Web Support of University Experimental Education by Means of Real and Virtual Lab Stands

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Abstract: - This paper is engaged in WEB support of new laboratory education forms by realization of physical lab models and virtual models. Virtual technologies connected with these new trends will cover topics as the shared collaborative learning environment architectures, WEB portals for actual hot links to the main information sources including links to the intranet/internet virtual laboratories etc. Important part there is possibility to remote laboratory stands access from the WEB environment, which allows realizing the elements of virtual WEB technologies for SCADA/MMI tasks. Remote monitoring and supervisory operating of real laboratory stands shown other possibilities of virtual approaches included mobile wireless systems. Laboratory stand Hot-Air Aggregate (HAA) presents miniature function module of air conditioning and it is used on the experimental laboratory education for all study forms. Specialized WEB portal “e-Automation” will be shown as an example of virtual technologies with WEB solution for e-Learning purposes, with program Workshop for support of experimental data presentation and approximation.

Key-Words: Lab Stand, WEB Program Support, WEB portal, Java Module, Hot-Air Aggregate

1 Introduction

The Web is an interactive, dynamic, and rapidly changing communications medium and every Web site should reflect this. Well-organized, edited, and timely original content set in an attractive, interactive, and consistent format are some traits of successful Web sites.

The convergence of the Internet and education create Internet-enabled learning. New challenge “e-Learning” eliminates barriers of time, distance, and socioeconomic status, allowing people to take charge of their own lifelong learning. Fundamental part of university education creates connection of theoretical approaches with experimental or simulation methods for verification of coincidence. Illustration of practical physical (real) models is cardinal importance for engineering experimental exercises, for comparing of the computer simulation tasks with practical experiences and with real-time measured signals from the technological or lab plants [1], [2]. Remote monitoring and supervisory operating of real laboratory stands shown other possibilities of virtual approaches included mobile wireless systems (see Figure 1).

The new trends with Web technology support for e-learning introduces innovation both in pedagogy and technology. It aims at developing tools that will allow for as many links of science teaching as possible with every day life. Sometimes students loose interest in science because they cannot relate what they are being taught to their everyday lives. Laboratory education in e-learning aims at overcoming the barriers imposed by the traditional classroom setting by using an innovative combination of a new approach to learning and the development and application of new technologies.

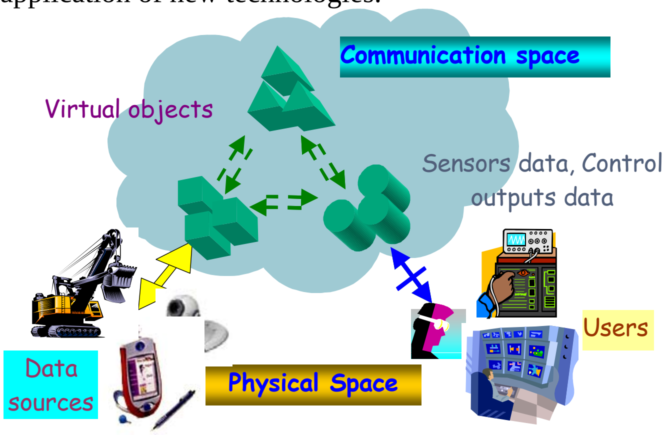

Fig. 1 WEB and wireless instrumentation for monitoring, diagnostics and control purposes

There will be presented two concrete examples with WEB support of laboratory education (Web PORTAL e-automatizace.vsb.cz, Workshop with Java P&A module) and one example of Internet control of real laboratory stand of hot-air plant connected to the different types of microcomputers and controllers for measurement and control tasks [3], [4], [5].

2 WEB support of laboratory education

The use of Internet resources has caused much excitement in the science education community because of their potential to enhance both traditional and distance education. However, such resources are not stable and permanent in the sense of a traditional textbook. In the jargon of the Web, this disappearance or inaccessibility of electronic documents is termed “link rot” or “web decay”. "Link rot" is a term applied to web pages that are no longer accessible either because they have been discontinued, or because they have moved to another address.

Web sites may be directly linked from the course syllabus, can be recommended by the instructor, or can be identified by the students. Whatever the route, it is highly frustrating and unproductive to be confronted by a message such as 'not found' or 'moved'.

The goal of the WEB portal e-automatizace [6] is to create an information access point into the automation field for students and academic staff and systematize information into logical hierarchy. WEB portal is based on content management software PortalApp Basic Edition 2.21, which uses Active Server Pages and Access 2000/or MS SQL database for storing data.

As a result of the student survey the main WEB page was changed to be more useable – emphasis was put on full text search and search form field was moved to main page. Other changes were implemented on the page with the catalogue of links. A hierarchy of links is at the top of every catalogue page and is visibly separately from the list of links. Additional information (rates & views of a link, report errors) was united into one group. Also title of link was highlighted (see the Figure 2).

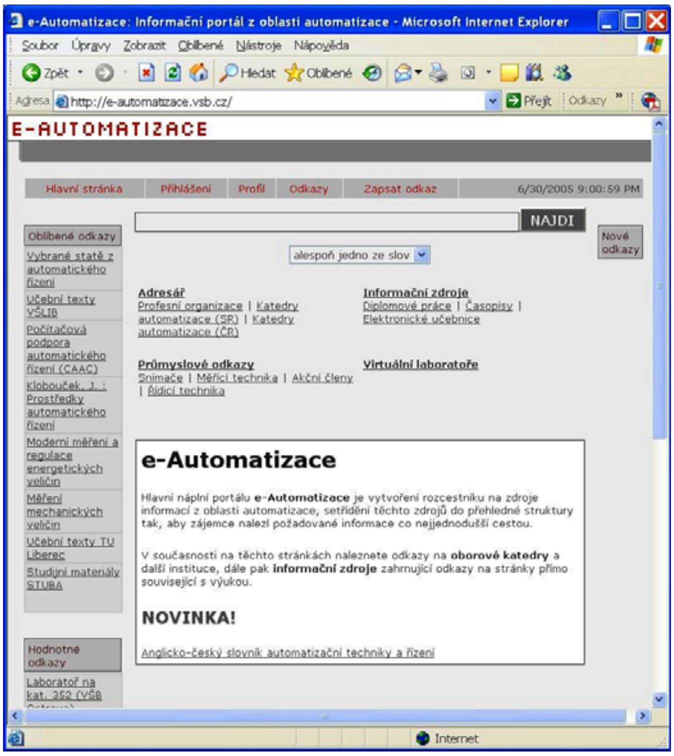

Fig. 2 Main screen of the WEB portal *e-automatizace*

New part of portal is Workshop pages with proposition of special program modules. Very interesting module for presentation and approximation experimental data is JAP.

Program module JAP there is support for experimental obtained data processing. Module is available from internet environment as a part of WWW page which is viewable by Internet browser. Module has graphic user interface and is able to reach a data locally or remotely via network from MySQL server. Realization was made in Java programming language [7].

On the Figure 3 we can see the JAP module main screen with two data files and two different approximation functions. There is the presentation of data files with approximations by exponential and parabolic functions.

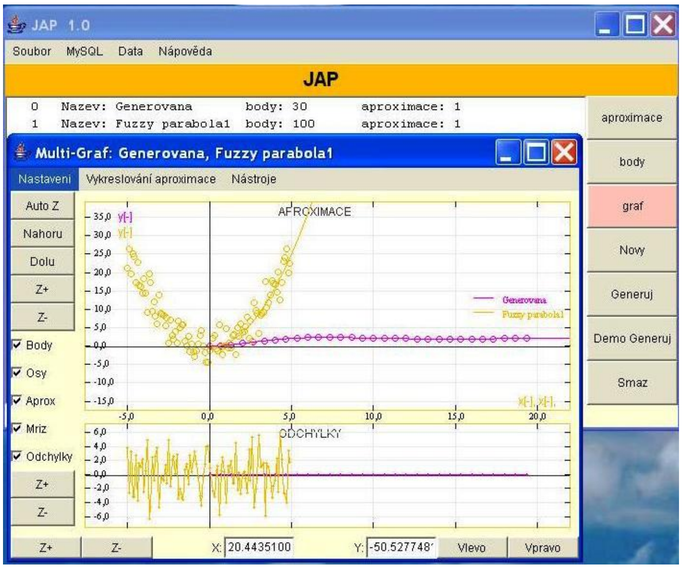

Fig. 3 The JAP module main screen with 2 data files and two different approximation functions.

JAP module can approximate by polynomial functions, cubical spline function, exponential functions (proportional term of 1st and 2nd order). The data format there is in text form with compatibility with other program modules from University programs products (APROX, WinAprox,) and MS Excel [7].

3 Laboratory stand Hot-Air Aggregate

The laboratory model Hot-Air Aggregate (HAA) is a physical model of air-conditioning as shown in Figure 4 and Figure 5. There are the source of heat air (the small bulb) with quick dynamic response and two ventilators as the sources of air flow. Together in the model, there are six transducers measuring the temperature of hot air flow at the three different positions from the bulb, two flow meters (propeller turbine and thermo anemometer) for volume flow measurement and one photo resistor sensor of bulb luminance.

The HAA model is a dynamic system with two inputs and two outputs. The two basic controlled inputs (action values) are the power of the bulb and other one power to the main fan (ventilator). Measured outputs there are a temperature from one of the temperature transducers (by

this position the time delay of the system is changed) by one of flow meters (with quick or slow response).
As a disturbance it can use the secondary fan with opposite air flow direction (the complementary action value).
This HAA model is used to train:

- MIMO control (temperature and air flow) with adjusted disturbances.
- Robustness of control via changes in working point. It influences time constants of transient responses (typical control task takes 2 or 3 minutes).
- Nonlinear control given by built in nonlinearities.

On the next few figures we can see examples of lab plants, which demonstrate the connection of real laboratory plant HAA with computers on the Web environment as a multilevel approach for operators with different access rights.

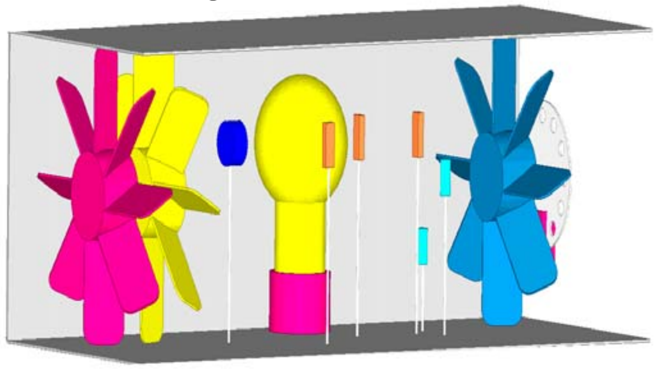

Fig. 4 Schema of stand HAA with two ventilators (main and secondary) and sensors of temperature (3), flow (2) and photo resistor sensor of bulb luminance (1)

Fig. 5 Plant of HAA (from left - physical model, power supply unit, electronic module with measurement unit CTRL v3) connected to PC

On the Figure 6 we can see block schema of lab stand HAA with smart sensor of temperature (STS) and software support with SCADA/MMI program InTouch (WonderWare) connected to the LAN and Internet/Intranet environment [8].

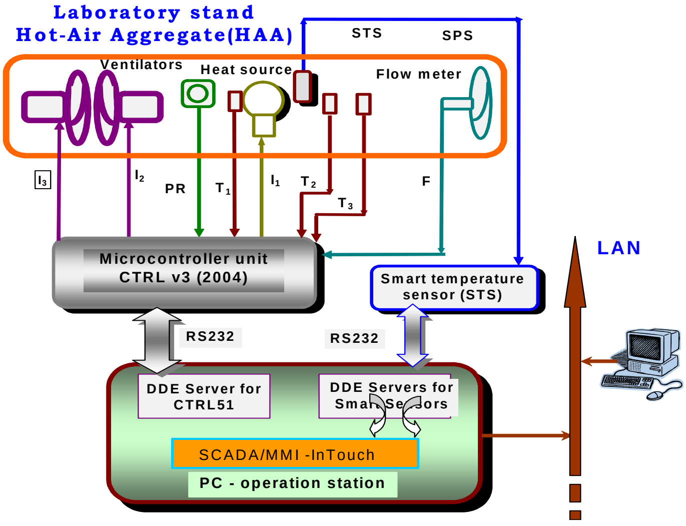

Fig. 6. Block schema of stand HAA with smart sensor of temperature (STS) and software support with SCADA/MMI program InTouch

4 Wireless data collection system

Other example for wireless communication with real technological object, now with GSM technology there is a model of family house security.

On the Figure 7 we can see the basic parts of the data collection system, based on the GSM controller. The system is periodically collecting data and storing it in the memory as separate records of the report. The GSM module time is used for process timing. This time can be synchronised with the connected computer PC with Internet interface. Its accuracy is sufficient because of a data collection period from ten minutes to one hour. GSM communication is used for sending alarms to the operator's mobile phone and in other ways for control messages, actual values setting, data requisitions etc.

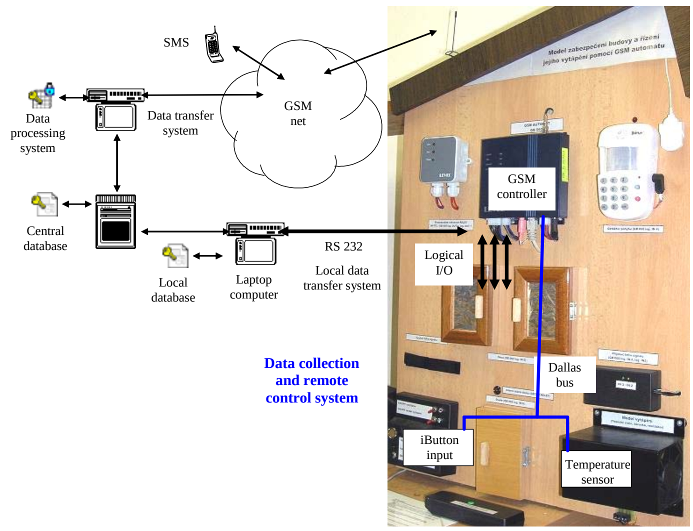

Fig. 7 Basic structure of GSM data collection system

This will return an SMS including information about the actual value of the first measures analogue quantity, applied iButton key and SIM card credit to the sender's mobile phone.

In this way it is possible to determine the state of all measured quantities and logical inputs, set all logical output values and available relay output.

7 Conclusion

Verification of theoretical findings is important part of education process. Although increasingly significant methods are computer simulations, now typical with simulation programs aid (for instance MATLAB-Simulink), experiments with real physical models are not interchangeable. Experimental stands allow easy understanding to principles of industrial plant parts, measurement and control devices, signals character, noise, dynamic responses and easier crossing to the real technological systems.

The e-learning methods and tools can solved these problems and designed to develop a learning environment that gives users remote access to a virtual workspace for collaborative inquiry-based learning using experimentation and modelling. In parallel with the technical development of the new virtual learning environment mainly on Web environment, a comprehensive support system is developed to help learners in their experimentation, collaboration and assessing activities.

LAN-Web properties benefit a new possibility of multilevel control and measurement systems mainly with SCADA/MMI program support. Experiences from practical lab exercises and Final Project on the Department of CSI confirm increasing motivation of students, better interconnection of theoretical knowledge with practical experiences and skills.

The decisive role of the laboratory experimental stands with computers for quality engineering education was confirmed also in very good results of Diploma thesis and yearly holds Student Creative Research Competition. Important part there is possibility to remote laboratory stands access from the WEB environment, which allows realizing the elements of virtual WEB technologies for SCADA/MMI tasks. Remote monitoring and supervisory operating of real laboratory stands shown other possibilities of virtual approaches included mobile wireless systems.

The examples of WEB program support and laboratory stand show the possibility to connecting of traditional experimental approach with e-Learning methods by WEB virtual laboratory technologies. The experiences with exploitation of this education tools are very good and they show other path to increasing of student motivation.

8 Acknowledgments

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