E-learning system and Virtual Laboratory for the study of Electronic Technologies

D. Demeter, J. Banský, S. Kardoš, Ľ. Livovský and I. Vehec
Technical university of Košice/Department of technologies in electronics, Košice, Slovakia
juraj.bansky@tuke.sk, dominik.demeter@tuke.sk, slavomir.kardos@tuke.sk, lubomir.livovsky@tuke.sk, i.vehec@tuke.sk

***Abstract* — The paper describes the e-learning system and virtual laboratory that are intended for implementation into electrotechnology-oriented study programs. It is a short description of the main functions of the systems as well as the technologies used for the implementation.**

***Keywords* — e-learning, CAD, education, open-source, video streaming, virtual reality**

I. INTRODUCTION

The main idea of this e-learning education system is to open up the laboratories for students. Before the e-learning system was created, the students have had very short time to get familiar with the facilities in the laboratories. In most cases, they had no idea, how some technological equipment looks like and how to use them. This e-learning system show the students the real view of laboratories and on the other side, by using videos created in our laboratories, it shows step by step the way, how to use the equipment and how to do some technological procedure.

This system is a good solution of problem with the capacity of laboratories. The laboratories of our department are relatively small and there is no enough space for a larger group of students to show them the technologies.

E-learning education in the field of the technologies in electronics enables the following benefits:

- Solution of a limited capacity of the laboratory. The safety regulations allow access for the students to the laboratory only for limited number of persons. It is necessary to repeat practical demonstration of the principles and the working of technological equipment for several groups of students. The solution is on-line connection of the laboratory with e-learning system via camcorder and suitable internet interface.
- An alternative of repeated viewing of technological method without necessity of presence in the laboratory. Video records of technological processes or interactive applications illustrating the processes enable in easier way to understand all the process and interconnect the theory with praxis.
- An alternative of such illustrating demos of technologies including into the education process, which are not accessible at the education institute.

It will also save time and money in the education process, because at the theoretical lessons we don't need to show the same technological process for every group of students again and again. It is enough to create some detail videos to get the students familiar with the processes in our laboratories, what will prepare them for individual practical laboratory work.

II. STUDY PROGRAMME

Department of Technologies in Electronics of the Faculty of Electrical Engineering and Informatics offers new study program in engineering study "Advanced materials and technology in automotive electronics" from academic year 2011/2012. Main subjects of the study program are:

- Production Processes in Electronics I.
- Production Processes in Electronics II.
- Quality and Reliability Management.
- Production Technologies, Structure, Properties and Applications of Sensors.
- Design Systems in Electronics.
- Diploma Thesis I and Diploma Thesis II.

Some of them are already implemented into e-learning courses. One of the key subjects of this specialization is the subject "Design systems in electronics". Goal of the subject is to familiarize the students with top Computer Aided Design (CAD) system for design of the PCB.

Figure 1. The CAD design system - Altium Designer. [1]

Choice of Altium Designer resulted from beneficial offer for universities with potential for inclusion in project

978-1-4577-0052-1/11/$26.00 ©2011 IEEE

of educational institutes, which should result in a competition or a presentation of the students PCB designs. This form allows the students to present their skills for scientific public and also allows addressing of potential employers not only in region of Eastern Slovakia. Also the web pages of Altium Designer offer wide range of study materials, which simplify work with the design system.

To increase popularity of the study program, the practical lessons by using technological equipment are included into education process. Also the space for student is created to make functional sample of the PCB by using milling machine at the end of the Design Systems in Electronics subject study. The prepared data from the CAD system (GALAAD-Percival) control movement of the milling machine, which with the help of a special tool creates the PCB pattern of conductive paths (see Figure 2). This "dry" method of the PCB production was selected because of rate of the sample production and contrary to "wet" way of the PCB production there is no need to liquidate the chemical waste (etching solution).

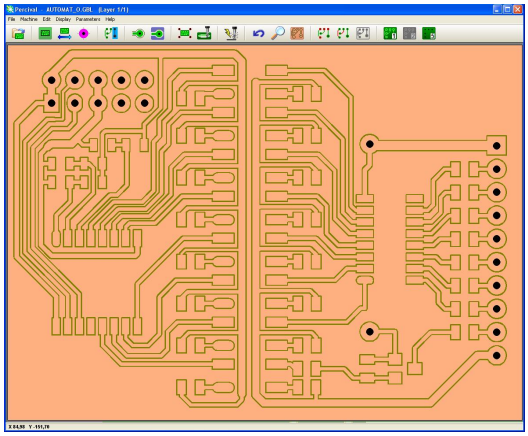

Figure 2. GALAAD Integrated CAD-CAM-CNC software – module Percival. [2]

Another e-learning supported subject is the Production Technologies, Structure, Properties and Applications of Sensors. It is focused on basic knowledge as well as for acquaintance with new progressive trends in the area of materials and technologies for sensors production. The subject acquaints the students with materials used at sensors production, with partitioning, principles (see Figure 3) and characteristics of sensors, with mainly used technologies: semiconductor, thin- and thick-film, as well as new technologies used in production of MEMS systems

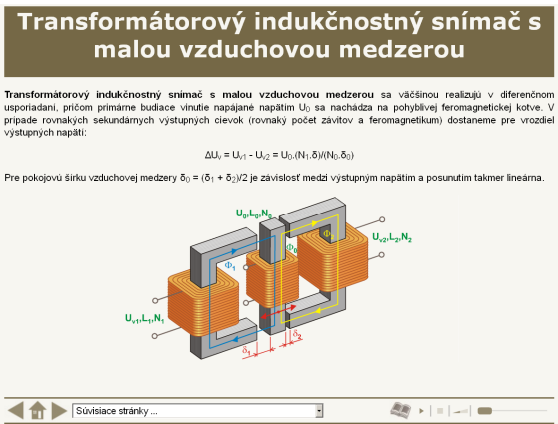

Figure 3. View to the sensors principles screenshot from e-learning module under the Moodle platform

for sensors used in temperature, mechanical, geometric, magnetic and chemical parameters sensing as well as of biosensors.

III. VIRTUAL TOUR

A. Main functions

The best way, how to prepare the students for individual work in the laboratories is to introduce them every piece of available equipment before they really go to the laboratories. At the practical lessons, the student should make real laboratory exercises instead of searching the applicable equipment or tool, or finding the laboratory, where the needed equipment is located in. For this reason, we have created a real life virtual tour from our laboratories.

From each laboratory at our department we have created a 360° panoramic picture, by using adequate technological equipment to eliminate optical defects. In the e-learning system, these panoramas are viewed by a special open-source web applet, which allows us to create some clickable areas in the panoramic picture. By clicking on these areas, the user can start some specific action, e.g. start a video, open some web page or go to other part of the virtual tour.

The user can look around in the laboratory by using the buttons (see Figure 4), or through automatic tour, as well as he can zoom to some selected part of the virtual tour.

Figure 4. Virtual tour with standard buttons

In the virtual tours, the interesting objects are highlighted by different color (see Figure 5). By clicking on them the user can open the card of the equipment, on

Figure 5. Highlighted clickable equipment

which he can find some basic information about the selected technological equipment (in which technological process can be used the selected equipment, link to its user manual), links to the video files and animations related to selected object and other.

B. *Technologies used for creating the virtual tour*

For creating of detail photos we have used a DSLR camera with a tripod and a special, self-made panoramic head, by which we have created digital photos without any optical defects. The panoramic head allowed us to create every photo from the same position (the camera is turning around of its optical centre), what is very important precondition for successful automatic sticking of the created photos. If we don`t use a panoramic head, it is impossible to stick the photos without getting some optical defects because of parallaxes (see Figure 6).

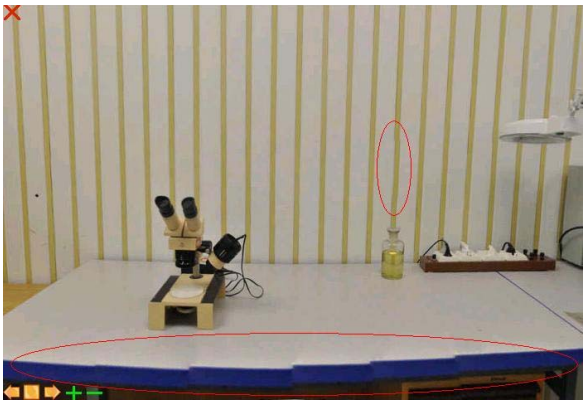

Figure 6. Optical defects because of parallax in a panorama made from photos taken without the panoramatic head

For sticking the photos to a panorama we have used the open-source program, Hugin. This software can be used for automatic sticking of the photos, what can save a lot of time. In case of some problems during the sticking, the user can help the program to find some control points to get better result.

The panoramas are showed by an open source java applet, PTViewer. This applet can view panorama pictures in web pages. The applet have a lot of useful features, e.g. creating of clickable areas, adjusting the size of the viewing window, zooming, manual or automatic turning around, high resolution parts of the panorama, etc.

IV. OTHER PARTS OF THE E-LEARNING SYSTEM

A. *Live video*

The second fundamental parts of the e-learning system are video files and video streaming. Existing internet connection in every laboratory allows us to create live online video streams from the laboratories about the technological procedures made at our department.

For capturing the videos, we have available two types of cameras. One IP camera with maximal resolution of 1.3 Mega-pixels at the frame rate of 15 frames per second (30 fps at resolution of 0.8 Mpix) and a classical digital camcorder connected to a notebook by a TV-card.

The first camera with fixed 4 mm lens is eligible for creating of some overview videos about the procedures made in the laboratories, while the second camera, if it is used with a tripod, can create detail, close-up videos. The video from the camcorder is streamed to the LAN by the open-source video streaming program, VLC.

Every stream will be collected by a multimedia server. This server will collect the video streams from every camera as well as from the computers connected to different technological equipment (climatic chamber, electronic microscope, etc.) and computers used for lectures (PowerPoint presentations with audio records from the lecture).

This server will use the collected multimedia materials as sources for streaming them to the local network as well as to the internet. This step is very important, because the cameras can not serve more connections and on the other side, the server will be the only computer visible from the internet. This is a big security advantage.

The server will stream multimedia in two ways (see Figure 7). In our local network there will be available a multicast stream, which need less system resources, but is reachable for everybody located in our network. To the internet, we will send unicast stream (as known as "on demand stream") – it will be available only for authorized persons. This method is less effective than multicasts, because it request more bandwidth and creates more load on the server, but it is not possible to stream multicasts out of our network (most of internet providers are blocking them).

The multimedia server will also create a copy from every stream for future use. This will generate us a multimedia archive, which will be used in education process in the future. This archive will be available for students and will be searchable by different criteria.

All component of the streaming server will be implemented on open-source technologies. For streaming the screen of the computers will be used application called VLC. This program will be also used for streaming the content from the multimedia server.

On the client side, the stream will be viewed by a java applet, alternatively by the vlc-plugin for internet browser. The first one seems to be a better choice, because it only need a java runtime environment, which can be found on most computers (if not, the most of internet browsers have built in function to install it), while the vlc must be installed manually (it requires more technical knowledge from the users).

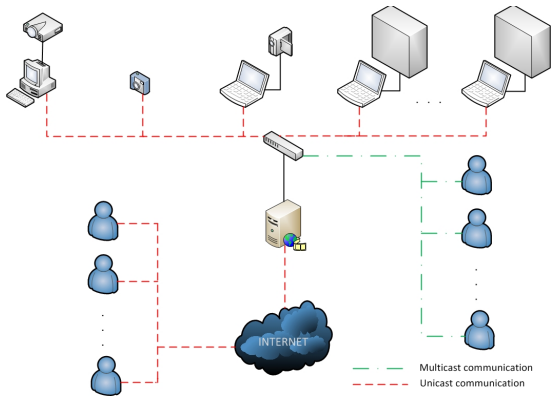

Figure 7. Communication system architecture

B. *Video archive*

A very important part of the e-learning system is a video archive, what is made up from videos created in our laboratories. These videos bring the students detail view to the technological processes made in the laboratories.

The videos in the archive can be sorted by different criteria, e.g. by technological process, by equipment, by laboratory, etc.

C. *Flash animations*

The third part of the e-learning system is flash animation support, which allows illustrating the technological processes. The animations are linked to the appropriate technological equipment as well as to the steps of some technological procedure. The animations in the system can be sorted by different criteria, too.

The preparation of animated components is realized by using the Adobe Flash CS4. From this platform the components are implemented into the study materials. The mentioned software was selected behalf various reasons. In particular it provides tools for producing of interactive animations, which allows creating of objects corresponding to real processes. In the following there is the possibility of increased interactivity with the user, what is scarcely possible to achieve with utilization of classic scripting tools.

In the Figure 8 and Figure 9 is static view to two of created Adobe Flash CS4 animations which illustrate the semiconductor materials physics and manufacturing in particular steps. The pictures show mainly structure of all pages for modules with color scheme, header on the top of the page and control/navigation toolbar for navigation across full course on the bottom of the page.

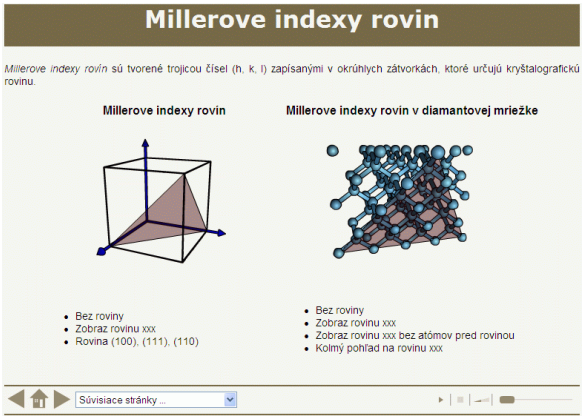

Figure 8. View to the Adobe Flash CS4 animated component embedded in e-learning module about semiconductor materials physics

The navigation toolbar has the standard form with buttons for previously browsed page, for home, for next recommended page, list of related pages, and toolbar for playing audio files (from left to right side). The on-line e-learning module is only in Slovak language recently.

Figure 9. View to the Adobe Flash CS4 animated component embedded in e-learning module about semiconductor materials processing

CONCLUSION

A number of study modules at the Department of Technologies in Electronics were created in the frame of e-learning support of education. Evaluated e-learning system and virtual laboratory solves the capacity limitations of laboratories at our department and it already helps our students to get familiar with the laboratories and their equipments as well as with the technological processes made at our department. Continuous preparation and practical utilization of animated components under Adobe Flash platform is in progress for educational process with the scope of technologies used in microelectronic industry. The described system has good preconditions to be a useful e-learning system that will help the students to study more effective and attractive.

ACKNOWLEDGMENT

This paper was elaborated in the frame of the KEGA project No.: 3/7117/09.

REFERENCES

[1] Ready to Teach Grant Program, United States Department of Education, http://www2.ed.gov/programs/readyteach/2005awards.html

[2] Adobe Flash Professional, http://www.adobe.com/products/flash/whatisflash/

[3] Cisco virtuálna učebňa pre stredné a vysoké školy, 2006, http://servis.inet.sk/clanok/3757-cisco-virtualna-ucebna-pre-stredne-a-vysoke-skoly

[4] CAD software: http://www.altium.com

[5] CAD software: http://www.galaad.net

[6] PTViewer Documentation: http://webuser.fh-furtwangen.de/~dersch/PTVJ/doc.html

[7] Hugin: http://hugin.sourceforge.net/

[8] VLC: http://www.videolan.org/vlc/