

## University Virtual Laboratory for Education and Innovations in Scientific Researches

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**Abstract:** *The purpose of article is to study the processes of creation and development of virtual laboratory for education, mathematical modeling and computer simulations in the scientific researches in the field of forestry, agronomy and veterinary medicine, corresponding to educational and scientific needs of University of Forestry.*

**Key words:** *Virtual Laboratory, Virtual modeling, e-learning, Life sciences, Forest resources, Agronomy, Veterinary medicine.*

### INTRODUCTION

The purpose of the present study is to determine the founding moments in approach for creation and development of virtual laboratory for education, mathematical modeling and computer simulations in the scientific researches in the field of forestry, agronomy and veterinary medicine.

Laboratory will be established as specialized research section within the structure of University of Forestry, Sofia (UF) with main goal research, development and implementation activities for research, application and development of complex scientific and educational innovations in the field of multifunctional usage of forestry resources, in the stable agriculture growth, plant protection and veterinary medicine. The laboratory will execute tasks concerning analysis, development and transfer of technologies for virtual education and virtual modeling in the scientific experiments in expedient interdisciplinary scientific fields.

### PROBLEMS AND CURRENT STATE OF VIRTUAL LABORATORIES IN EUROPEAN SPACE

Integration of modern technologies for education and perspective information and communication solutions in the national educational system is most effective within unified educational space and means reorganization of both content and organizational forms of educational activities, creation of modern means for information-technological support and development of both educational and research processes.

Realization of such strategy requires creation, within the educational institution (or network of institutions), of integrated information platform for education, based on specialized program-instrumental means and educational content, which could be defined as information-resourceful or rich in content virtual platform for education and innovations in the scientific researches.

Educational platform of modern educational systems is formed from cooperation between traditional and innovational learning models, systems of standards, integrated content of learning plans and programs, educational means and materials, as well as new interaction quality, dialogical and corporate communication between the educational subjects. Creation of mobile information-educational platform, based on modern information and telecommunication technologies, guarantees principally new level of access to quality education.

One of leading aims of high university degree specialists' preparation is their ability to produce and implement innovations, for which they should possess adequate knowledge, to be familiar with the technology for discovering novelties and their implementation. University education is connected to generation of new knowledge most of all, their management, as they are key components of the innovational process.

It is important to analyze whether form virtual laboratory for education and innovations in the scientific researches is being applicable currently and if it has

potential and perspective. Analysis reveals, that such forms are up to date and used in Europe and Bulgaria. Brief analysis below illustrates the accumulated experience.

University of Rousse - "Angel Kanchev": Virtual laboratory in electronic education in discipline "Computer organization"; Virtual laboratory in physics – offers to students group of virtual exercises from all fields of physics.

Medical University – Sofia: Web-based course; enhances the traditional education in biochemistry with interactive simulations of clinical cases, virtual laboratory and visualization of complicated processes.

Technical university – Sofia: Laboratory and center for Virtual engineering. A connection is expected, between system for virtual reality in TU – Sofia and newly founded center for technological engineering solutions within University of Karlsruhe, Germany for combined projects and cooperation; Virtual laboratory within Faculty of telecommunication technique and technologies, part of global project – vLab – Virtual laboratory for "Automated systems for measurement and control".

University of Chemical Technology and Metallurgy – Sofia: Virtual laboratory in applied mechanics.

European Virtual laboratory in mathematics (EVLN) <http://evln.stuba.sk/>.

University of Poznan – Vlab: Architecture of Virtual Laboratories (<http://vlab.man.poznan.pl/eng/>).

University of Oulu, Finland – <http://vlab oulu.fi/eng/index.html>

Institut für technische chemie, Universität Leipzig – An Internet-Based Laboratory Course in Chemical Reaction Engineering and Unit Operations;

Alcalá University, Madrid – Internet Based Laboratory for Experimentation with Multilevel Medium-Power Converters.

The above stated examples show, that creation of Virtual laboratories is an ongoing practice in Europe and Bulgaria and is supported by research programs of European commission. Laboratories integrate the efforts of interdisciplinary teams of scholars.

### **APPROACH FOR CREATION OF VIRTUAL LABORATORY**

Virtual laboratory is intended to combine, based on the program-goal principle, the scientific and educational capacity and resources of UF for researches and creation of high-end technologies for virtual modeling and education in the field of forestry and forest industry, landscape architecture, agronomy, plant protection and veterinary medicine.

In the work of virtual laboratory will be involved lecturers from Department of Computer Systems and Informatics, as well as leading lecturers and scientists from University of Forestry.

For completing its tasks and goals, vLAB will be used and will assist the development of information and technological structure of the university as a general virtual platform for education and development of scientific researches in prior interdisciplinary fields:

- ✓ stable usage and development of biological resources in forestry, agronomy and veterinary medicine;
- ✓ application of GIS-technologies and modern distance methods for protection, monitoring and reproduction of environment;
- ✓ stable management and development of forestry sector, agriculture and plant protection, veterinary medicine.

The approach for creation and development of virtual laboratory for education, mathematical modeling and computer simulations in scientific researches in the field of forestry, veterinary medicine, agronomy and plant protection is based on complex system for interdisciplinary scientific researches and education, including virtual and

distant experimental components, interactions between courses, seminars and testing systems.

The task is to analyze the possibilities of virtual reality (VR technology) and simulation modeling for assisting the education and support of the scientific researches in above mentioned interdisciplinary fields.

**Forestry and its compatibility with VR.** Forestry is a field, where precision of the scientific prognosis and the effectiveness of the management strategy are essential parts of success. Temporal frames, within which the forest systems react on performed events, are wide. More and more often, scientists turn to computer tools for modeling and visualization, for projecting the changes in the forest and estimation of their influence. Not long ago, visualizations were used mostly for modeling the effect of the global ecological changes, for estimation of yields, for visualization of different features and changes in the forest or for visualization of landscape. The importance of visualization in forestry is obvious. The need of visualization tools is growing, in particular for such instruments that could model the future forest resources and visualize dynamics of the forestry processes and ecosystems in time. This determines the increased attention to VR in forestry decision making.

VR is particularly suitable for assistance in solving problems in the following fields of forestry: temporal dependence, decisions irreversibility, spatial-volume modifications and multifunctional forest management.

**Interactive program/simulation/ models and applications in veterinary medicine.** Veterinary profession requires precise estimation and dynamic decision making. Learning is based on approach related to monitoring and repeating. Simulation-based approaches provide option for multiple repeating of observations till sufficient level of experience is reached. Fields of veterinary medicine in which simulation models in education are created and used are as follows: animal, fish and birds feeding, histology, pathology, radiology, surgery, anesthesiology, medicine dosage, clinical laboratory, meat hygiene. Application of simulation models in virtual laboratory assumes students to gather and analyze data on screen in such way that can be done with traditional equipment; realization of educational activities related to answering questions with one or more possible answers for testing of factological knowledge; exercises, related to analyses and data interpretation.

Implementation of multimedia learning, in which various situations are analyzed, present expert decisions, allows development of skills for thinking and decision taking in observation of several perspectives and availability of more than one possible ways to solve the problem. Setting up active knowledge in students becomes possible with integration of situational, strategic and full of matter knowledge.

**Geographical information systems (GIS) and their implementation in agronomy and plant protection.** GIS is a software pack and hardware designed to collect, store, update, analyze and visualization of information, connected with geographical location of the objects, for which it stands for. This type of information is realized through maps, geographical data and models for data analyses. Modern GIS provide opportunity, information for current nature and social phenomena in all fields of human activities, related to geographical alteration, to be permanently actualized and provided to users for analyses and decision taking in processes management. Computer technologies and contemporary aeronautic devices for observation of Earth provide possibility for real time monitoring and detection of variation in Earth surface, which are result from nature phenomena and human interference. That is why GIS is becoming popular in the area of agricultural resources management, especially in agronomy and plant protection.

Increasing in yield volumes is the major goal for achieving success in

contemporary competitive agricultural resources market. This situation requires growers to look for ways to increase the yields from the available lands under crops. One of the approaches for achieving effective results is the proper organization of the land fund in the agriculture, aiming achieving of effective cyclic recurrence in agronomic technologies for support and ecological self recovery of the soils.

Implementation of GIS-based models in learning process provides opportunity for achieving analytic skills, planning and management of agricultural activities, related to hydro melioration events, treatment with agrochemicals and fertilizers, fighting plant deceases and agricultural pests, based on structure information for the current and prognoses status of geographical characteristics (soil, landscape and climate conditions) of the cultivable area.

### **PRACTICAL STUDY OF POSSIBLE INSTRUMENTS FOR VIRTUAL LABORATORY**

The approach for creation of virtual laboratory, includes examination of simulation and visualization tools and instruments in the field of streaming media as well as estimation of there possibility.

In the present investigation were researched and analysed following simulation and visualization instruments:

*Forsi-simulator* – product of the Finnish company Plustech. It is with high level of precision in representing the forest landscape, with marking structures on the map, but does not allow movement or interaction with the basic objects;

*UVIEW* – designed by Robert J. McGaughey from USDA Forest Service, Pacific Northwest Research Station – computerized graphic representation, which picture the existing or expected landscape conditions. System offers flexible tools for analyses;

*Monsu* – developed by Timo Pukkala, University of Joensuu, initially has been designed for multifunctional forest planning, but also includes high visualization abilities;

*SmartForest* – developed by Imaging Systems Laboratory, University of Illinois, in cooperation with USDA Forest Service and University of Helsinki. Contains advanced instruments for moving and interaction within forest area.

*World Construction Set, Visual Nature Studio and Scene Express* – developed by 3D Nature LLC. Provides options for realistic views of real nature objects and places, using vector data DEMs/DTMs and information from remote sensors. It can model long term forestry planning, underground flows, ecological projects and recreational scenarios. Allow creation of maps, plans, stereo panoramas and “flight”. It can model disaster areas and show their progress.

The realistic view is possible through the option for setting digital data for leaves, clouds, mist, water, reflection, sun, sun rays, etc. The software allows modeling of objects alteration in time from one day to million years. Possible integration with ArcView/ArcInfo, ERDAS Imagine, ERMapper, AutoCAD, MicroStation, 3D Studio MAX/Viz, LightWave, etc.

The above mention instruments can complement different developments in the field of simulation modeling, based on scientific researches in university.

Some of the possibilities for high quality services connected to streaming media are:

*HELIX SERVER* – represents solution for acquiring streaming media with high quality. General advantages of this solution are acquiring of streaming resources in different audio and video formats, optimized ratio of investments to number of service users, and also possibilities for flexible politics towards using new formats. Observations show that solution fits well in heterogenic environment and allows decrease of expenses related to using different devices.

Another suitable solution for streaming media is *FLASH MEDIA INTERACTIVE SERVER 3*. Its advantage is the option to combine access to streaming media of large

number of users, with flexible and functional platform for creation and processing of streaming content. Also interesting are the possibilities for security management of the streaming media considering their classification based on access rights, broadcasting in real time and supply of content to mobile users, using phones with Adobe compatible software. This solution helps for effective usage of possibilities of the network infrastructure to supply content, as well as optimizing the process in accordance to the client possibilities to work with the streaming media.

As for decision choice, solutions with open source can be used, for example *Darwin Streaming Server*. This server for streaming media represents solution based on Apple QuickTime Streaming Server and is using standardized protocols for supply of streaming media. Solution can be realized on different platforms, allowing change of outsource depending on specific needs, but on the other side assumes availability of well prepared IT and communication technology unit.

*Microsoft Windows Media Services 2008* is free of charge as part of server operational system Windows. Solution is suitable for clients, using actively Microsoft products within their intra- and extranet networks, as well as internet services. Advantages of such solution must be found in opportunity for combining streaming media services with other network services, as well as many means for development activity. This can contribute for creation of new quality applications, combining different existing technologies and approaches.

### CONCLUSIONS AND FUTURE WORK

Virtual laboratory provides opportunity for alteration of parameters of the researched objects, characteristics and scale of surroundings, construction of which is too complicated to be realized in the real physical experiment. Preservation of the created model with option for future usage and reproduction of the experiment under changed parameters and conditions will accelerate scientific researches.

Virtual laboratory will provide hypermedia platform for delivering all types of information – text, graphics, audio and video, which will ease and intensify communication between young scientists, PhD students and post-docs. Result of the scientific researches will be available anytime and from any place with access to Internet, which provides flexibility, dynamics, interactivity of communications between them and new opportunities for their development.

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