

# SENS, Design, development and evaluation of a digital course on signal processing

Authors: Arie Taal, Bert Andree, Wim Lourens<sup>1</sup>

Dept. Computational Physics

Faculty of Physics and Astronomy,

Utrecht University

The Netherlands

## Abstract

A digital course on signal processing has been developed and has run during the months March and April of this year. The educational model underlying the project focused on issues like: Information, Communication and Interactivity. Special attention was paid to communication by supplying the student ample abilities for shared workspaces and other tools for group collaboration. Templates for several kinds of assignments and tests have been developed.

Object technology and browser technology have been extensively used in completing the course. Part of the object model is described in this paper. The pedagogical results of the course in comparison with a more traditional approach were evaluated. The results are presented in the conference contribution.

## Keywords :

Self-Training and Evaluation, Distance learning, Distributed Environments, Internet, Sciences for Engineers, Pedagogical Strategies, Learning Types, Learner Models, Java, Browser, Object modeling

## I. INTRODUCTION

A pilot project to convert a regular course into digital (electronic) format was started in our university a year ago. The project was carried out primarily to assess possibilities to improve the quality and efficiency of the education in the first four semesters in the faculty of Physics and Astronomy. The project, SENS, deals with an introductory course on signal processing. The work was financed by the Dutch Ministry of Education<sup>2</sup>. An WWW environment has been created with the objective to supply students with tools to study, to communicate, and to work side by side on exercises. In order to exploit fully the interactive possibilities of the environment, a considerable amount of the objectives was realised in the JAVA<sup>3</sup> language. Applications based on E-mail technology also play a major role in the environment created. Web pages in HTML are solely used to inform students about the work to perform and to supply them with the necessary background information. The course ran in the third semester, for two months. An extra week was added for conducting individual tests. The results of the project are subject of analysis at this moment. Parts of the analysis are interviews with students and teachers. These interviews are taken before, during and after the experiment.

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Address: Minnaert Bld, Leuvenlaan 4

PO box 80195, 3508 TD Utrecht, The Netherlands

E-mail [W.Lourens@phys.uu.nl](mailto:W.Lourens@phys.uu.nl)

<http://www.fys.ruu.nl/~wwwfi/><sup>1</sup>

<sup>2</sup> K&S project N&S 32.1

<sup>3</sup> JAVA: The Java language specification, J. Gosling, B. Joy, G. Steele, Addison-Wesley, 1996

## II. GOALS

Objectives for the “SENS” project were: To design and develop a telematic learning environment in which students can practice newer forms of education, while we, the developers, learn about how to realise this form of instruction in general (develop a blueprint).

The learning environment has to take care of (in this order) raising the student's:

- Knowledge
- Conception (understanding)
- (Small-scale) skills
- Ability to relate the specific subject to existing (physical) concepts

This has to be reflected in the material, and the exercises. We focused on the development of the exercises towards more aggregation, more complexity. Starting from: Simple problems, preferentially from common templates, towards complete assignments which finally had to be worked on by a group of students in ‘Shared work spaces’

Finally answers to problems, interviews, mutual exchange of information, etc. had to be logged and analysed in order to evaluate the results.

In the next paragraph design and implementation of parts of the environment is outlined.

## III. DESIGN AND COMPONENTS

New jobs emerging today demand for people able to deal creatively with information and to communicate within an organisation. In distance learning projects using ICT (Information and Communication Technology) the information component is often dominating. In a WWW environment suitable to prepare students for the new demands of tomorrow's jobs, the communication part has to be interpreted in a broader sense. Applications based on the JAVA language provide the possibility to extend the communication part into new areas of co-operation. Therefore, in the project presented the main focus was on the design of a ‘Shared Workspace’ mainly implemented in the JAVA language. Shareware and commercial GroupWare offer the possibility to communicate via chat boxes, document sharing, collaborative browsing and whiteboarding. Still these facilities don't fully meet the requirements one has in an educational environment. Most of these products however are point to point applications. Instruction and demonstration requires an arbitrary number of people to be able to share the same medium. Moreover in whiteboard applications the possibility is lacking to include symbols and icons specific to the curriculum.

To this end we designed a ‘Shared Workspace’, mainly implemented as an Applet in the JAVA language, which can be easily integrated in a website. This ‘Shared Workspace’ Applet, named “Educator” supplies a student with all services to communicate and to work out assignments. The “Educator” provides for access to a personal database where exercises can be stored. An exercise can be an Applet allowing a student to manipulate buttons and scrollbars in solving a problem. A whiteboard drawing is another example, also the output from a server for symbolic manipulations<sup>4</sup>. All these entities must have the common feature that a student can activate store and exchange those exercises with other students just by mouse clicks. To meet these requirements exercises are implemented applying JAVA's Object Serialisation. Object Serialisation supports the encoding of objects into a stream of bytes (including their internal state), as well as the complementary reconstruction of an object from a stream of bytes. Byte streams can easily be stored in a database, exchanged over the Internet via sockets, and deposited on a server as a persistent object. Exercises like documents produced by for instance Word, are treated separately. These are stored as files and exchanged by attachments via E-mail

## IV. IMPLEMENTATION

Object Serialisation, Communication between Applets in different browsers (virtual machines) was accomplished by RMI, Remote Method Invocation. Normally an Applet loaded in a browser runs in the so called ‘sandbox’, only allowing for a network connection with the host it is loaded from. A lot of effort in the project was consumed in designing interactive exercises in the form of JAVA Applets. Knowledge of JAVA to implement an exercise can not be required as a skill of a teacher. A solution is provided by JavaBeans, a tool to build applications by manipulating components just by means of a graphical interface. Some specific Applet templates were designed for images and graphs using “hot spots” for launching questions and actions; for multiple choice problems and for problems for which

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<sup>4</sup> e.g. Mathematica, Maple, etc.

the solutions can be given in patterns. For these templates special editing and grading functionality has been added.

Each of the mentioned service was supplied with its own server, written in JAVA. An “Access Server”, “Chat Server”, “Whiteboard Server”, “ZAP Server”, and a “Symbolic Manipulator Server” were installed on different platforms: Windows '95, Windows NT, Linux and Digital Unix.

The computers available are Pentium-Pro 180 MHz machines with 16 Mbytes of internal memory. The browser used was Netscape Communicator 4.03 with a patch for full JAVA 1.1 support.

## V. EVALUATION

When writing this abstract the course is just finished. The course started with 17 students of which 14 finished. One student joined after 5 weeks and was able to catch up more or less. Before the start of the course a questionnaire was presented to the teacher and to the students, another one after the course finished. The analysis of the answers can be presented at the workshop, together with an analysis of the way the students carried out their 15 assignments.

## VI. TENTATIVE CONCLUSIONS

From experience some tentative conclusions can be drawn:

- Participation of students during the course is more intensive than with the traditional approach, which was followed the past five years. Students are switching from “passive” listeners to “active” trainees.
- By analysing results of the exercises individual profiles in knowledge and conception of the individual student emerges
- These analyses are rather time consuming. It is not clear how to proceed with a larger number of participants
- A lot of shortcomings, technical, but especially educational, were detected.