The role of Ukrainian universities in the development of the global information society

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Abstract

This paper presents observation of the positive experience obtained by Kharkov Technical University at the area of education specialists for the development Information Society Program. Economical problems postpone beginning of Information Society Program in the Ukraine. Nevertheless Ukraine has now good possibilities to apply the best experience of western universities and speed up the process of transferring existing education to the European level. The paper also presents analyse of the main trends that are taking place in that education. The paper uses the example of one of leading Ukrainian technical universities to show the possible ways of positive changes in education in the framework of the developing the national infrastructure of the Ukraine. The examples show how the universities' science can be involved to large-scale transeuropean projects connected with problems of the Global Information Society.

INTRODUCTION

Ukraine is a republic located in the eastern Europe and it is a founding member of the Commonwealth of Independent States, which in December 1991 succeeded the USSR. With a total area of 603,700 sq. km and population of 51 million, Ukraine is now the second largest country in Europe (after Russia). Traditionally Ukraine has been on high level in science and education. It has hundreds of universities and research institutes, and it has been on quite high level in universal and obligatory secondary education. Economical problems, connected with disintegration of the states of the former USSR, and Chernobyl catastrophe, postponed the initiation of Information Society program in Ukraine. The ongoing process of the infrastructure development presupposes solution of several problems connected with cultural and ethical peculiarities of the Ukraine.

Information Society program has been started in the Ukraine. First official document: “National Information Society program of the Ukraine: Urgent Steps for the period 1996 - 2000” has been signed in Kiev at 30.10.1995 by the head of Agency for Information Society Problems attached to the President of the Ukraine. The Document notes that current level of the Ukraine in the area of Information Society development is unsatisfactory (2 - 2.5 % comparably to Western countries). It also includes the analysis of factors that are slow down processes of successful development of the Information Society Program. The budget funds are planned to support:

- development of the National Infrastructure;
- development of the National Telecommunication System;
- information support development of the strategic directions of the State interests, security and defence, social sphere.

The urgent steps are to develop the base of standards and laws for Information Society Program of the Ukraine towards to be co-ordinated with International standards.

THE ROLE OF EDUCATION IN INFORMATION SOCIETY OF UKRAINE

We suppose that Ukrainian universities are able to make essential income to the success of the Information Society program through:

- education of a new type of specialists;
- co-operation with foreign universities and applying their best experiences in education;
- making research at the strategic directions of the Global Information Society;
- spread the culture of the Information Society;
- developing exchange programs for teachers and students;
- applying European foundations to support joint projects.

To become the driving force in the Information Society development, Universities themselves have to develop a lot in their own organization. We suppose that Universities have to:

- develop curricula for Computer Science specialities towards best standards of European education and in the same time to keep up best of national traditions (for example, high level of mathematical studies);
- pay more attention to language studies, co-operation and negotiations skills to prepare possibilities for wide exchange programs;
- reconsider economical education in the universities taking into account essential changes in national economics;
- develop administrative structure of universities by applying evaluation technique which is based on well defined formal criteria;
- develop the system of funds distribution between and inside universities towards formal criteria also (such as international conferences, papers, exchange programs, doctoral thesis and etc.);
- begin use and teach to use legal software;
- find possibilities to install Internet and WWW facilities in the universities.

We consider that such changes in universities would help very much in developing the national infrastructure because of following trends:

- co-operation between Western and Ukrainian universities is growing. Western partners help very often with computers, organization of Internet connections. New modern courses applied in Ukrainian universities will need facilities quite soon for teleeducation and teleconferences using the experience of best lecturers from abroad. The requirements to apply most of European Community foundations mean for universities the necessity to find new partners, to establish new contacts. In such situation the infrastructure of Ukrainian higher schools will be developed quite fast;
- Ukrainian companies also need partners from Western countries as well as new information technologies and good specialists. This means that contacts will grow (including information exchange and electronic connection) between universities, who will be first involved to the European infrastructure, and Ukrainian companies. Thus the Ukrainian companies are also expected to join the Information Society quite soon;
- Scientific schools and research laboratories of Ukrainian universities have already results and experiences at their disposal in traditionally strong areas of national research that allows them to start some large scale transeuropean projects together with Western partners. This would effect very much on the role of the Ukraine in the European infrastructure and makes it possible to earn essential funds for the developing of the Information Society program of the Ukraine.

Kharkov State Technical University of Radioelectronics (KHTURE) is one of the main universities educating specialists for the Information Society program of the Ukraine. KHTURE is the main institution to develop Information Society Program in the most industrially and scientifically developed region - the north-east of the

Ukraine. The way, which has been selected to improve the level of research and teaching activities in KHTURE, is international co-operation and use the experience of Western universities. *Faculty of Computer Sciences* with four specialities and twelve scientific schools in the area of Computer Sciences is the leading faculty among Ukrainian universities. It develops curricula, methods, teaching aids that are applied to the education at the similar faculties of other technical universities. *Research and educational laboratory Metaintelligence* as part of KHTURE has the main goal to participate development of the Information Society program of the Ukraine through international research and co-operation. Research topics of the laboratory include: knowledge and metaknowledge engineering; expert systems and multiple experts problems in medicine; metamodels and metatools for information processing; mathematical methods and tools for biosignal analysis; metamathematics; computer supported co-operative work; intelligent navigation in information systems; human-computer interface.

In this paper, we show some experiences of the KHTURE and the Metaintelligence laboratory in developing education and research projects in the framework of the Information Society program of the Ukraine.

DEVELOPING CURRICULA FOR COMPUTER SCIENCE SPECIALITIES

The new curriculum, which has been developed in KHTURE in co-operation with University of Jyvaskyla (Finland), includes the following main changes in comparison with traditional education in the Ukraine [14]:

- economical education is extended twice and the contents of it takes into account changes in Ukrainian economics towards the market orientation;
- mathematical education has still essential role in the curriculum but it is also improved by developing the contents of some courses, for example, statistics, symbolic mathematics, and optimization methods;
- the curriculum includes a choice of main speciality of two ones: Artificial Intelligence and Information Systems. The traditionally high quality AI education will be strengthened by additional up-to-dated courses. The block of Information Systems courses is totally renovated. It will include the following courses: Information Management, Tools of Personal and Group Work, Object-Oriented Development of Information Systems, Designing Information Systems, Advanced Course on Developing Information Systems, Theoretical Foundation of Information Systems, Strategies for Information Technologies and Business Development, Computer-Supported Co-operative Work, Management Strategies for Information Technology and its Assessment;
- the Educational and Industrial Training, which has previously been shared through the whole 5-year education using summers, has now been reorganized into the System Development Project according to the best experiences of the Department of Computer Science and Information Systems of the University of Jyvaskyla;

- the language education is extended almost twice and the language studies are planned to be essentially improved by modern methods and students' exchange.

In the new curriculum, software systems are expected to be developed and used during many courses, for example: in general studies small information and expert systems will be included, in economic studies accounting and other economical systems will be used, in mathematical studies training systems will be used, in artificial intelligence studies some research prototypes will be produced, and most of M.Sc. thesis will also include development of software that implements or verifies the ideas presented. Students will also be supposed to produce and present software in workshops, conferences, and exhibitions as previously.

Recent plans in education area are to develop the University infrastructure and to organize distance education (lectures, summer schools) using lecturers and telelearning facilities of the University of Jyvaskyla, which is the main foreign partner of KHTURE.

Authors are optimistically considering perspectives of Ukrainian computer science education and its effect to fast development of the Information Society in the Ukraine. They also sure that co-operation, between European partners (companies and universities) and Ukrainian universities, seems to be beneficial to both sides.

MULTIPLE EXPERTISE AND TELECONSULTING TELEMEDICINE SYSTEMS' DEVELOPMENT

This project is initiated by the Metaintelligence laboratory together with students of KHTURE and concerns the area of artificial intelligence applications in telemedicine. The project brings together experience of Ukrainian researchers in computer-based intelligent medical systems, with experience of Finnish researchers in the area of telecommunications, with their common experience in the area of multiple experts and also with the expertise of German researchers in development of adaptive procedures of time series analysis and their application to problem settings in the biosignal analysis. The main goal of the project is to manage multiple expertise obtained from experts-physicians in different countries to develop decision support medical system of broad earmarking based on telecommunication tools.

Project objectives

The project brings together experience of Ukrainian researchers in computer-based intelligent medical systems [3,4,5] and signal processing [1,8], with experience of Finnish researchers in area of telecommunications (completely new, innovative telematic Studio local and remote multi-media groupware, computer-aided negotiation suites, and telelearning environments simulation and virtual reality, SUN and Silicon Graphics, Internet, WWW services) and computer-supported co-operative work [9,10], with their common experience in area of multiple experts

[2,6,7,15,16], and also with expertise of German researchers in development of adaptive procedures of time series analysis and their application to problem settings in biosignal analysis [11,12,13].

The long and successful history of research co-operation between Ukrainian and Finnish Universities and reasons to develop it further are presented in [14]. The very important results obtained in the Institute of Biomedical Engineering and Medical Informatics (Technical University of Ilmenau) and mutual interest for co-operation was the reason to include the German partner into the project.

Research methods

Multiple experts voting-type technique

The voting-type technique to manage knowledge obtained from multiple sources was proposed by Prof. S. Puuronen (University of Jyvaskyla) and Prof. V. Terziyan (Kharkov State Technical University of Radioelectronics) in [2,6,7].

The technique used is based on the derivation of the most supported opinion of the group of experts and refining it further using a multilevel structure of knowledge sources or concepts.

The final statement (diagnosis) obtained as the result of refinement process takes into account opinions of all experts according to their competence area and the level of their expertise.

Metaclassification technique with multiple statistical methods

The first version of intelligent system for statistical data processing MetaHuman-96 (MH96) was developed by researchers of Metaintelligence Laboratory (Kharkov State Technical University of Radioelectronics) for the decision of medical diagnostic's problems [3,4,5]. The problem of medical diagnostics was solved with the help of modern methods of discriminant and regressional analysis with use of the information from training sets. MH96 contains the metamethod to support a user decision-making about choice a method for a specific problem of medical diagnostics. The metamethod advises to a user a selection of one of the methods available in the system or offers a combination of them. The system allows to manage various medical databases (user is allowed to configure structures of databases) and, using these data, to make an analysis of a new object of diagnostics.

Adaptive procedures for biosignal analysis

The researchers from the Institute of Biomedical Engineering and Medical Informatics (Technical University of Ilmenau) leaded by Prof. G. Grießbach are focused in development of adaptive procedures of time series analysis and their application to problem settings in biosignal analysis. In the computer-aided analysis of biosignals, adaptive time series analysis methods [13] are gaining more and more importance. Due to their recursive proceeding, they permit an on-line evaluation of the time series, and, due to their adaptive properties, a quick adaptation to changes occurring in the time series. In addition, they are robust against the great variety of signal structures, thus representing an algorithmic initial approximation equally for deterministic signals with trend and transient signals. The recursive consistent estimate functions for parameters of stochastic processes are the mathematical background of the adaptive procedures.

Dynamic methods in the spectral domain are necessary to analyse biological signals because of the frequently nonstationary character of the signals. At present not only the development of other adaptive parameters (e.g. adaptive recursive test statistics) is investigated but also their mathematical-algorithmic properties. In addition they are implemented by means of object-oriented technologies [11]. In [12], an adaptive procedure was proposed, of fitting time-dependent models to nonstationary signals, which is suitable for on-line calculations.

The essential role in developing telemedicine projects belongs to students of KHTURE who are already well educated to develop large software systems. Installation of such teleconsulting centres in the Ukraine helps first of all to persons who have hard consequences of the Chernobyl catastrophe and gives them a possibility to use also the experiences from foreign experts.

INTERNATIONAL TELECONSULTING CENTRE ON MATHEMATICAL EXPERTISE

The another important positive tradition in research in countries of the Former Soviet Union is the high level results in area of mathematics. Now it is very important and useful to make all those results, that have been obtained during the long history of main mathematical schools in Russia and other eastern countries, available to the European and world society. One example of possible way to establish access to the mathematical expertise is discussed in this chapter. The example supposed that profit obtained from realizing of such possibility can be used by the Russian and Ukrainian universities to develop their own infrastructure.

Modern technological processes consist of complicated movements of media in different phases and dynamic phase transitions on free surfaces: melting, solidification, evaporation, condensation, etc. Most of the current mathematical models of phase changes include only a part of the physical phenomena (for example separate Stefan equations or separate Navier-Stokes equations). For many physical situations it is very important to take into account interactions between different types of processes and media. The physical experiments in this area are very expensive and it is difficult to get the full information about processes of interest. One can make inaccurate conclusion about the behaviour of the physical system. For this reason the correct construction of the full complete model with coupled system of equations for different processes and media with phase transitions has a big and practical interest. Using the expert system the investigator can choose the different mathematical models according his needs:

- mathematical model of stationary flow and heat mass transfer with fixed or unknown boundaries between the phases;

- mathematical model of deformation and thermodynamic state of solid body with a boundary between solid and liquid phases;
- quasi-stationary mathematical models of phase change problems (the stationary Navier-Stokes and the constitutive equations for free solid part and non-stationary thermodynamic equations);
- non-stationary mathematical models of phase change problems (melting process, the non-stationary Navier-Stokes and constitutive equations for free solid part and the non-stationary thermodynamic equations.

Theoretical analysis of this mathematical models includes the proof of smoothness, uniqueness and stability. Finite element method is used for the numerical analysis of phase change problem. Using this method one can get:

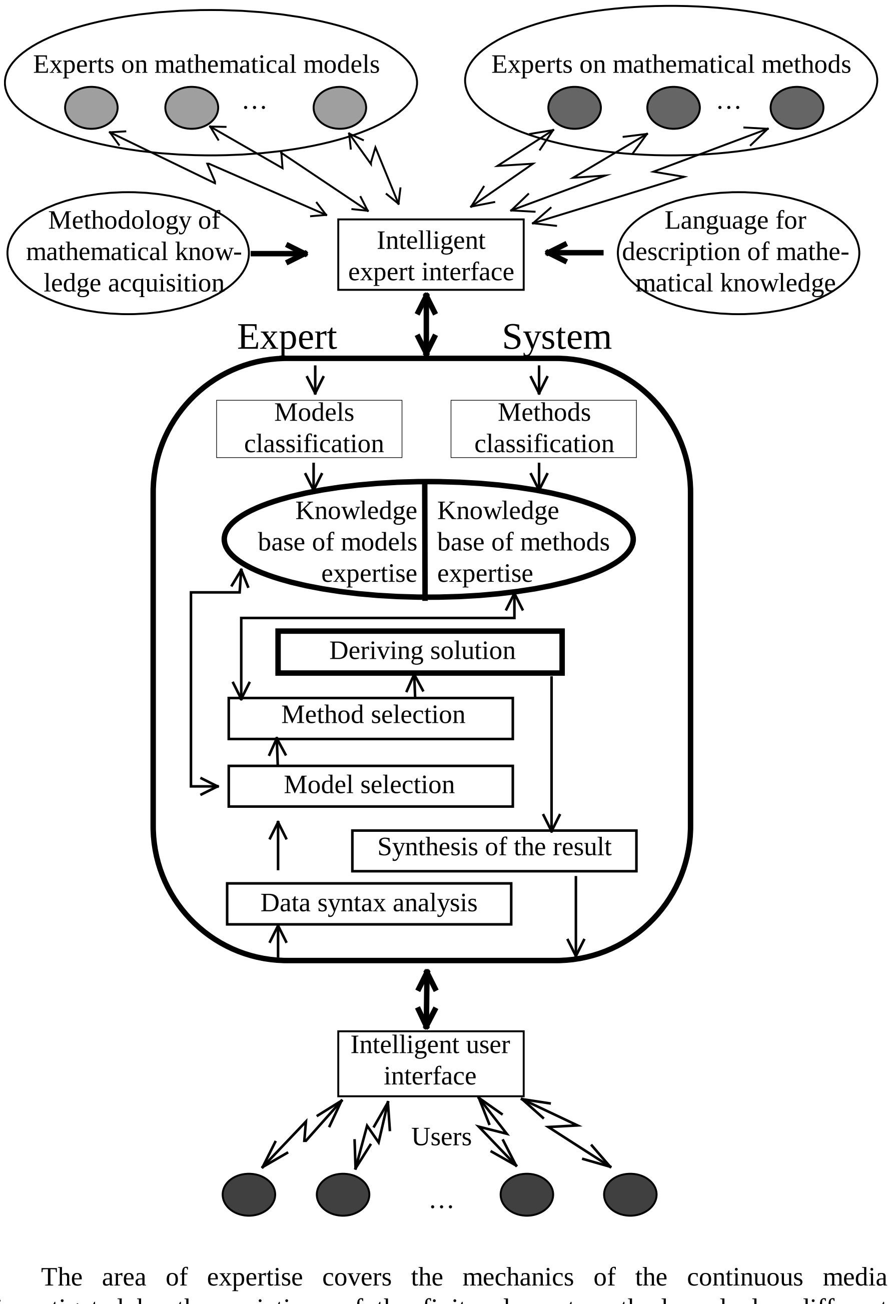
- numerical simulation of the stationary boundary problems for the Navier-Stokes equations, using domain decomposition method, parallel algorithms, multi-resolution method, grid refinement;
- numerical simulation of the initial boundary problems for the nonstationary Navier-Stokes equations for arbitrary domain's shape, using projection method, domain decomposition methods, up winding schemes;
- numerical simulation of boundary value problems of solid and mixed medium in arbitrary domain;
- numerical simulation for coupled phase change problem.

In this project the expert system will suggest to the investigators the models for the different phase change problems and their numerical simulation. The models will include thermodynamic and constitutive equations for each phase and physical natural conditions on the unknown boundary between the phases. Expected results: using the expert system the investigator can choose some of the mathematical models, test is it correct or not and get a numerical simulation of the problem.

The International Teleconsulting Centre on Mathematical Expertise (TELEMATH) is planned to be installed at the Laboratory of Scientific Computing of the University of Jyvaskyla. The TELEMATH Centre will sale services to a wide network of users all around the world. The structure of the TELEMATH Centre is presented in Figure 1.

The expert system of TELEMATH is intended for solving complex multiphase and multiinterfaces problems using knowledge of mathematical models and methods acquired from multiple experts-mathematicians.

Fig. 1. Structure of teleconsulting centre on mathematical expertise



The area of expertise covers the mechanics of the continuous media investigated by the variations of the finite element method, and also different mathematical models: the reaction-diffusion; the heat conduction; the laminar and turbulence flows of the viscous compressible and incompressible liquid and gas; the deformation of the solid body with different reological laws; coupled problems with the phase changes and free boundaries and others.

The TELEMATH learns by acquiring expertise from different experts through an intelligent expert interface using a special methodology of mathematical knowledge acquisition and representation or unique expert language for mathematical knowledge description. Expert system receives a problem from a user through the intelligent user interface, controls its correctness, selects mathematical model, determines the regions geometry, initial and boundary conditions, selects a method (the type of the finite element, the order of approximation, domain discretization, the way of solving the final system of equations), derives the solution and introduces it to a user. The system is able to organize a teledialog with experts in cases when it cannot itself make a decision. It is also possible to expand the knowledge bases by new models and methods permanently obtained from the experts. The organization of expert system, methodology of knowledge acquisition, language, classification technique, interfaces supposed to be easily reoriented to new groups of models and methods.

The project uses methods described in previous chapter. The *voting-type technique* is used to manage knowledge obtained from different experts about the same mathematical object. It allows to find consensus among the experts concerning the description of a method or a model. The *metaclassification technique* is used to describe metamethods of selecting mathematical methods for a problem solution.

The project brings together experience of Ukrainian researchers (KHTURE) in development large computer-based intelligent systems, classification techniques and multiple expertise, with experience of Russian mathematicians (St. Petersburg State Technical University and North-West Polytechnics Institute) in area of mathematical models of the mechanics of the continuous media and variations of the finite element method [17,18], with experience of Finnish researchers (University of Jyvaskyla) in area of telecommunications and information technologies. The project is also supposed to use widely students to develop and classify mathematical methods and develop software.

CONCLUSION

This paper presents observation of the positive experience obtained by Kharkov Technical University at the area of education specialists for the development Information Society Program. Economical problems postpone beginning of Information Society Program in the Ukraine. Nevertheless Ukraine has now good possibilities to apply the best experience of western universities and speed up the process of transferring existing education to the European level. The paper also includes the analyse of the main trends that are taking place in that education. It presents an optimistic view to a future of Ukrainian education and its essential role in the process of developing of the Information Society in the Ukraine. It uses the example of one of leading Ukrainian technical universities to show possible ways to develop the organizational structure, education and research activities in Ukrainian higher schools to be able to participate the development of the Global Information Society.

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