that allows students in the five universities to run real time distributed on-line simulations,
f) dissemination of all results, practices, and concepts developed

ASU is the lead university, and will execute all the software development tasks. The ASU group will also develop exercises, assessment instruments and dissemination materials. UWB will develop and assess all the computer exercises on the *Multimedia Computing* course;   URI, UCF UTD will work on their *Signals and Systems* courses.

EDUCATIONAL INNOVATION

Several educational technology innovations will be made available to the education community including:

- o **integrating seamlessly web lectures, simulations, animations** in one unique learning environment.
- o **synchronizing simulations with streaming lectures**; keywords in lectures activate simulations using *J-DSP scripts [3]*
- o **capabilities for geographically distributed laboratories;** students from different universities will be able to integrate and run simulations concurrently from different locations;
- o **J-DSP scribe tools;** capabilities for the lab instructor to monitor student actions on J-DSP from a remote location in order to provide feedback on-line
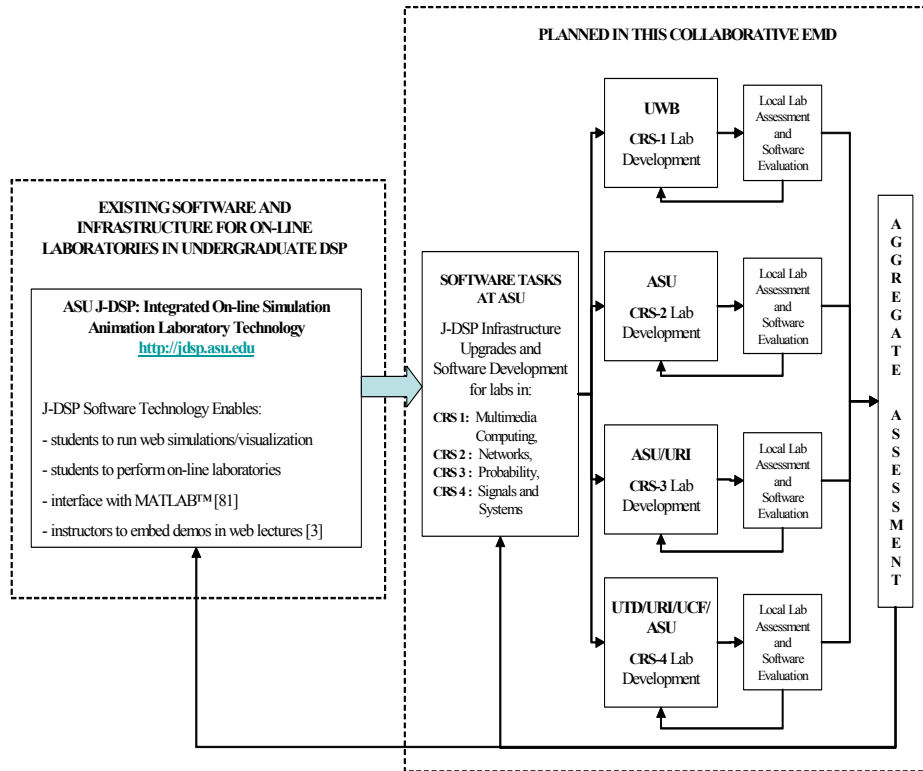

Figure 1.   The Collaborative project involves: a) a software task; b) laboratory development for 4 courses; c) geographically diverse assessment.

A COLLABORATIVE J-DSP LABORATORY

In addition to the online labs developed for the different courses, Figure 1, we are creating a laboratory that enables students at UWB, UTD, UCF, URI and ASU to work concurrently on a distributed real time web lab.

We have developed new software and server infrastructure to support this exciting concept. The new J-DSP infrastructure enables collaborative web simulations from at least two different locations. The J-DSP features that enable collaborative simulations are called *J-DSP Scripts* [3]. Students from different universities are now able to integrate and run simulations concurrently. The current version's initial login screen is shown in Figure 2 with the new LoadScript capability that enables the multiuser functionality.
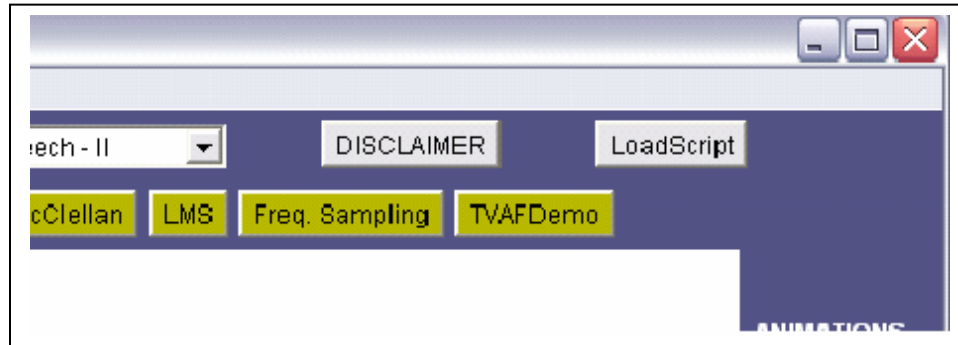

Figure 2. The LoadScript Capability in the Multiuser Version.

Most of the GUI for Editor Frame is identical to the basic J-DSP version except for the 'LoadScript' button on the top right hand side. The initial login screen is replaced by a list of current users logged in as shown in Figure 3.
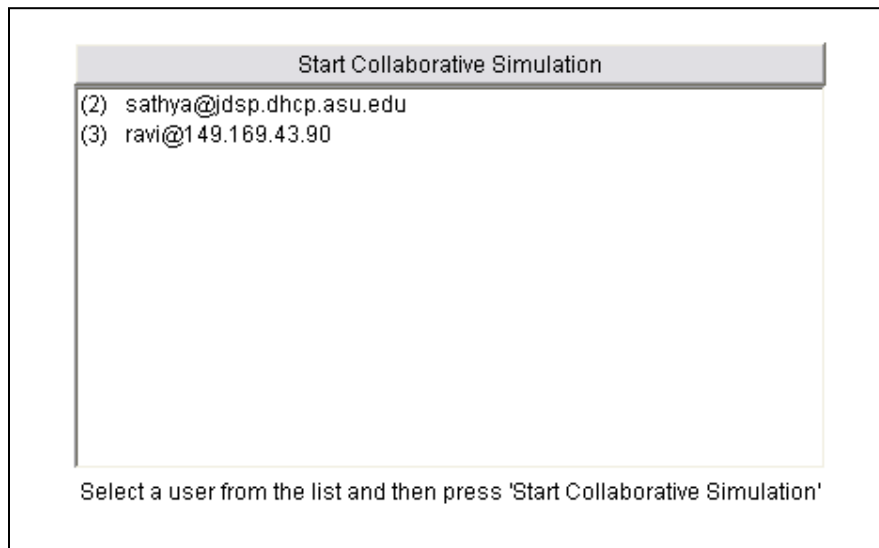

Figure 3. The list of users in a Multiuser session.

Once users are available on the list, they can be selected. Clicking the button 'Start Collaborative Simulation' begins the session. A channel is created between the two users

via a server that continuously runs from a UNIX machine that uses sockets. Also the list of users is replaced with a screen containing the user's login name and the J-DSP multi-user version logo.

The Export Script mechanism available in J-DSP is used to transform the graphical simulation into a series of J-DSP Scripts which are sent as a java String. As soon as a user participating in a collaborative simulation exits, the other user in the collaboration is notified. A list of the login names, their host addresses, login times etc are displayed continuously on the UNIX terminal and hence the administrator can keep track of the different users. A figure with the UNIX terminal displaying a list of user login times, user numbers, host addresses and user ids is shown in Figure 4.
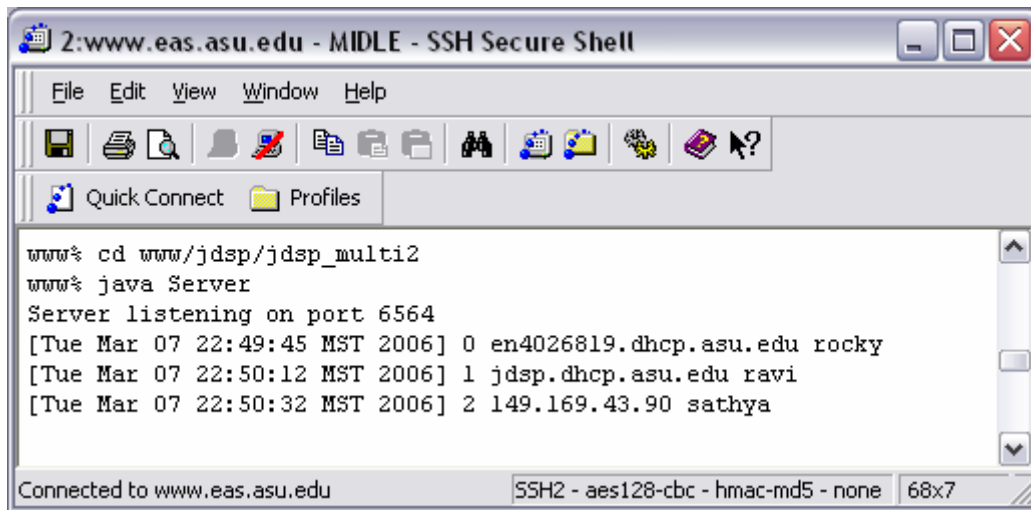

Figure 4. The UNIX terminal displaying a list of user login times

LABS AND ASSESSMENT AT ASU

Assessment results collected from the EEE407 class (87 students) are analyzed here. *General* and *concept-specific* evaluation forms have been developed. The *general* forms are used to obtain an overall subjective opinion on the J-DSP software. The *concept-specific* forms provide the laboratory evaluation and its impact on learning specific DSP concepts. The newest assessment instrument, called *pre-/post-lab* assessment, focuses on evaluating whether learning of certain topics is attributed specifically to using J-DSP.

In particular, while designing the assessment instruments, the following criteria have been considered: 1) the simplicity and interactivity of the J-DSP simulation environment; 2) the adaptability of J-DSP and the associated on-line laboratories in DSP courses at other universities; 3) the effectiveness of the J-DSP labs and interactive simulations in teaching key DSP concepts; 4) the improvement in average student scores after performing J-DSP labs; 5) the improvement in number of students responding to a particular lab question correctly before and after viewing a J-DSP demo/interactive simulation; 6) the success of J-DSP in providing hands-on laboratory experiences to distance learners; 7) the impact of the J-DSP tool on the EEE 407 course at ASU; and 8)

the scalability of the J-DSP tool in terms of extending its functionalities to other interdisciplinary areas.

A. General Assessment

The *general* assessment questionnaire consists of a specific set of items that assess the ergonomics and the usefulness of the J-DSP software. In this assessment, students provide information on logistics, software capabilities, academic standing, browser compatibilities, expediency of the user-manual, etc. Student responses revealed that the graphical-user-interface (GUI) and the free access to J-DSP were received positively. Most students found J-DSP simulations highly intuitive. In fact, 95% of the students liked the concept of Internet-based simulations, and 70% of the students responded that it took them much less than 30 minutes to learn how to use J-DSP. Moreover, 85.5% of the students agreed that they would consider using J-DSP to construct their own educational simulations.

B. Concept-specific Assessment

The *concept-specific* assessment questions are directly related to the technical aspects of the J-DSP on-line laboratories. The *concept-specific* forms focus on each exercise by posing questions that determine whether the student has learned a specific DSP concept. For instance, 87% of the students agreed that the filter design exercise helped them understand which window is suitable for sharp transitions; 88% of the students understood better the signal symmetries in the FFT spectra because of J-DSP visualization; and 91% of the students reported that the z-transform exercise helped them understand the relation between the PZ locations and the frequency response plots.

C. Pre- and Post-lab Assessment

In the evaluation the students were asked if the J-DSP and the on-line laboratories enhanced the learning process. Ninety-two percent of the students responded positively. However, in order to obtain even more reliable statistical results for this scenario, the *pre-/post-lab* assessment questionnaire has been developed. In the *pre-/post-lab* evaluation, the questions are technical and are posed to evaluate the student's understanding of the key DSP concepts before and after performing a particular J-DSP lab assignment. The *pre-/post* quiz and the lab are assigned after the relevant theory has been introduced in class. This assignment ensures that all the students have had some, or ideally the same, exposure to the topics covered in the lab, so that the effect of the J-DSP labs on the student learning can be isolated. The students are asked to complete the pre-lab assessment before working on a J-DSP lab. After performing the J-DSP lab assignments, they submit the post-lab assessment. The questions on the post-lab are the same as the pre-lab but given in a different order.

J-DSP labs resulted in improvements of 13.5, 9.5, and 12 marks (out of 100), respectively. This improvement can be attributed primarily to inclusion of simulations involving interactive graphics in these J-DSP labs. Moreover, this assessment result was

influential in redesigning many of the J-DSP blocks to incorporate animations. The percentage increase corresponding to certain labs was significant, i.e., 45%.

D. J-DSP Assessment and Pedagogy

The pedagogy adopted for the integration of J-DSP laboratories in the course included the following sequence of activities: lecture on the pertinent DSP topic, a pre-lab quiz associated with the topic, an on-line laboratory using J-DSP visual programming, and a post-lab quiz. The pre- and post-quizzes are part of both the pedagogy and assessment. The pre-lab quiz emphasizes the key concepts and provides information to the instructor and students on deficiencies and on areas that require further review. The J-DSP laboratory includes exercises that address these key concepts and enable students to improve their performance and eliminate deficiencies; the post-quiz measures whether additional knowledge was gained and whether deficiencies have been eliminated by attempting the J-DSP lab.

REMARKS

A summary of a collaborative NSF EMD project was presented. New J-DSP functions and experiments have been developed and beta sites have been established at five different universities. The assessment at Arizona State University has already occurred and is presented here. By the end of the spring semester, we will have preliminary assessments from the other universities. A new concept for concurrent collaborative laboratories was also presented.

ACKNOWLEDGMENT

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