A NEW COLLABORATIVE ACTIVE LEARNING TOOL
for
SIGNAL PROCESSING EDUCATION

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ABSTRACT

This paper introduces a distributed object based collaboration system called *Collaboard*, which can be effectively used to conduct Signal Processing classes in an interactive fashion. Collaboard allows a group of users in a heterogeneous network environment to share multimedia objects, such as text, geometric entities, equations, images, audio/video objects, and OLE™ objects. Collaboard supports multiple user groups and allows a user to actively participate in multiple learning groups. Matlab™ has been integrated into this Collaboard as the computational workhorse. The Matlab programs or tasks initiated by any participant are replicated over the network to every participant. Our Collaboard architecture is a distributed object-based tool supporting object video and object audio. The current version of the system includes a RealAudio™ Server to support streaming audio capability. We believe that the comprehensive and user-friendly architecture of this Collaboard will be a very powerful working tool for DSP/Communication systems classes in active learning environment.

1. INTRODUCTION

There is a long history of research on cooperative, competitive, and individualistic learning efforts. Since the first research study in 1898, almost 600 experimental studies and over 100 correlation studies have been conducted [1]. The findings from these studies have been classified into three broad classes: *positive relationships*, *achievement/productivity*, and *psychological health.*

It is clearly evident from the literature that *cooperation, compared with competitive and individualistic efforts, typically results in:*

(a) *Higher achievement and greater productivity,*
(b) *Caring, supporting, and committed relationships, and*
(c) *Greater psychological health, social competence, and self-esteem*.

The positive effects that cooperation has on so many important outcomes makes cooperative learning one of the most valuable tools for educators [2].

Teacher-centered approach has been repeatedly found inferior to instruction that involves active and cooperative learning modes. Today, we are moving towards a coach-centered model [3] where the role of the teacher is to guide students in their active-cooperative learning process. It has been observed that coach-centered model leads to *active* and *cooperative learning modes.* In the active learning mode, students solve problems, answer questions, formulate questions, discuss, explain, debate, and brainstorm during/after class. In cooperative learning mode, however, team building is essential where students work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability.

It has been identified that interaction/communication among participants is essential in collaborative/cooperative learning. The communication medium linking all of the collaborating parties, if used efficiently, removes all the barriers, i.e., distance, time, space, etc. Use of telephone, fax, television, and video, as a communication medium for collaboration is not new. The use of computer mediated communication, as a means of collaboration environment is not new either.

There has been a great amount of work in the field to provide various types of communication services including Video-conferencing, Whiteboards, Chat Tools, Multimedia Mail, Voice-Mail, Internet telephony and others. Today the market is full of these tools each with a different level of functionality and level of interaction. Each appears to be offering a partial recipe to the problem. But most --if not all-- of these tools have been designed for a corporate user and do not address the needs of various engineering disciplines. Even the leading software tools such as DataBeam Corporation's Learning Center or Microsoft's NetMeeting do not provide sufficient tools, which are suitable for expressing engineering and science concepts, let alone active participation in design and discussion.

In the software engineering community, tools designed for group communication are generally known as the GroupWare. In this study, we present a distributed object communication environment designed and implemented by the Multimedia Communication Group at San Diego State University to offer better dialog between the instructor and the students and among the students themselves in an active collaborative learning environment.

2. DISTANCE LEARNING TODAY

Multimedia communication group at San Diego State University has been investigating the design and implementation of both asynchronous and synchronous communication tools for collaborative instruction in engineering and science curricula. We would like to point out that we will use the term asynchronous for off-line and human-to-computer interfaces, such as WWW or audio- and video-on-demand services. Majority of the distance education efforts falls into this category, which in many cases do not go beyond an electronic textbook and completely lacks interactivity.

During the last two years, we have provided the students enrolled in a number of courses, our lecture notes and a considerable amount of on-line examples including a number of simulations over the network as an electronic classroom application. We have observed that almost all of our students are printing the electronic material and looking for an empty table to gather around and discuss the concepts at hand. As it can be easily deduced from this observation that the asynchronous education, if not supported by synchronous tools and student teacher or student-student interaction, is not accomplishing the mission.

To the best our knowledge, synchronous distance education tools available to the educational community today are very limited. Most of these tools support streaming video and audio successfully, however, only a few of them come with a text and graphics whiteboard. On the other hand, the dissemination of signal processing concepts require more than simple geometric objects and live video for successful collaboration since we express our concepts in the form of equations, the use of concept maps; we run simulations and share the results of a computation.

It is clear from the presentations of past few ICASSPs that our in-class instruction habits are changing in the form of live simulations using Matlab and other computational environments. Today most professors are utilizing computers with varying degree of success in face-to-face classroom education for case studies and simulations of examples. However, when the distance learning or instruction over the network becomes an alternative, the collaboration tools they are utilizing should not take away the richness of the in-class education. The collaboration tool should provide all the functionality as in the case of face-to-face education. Our efforts in this undertaking, therefore, are concentrated around configuring, designing and implementing synchronous instruction tools that will enable engineering and science communities --which can be easily expanded to other disciplines-- to exchange ideas in any form over the network in a live session.

At the time of this writing, we are in the process of launching the Collaboard that is expected to fulfill the needs of signal processing community to a great degree. We hope to provide them with the ability to share objects, to create concept maps on a shared whiteboard, to write and modify equations, to share image and speech databases, and to perform replicated and distributed simulations.

Collaboard is currently supporting most of the Object Linking and Embedding (OLE™) objects and a number of applications with ActiveX™ control. The software has the capability of integrating and sharing Microsoft Word, Excel, equations, charts, images, graphics, audio and the Matlab Toolboxes™ and Simulink™ over the network. In figure 1, we attempt to illustrate a possible subset of objects available to Collaboard users. It is worth pointing out that OLE objects include a massive quantity of applications such as Microsoft Word, Excel, Equation Editor, etc.

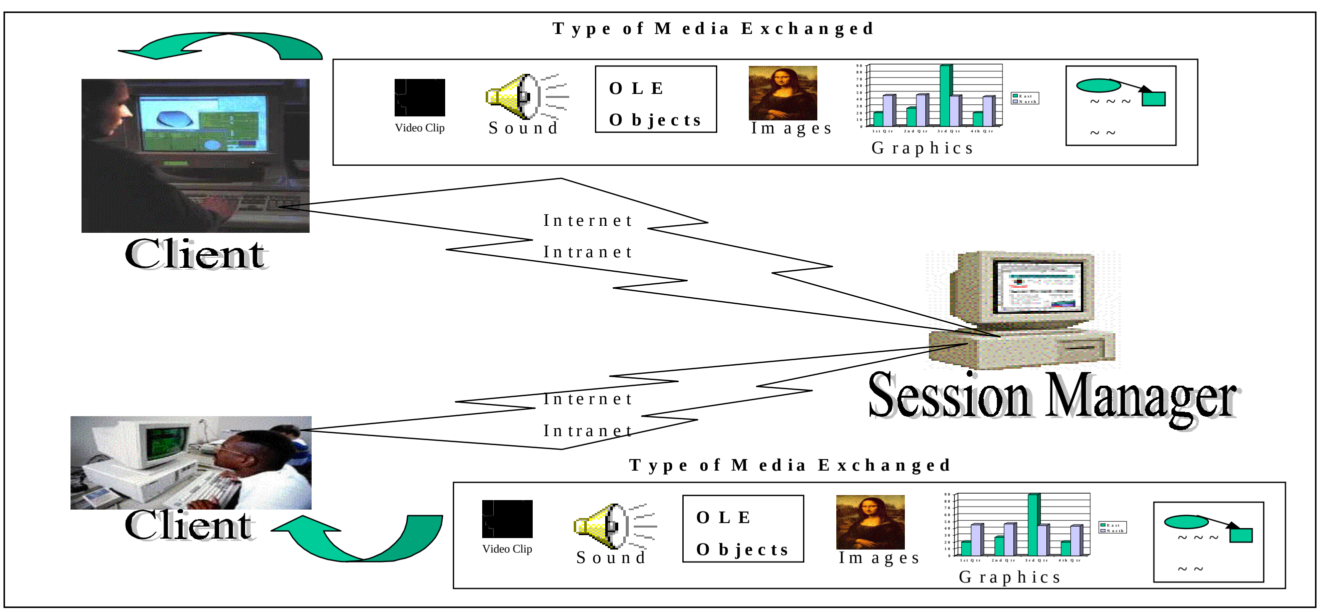

Figure 1: Information flow Among Collaboration Center Users.

3. A LECTURE ON NOISE CANCELLATION

To demonstrate the capabilities of Collaboard we have selected a very simple example to be presented to a group of second-year electrical engineering students. The chosen application was noise cancellation by means of simple filtering. Students are introduced to the concepts of signal, systems, and noise through a self-study chapter posted on our website. As expected, the self-study material over the WWW does not provide any interactivity.

During the deployment of Collaboard the students are first presented with signal and noise examples as shown in figure 2.

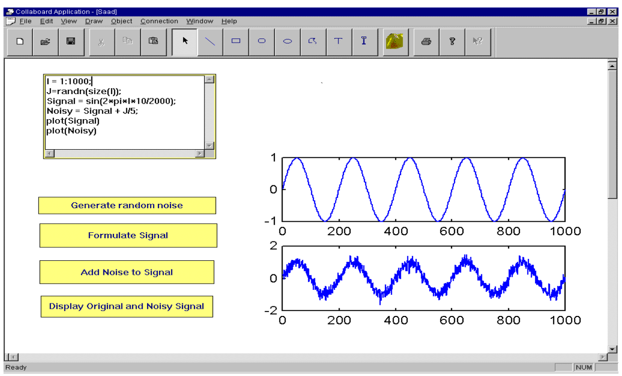

Figure 2: Illustration of Signal and Noise Waveforms.

Here we can see the Collaboard geometric objects and the Matlab window and the same screen shot given appears on each student's display. Also each individual student is able to access the Matlab variables generated by the program sequence of figure 2.

In the next step of the active learning session, we have introduced the concept of simple mean-filtering and the convolution operation using geometric objects, equation object and the Matlab gateway. The two screens used in the presentation of mean-filtering and convolution are shown in figures 3 and 4, respectively.

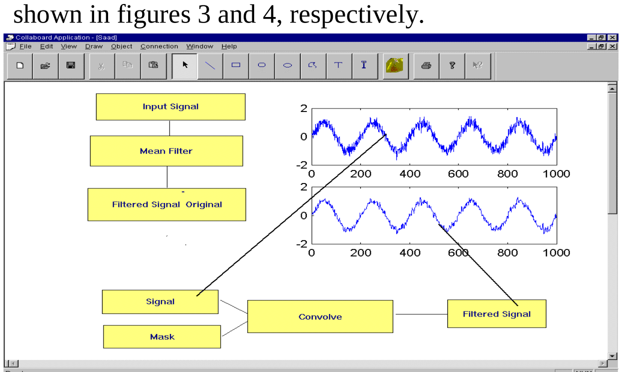

Figure 3: Demonsration of Mean-filtering.

As we see from these figures our Collaboard architecture does not limit the boundaries of the active learning session. On the contrary, it provides several key objects needed in learning the signal processing concepts.

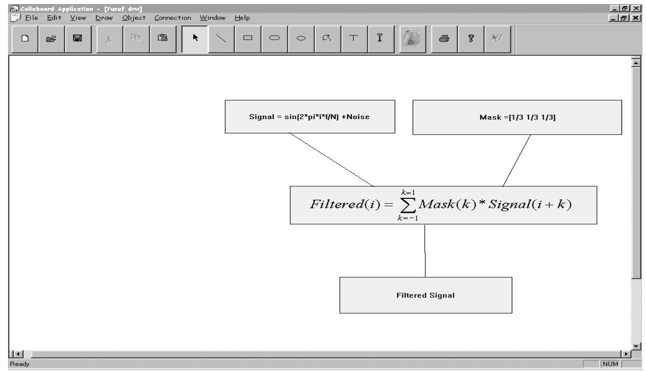

Figure 4 : Convolution Operation.

It is needless to say that each student at any point can make modifications and reflect the results of this modification to the overall participants in the group. The instructors' role here is simply to coach and guide students as well as providing a teacher centric decision-making. To run Matlab simulations the Collaboard architecture provides a dialog box for editing Matlab commands and programs as shown in figure 5. The programs submitted within a Matlab dialog box are executed simultaneously on all the clients participating in the active learning session.

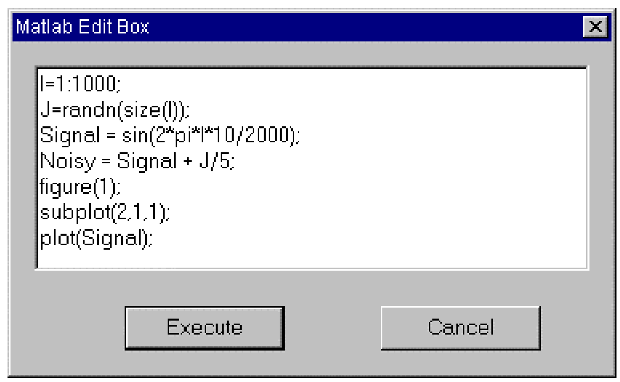

Figure 5 : Dialog Box for a Matlab Application.

Figure 6 shows a screen capture from another active learning session on filters.

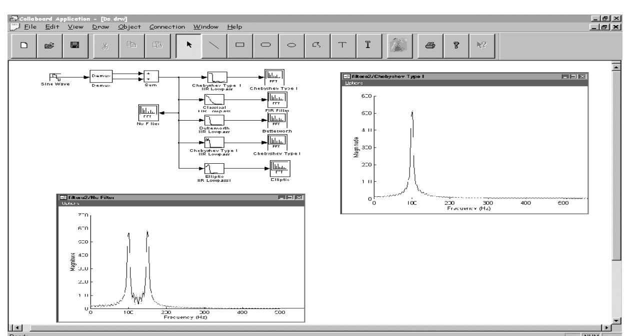

Figure 6: Screen Dump of Discussion on Filter Design.

This time, we have employed the versatile Matlab's Simulink™ tool to support the lecture. Again the simulations showing the results of each filtering action replicated to each student and they had explored to see the effects of different classes filters, such as high-pass, bandpass, and band-stop.

4. COLLABOARD ARCHITECTURE

The collaborative whiteboard application --*Collaboard*-- is a software tool package designed to fulfill the needs of engineering and sciences communities by providing them an ability to share objects, to create concept maps, to write and modify equations, to share audio and images, to perform replicated and distributed simulations. The Collaboard is a client/server application, which currently supports geometric shapes, text, live audio, and many Object Linking and Embedding (OLE™) objects as well as certain ActiveX™ control applications.

The software is composed of two fundamental modules, namely, the server and the clients. The Collaboard client module is responsible from following:

- To provide each user with a global workspace for sharing information.
- To support basic drawing objects
- To support means of adding text to geometric entities.
- To support live audio.
- To provide the ability to share OLE™ objects.
- To permit users to access and share a common Matlab™ workspace.

The Collaboard server consists of three modules and is responsible for session management, floor control and tunneling of DCOM™ objects. They are:

- A WinSock session manager for routing UDP requests in addition to keeping track of new and departing clients.
- A DCOM™ ™ server to route DCOM requests and be responsible for sharing OLE™ objects and the Matlab requests.
- A RealAudio™ server is needed for broadcasting voice over the network.

4.1 Collaboard Data Types

Collaboard users have an ability to create and exchange various data types. Capability to handle different data types makes Collaboard a richer and a more constructive learning environment. In the next few paragraphs, we will discuss currently data types.

4.1.1 Geometric shapes. These are rectangles, round rectangles, ellipses, and lines. Shapes are known to provide important feature in designing flow charts, and state diagrams. Users can choose different colors and different frame widths for a particular shape. Furthermore, a shape can be assigned a text as an attribute.

4.1.2 Text. An Edit box object will allow users to share text information. Having a text area serves many purposes including asking questions, receiving answers, or simply sharing comments.

4.1.3 Live audio. With components, such as the commercially available, RealPlayer™, the RealEncoder™, and the RealServer™, clients could integrate and share live audio[1]. It has been our experience as well as those of many other educators that the audio communication constitutes a better medium of discussion than simple text or graphics. However, when combined with visual media, audio tools convey a richer presentation of the material at hand. The application presented here provides an integrated audio and video common environment for engineering and sciences curricula.

4.1.4 OLE™ objects. These objects are entities created by different applications (called OLE servers) and embedded into the Collaboard's ViewWindow. An embedded equation or a Word document is a good example of OLE objects. We think that the OLE object sharing capability among Collaboard clients is a real breakthrough, since OLE objects help to extend the application beyond its built-in features.

4.1.5 A common Matlab environment. Sharing a Matlab environment is the most critical feature functionality supported by the Collaboard architecture. As the Signal Processing community is well conversed with the fact that Matlab™ is a powerful computational environment and through which the Collaboard clients can easily perform complex computations as well as share various plots and graphs.

5. REFERENCES

[1] D.W. Johnson and R.T. Johnson, *Cooperation and competition: Theory and research*. Interaction Book Company, Edina, MN, 1989.

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[3] H. Abut, Y. Öztürk, "Interactive Classroom for DSP/Communication Courses", ICASSP-97 Proceedings, Munich, Germany.

[4] G. Shepherd and S. Wingo. *MFC Internals: Inside the Microsoft Foundation Class Architecture,* Addison-Wesley Publishing, 1996.

1You may visit the website http://www.real.com for a free download of the RealNetworks® products.