An interactive web platform development for teaching signal processing

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Introduction

Our bilingual (French-English) platform called e-TSLIS makes signal processing teaching more accessible and interactive by using up-to-date multimedia support (Internet, Web). The main aspects of the e-package presented here were conceived within the work of the Research Group SIN (Signals and Images in Natural environments) of the Signals and Images Laboratory (LIS) at ENSIEG (Ecole Nationale Supérieure des Ingénieurs Electriciens de Grenoble) in collaboration with the IFP-School (Ecole Nationale Supérieure du Pétrole et des Moteurs).

E-Learning is defined as training that uses new means to improve teaching: assistance with the organization of personal work time, formal teaching, access to documentary resources, tools for evaluation, and training and simulation (Toxopeus et al., 2003, Hesthammer, 2003). However, technological problems remain: the quality of an e-learning product is called into question when the learner doesn’t benefit from all the necessary tools. For example, in the case of a module using sound animation, if the learner’s computer does not have a sound card then interest in the on-line course will fade. Another issue is the concentration time of the learner, which on average is equal to 20 minutes; it is therefore necessary to be able to structure the e-learning in the form of a cycle of training, which introduces data-processing constraints.

E-learning must remain a complementary tool to the traditional course: a 50/50 mix (50% traditional course, 50% on-line) preserves the richness of the exchange between learners and their teachers. Nevertheless, on short duration courses (a few days), we can consider including more on-line than traditional work. A correctly proportioned mixture of remote course and traditional teaching can be presented in the form of a system rich in resources such as CD-ROMs, Internet, teaching models (simulators), etc. Thus, e-learning allows the course to be undertaken in bursts and in a variety of places. Adapting on-line courses to the level of the learner is an important point. Learner build their knowledge by giving instructions to the computer: they test, make errors, and solve problems. Learning while ‘playing’, allows the attention of the learner to be captured for a longer time. Elements of creativity within an e-learning project should not be neglected; the curiosity of the learner must always be stimulated. The open and remote learning can be presented in two forms: synchronous (videoconference, virtual classes, etc) and asynchronous (educational software, personal work, etc) characterized by the following two dimensions: on the one hand the collective versus the individual and on the other hand, presence versus distance. The e-TSLIS program is used by a large audience: researchers, geoscientists, graduate students, and undergraduate students in specialized schools. We need on average three to five years for an e-learning project to give positive results. This implies that the effort of development must be maintained through the medium and long term.

Objectives and constraints

The aim of the e-TSLIS web-based on-line tools is to present, through a succession of animated lessons, the means and methods of signal processing used in seismic exploration. A series of interactive exercises allows the learner to acquire knowledge and at the same time to validate it from a test set of questions. The range of animations is wide. Those which use data coming from experimental measurements reference the authors and the organizations that provided them. The currently available courses were based on a signal processing CD-ROM (Glangeaud et al., 1999)] and the ‘Signal processing for geologists and geophysicists’ series, which is composed of several volumes (Mari et al., 1999, Mari et al., 2001, Glangeaud et al., 2001, Mars et al., 2004). Ergonomic design of the platform was inspired by the on-line course in geophysics of the University of Lausanne (Chapellier et al., 2002).

Thus, the Well Seismic package course (Figure 1) is composed of two chapters entitled respectively ‘Prerequisite signal processing’ and ‘Vertical Seismic Profile’, a glossary and three indexes (names, authors and data). Each lesson includes a text, an interactive image, a set of formulas if necessary, and an evaluation part including a multiple-choice test. The principal constraints related to the deployment of the e-TSLIS platform are to ensure the compatibility of the hardware and software that will be used to deliver the module (version of the PC system, the web navigator) and to ensure adequate bandwidth for the images (animations in the form of Java applets, implemented through applications on Web pages). Moreover, various technologies (data-processing, telecom) must satisfy the constraints of remote learning.

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Selected solutions
We wanted to design a user-friendly platform, accessible to a large audience, easy to use for both tutors and learners. For that, access to our application had to be through the Internet network using a navigator in which the user would only have to specify the address of the e-TSLIS website. The easiest way to carry out a tutorial is to allow the person who follows the on-line course to ask questions and to obtain the answers within a short time. To achieve this aim, we used the possibilities offered by electronic mail (e-mail). We have left ourselves the option to set up a space for discussion (forum, etc.) in a forthcoming version of the project, depending on the outcome of experience with the system.

Lastly, to make this platform more interactive, we had to create a database able to manage the test question sets, to allow the automatic generation of the table of contents, but also to manage users, etc.

We chose to break up the system into users, environments, and interactions. Three types of user of the platform are provided for. 1) Administrators can add or remove a user account (student or teacher), and also update the database with the courses provided by the teachers. 2) The tutors are able to modify an already existing question test to which they have access. In the space that is reserved for them, they can follow the progress of their trainees. 3) The trainees access the module to which they are registered and evaluate the knowledge that they acquired, thanks to a progressive series of interactive exercises (Sahli et al., 2002, Sahli et al., 2004).

Implementation
Animation is used to reduce the text content (Figure 2). The objective can be the presentation of specific or technical methods used in signal processing and applied in seismic processing. Another objective is to show one or more applications of geophysical processing on simulated signals and on specific geophysical data, for example, the dispersive waves recorded during seismic acquisition.

Animations allow the visualization of data, to study the influence of processing parameters chosen by the reader. The first stage in the creation of an animation is the realization of a MUSTIG program, in the form of a graph of dependencies. The graph is a synthetic data processing sequence applied to the data presented in the image. It shows the architecture of the MUSTIG processing sequence used to carry out animations. It appears as interconnected boxes, where each box corresponds to a tool for processing, made up of elementary functions. Parameters can be modified by moving cursors, calculations being made in real time by a run time version of MUSTIG software. The images are conceived so as to allow an immediate visual comparison and to evaluate the influence of a change of parameter on the data processing. The second stage consists of generating automatically the JAVA files, thanks to the transcription integrated into MUSTIG.

Mathematical formulas can be presented as slides (Figure 3) to illustrate the animation and the text. Notations used and demonstrations are fully explained in the books associated with this product.

Evaluation is carried out by way of a multiple-choice test as shown in Figure 4. This is included so readers can assure themselves of a good comprehension and knowledge of the processing presented in the animation. The level of knowledge acquired is validated by a final grade (marks). Retrieval and generation of the questions are dynamic. Only one answer is possible for each question. Learners validate their

Figure 1 e-TSLIS site introduction page.

Figure 2 Animation.
choice by clicking on the button ‘Answer’. Once the answer is validated, users reach either the following question thanks to a button ‘Next’, or their marks, if they answered the last question of the associated lesson. We do not allow learners to go back to an already validated preceding question. Indeed, these exercises aim at evaluating acquired knowledge: if candidates could rectify their answers, the final result would not represent their real level. After a long time and multiple access, a user will have an idea of the correct answers. Moreover, it appeared important to us that learners have the answers to the questions directly after the test. There is a logical sequence to the questions. The mark at the end of the question test is recorded in real time in the database as well as the time it took the learners to go through the whole multiple-choice test. In the same way, the various choices made by the learners for the various questions are also saved. The tutors can visualize and analyze the results of their learners. The objective is to understand their errors and to follow their progression.

The table of contents is generated automatically from the names of chapters and lessons existing in the database. Teachers can update their course, without having to program, but by going directly to the level of the database. Teachers can easily modify and create lessons.

The site also has three types of indexes: names, authors, and data. In each index and in the text, a link on a word redirects the reader towards the glossary, and the numbered links return to the corresponding lesson. On-line help is brief and is presented in a friendly way, with bubbles containing the messages as in a comic strip. The objective is to capture as much as possible the attention of the reader (Sahli 2004).

Experience so far
From the user point of view, this platform meets specific needs thanks to simple means. It builds knowledge of signal processing by the acquisition of concepts, theories, and techniques. The students learn by the use and mobilization of their knowledge for the resolution of a scientific problem. They also learn how to be autonomous, to be evaluated, to enter into dialogue, to collaborate, and finally to acquire knowledge. These methods of teaching support collaborative work and structure individual work. The e-learning system is currently under evaluation by university and IFP School students. The IFP students are already used to working with field data and in integrated teams, but they often ask for courses where they are more involved. The increasing diversity of their background has led the IFP school to modify both the structure of the courses and the teaching methods. However, it is important to note that the on-line course is complementary to signal processing CD-ROMs and does not replace books, which include more detailed information (demonstrations of formulae, etc). Reference to basic works in signal processing remains essential. Experiment shows that the practice of e-learning with follow-up by a tutor (in the form of completion of a project, or preparation of a talk) makes the acquisition of knowledge more effective. A way of reducing teaching time is to use multimedia tools to give the learners the opportunity to manage their own time by acquiring, at least in part, the fundamentals at home or in their company. The time saved may be used for:

Reducing the duration of the face to face course, although the distance learning time cannot be neglected. Consequently time-sharing must be clearly defined between the trainee, the company, and the training organization. As a conventional, continuous education session requires a minimum number of participants to be cost effective, the time saved may also enable training sessions to be maintained despite the limited number of participants. Improving the knowledge of fundamentals by responding to the specific requirements of participants with different backgrounds or by increasing supervised classwork. Improving the content with regard to advanced techniques by adding specific lectures or by increasing the number of case studies.

The time-sharing and the course content sharing are trainee dependent and must be adapted to the training objectives: experience has shown that the same blended course has been appreciated differently depending on the trainees’ profiles. Interest in the multimedia tools used in continuous
Conclusions

Blended learning is a mixture of e-learning and conventional courses. E-learning preserves the richness of the exchange between learners and lecturers. A correctly proportioned mixture of distance course and traditional teaching must be presented in the form of a system of operation rich in terms of resources (CD-ROMs, Internet, web-based on-line tools). E-learning allows the splitting of times and places for training. Learners build up their own knowledge and learn how to learn. The IFP School experience conducted over four years with about 200 students has demonstrated that blended learning will in future be a major form of continuous training. E-TSLIS is the e-learning part of a blended learning course devoted to signal processing. The e-TSLIS on-line course uses examples of specific applications. It allows learning in a more independent way. The e-TSLIS platform as well as the etslis database have been produced. The whole ‘Well Seismic’ course (lessons, animations, formulas, question tests, etc) is available, as well as the management of various spaces of communication (tutor and trainee). All the architecture of the site is conceived so as to make the platform evolutionary: integration of other courses (the course entitled ‘General information in signal processing’, for example) is being considered. The e-TSLIS project is in constant evolution: the integration of the ‘General information in signal processing’ course in the platform is the subject of one training course at the Electrical Department of the Institut National Polytechnique de Grenoble and IFP School. In the future, the installation of new functionality could be considered, such as the automatic creation of a complete course, the installation of a search engine to improve navigation in the site, and the adaptation of the platform to other types of course (image processing, etc).

References