ELECTRONIC STUDY SUPPORT FOR BACHELOR AND MAGISTER FIELDS AT CTU FBME

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Abstract
Faculty of Biomedical Engineering CTU is the second youngest faculty of CTU and is very motivated to offer a few examples of the electronic support of education in bachelor's and master's degree fields. In particular, attention is paid to the support of studies in the paramedical fields. Due to the interdisciplinary approach to study at the faculty is to use just as much as possible electronic support teaching and learning. Among the used electronic support study includes use of e-learning system Moodle, working in various modules NIS, educational videos, animation, testing knowledge via EduBase2 system (especially for the medical terminology), both for self and for the final tests, as well as several web portals focusing on imaging systems in medicine. Given the priority of the faculty to develop high-quality laboratory facilities, is to link each laboratory with the aforementioned tools and technologies and other means. Such examples are both artificial laboratory simulation and patient anatomy and physiology lab. In the laboratory of the artificial patient simulation is newly available recording system METI Vision, which enables complete documentation of rescue team activity at reviving of the injured. In the laboratory of anatomy and physiology is available specialized software environment which allows the connection of real experiments and the results of these experiments used in the models. In conclusion, the paper is then carried out summary and discussed some specific examples of experience from e-learning support.

Key words: electronic aided teaching, e-learning, www aided learning

Faculty of biomedical engineering at a glance

The Faculty of Biomedical Engineering (FBME) is the second youngest faculty of Czech Technical University in Prague (CTU). It was established in 2005 by a transformation of the Institute of Biomedical Engineering. Its history dates back to 1996 when the Centre of Biomedical Engineering (CBME) was founded at CTU. Its objective was to create a central coordination workplace of research and educational activities in biomedical engineering at CTU. The CBME CTU tasks were oriented above all towards research, and thanks to the suitable structure of its staff´s professional focus encompassing a large part of

biomedical engineering, widely focused scientific research projects could be solved. In 2002, the CMBE prepared documentation to implement a 3-year bachelor program “Biomedical and Clinical Technology“, and was transformed into the Institute of Biomedical Engineering (IBME) of CTU. In 2004, the bachelor program “Biomedical and Clinical Technology” was accredited, and the education began in the academic year 2003/04. Based on the decision of the Academic Council of CTU as of 15 December 2004 and an affirmative opinion of the Accreditation Committee of the Ministry of Education, Youth and Sports of the Czech Republic (MEYS CR), the Faculty of Biomedical Engineering was established by registering the changed CTU Statute by the MEYS CR on 27 May 2005. In the academic year 2005/2006, the first 48 students of the bachelor program graduated. Most of them decided to continue in the follow-up master program of the same name accredited in the beginning of 2006. This double-specialization study program has two study fields – “Appliances and Methods for Biomedicine” and “Systematic Integration of Processes in Health Service” in a full-time study form. The former is primarily intended for preparation of engineers for research and development activities as well as for implementation and maintenance of sophisticated technology, while the latter offers preparation of engineers for managerial positions in the health system. The education is project-oriented and is held in modern-equipped laboratories. Based on a recommendation of the Accreditation Committee of the Ministry and approved by the Scientific Board of the Faculty, from September 2009 there are two different specializations within the study field Appliances and Methods for Biomedicine: New Technologies for Biomedicine, and Medical Imaging Systems. In accordance with the “Long-Term Plan for Educational, Scientific, Research, Development, Artistic and Other Creative Activities of CTU”, a newly accredited doctoral study program “Biomedical and Clinical Technology” commenced in March 2007.

During the time period from 2009 to 2011 there were newly accredited next study programs and study fields, especially paramedical study fields. The detailed list is included within the next paragraphs.

Now FBME is "standard" faculty within the CTU with all levels of higher education and corresponding graduates. Faculty has 11 study fields, 30 laboratories, app. 1400 students, including 72 Ph.D. students, 100 employees and 6 departments including dean's office (departments are given under the chapter Faculty research). Faculty is situated in Kladno.

Faculty study programs and fields

One of the priority from the point of view of the faculty development is to cover paramedical study fields in particular. The following text includes all study programs and study fields (see Tab. 1). Description is available in [2].

Table 1: Study programs and fields at FBME CTU

B.Sc. (Bc.) 3Y Biomedical and Clinical Technology - Biomedical Technician (profession) - full-time and long-distance study - study in English - Optics and Optometry (profession) - full-time study - Biomedical Informatics - full-time study
B.Sc. (Bc.) 3Y Specialization in Health Care - Physiotherapy (profession) - full-time study - Radiological Assistant (profession) - full-time study - Paramedic (profession) - full-time study
B.Sc. (Bc.) 3Y Protection of Citizens - Planning and Management of Crisis Situation - full-time study
M.Sc. (Ing.) 2Y Biomedical and Clinical Technology - Apparatusses and Methods for Biomedicine - full-time study - study in English - Systematic Integration of Processes in Health Service - full-time study and long-distance study
M.Sc. (Ing.) 2Y Protection of Citizens - Civil Emergency Planning - full-time study
Ph.D. (Ph.D.) 4Y Biomedical and Clinical Technology - Biomedical and Clinical Technology - full-time study, long-distance and study in English

Faculty research

Faculty research is concentrated into the following research topics.

Interaction of XUV radiation with biological objects

XUV radiation is electromagnetic radiation with wave lengths of 1-100 nm. It is very strongly absorbed by the atmosphere and the majority of substances in our surroundings. Therefore, we do not get in contact with natural sources of this radiation in ordinary life. Significant potential implementation of XUV radiation is expected mainly in new technologies and in biology. Technological applications include mainly lithographic procedures in the production of highly integrated electronic elements, whereas in biology research covers the imaging of small objects, such as cells, and photophysical phenomena. The best known sources of XUV radiation are synchrotrons. Alternative sources whose research is currently highly accentuated are laser plasma and a high-voltage electrical discharge.

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Optimization of artificial lung ventilation

Artificial lung ventilation is a highly effective method used in solving respiratory insufficiency or in the case of the failure of the patient's spontaneous breathing. At the same time, however, artificial lung ventilation negatively affects and damages the patient's respiratory system. The research objective is searching such artificial lung ventilation modes which minimize the undesirable effects on the patient's lungs. particular, high-frequency ventilation applying very small breath volumes and small pressure amplitudes, which reduces the unfavourable effect of artificial lung ventilation. Research is aimed at technical problems related to high-frequency ventilation, the study of gas flows during high-frequency ventilation, the monitoring of high-frequency ventilation and, in cooperation with clinical workplaces, also at seeking a target patient group that may profit from high-frequency ventilation. Significant achievements include the development of a device called the "Demand Flow System" allowing spontaneous ventilation of patients connected to a high-frequency ventilator, which favourably affects patient's respiratory system. The research team also deals with other non-conventional ventilation technologies, such as the use of heliox – a mixture of helium and oxygen where thanks to its

physical characteristics heliox flows through the respiratory system with a much greater ease than air. Patients with obstructive lung diseases may breathe heliox spontaneously even in cases where they would not be able of spontaneous ventilation while breathing air and they would have to be connected to the ventilator.

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Thin layer applications in medicine

Research performed by this team is oriented towards three areas of interest. The first is the preparation and study of thin layers for applications in medicine. Thin layers of biocompatible materials (hydroxyapatite, diamond-like carbon, bioglass, zircon …), doped biocompatible layers (with silver, molybdenum, …), nanocrystalline and nanocomposite layers are prepared and studied. The objective is to develop new types of biocompatible thin layers with applications in medicine and sensorics.

The second area of interest is a modification of implants' surfaces – the surface of biocompatible materials for implantology is modified, both mechanically and by laser radiation. The third and equally important area is the study of interaction of UV laser radiation with a substance – the interaction process of laser radiation with a substance (tissue) is studied using a thermal camera, fast thermal radiation sensors, optical and spectroscopy apparatus.

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Biotelemetry systems

The research team deals with scanning, transferring, on-line processing, imaging and saving of biosignals in real time. The team is currently involved in a creation of a mobile workplace for a research of the cardiovascular system and biofeedback in clinical practice investigating the optimum possibilities of a telemetric transfer of physiological signals into the measuring module. At the same time, key algorithms for an analysis of individual modes are investigated

and developed. The objective is to set up a special modular system for scanning, digitization, transfer, online processing and saving of technical and physiological variables (EEG, ECG, EMG, skin resistance, temperature and respiratory curve) that is able to work in an environment with extreme interference during experiments. Another objective is the design and implementation of a complex experimental software system for interactive visualization and advanced processing of multi-dimensional biomedical data obtained from the measurements, and the performance of validation experiments on the designed modular measuring system with the aim of full integration of the developed methodology into experiments on biological objects.

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Health technology assessment for medical devices

The objective is to create a methodology of the assessment of health technology applications within existing socioeconomic conditions of the Czech Republic, develop its design for the conditions of the Czech Republic and verify the potential of its use on selected items of health technology. Research in Health Technology Assessment is oriented towards technologies connected with sophisticated medical devices; no standard procedures have been developed in this area so far. The development of the health technology assessment methodology may contribute to correct investment decisions and bring economies in financial resources allocated to health care. In the past, the team primarily concentrated on balancing the technical, economic and medical education in the branch of study, Systematic Integration of Processes in Health Service. Time has shown that the graduates find very good jobs, mainly in large health care facilities.

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Rehabilitation process quantification

The research group is engaged in monitoring and quantification of the rehabilitation care process provided to patients with focal brain damage using (3D) virtual reality for the rehabilitation of patients with balance disorders. The objective of all rehabilitation procedures is to improve the patients' functional abilities. To this end, numerous rehabilitation procedures are used working with the patient in the rehabilitation workplace environment, or the patient rehabilitates in the home environment which is relatively constant. Rehabilitation, in particular during the early phases, represents a rather high load for an ill person that may significantly affect the functioning of the cardiovascular apparatus; having exceeded a certain load tolerance limit the load may slow down the rehabilitation process or even make the patient's condition worse. The group is now working on monitoring of the rehabilitating patient's locomotion activities and the reactions of the cardiovascular apparatus, on using virtual reality for rehabilitation of patients with balance disorders and on monitoring the rehabilitation development of motility disorders – objectivization of the range of motion.

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New trends in disaster medicine

Protection of the population from extraordinary and emergency situations is characterized as a set of activities, procedures and measures aimed at minimizing the impacts on the lives and health of people, property and the environment. It is based on fundamental principles implemented all over the world in developed countries where protection of people is organized. An important component of population protection is civil emergency preparedness as an autonomous, non-military area of planning the protection from the impacts of extraordinary events and crisis situations. Within the Czech Republic's safety system, civil emergency preparedness is, in particular, a process tool for predicting serious extraordinary events and crisis situations and for making preparations to cope with them. Our research activity is focused on three priority areas:

- fast diagnostics and protection of the organism from damage by chemical, biological, radiological and radioactive substances through the

development of new biodosimetric methods and technologies for field and laboratory analysis of chemical warfare agents and other toxic compounds presenting safety hazards with an emphasis on their testing and designing innovative decontamination measures. Another priority is the development of the TOXALS methodology;

• study of pathophysiological phenomena in stress situations, adaptation of the organism to cold and heat, and possibilities of potential protection of the organism from permanent consequences, study of optimum nutrition habits in the conditions of exposure to external threats. A special emphasis is on wound healing in extreme conditions and the development of relevant technologies;

• elaboration of critical infrastructure principles in healthcare and their application within corresponding emergency plans and methodological procedures.

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Evaluation of immediate eye, head, limbs and body position in clinical practice

Numerous systems for the evaluation of eye and body positions are currently offered, but their wider application is impeded by their high financial demands. The systems developed at CTU are their direct opposite trying to use technology commonly available even in everyday life. The adaptation of older, but also new devices to the doctors' needs, their replacement with new units, but also the design and construction of completely new specialized devices, all this falls under the research team's rich activity involving the participation of many students. Within the wide scope of activities, the following three applications must be mentioned:

• pupillometry and craniocorpography

• a system for a measurement of immediate head position based on an analytical calculation of angles evaluated by means of two cameras placed opposite each other, with a correction of axial non-alignment;

• measurement and analysis of motion in neurological patients.

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Electronic study fields and subjects support examples

The paper abstract presents selected examples of the electronic support of education at the Faculty of Biomedical Engineering CTU, which are within the faculty very important. Below is a brief description of these examples. At the same place, there is available contact responsible person.

Neurophysiological signals

Within the teaching, the issue of sensing and processing of biosignals is very important, especially for technical study fields. In this case, it is important for students to illustrate ways of sensing, processing and evaluation of biosignals. A very good example is the support for this issue via e-learning system Moodle [4] in the field of neurophysiological signals. There are available specialized SW for students (under Windows and DOS), educational videosequences and educational texts. Below are summarised some details about selected educational items from this topic (see Figs. [1]-[4]).

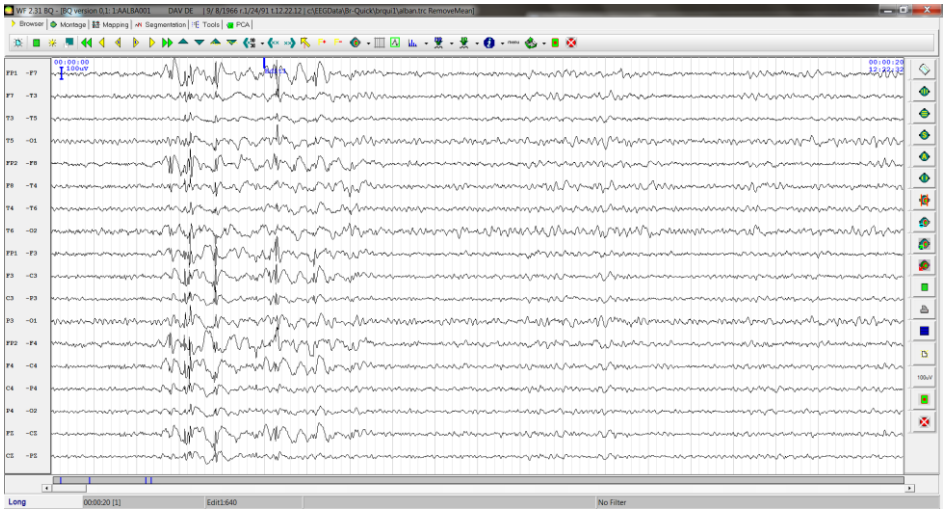

Figure 1: SW WaveFinder for EEG records processing

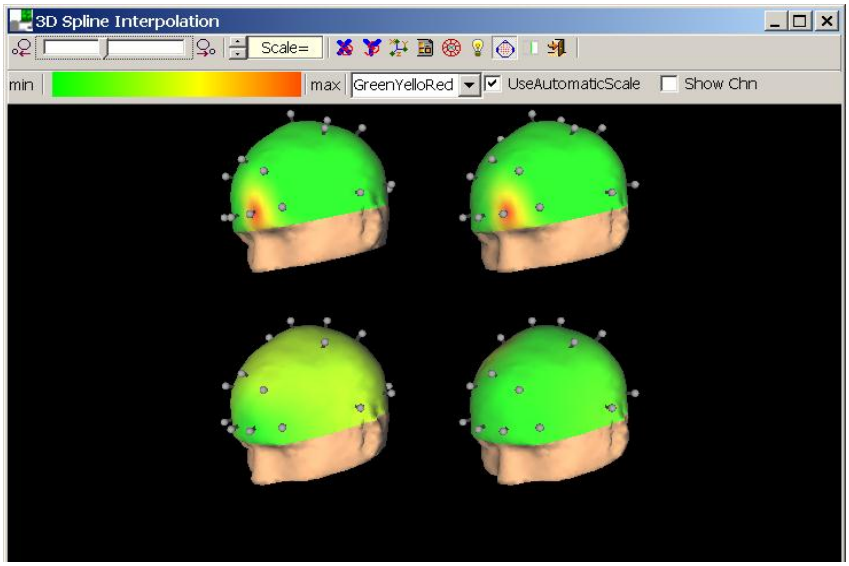

Figure 2: SW for brain mapping

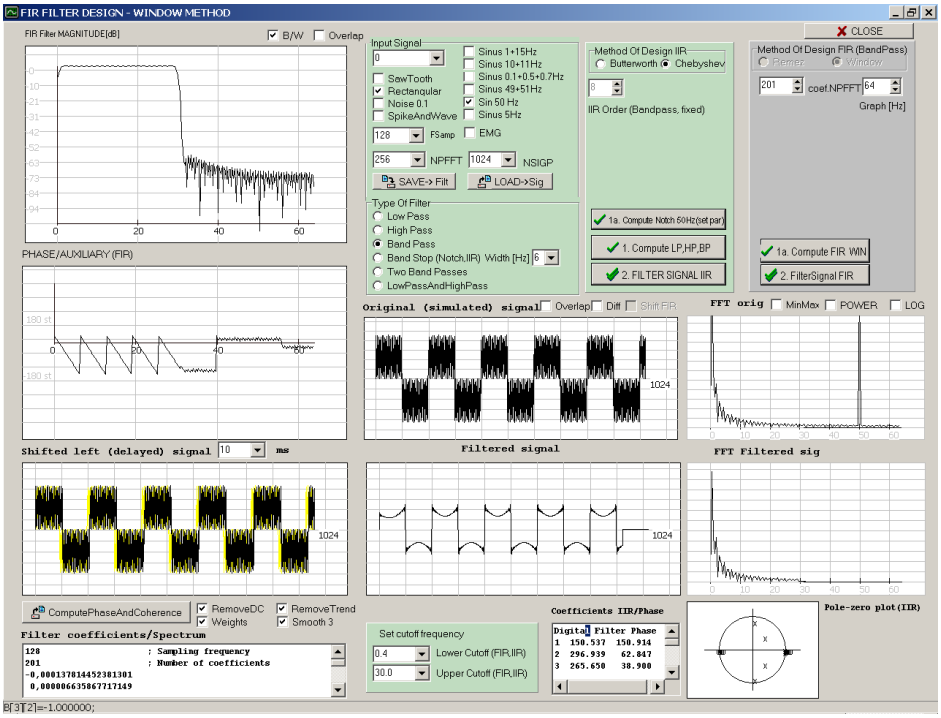

Figure 3: SW for digital signal filtration, IIR and FIR filter design and spectral analysis

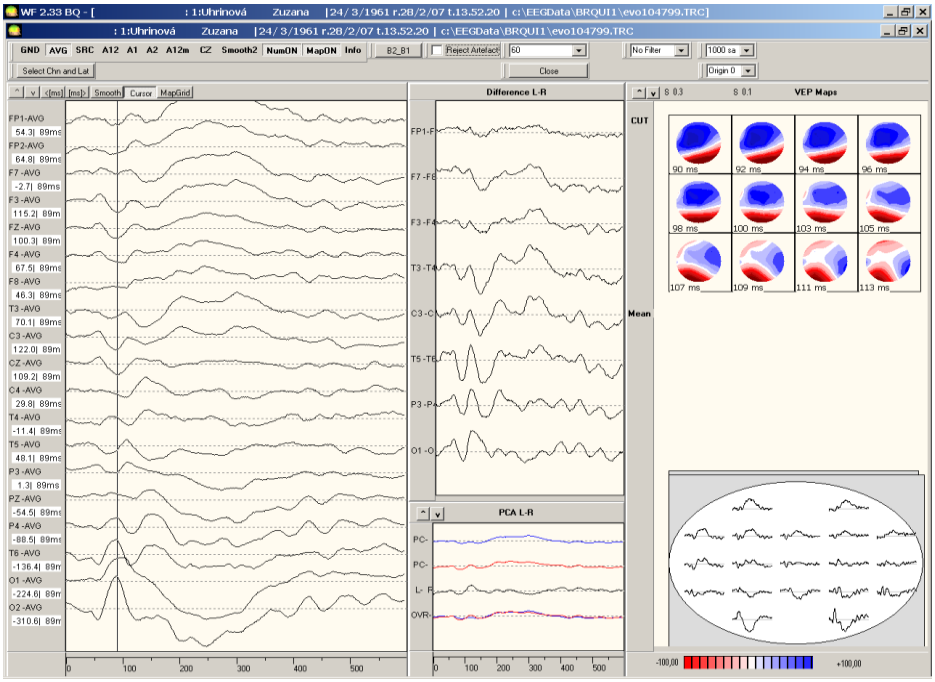

Figure 4: SW for flash VEP (Visual evoked potentials)

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Hospital information system

Based on the external experts requirement was introduced in the teaching the commercial software product - the hospital information system (HIS). This product allows for different levels to familiarize students with the basic tool used in health care. Students can be users, managers, as well as programmers and to have possibility to develop system according to specifications during exercises. Another advantage is the ability to connect devices via a defined interface to simulate the real situation in a medical facility.

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Testing knowledge via EduBase2 system

This system is mainly used as a form for self-study and self-verification before the credits, classified credits and exams, but also within them. A typical example of utillization is the subject Medical terminology in the field of study

Biomedical technician, but also within other fields. The following screenshots (see Figs. [5]-[7]) illustrate the important phase of the system. Detailed description is available on [5].

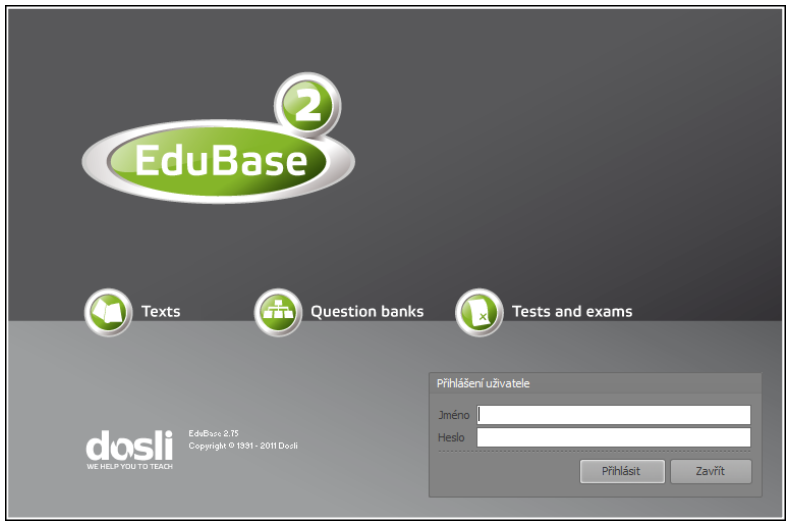

Figure 5: Introductory screen of the EduBase2 application

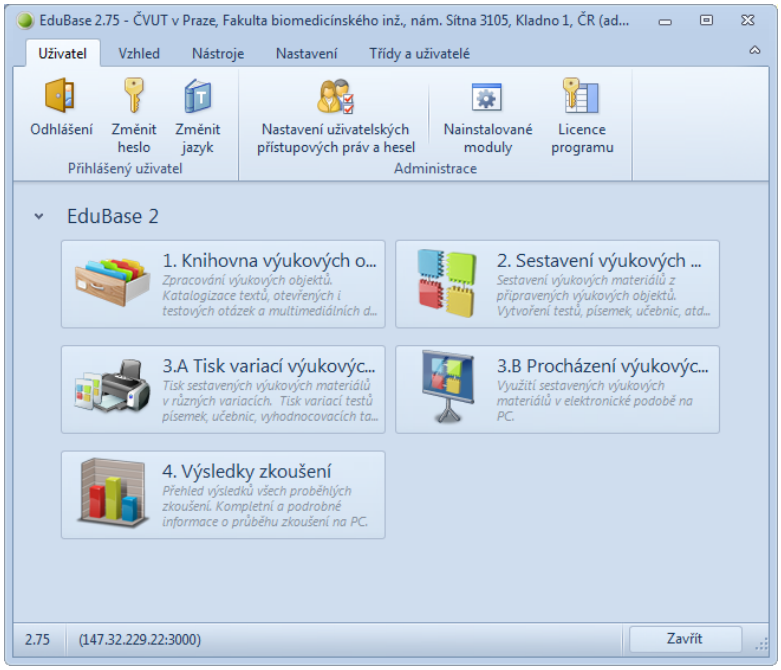

Figure 6: EduBase2 environment with all possibilities

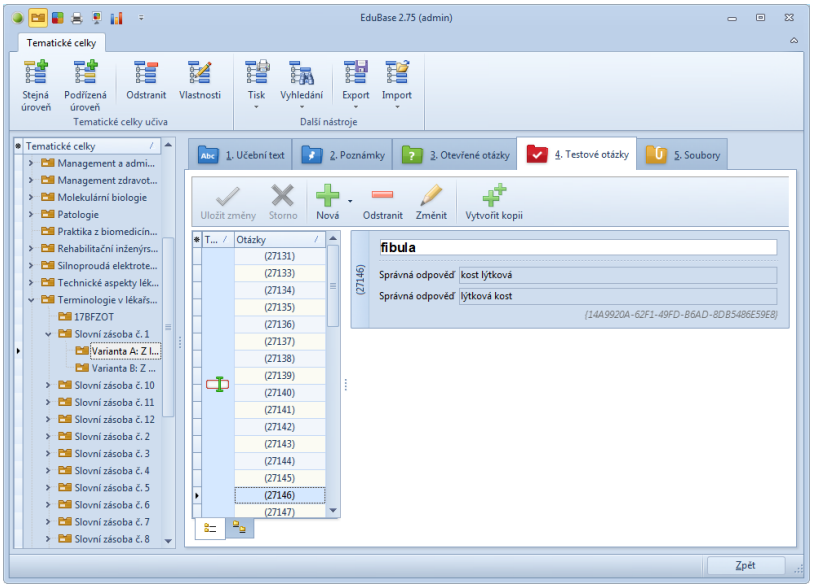

Figure 7: EduBase2 question editing tools

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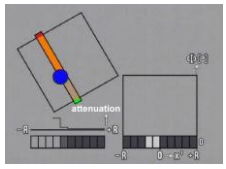
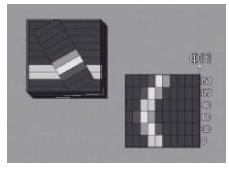
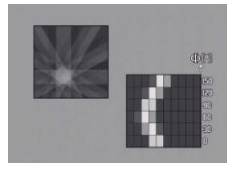
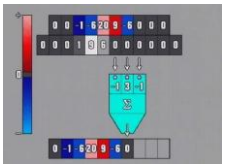
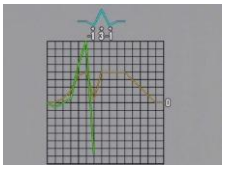
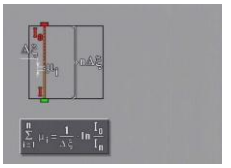
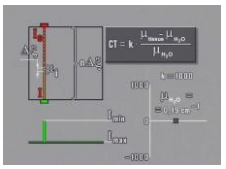
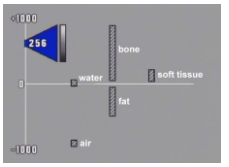
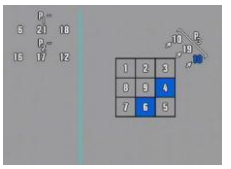
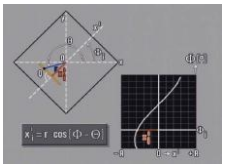
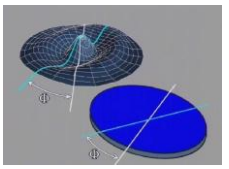
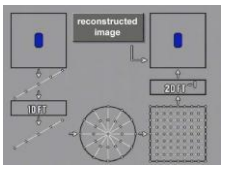
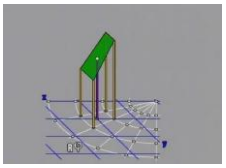
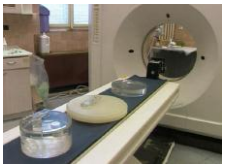
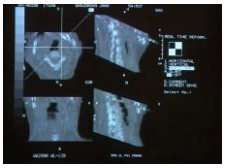
Medical imaging systems

This topic has a very good support which was created for a long time. There were created educational videoprograms from the field of CT (in Czech and English as well, [8]), web portals as SPECT-PET and X-ray [6], [7], support of the image sensing and processing [13], [14] etc. All items are very good selfstudy tools. Below there is Tab. 2 with a few illustrations from the CT educational videoprogram.

Table 2: The most important illustrative parts of educational video-program

		
Radon space	Direct back projection	Star artefact

		
Filtered back projection	Convolution principle	Basic physical principle
		
CT numbers	Displaying of CT numbers	ARM (iterative method)
		
Different sinograms	Fourier method of reconstruction – intro	Fourier method of reconstruction - scheme
		
Interpolation	Phantoms and calibration	Different planes of slices

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Simulated workplace of the ICU

The newest laboratory is a simulated intensive care unit workplace where all fields of study have possibility to use artificial patient METI ECS [11]

including modern medical devices. In addition, selected devices have the ability to connect to the HIS, or have the opportunity to be controlled from the PC. In addition, this workplace has a real physical hardware simulator of the hospital electrical distribution, which provides conditions as it is a real hospital facility. The workplace is used to teach technicians, but also for other health professionals. A significant advantage is the ability to create artificial pacient scenarios behavior and verify the behavior and activities of students. This workplace is also equipped with other simulators, both physiological parameters, as well as testers and analyzers for medical devices. The workplace is also suitable for teaching within the accredited qualification courses of the Ministry of Health Czech Republic.

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Anatomy and physiology

Since the anatomy and physiology in particular, are among the priority fields for all disciplines in the Faculty of Biomedical Engineering CTU, there is dedicated to teaching aids in this area high interest. Therefore, there were selected products A.D.A.M. Interactive anatomy and ADInstruments PowerLab. In addition to high-quality graphics, applications PowerLab offers also very good extension for connecting hardware simulation module, which allows verification of selected physiological functions and parameters directly to the student with the necessary sensors and transducers. These tools seem to be a very suitable interdisciplinary teaching tools within the biomedical engineering. Detailed description is available on [9] and [15].

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Other examples

At the end of this paper we would like to include last but not least examples of the electronic aided teaching. One example is www page of the Radiobiology [12] where is available teaching texts from the fields as the physical aspects, effects, detection and dosimetry of ionizing and non-ionizing radiation. The whole texts are complemented by videosequences, presentations (in PPT, PDF and PNG format) and questions under the selftest. This web page is very good base (complex interdisciplinary summary) for all fields of study at the Faculty of Biomedical Engineering, CTU in within the topic - ionizing and non-ionizing radiation.

The second one is from the field of the image acquisition and processing in biomedical microscopy. The main idae is to perform support of the field of the image processing. From these reason there were created specialized teaching SW MIPS, which is available at the www page [14]. Unlike commercial software, this educational MIPS software allows users to try everything from the field of the image processing and analysis and use on-line help also to understand everything. Another advantage is very easy to use without complicated installation and functionality independent of the OS platform. This educational SW MIPS is freeware under the condition of the non-comercial use.

There is also available educational videoprograms from the field of the rehabilitional engineering in Czech (conventional prostheses, myoprostheses etc., see Fig. 8).

Figure 8: Introductory screen of the educational DVD video

Contact persons are available on the relevant www pages, please see [12] and [13].

Conclusion

One of the main priorities of our faculty is to have a very good laboratory infrastructure for high-quality teaching and research experiments from the field of biomedical engineering and paramedical fields.

From this priority follows our aim to offer complete electronic support of teaching and learning as the second the most important possibility how to guarantee the required quality of paramedical professions. There is added value in the idea to perform relationships between the hardware oriented experimental laboratory teaching and electronic support of this teaching.

This approach is very time consuming and expensive. But the result is highly valued by students (especially within the long-distance study) and experts from clinical practice.

Our faculty is interdisciplinary based faculty with high interest to co-operate with experts from such fields as biology, medicine, informatics and other related fields to biomedical engineering. Our idea is to create teaching material and tools under the co-operation with the above mentioned experts. From our point of view this is only one possible way how to create quality interdisciplinary teaching material and tools.

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