

**Graphical User Interface and
MATLAB Web Server for
Multimedia Teaching on WWW**

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Abstract

The World Wide Web provides new opportunities for distance education over the Internet. The Web when combined with other network tools can be used to create a virtual classroom to bring together a community of learners for interactive education.

The specific issue addressed here is tailoring specific functionality to allow a group of instructors and students to carry out the learning process in Signal and Image Processing in an electronic virtual environment that is meant to replace the physical class environment. In order such an environment to be performed, not only the course content itself but and different Web-based tools for interaction between the students and instructors are presented as well. Graphical User Interface (GUI), designed and presented here, brings together the students and course instructors through virtual lab-sessions, help and chat rooms. It is mainly developed using Macromedia Flash. As Signal and Image Processing are areas, which heavily depend on mathematics, the lab-sessions are performed through MATLAB Web Server. Some specific applications of it are shown as well as complementary tools like Web-calendar and digital library.

Finally, conclusions and future work on this virtual classroom are given.

1. Introduction

The World Wide Web and other Internet-based collaborative tools have significantly enhanced the ability to train and educate electronically. When integrated with tools such as white-board, help rooms etc, the Web can greatly increase students' level of involvement in the training experience. The web provides an effective mechanism for integrating many of these tools into a single interface and is an ideal tool for information which is itself rapidly changing. The Web is revolutionizing some areas of study through increased opportunities for learning and alternative formats for information.

A web course, having an instructor and registered group of participants, brings together a community of learners into a virtual classroom where they can interact with each other.

The goal is to create a virtual classroom, using methods that will fully engage the students in the learning process through an interactive, dynamic environment involving the student, on-line materials and instructor.

2. Planning of a Virtual Classroom

The virtual classroom is planned to be in charge of students in engineering and most particularly for courses on signal and image processing. The courses are meant to be wholly on-line and only for students enrolled in the particular course. Finally, the courses' testing and examinations are planned to be wholly online as well.

For testing reasons, in the beginning, it could be a supplement to a class that meets in a traditional classroom, and more than only students inscribed for a course could be able to use it.

3. Designing of GUI, which serves the Virtual Classroom.

The GUI for the system performing multimedia teaching on WWW is designed to be on four levels (Fig. (1)). In this way all the capabilities of the system are permanently accessible. On the first level is the *Main Interactive Hall*, on the second level - *Courses*, on the third - course *Content*, and on the fourth - *Support Center*.

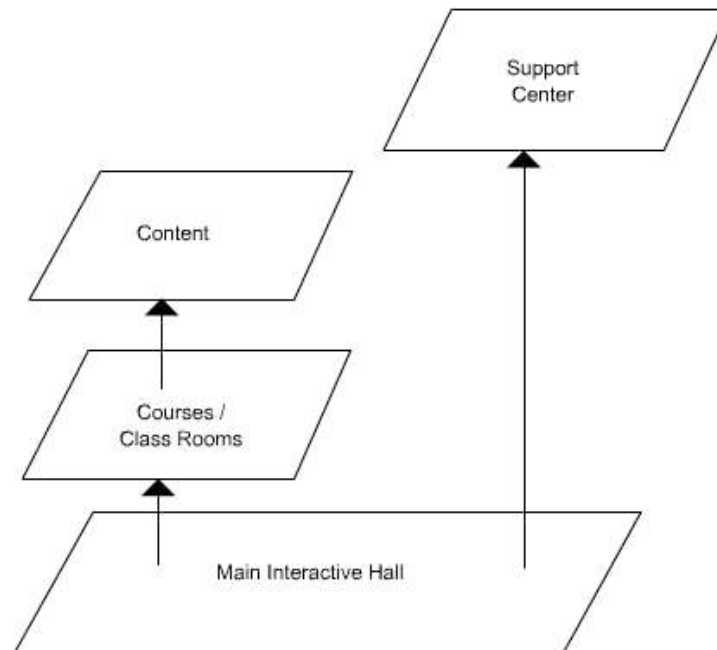


Figure 1. Levels in GUI

The third level is accessible through the second one, meaning the course material can be reached through passing descriptions and requirements for taking the course. Support center is directly accessible from the Main Interactive Hall.

Main Interactive Hall, which is on the first level, consists of three nodes. These are *Administration*, *Support Center* and *Courses*. Organization of the Main Interactive Hall is graphically represented on Fig. (2).

Administration provides statistics on user and system behavior.

Support Center is build from *Digital Library*, *Help room*, *Chat Room*, *Students home pages*. In Digital Library, materials that were traditionally on paper or other conventional material, here are available in digital forms. For instance, book, or articles scanned. Each of the students taking a particular course is presented in Students home pages section. Chat Room is for synchronous communication between students. In Help Room are opened some discussions on course material and this is the place where the students and instructors are meeting. It is a question-answer activity, where if the instructor asks a discussion question, every student must supply an answer before he or she can see the answer of the other students. This is clearly an improvement over the face-to-face class where such discussions are usually dominated by the same small percentage of the students. This feature forces equal participation in any discussion issues the instructor triggers in this manner. It forces each student to do independent thinking about the issue.

Each course is represented by *Class Info*, *Schedule/Calendar*, and *Announcements*; *Help Room*, *Students* and *Learning Links*. In Class Info is given basic course information-procedure of taking the course; to students of which semester it is given; etc. Course schedule is given trough the Schedule/Calendar. Instructor can post the announcements according the course on the Announcements. Help Room provides whiteboard like a tool for interaction between students and instructor in case of questions of students concerning the course material. The link to the third level where is the course material is through Learning Links. Content is organized in house, rooms, walls and bricks, where the basic concept is represented in a brick. [4]

After entering the navigation tool, password verification is required. If the verification is successful, the user is automatically led to the Courses node. From each node the other two remaining are always accessible, meaning if a user is in Courses he has equal possibilities to go to Support Center or to Administration, or if he/she is in Administration he has the choice to go to courses or support center, or if the user is in the Support Center he could go to Courses or Administration.

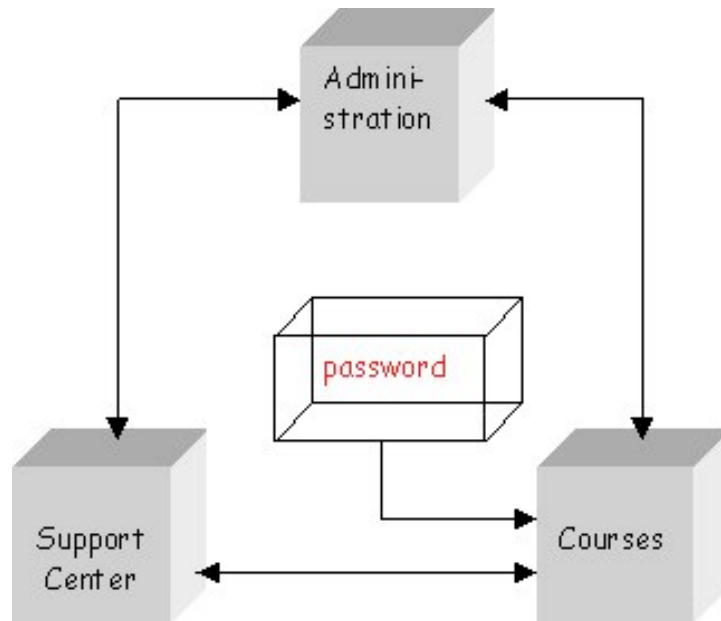


Figure 2. Main Interactive Hall, connections between the nodes.

The Administration node is accessible only from users who have administration privilege. Courses and support center are accessible from students and instructors as well.

4. Development of GUI

The development of the GUI is done mainly in Macromedia Flash 5. Flash excels at being able to deliver graphics for realistic-looking user interfaces.

Using Flash as an illustration tool has several significant advantages of its vector nature. The first major advantage of Flash-based illustrations is the ability to display any range of elements with anti-aliased edges. Flash also includes a feature that allows the user to easily zoom in and take a closer look at illustrations. Another advantage of Flash

movies is that any portion of a graphic can be included as a hotlink to another site or page. Since the entire Flash illustration is composed of vector objects, each object can be individually assigned to a particular URL without the use of external programming or code.

Unlike raster images on the Web, the print quality of a Flash image will equal the quality of the user's printer. No matter what the dpi capability of the printer is, the Flash image will print out at the current resolution of the printer.

Flash provides a completely vector-based environment for creating animations. Most other methods are based on raster images, meaning that they take significantly longer to download with no particular method overcoming the problem of file size.

Finally, one of the most intriguing things about Flash is its ability to integrate sound. Sound is a very important in creating a system performing multimedia teaching on WWW, since a big amount of information is carried by it. Sound files that are used within authored Flash movies are stored within the SWF file format. Inside the Flash file, sounds can be compressed with MP3, making it possible to create long-playing animations with voice-overs or music with smaller files. Moreover, since the audio is stored inside the SWF file, there are no external references or additional HTML code needed.

The Main Interactive Hall is developed in 3D. Selected pictures for every one of the nodes are shown in the Appendix.

In order to enter the system a password is required (Fig. (A.2), see the Appendix).

The most straightforward way to add interactivity is adding buttons. Interaction for every one of the tree nodes in the GUI consists of buttons as well. The main button on every one of these stages is an animated 3D cube, through which the user enters into the each node. The other two buttons leading to the other nodes are arrows in the both left and right directions as shown on the Fig. (A.3), (A.4), (A.5).

After entering the Courses node (Fig. (A.3)) the user is led in the courses option, where a list of available courses is given. From this point, it is possible to be sent email, or to use a calendar. For better user's orientation there is a map of the site provided, as shown on Fig. (6). From this map a direct access to any of the other nodes is possible.

The map in the case of LTS courses is shown on Fig. (A.9). If the user chooses calendar, it is possible to verify any chosen date after entering it in the required fields. The calendar interface is shown on Fig. (A.7). Sending e-mail is possible through choosing the email option. The interface for this is shown on Fig. (A.8).

After choosing any of the courses offered the user is in the classroom. The case for Digital signal Processing classroom is shown on Fig. (A.10). From here are available the class info, schedule of the course, announcements made by the instructor, help room, the content and students home pages. The interface for every one of them is shown respectfully on the Fig. (A.11), (A.12), (A.13), and (A.14). In the classroom is the connection between second and third levels, as well. After choosing the “learning links” button, the access to the content and course material is performed on the separate level.

The organizing of the content is in a house, separated in rooms, every room has walls and every wall has bricks. Here, the house corresponds to a book, room to a chapter, wall to a paragraph and brick to a basic concept [4]. The following example with the DSP course is provided for better understanding of this organization.

The Digital Signal Processing (DSP) house is depicted on Fig. (A.16) with the six rooms consisting in it [3]. These are:

- I. Digital Signal and Systems*
- II. The z-Transform*
- III. The discrete Fourier Transform*
- IV. Fast Unitary Transforms*
- V. Digital Filtering and Digital Filters*
- VI. Digital Spectrum Analysis*

Choosing any of the rooms leads to the detailed representation of it, meaning which exactly are the walls building it. For instance Digital signal and systems room consist of the following walls (Fig. (A.16)):

- 1. Digital Signals*
- 2. The Fourier Transform*

3. *Correlation of signals*
4. *Digital Systems*
5. *Linear Shift Invariant Systems*
6. *Sampling and Reconstruction*

Every one of the walls in the room could be extended to the bricks building it. For instance, Digital Signal wall of the Digital signal and Systems room consists of the following bricks (Fig. (A.17)).

- I. *Definition and Classification of a signal*
- II. *Digital Signals*
- III. *Some elementary signals*
- IV. *Classes of digital Signals*
- V. *Generation of Digital signals*
- VI. *Elementary Operation on a signal*

There are rigorous and intuitive definitions, qualitative and quantitative examples for everyone of the bricks. Example of brick is shown on Fig. (A.18). The text is supported with audio. And after finishing of presentation of the information in the brick, there is a possibility for passing through it once again. All the bricks in one wall are linked, so that after seeing the first brick, the user is able to go to the following and so on to the end of the wall. Passing through the walls and the recommended time for spending on a brick are specified in the Schedule of the course. In case the maximum recommended time for a brick is over the system automatically loads the consecutive brick.

The links to lab session and exercises are available in the end of each wall. They are also performed online through connection to a MATLAB server.

Support Center is directly accessible from Main Interactive Hall (Fig. (A.19)). As mentioned before, it is designed to be on fourth level. From the Support Center are accessible Digital Library, Help room, Chat Room, and Students Home pages. As on the third level, here is possible to check the map as well, send email or use a calendar as in the Courses option.

The interface for Digital Library is shown on Fig. (A.20).

Help and Chat Rooms are still in process of developing.

4.1 Preloader

Due to the way they are written, Flash files are a streaming file format. The term streaming describes the way in which data flows from the HTTP server to the end user's computer. Normally, before a browser can render a graphic, text or other element to the screen, the entire file must be downloaded from the Web. Thus, if a slow connection exists somewhere between the end user and the server, content loads very slowly because the file has to be fully downloaded before it can be viewed. Flash files, however are written sequentially; that is, Frame 1 is written, then Frame 2, and so on. Therefore, as soon as the data associated with Frame 1 is downloaded, it can be played-even if the remainder of the file is not downloaded.

Streaming multimedia files over the Web will only play smoothly if the rate of playback is less than or equal to the rate of downloading. Any time the rate of playback is faster than the rate of download, a noticeable pause may occur because the multimedia asset must stop and wait for more data to load.

Flash movies always stream. The effectiveness of SWF streaming ultimately depends on the amount of data required for each frame. If large bitmaps or lengthy sounds are present, the data requirements for the frame become quite large and can negatively affect the streaming process. Although optimizing may yield some decrease in file size, often it is not enough to avoid a presentation pause.

Preloaders are simply a set of frames in the beginning of a normal movie file that loops or plays while the remainder of the movie file is downloaded.

The size of present Flash movie is 1.45MB, which presents a need of using preloader.

Simply, it is a set of frames that loops while waiting for the content to load. Once a particular frame is loaded it jumps to a particular another one while all the rest is loaded. (Fig. (A.21)). Preloader is only detected when the connection requirements are slow.

5. Performing Lab-sessions through MATLAB Web Server

MATLAB Web Server (MWS) exploits the power of WWW by integrating the visualization/computational capabilities of MATLAB with the remote access capabilities

of WWW browsers. It enables creating MATLAB applications in such a way that allows clients to transfer their data through WWW to MATLAB for the necessary computations. Consequently, the output of the computation, whether numerical or graphical, is accessible on the client's browser through the WWW.

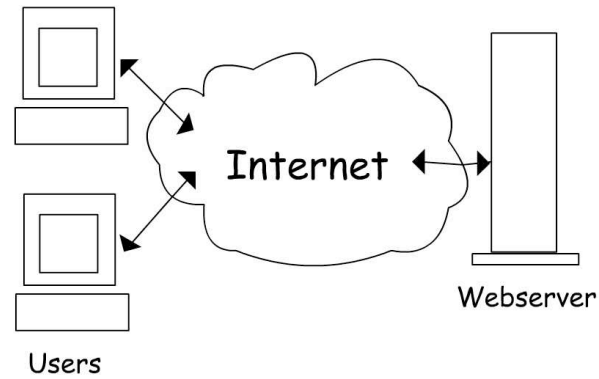


Figure 3. Client/Server structure based on MATLAB Web Server

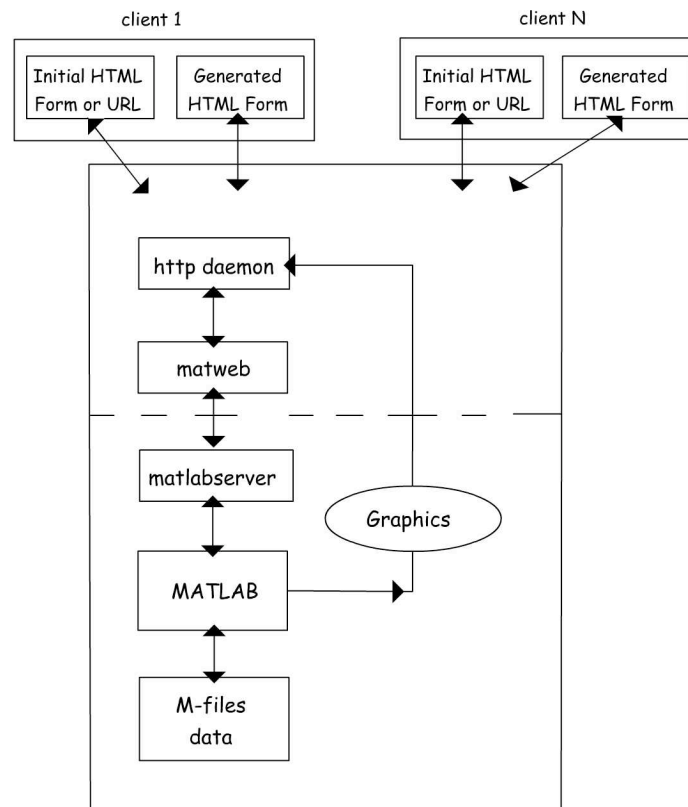


Figure 4. Configuration and interaction between clients and MWS

These features of MWS allow clients to run MATLAB applications through the Internet without having MATLAB software installed on their machines. To achieve this purpose a Web browser runs on the client PC, whereas MATLAB, MWS and the Web Server daemon (httpd) run on the server machine.

The interaction between clients and server is illustrated on Fig. (3). As shown, the users are interacting with MATLAB over a network using a TCP/IP protocol. This interaction takes place through HTML forms. These HTML forms serve as a point-and-click GUI for MATLAB applications. These capabilities not only allows users to use MATLAB based tools without any prior MATLAB programming knowledge, but also prevents unauthorized user access to source code and the MATLAB command lines.

The interaction between clients and MWS and the role of HTML forms as GUIs for MATLAB application is shown on Fig. (4).

An example of HTML form is shown on Fig. (5). The user enters appropriate data in the relevant spaces before pressing “Generate filter”.

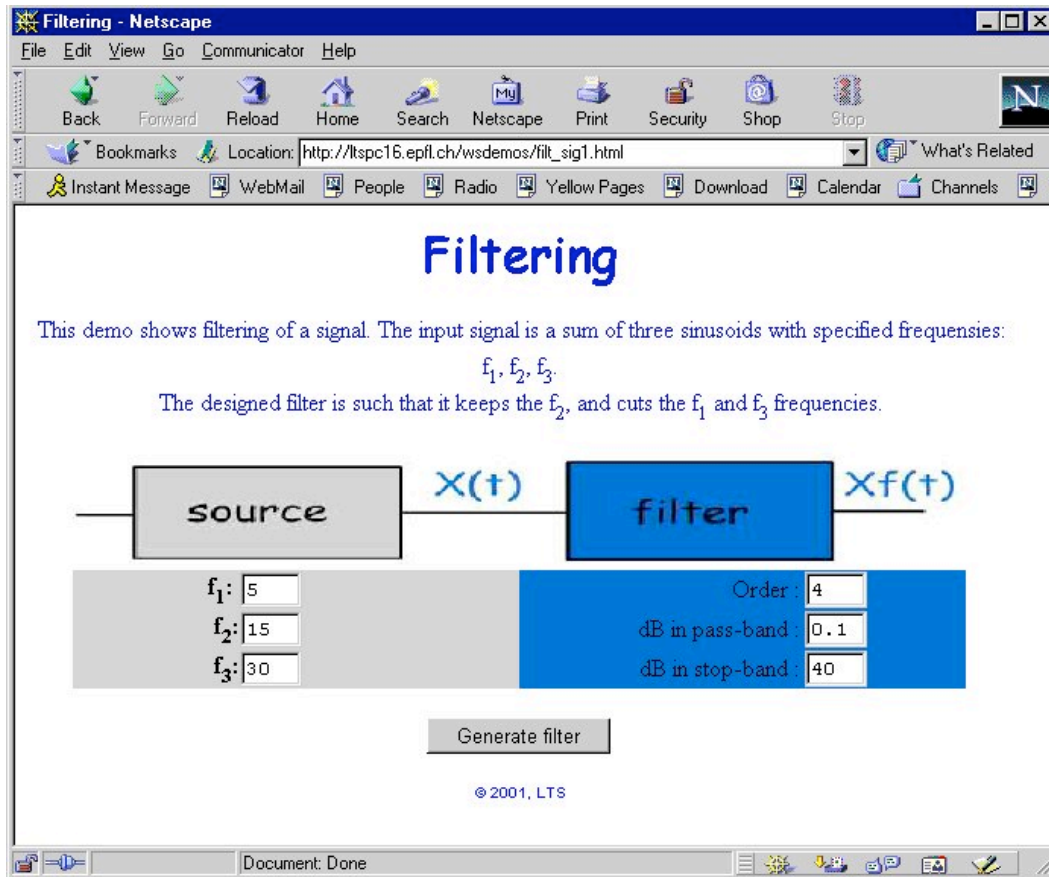


Figure 5. An example for input HTML form

The data is then transferred to the server machine, housing the MATLAB software and the corresponding m-file. This step is initiated by *matweb* (the client of MWS that uses Common Gateway Interface (CGI)), which takes the data from the HTML form and transfers the information to MWS. The MWS then runs the application that is written in m-files to produce desired responses.

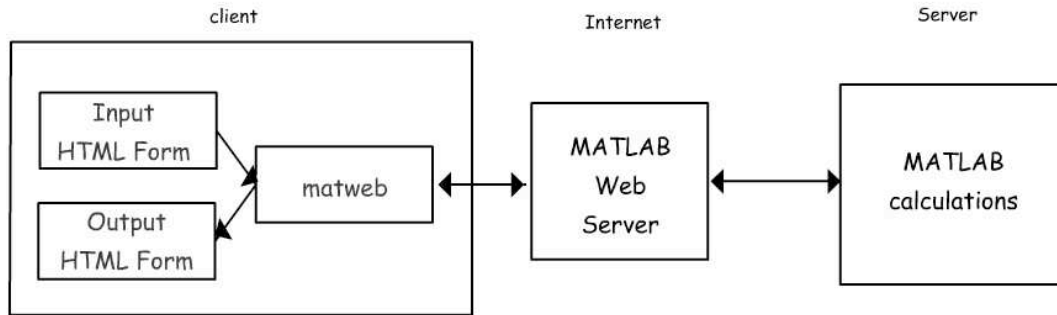


Figure 6: The information flow graph between clients and MWS.

These responses travel in the opposite path to arrive at the related output HTML file. This sequence of information transfer is depicted on Fig. (6).

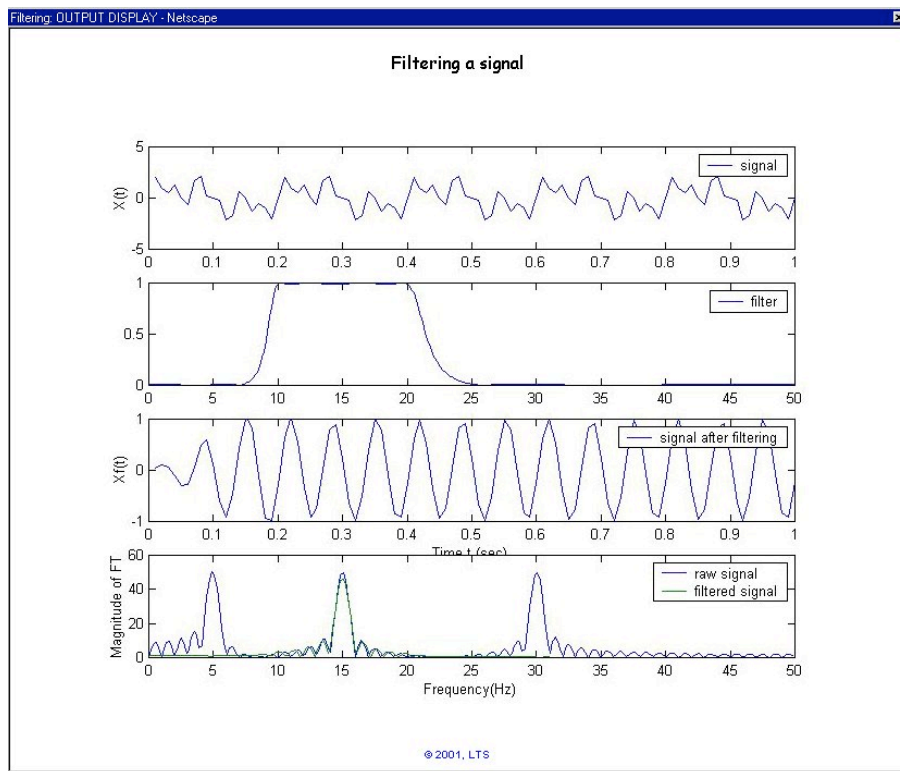


Figure 7: Example of an output HTML form.

The example provided is about filtering a signal. As it is shown on the input HTML form, the signal is a sum of three sinusoids at different frequencies and after this the signal is filtered so that the resulted signal contains only the second frequency. The user chooses the three frequencies as well as the order and dB in the ripple of the pass- and stop-band as shown on Fig. (5). These variables are sent to MATLAB and the result of the calculations is displayed in the output HTML form on Fig. (7), where the input signal, the filter and the output signals are plotted. The final graph shows the frequency content of both raw and filtered signals.

6. Conclusions and future work.

Mainly, there are two benefits to learning in a classroom setting, which are independent of the material covered in the course. First, the students get the ability to get away from their other responsibilities and concentrate on learning the course materials greatly increases the amount that they learn and retain. Second, the interaction with other students and instructors, whether it is side discussions during the lab periods or simply listing to questions asked by others, often results in people rethinking their own computing techniques and suggest new solutions to their problems.

This virtual classroom described here, is meant to be tested as a support to a usual class and later on to be available independently. Developing of an authoring tool will give more freedom to the instructors, so that they could change or update the course content.

Finally, a tool for testing is going to be designed, so that the course exams will be performed on-line. This will help the courses to be holding wholly and independently on-line.

APPENDIX

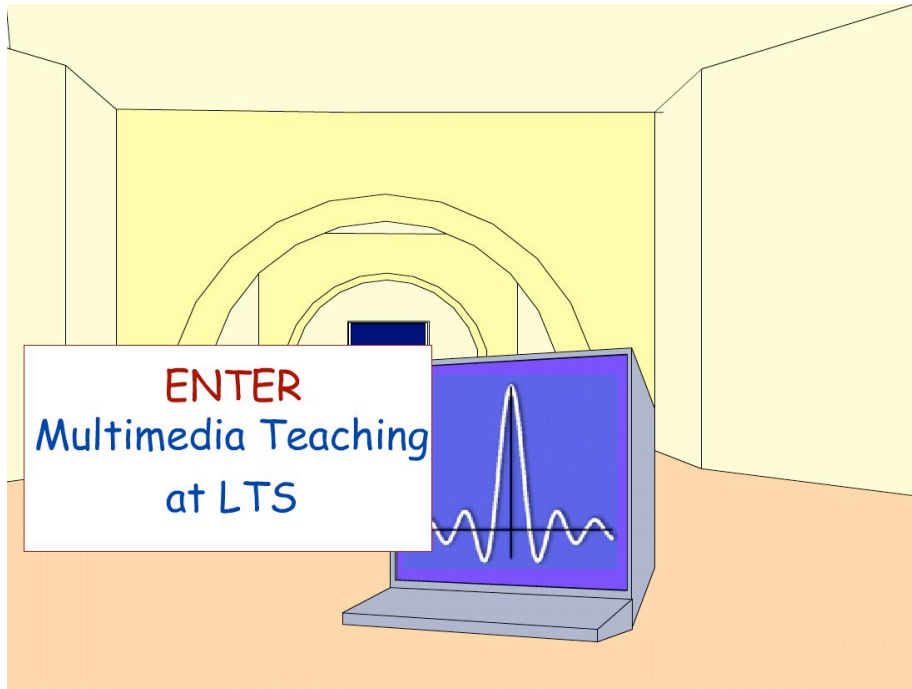


Figure A.1: Main Interactive Hall: entering

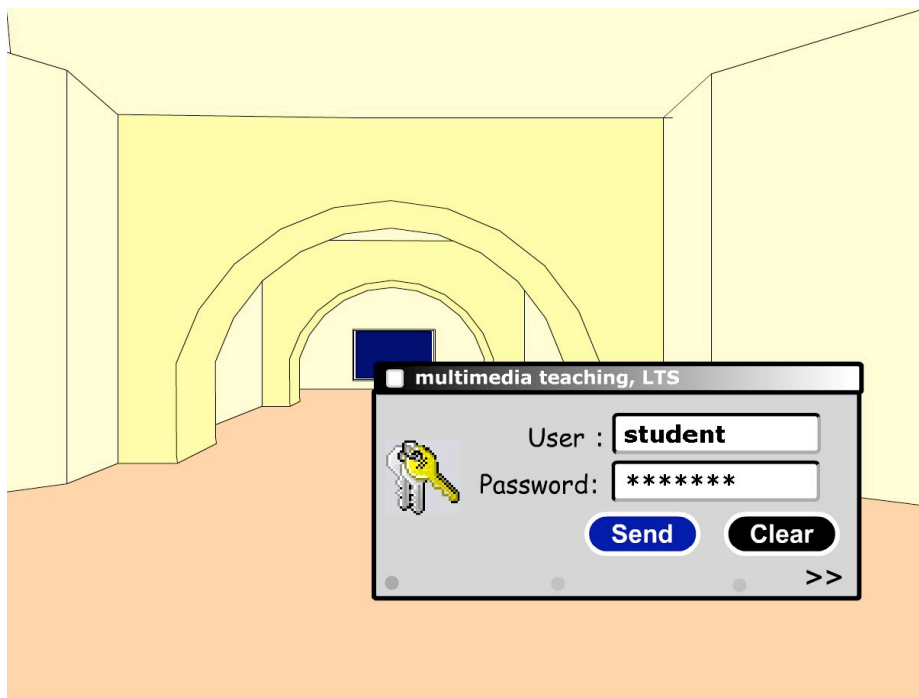


Figure A.2: Password verification

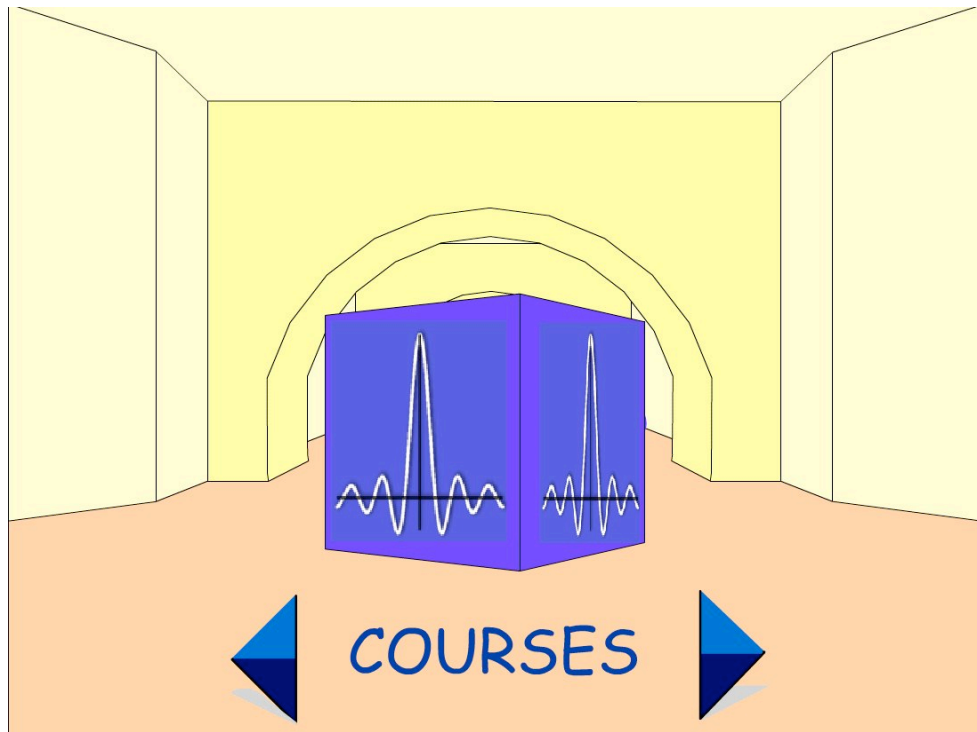


Figure A.3: Courses node of the Main Interactive Hall



Figure A.4: Administration node of the Main Interactive Hall

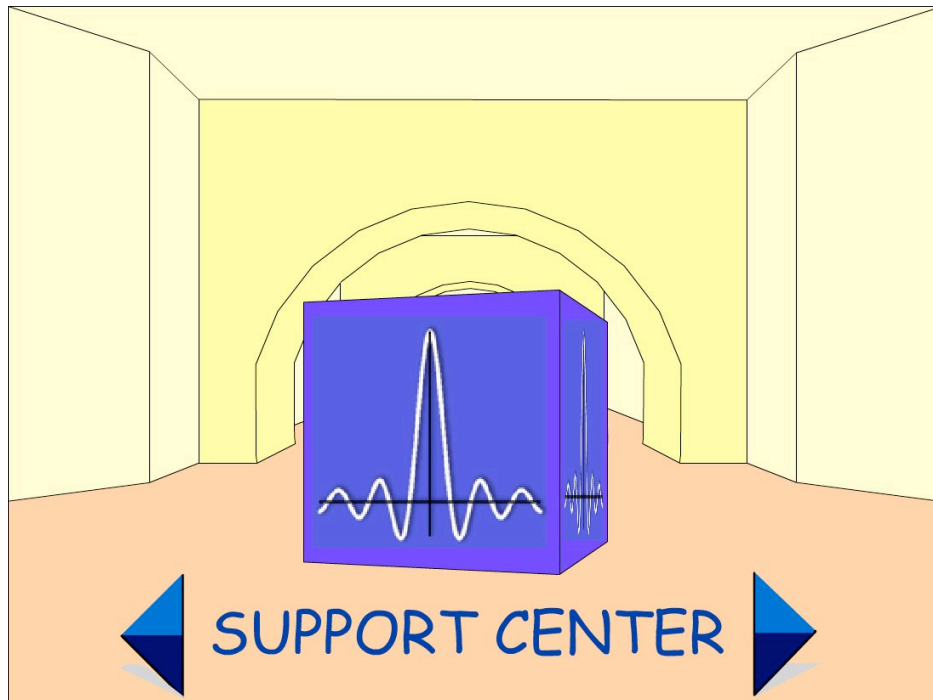


Figure A.5: Support Center node of the Main Interactive Hall



Figure A.6: LTS Courses

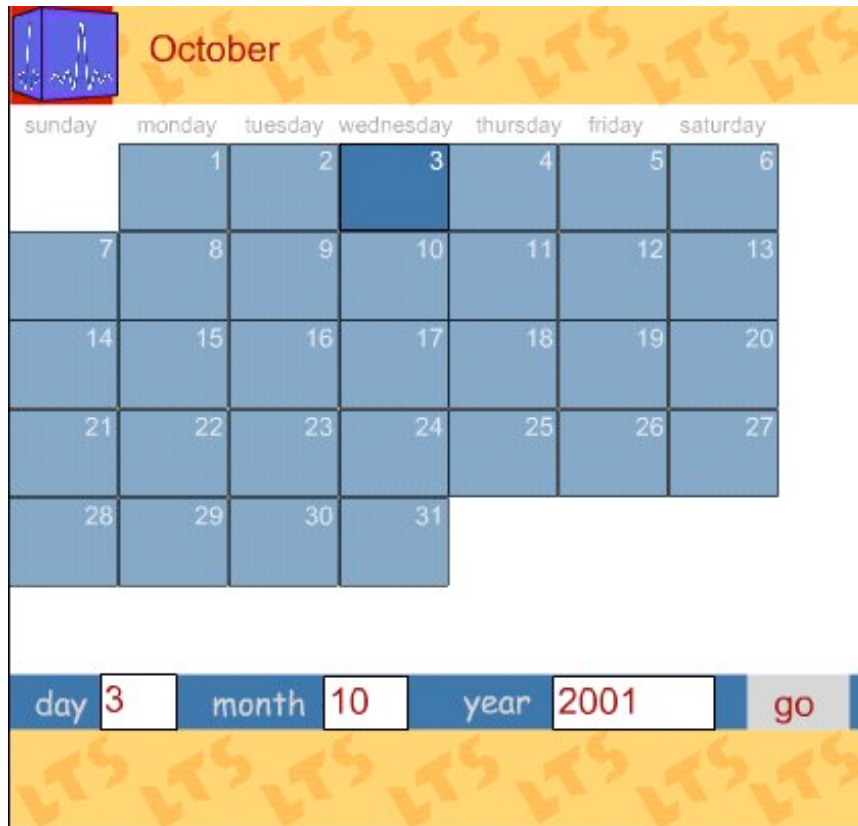


Figure A.7: Calendar interface.

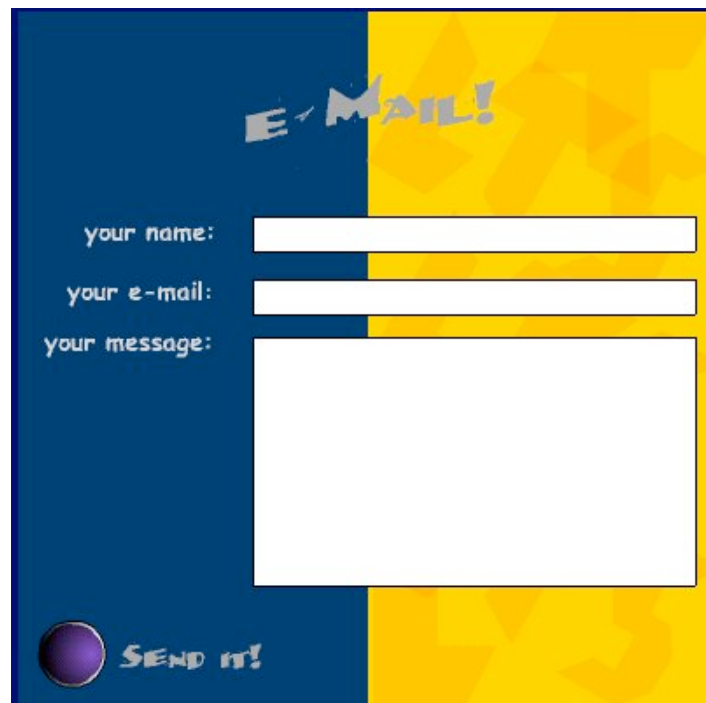


Figure A.8: E-mail interface

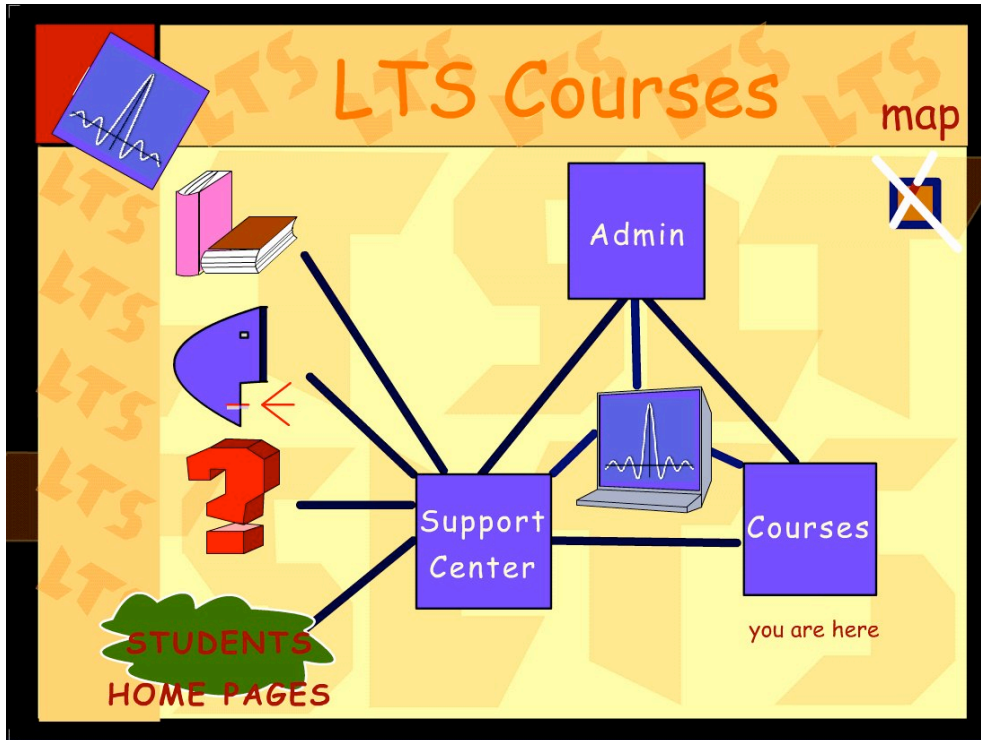


Figure A.9: Map of the GUI in the case of LTS Courses

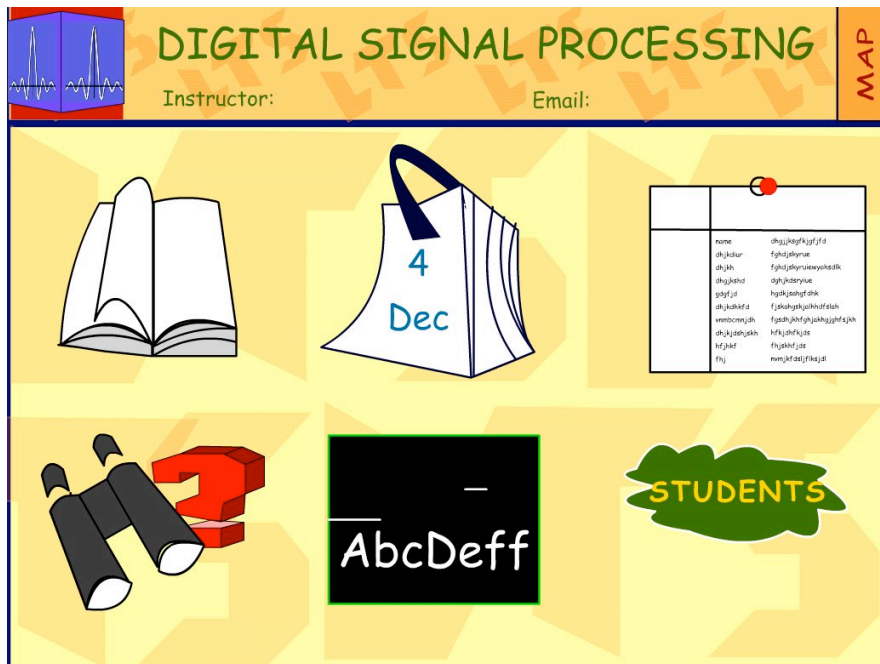
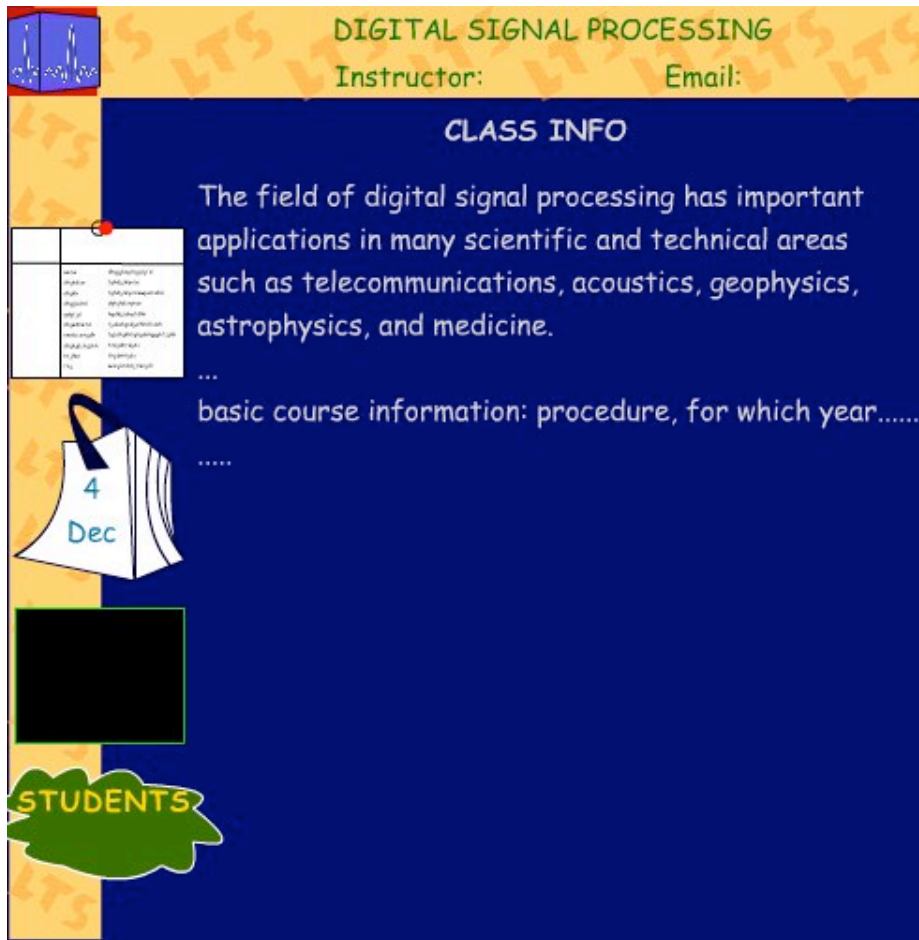


Figure A.10. Digital Signal Processing classroom.



DIGITAL SIGNAL PROCESSING
 Instructor: Email:

CLASS INFO

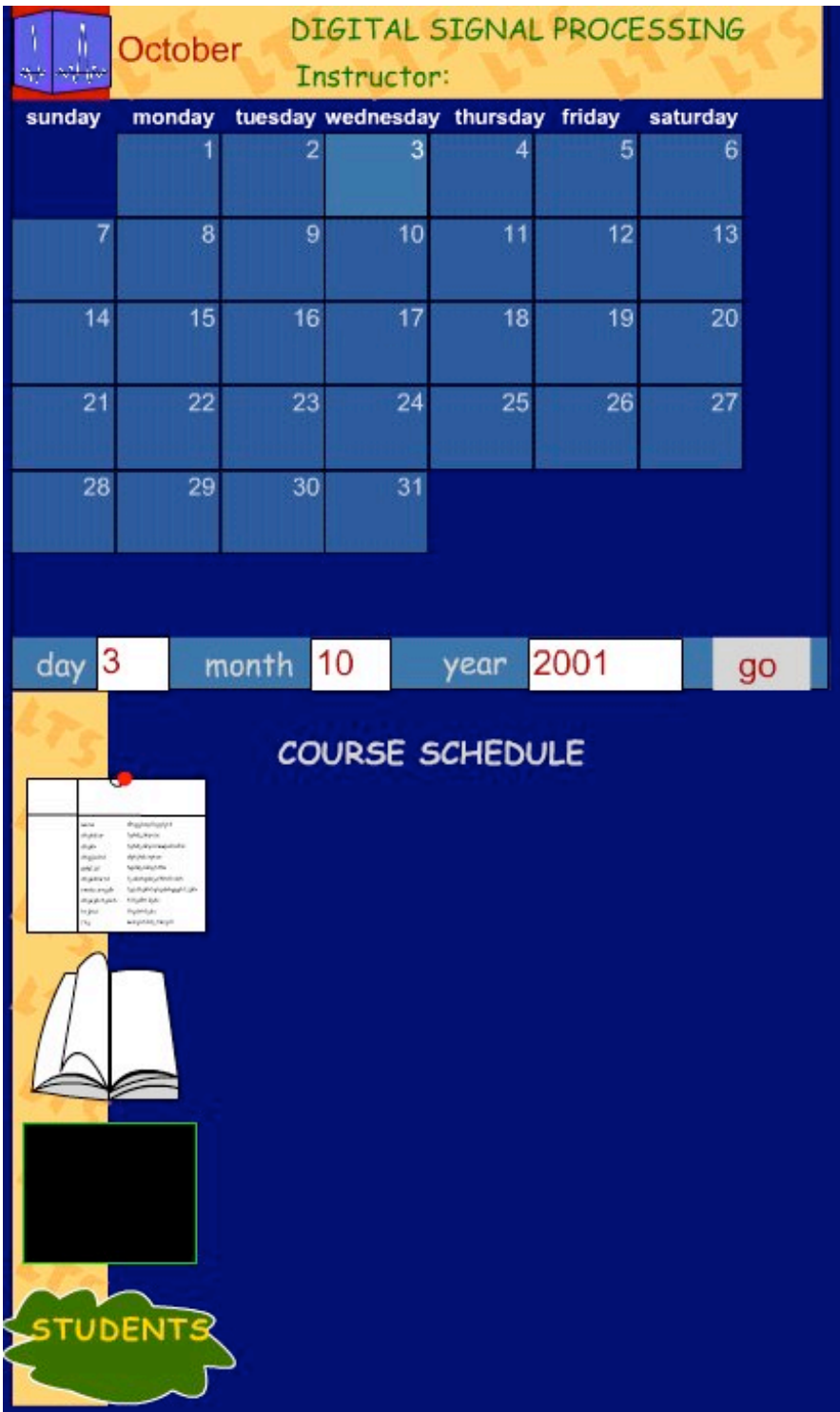
The field of digital signal processing has important applications in many scientific and technical areas such as telecommunications, acoustics, geophysics, astrophysics, and medicine.

...
 basic course information: procedure, for which year.....

4
Dec

STUDENTS

Figure A.11. Class info, DSP classroom.



The interface features a yellow header with a logo on the left, the text "October" in red, and "DIGITAL SIGNAL PROCESSING" in green. Below the header, the text "Instructor:" is displayed. A calendar grid shows the days of the week and dates from 1 to 31. Below the calendar is a date selection bar with fields for "day 3", "month 10", "year 2001", and a "go" button. The main area is titled "COURSE SCHEDULE" and contains a table with a red pin icon, an open book icon, a black square, and a green "STUDENTS" button.

October **DIGITAL SIGNAL PROCESSING**
Instructor:

sunday	monday	tuesday	wednesday	thursday	friday	saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

day **3** month **10** year **2001** go

COURSE SCHEDULE

www	http://www.lts.edu
mailto	mailto:info@lts.edu
ftp	ftp://ftp.lts.edu
tel	tel://703/253-1234
fax	fax://703/253-1234
url	url://www.lts.edu
mailto	mailto:info@lts.edu
ftp	ftp://ftp.lts.edu
tel	tel://703/253-1234
fax	fax://703/253-1234
url	url://www.lts.edu

STUDENTS

Figure A.12: Schedule/Calendar, DSP classroom.

DIGITAL SIGNAL PROCESSING
Instructor: Email:

ANNOUNCEMENTS

Allows instructor to post announcements to the calss.....

AbcDeff

STUDENTS

Figure A.13: Announcements, DSP classroom.

DIGITAL SIGNAL PROCESSING
Instructor: email:

STUDENTS

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 9.
- 10.
- 11.
- 12.
- 13.
- 14.
- 15.
- 16.
- 17.

1	AbcDeff
2	AbcDeff
3	AbcDeff
4	AbcDeff
5	AbcDeff
6	AbcDeff
7	AbcDeff
8	AbcDeff
9	AbcDeff
10	AbcDeff
11	AbcDeff
12	AbcDeff
13	AbcDeff
14	AbcDeff
15	AbcDeff
16	AbcDeff
17	AbcDeff

Figure A.14: Students home pages, DSP classroom

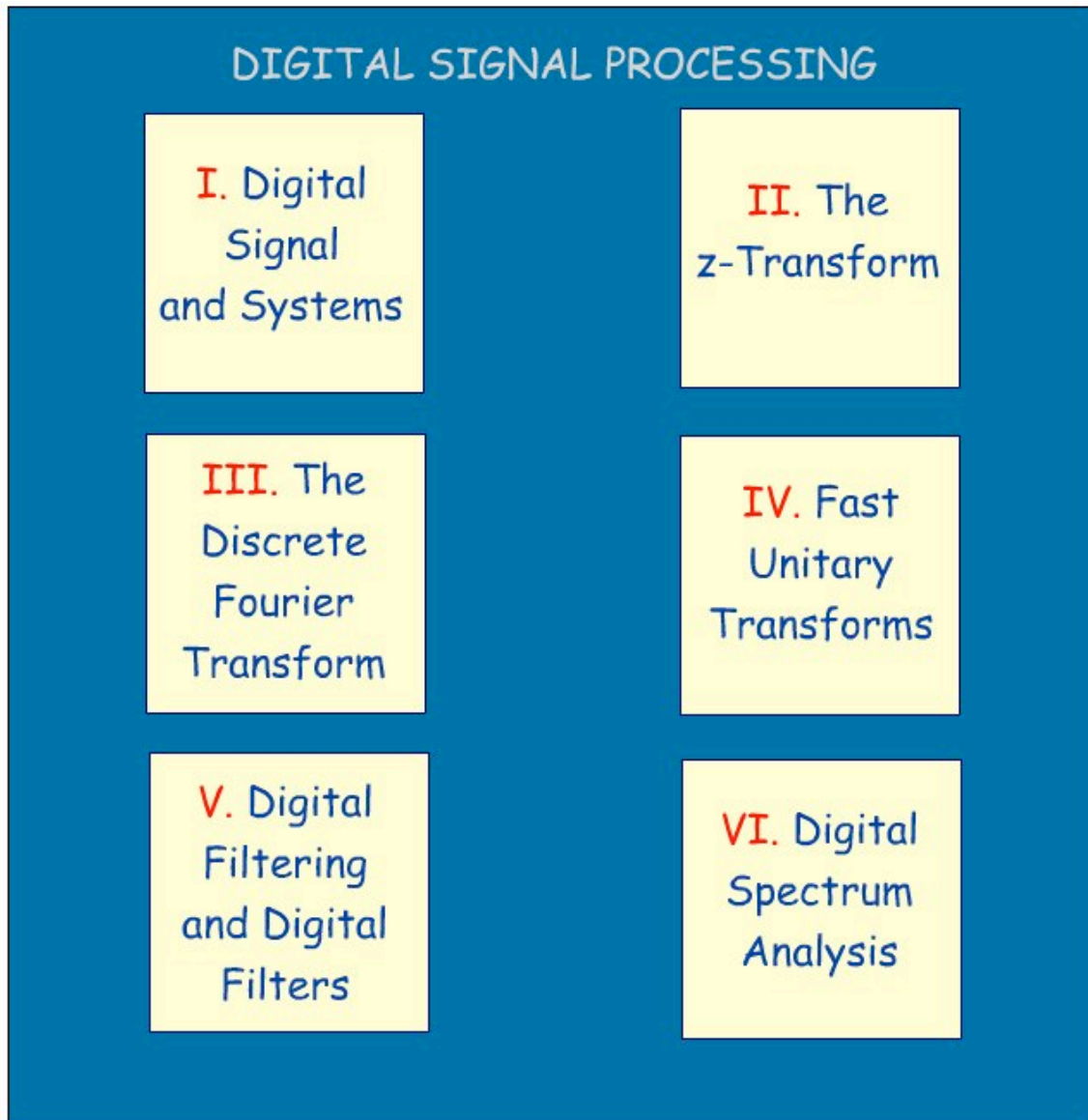


Figure A.15: DSP house

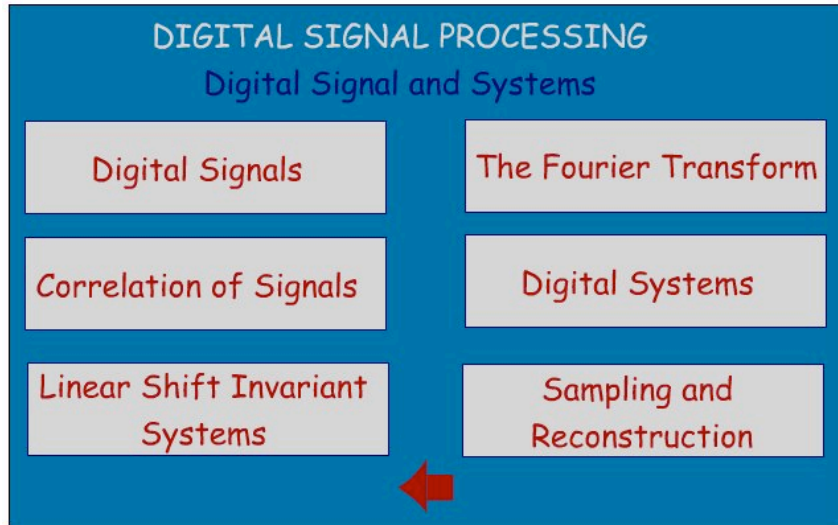


Figure A.16: Digital Signal and Systems room

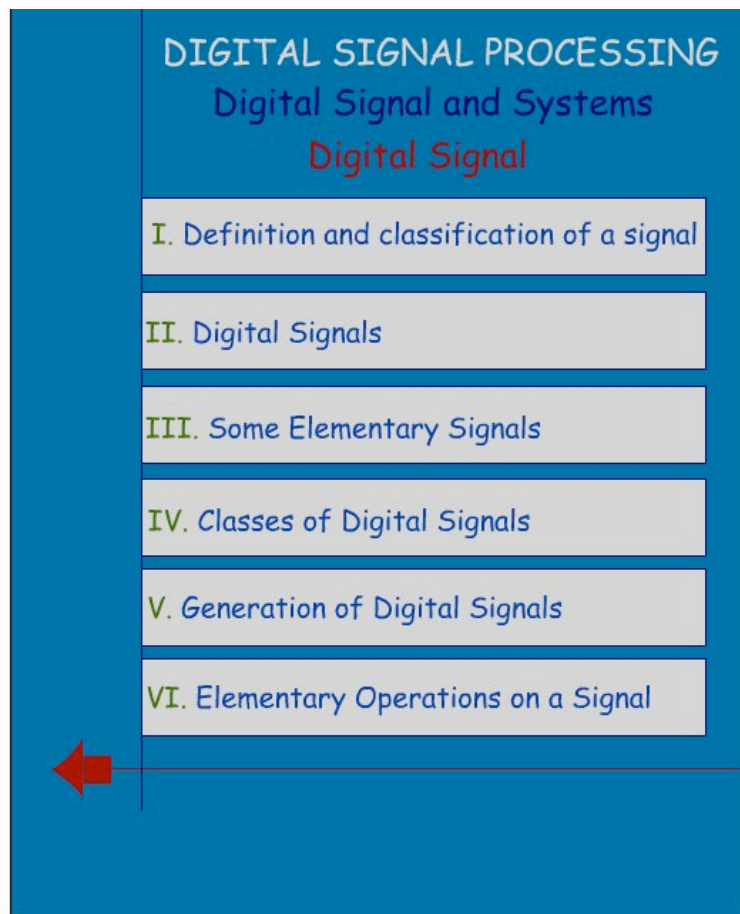


Figure A.17: Digital signal wall.

PREVIOUS
CONCEPT

RIGOROUS
DEFINITION

INTUITIVE
DEFINITION


QUALITATIVE
EXAMPLE

QUANTITATIVE
EXAMPLE

LAB
SESSION

EXERCISE

NEXT
CONCEPT

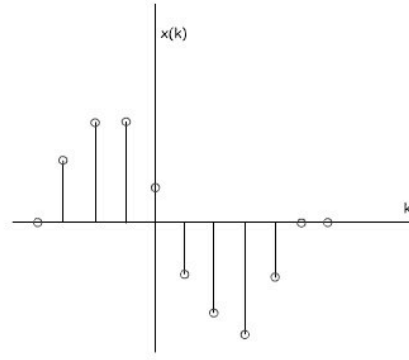


rigorous definition

DIGITAL SIGNALS

A digital signal is a discrete signal whose amplitude is quantized. A discrete signal is a sequence of real or complex numbers.

A graphic representation of a discrete signal is :



DIGITAL SIGNAL PROCESSING

Figure A.18: brick- Digital signals.

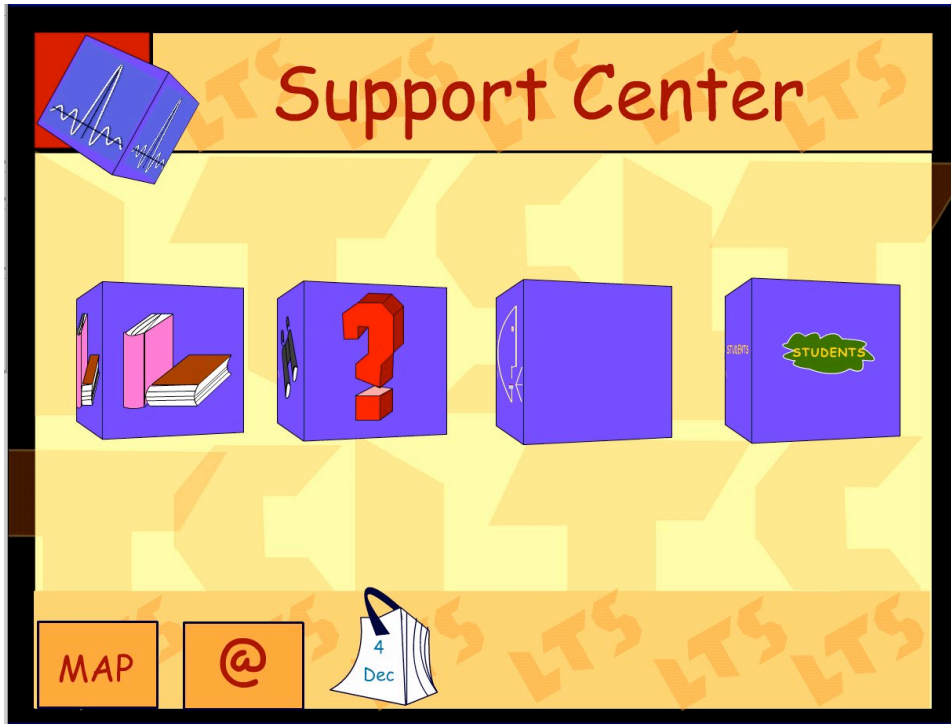


Figure A.19: Support Center of the Navigation Tool

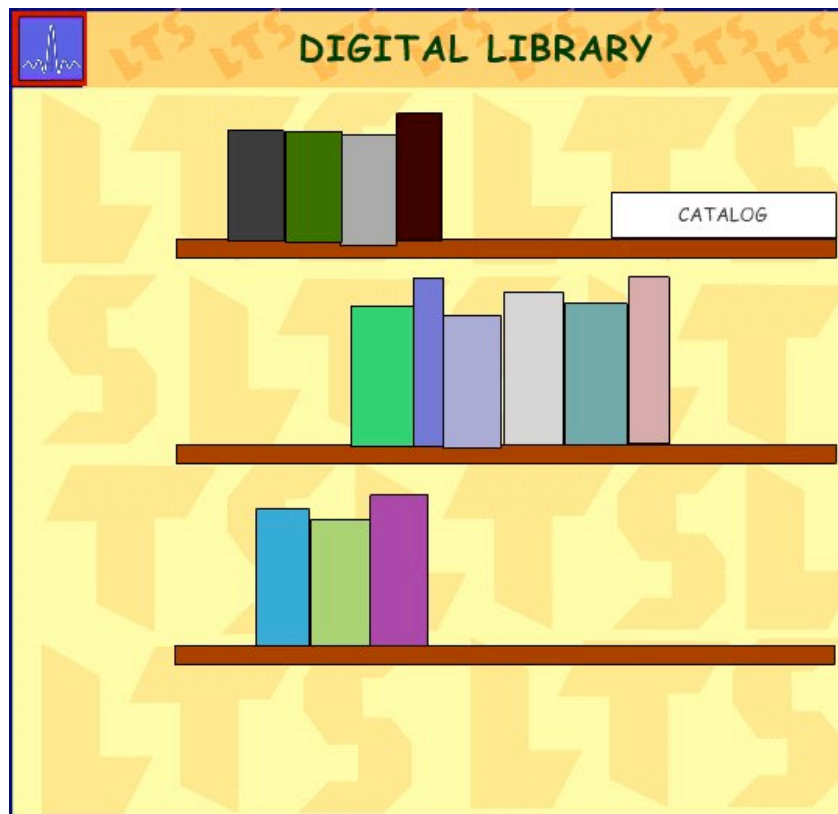


Figure A.20: Digital Library

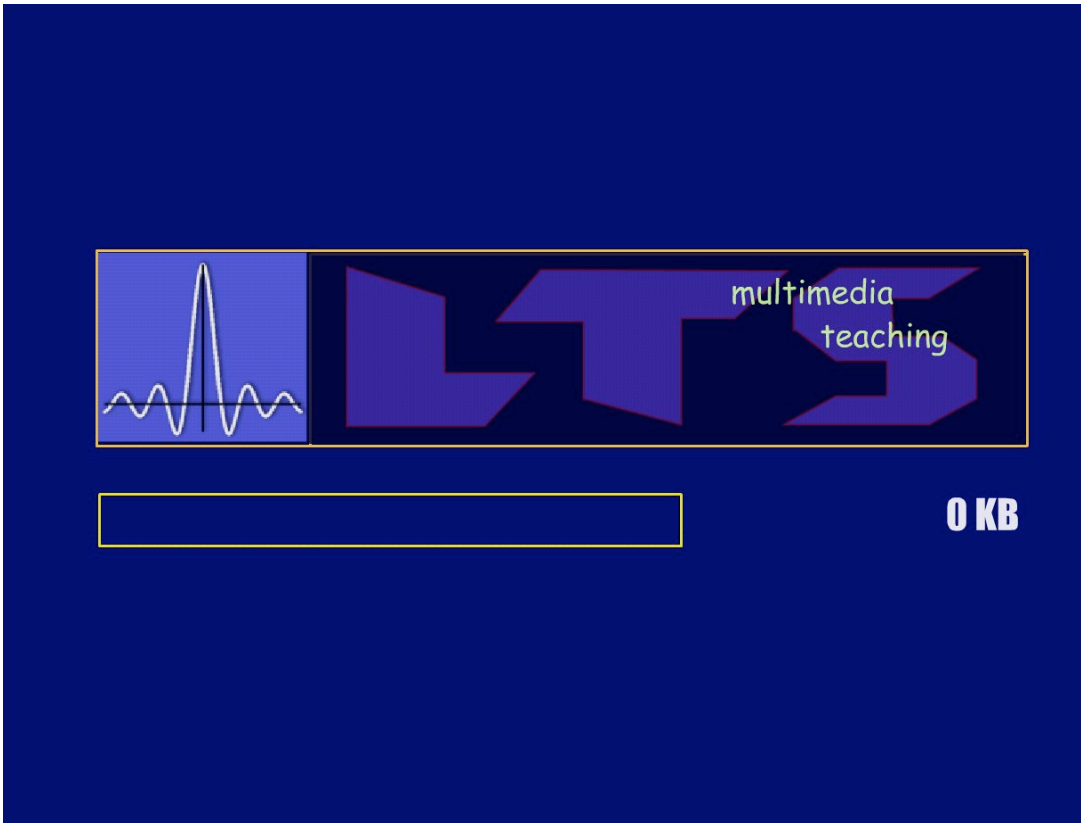


Figure A.21: Preloared

REFERENCIES

- [1] Hiltz, S. R., 1993, Correlates of Learning in a Virtual Classroom, International Journal of Man Machine System, 1993

- [2] Kerman Ph., “Macromedia Flash 5 in 24 hourse”, SAMS, Indiana USA, 2001

- [3] Kunt M., “Digital Signal Processing”, Artech House, 1986

- [4] Kunt M., Vesin JM, Ebrahimi T., Pinol F., Multimedia teaching on WWW, LTS internal report 97.03, EPFL, Lausanne, 1997

- [5] MATLAB Web Server manual, Mathworks, Inc., 1998

- [6] Musciano Ch., Kennedy B., “HTML, the definitive Guide”, O'REILLY, 1998

- [7] Mohler J. L. ”Graphics, Animation & Interactivity with Flash 4.0”, Delmar Thomson Learning, 2000

- [8] Starr R. H., “Teaching in a virtual classroom”, ICCAPI'95, Chiao Tung University, Hsinchu Taiwan