COMPUTER ASSISTED AND WEB-BASED LEARNING TECHNIQUES IN ELECTRONICS AND TELECOMMUNICATION EDUCATION PROCESS

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Abstract
This paper is dedicated to modern, computer-aided and distance learning education methods. Firstly, general outlook is presented. Then, practical applications developed at the Faculty of Automatic Control, Electronics and Computer Science of the Silesian University of Technology are presented with special emphasis on Electronics and Telecommunication specializations and Circuit Theory (CT) and Signal Processing (SP) courses. Various aspects of evaluation of distance learning methods are discussed, including the output of the international cooperation, internal projects and future plans.

Key Words
Web-based education, distance education, e-learning, computer-assisted learning

1. Introduction

Today, computers are used practically in every sphere of human life. Whereas the application of personal computers for various engineering calculations and simulations can be regarded as standard, the appearance of new modern Internet-based means of communication started a new era in education process [1],[3],[4],[7],[8].

Traditional applications support ordinary lectures, classroom and laboratory exercises or projects. They can be classified into two following categories.

- Computational programs and simulators that aid calculations performed when completing a student project or laboratory exercise. Normally, professional programs are used or sometimes, specialized self-made programs are used, when professional programs are not available or too costly.
- Educational self-made programs that imitate engineers’ problems and show possible solutions.

Internet applications become more and more popular and it looks that they will dominate education process in engineers’ courses. Generally, two attributes designate a character of teaching-learning process: time and place.

In the traditional learning, both: students and a teacher are at the same location. However, teaching-learning process can be carried on at the same time or can be separated in time. In the learning process that utilizes Internet connections, called web-based learning or e-learning, students and teachers are at different locations, while teaching-learning process can be carried on simultaneously or can be separated in time and two different classes of e-learning can be distinguished accordingly:

- Synchronous (On-line) learning,
- Asynchronous (Off-line) learning.

2. Applications of Computers in Electronics and Telecommunication Education

The Faculty of Automatic Control, Electronics and Computer Science of the Silesian University of Technology has been involved for several years in the modernization of the education process by means of computers and web-based learning techniques. Numerous international and internal projects have been launched. In 2003 the Faculty has started development the own e-learning platform. This project aims at creation of the new or integration of the existing tools and development of e-learning platform content. The project consists of two stages. At the first stage, selection of data formats has to be completed. Next, the existing educational software has to be examined and eventually adapted, as the platform content. This may require creation of new own tools of the content development. These tools should enable unification of data format and form of the contents presentation [2].

Some other projects will be presented in details, with the special emphasis on Electronics and Telecommunication specializations, Circuits and Systems (CAS) and Signal Processing courses.
2.1 Traditional learning

Apart from professional programs that perform engineering computations, such as SPICE, LABVIEW or MATLAB, self-made programs are used. These programs as well as educational programs are normally developed by undergraduate or postgraduate students, as part of MSc final project or PhD dissertation. That way a substantial, initial library of specialized programs has been created and it is continuously supplemented. Among numerous educational programs dedicated to CAS Theory and Signal Processing courses developed by Electronics and Telecommunication (ET) students at the Silesian University of Technology, the following could be enlisted: transient analysis visualization, transmission line traveling waves visualization, graphical composition of periodic waveform expressed by harmonic sine waves.

2.2 Synchronous e-learning

The On-line form of learning is best suited to lectures. This form of education is very similar to "at location" traditional form of learning. Lecturer delivers a lecture in a lecture room located in the Home Unit while students are located in classrooms of Remote Units and eventually also in the Home Unit lecture room, together with the lecturer. Picture and voice is transmitted in both directions, via Internet connections, so that the students can see a blackboard and the lecturer and the lecturer can see the students. These Remote Units can be Satellite Units of the same University or Units of different Universities that have established an educational consortium. Silesian University of Technology located in Gliwice has two Satellite Units located in Rybnik and Sosnowiec, 30 km and 40 km from Gliwice respectively. Selected lectures, such as Circuit Theory, are delivered simultaneously, from Gliwice, to students of all three Units. This solution, similar to videoconference, has many advantages. First of all, it saves lecturer’s time (one lecture instead of three). At the same time, it saves the University budget money (one lecturer’s fee instead of three), such that money spent on the multimedia equipment are quickly redeemed. For a consortium project, best lecturers can be engaged, regardless their permanent residence, even from abroad. This form of education does not require any additional lecturer’s effort, when preparing lectures.

2.3 Asynchronous e-learning

In the Off-line distance learning numerous applications of computers can be distinguished. The main one are listed below.

- Support of traditional courses.
- Consultations, in audio and/or text mode.
- Complete courses.

All these applications may use different forms of knowledge delivery, such as:

- text, audio, graphic or animation (video) files on www pages
- files contained on CD-ROM
- e-mail
- chat line
- multimedia transmission.

For many years, basic information related to courses offered to ET students, such as: course content, basic terms and concepts, drill (examination) problems are available on www pages (www.iele.polsl.gliwice.pl). Some courses, such as Circuit Theory, Signals and Communication are available also in English. Recently, international projects have been developed at the Faculty of Automatic Control Electronics and Computer Science of the Silesian University of Technology, and they will be described in the next Sections 3 and 4. In Section 5, internal projects will be presented.

3. LINK project

The Faculty of Automatic Control, Electronics and Computer Science staff participated in the international collaboration project called LINK [5]. The general aim of the project was to work out the methodology and tools for preparing lectures that would include multimedia components and that would be accessible via the Internet. The project was part of the open and distance learning group of projects developed within the modern education methods and tools component of the European collaboration program Socrates/Erasmus. The project should result in easier development of multimedia-rich lecture presentation and easier dissemination of such lectures with respect to international audience. Typically the development of such kind of course and lectures includes the mastering of some tools for creating and including multimedia components as well as some authoring type of software. It should be as simple as possible to teach the lecturers how to work with such tools and there should be no technical problems with enabling such prepared lectures to the students via the computer network (campus intranet or Internet). Another important aspect of LINK project concerned the collaborative work of lecturers while preparing their modern, multimedia and distance-learning oriented presentations. Because one of the general objectives of the project included the testing of newly prepared courses by students from various countries universities, it seemed essential to invite lecturers from various universities to prepare such lectures in collaborative manner. This corresponds to the extended title and motto of LINK project: “Linking professors to produce better courses”, and this was the general idea of the project.

The pilot courses were prepared in the LINK project using the open distance learning paradigm in mind, which included the concept of generally asynchronous access to the courses by the student using his own computer and typically outside the university building. The course
materials – sometimes multimedia rich and of very complicated structure – are uploaded by the lecturer to the server computer in one of the collaborating universities. The students go through the course by their own, connecting to the server computers via their personal computers and working basically without the tutor guidance. Of course several tutorial sessions proved to be of great value and the concept was to organize them at various phases of the students’ work with the course and at all universities that used the specific course material. The concept of the tutorial sessions was to exchange views on potential problems within the group of students and solve the introductory, exemplary and test tasks under the supervision of qualified teacher/tutor. As usual in the open and distance learning courses, it was proposed to include in the course materials the tools and specially prepared data for running the self-assessment sessions by the students which would enable them to control their understanding of course parts and the level of skills that they gain while working unattended by the tutor. These self-assessment tools should be accompanied by the several levels of quizzes, tests and exams, however, the final examination was supposed to be organized in the traditional, direct contact way.

3.1 Specific Objectives of the LINK Project

The detailed objectives of the project included the following activities and outputs [5]:

- Creating a survey on currently existing materials and courses concerning the multimedia oriented presentations and lectures; creating a survey on the possibilities and availability of modern authoring tools.
- Creating a survey on courses developed in the project partner institutions that could be extended to the multimedia and distance learning concept as proposed in the LINK project; exchanging the experience on the development of distance learning courses and the necessary level of interactivity.
- Development of methodology concerning the usage of off-the-shelf software tools necessary for the multimedia-rich course development. Working out the guidelines concerning structuring of such course and preparing the course components.
- Setting up a computer network based platform for the collaborative development of the courses by lecturers from various countries universities. The level of direct collaboration and its influence on the necessary technical elements of such platform and their cost should be also considered.
- The joint preparation of several pilot courses by teachers from partner universities, in part on the basis of existing course materials.
- The proposed methodology for collaborative tutorial sessions organization, the assessment of the role and number of such sessions and tutors’ participation, assessing the concept of unattended self-evaluating as well as interactive tests and quizzes as part of such sessions and courses.
- Testing out the overall open and distance learning platform developed in the project, evaluating the quality, flexibility and efficiency of the tools and solutions used and developed within the project.

3.2 LINK Project Implementation

The details concerning the results obtained in the LINK project present in this section concern the participation in this project of the staff members from the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology, Gliwice, Poland.

In the pilot phase the work concentrated on two courses that were chosen as sufficiently well prepared for the adaptation towards multimedia, distance learning courses. The first one is called Signal Theory and is routinely offered to the students of the sixth semester, Electronics and Telecommunications direction, all specializations (Fig.1).

Fig. 1. Exemplary applet used in LINK courses

Some parts of the course were delivered to the students during summer semester in the PowerPoint version. The first modules were transformed to HTML version and delivered to the students of the ninth semester, Automation and Robotics direction, Computer Controlled Systems specialization, as part of the course on Digital Signal Processing – laboratory exercises, as well as part of the courses on Adaptive Control and Computer Controlled Systems Programming. The modules were also translated into English language – in PowerPoint as well as HTML version, which was necessary because of the international context of the LINK project and planning to use the lecture components for groups studying in English at the Silesian University of Technology. The second course chosen for testing the concepts of distance learning techniques and methodology was called Computer Systems and Networks. The CSN course was typically offered to the students of the ninth semester, Electronics and Telecommunications direction, all specializations, nonobligatory course. Once again the modules were presented in simple PowerPoint version and transformed...
into HTML. The course was offered in on-line version to few students in English language version, for the summer semester a Polish language version has been prepared for the students from Automation and Robotics direction.

The users of both courses were students of the Faculty of Automatic Control, Electronics and Computer Science. Students were from both Automation and Robotics direction of studying as well Electronics and Telecommunication direction. There are several specializations within both Automation and Electronics directions but the courses on Signal Processing and Computer Networks mentioned above could be offered to students of all specializations – which greatly enhanced the possibilities of testing the courses modified as part of the LINK project activities. It was adopted as the general principle by the faculty authorities that the courses offered as part of the distance learning framework should be at least bi-lingual, i.e. in most of the cases in Polish and English, because of the possibility of accessing the courses material from any university students via the Internet and the usefulness of such courses for foreign students incoming to the Silesian University of Technology as part of international students exchange.

4. Virtual Laboratory Project

There are several courses taught at the Faculty of Automatic Control, Electronics and Computer Science that concern high technology fields and are supposed to be accompanied by the laboratory exercises involving expensive apparata and specialized personnel. Of course it is in general very difficult for the university to have direct access to all necessary advanced laboratories in all relevant engineering specializations. It is also true that typically the most interesting advanced technology laboratories are developed because of research oriented activities of the university and it is always so, that any specific university research interests are not all-spectrum ones. Whats more – it is possible that the university does not employ the staff members of necessary competence to run the advanced technology laboratories in the fields that are not covered by the main research interests of the university. The situation is even worse now in several European universities as the number of engineering students decreases constantly and that means that also the number of staff members decreases and there are simple not enough specialists to maintain several advanced engineering laboratories. It is perfectly possible for the university to become too small and too weak to compete with other universities in all fields of research and education. On the other hand there are several universities – especially in Central and Eastern Europe countries – with a great number of highly skilled specialists and enormous lack of budget in ordere to equip and run high-tech laboratories. Such universities have competent people to work with students but they have not apparata and materials in order to perform laboratory exercises. All the above reasons justify the idea of exchanging the laboratories among several universities, possibly from various countries. By exchanging laboratories it is meant that there are technical means of accessing remotely – possibly via Internet – the laboratory instruments, setting up the experiment, initiating it and controlling the experiment run as well analyzing the acquired experiment results. Such way of running the laboratory experiment is known in the literature as tele-laboratories. Usually as an alternative to tele-laboratories so called virtual laboratories concept is considered [6]. In the latter case the laboratory instruments as well as the phenomenon being examined along with its environment are simulated by means of sophisticated software and typically the access to such virtual laboratory is also realized by means of computer network facilities.

It should be stressed that the concept of tele-laboratories and virtual laboratories routinely utilizes the communication possibilities offered by computer networks but they are substantially enhanced while using the Internet for communication. In this case the access to the tele-laboratory becomes the global one as it is not physically restricted by the e.g. faculty local area network borders. By using Internet as a platform for accessing tele-laboratories and virtual laboratories it is possible to setup broad networks of collaborating universities that exchange their well prepared advanced technology laboratories with partners, thus enabling their students access to the whole spectrum of valuable laboratory experiments. It is doubtless that such collaboration would results in better education possibilities at all participating universities and better qualification and skills of the graduates.

The reasons for sharing laboratories with other universities, formulated above, are perfectly true with respect to the Faculty of Automatic Control, Electronics and Computer Science of the Silesian University of Technology. One example could be the laboratory experiments accompanying the Adaptive Control course and especially the experiments concerning the active noise and vibration control (Fig. 2, Fig. 3).

Fig. 2. LABLINK Laboratory of Active Noise Control
5. Development of tools for Web-based Learning and Education

The Faculty of Automatic Control, Electronics, and Computer Science long term development plan includes the substantial modernization of the education tools and methodology also by means of broad utilization of distance learning techniques. Such techniques were examined as part of several internal research and testing initiatives as well as a result of the participation in international collaboration project in the field of modern and multimedia techniques for education. The collaboration involved the participation in Socrates/ODL/Minerva projects LINK and LABLINK (see previous Sections), concerning the preparation of tools and methodology for remote and asynchronous access to multimedia oriented course materials as well as remote access to high technology laboratories at Silesian University of Technology. The tools, methods and techniques were developed especially in such fields as signal processing, computer networks, control and identification courses.

The following groups of tools have been developed among other at the Faculty of Automatic Control, Electronics and Computer Science:

- Set of applets in Java for signal processing simulation, including analog and discrete signal processing experiments, graphical user’s interface and simulation visualization.
- Platform for distance learning, including the possibilities of posting lectures with additional materials, enrolling students, preparing and running tests and quizzes, extensive communication tools. The platform has been developed using PHP and PostgreSQL technologies and its functionality is similar to some existing commercial distance learning platforms (fig. 4).
- Set of internet database oriented tools for cataloguing books, journals, theses and reports available at the Faculty of Automatic Control, Electronics and Computer Science.
- Internet database for accessing and modifying the curricula at the Faculty of Automatic Control, Electronics and Telecommunications and Computer Science. The curricula in full detail can be accessed by the faculty staff and students as well as by abroad students considering studying at Silesian University of Technology.
- Set of tools for routine maintenance of the Silesian University of Technology International Relations Bureau portal. The tools enable the International Relations staff to input and update the information on contacts, programs and projects, collaboration possibilities, current announcements etc. The systems takes care of the presentation form of the data thus freeing the International Relations Bureau staff from being HTML masters.
- Platform for tele-laboratory (virtual laboratory) in the field of advanced adaptive control methods applied for the active noise control task. The laboratory includes several microphones, loud speakers, mixers, filters, computers and DSP boards. The laboratory seems to be the perfect example of the usefulness of the tele-laboratory concept.

The other projects and tools developed at the Faculty of Automatic Control, Electronics and Computer Science concern among other the usage of XML, Java servlets and JSP for enhancing the faculty and courses portals, the database/communications tool for communication...
between dean’s office, teaching staff and students, as well as flexible tool for distributed management of laboratory exercises for various courses.

Fig. 4. Distance Learning Software developed at the Faculty of Automatic Control, Electronics and Computer Science

6. Conclusions

E-learning seems to be inevitable part of education process in Electronics and Telecommunication, as well as in all other engineering specializations. Nowadays, problems in a broader implementation of e-learning are in organization sphere more than in technology. Advanced, dynamically developing technologies enable immediate replacement of traditional education by e-education. Main obstacles of broad implementation of e-learning are of an organizational nature and generally fall under two categories:

1) Lack of standardization of multimedia systems and Internet platforms.

2) Difficulties in finding a good method of covering personal (lecturer) costs, such as:
   a) costs of e-courses preparation,
   b) e-lecturer’s fees, that will satisfy lecturers and could be accepted by the University budget.

It has to be emphasized, that already available e-learning tools enable preparation of e-courses by lecturers that are not familiar with programming, not only by lecturers employed in the Computer Science Department. The problem lays in financing their initial work, when preparing lectures. This is very time consuming and significant funds have to be collected in the University budget to cover lecturers’ effort and initiate the e-learning process. E-learning is convenient for students and may motivate them to study Electronics & Telecommunication. However, this form of study seems much more costly than the traditional one, as it requires expensive equipment, then license fees and finally, it is more time consuming for academic staff. Nevertheless, good solution to these problems has to be found in the near future.

Lack of standardization is the second organizational problem. Different multimedia systems are offered by the Industry. Good system should be compatible, serve not only own University but also should enable communication with other Universities and Conference Centers. Same applies to the e-learning platform.

It is a great believe of the Silesian University of Technology authorities, that in the near future, at least MSc correspondence courses will be fully carried out in the e-learning form and all other courses will be supported by this form of education.

References: