Development of Methods and Program Systems for Remote Educational and Research Real Time Complexes with Visualization of Experiment Design, Control and Monitoring

V.I. Khalimon, O.V. Prostitenko

Abstract: ***This work is devoted to creation of the computer educational and research system allowing remotely in real time visually to set the program of carrying out an experiment on real technological installation. At realization of a remote laboratory practical work this system allows to investigate work of the technological installation located at remote distance from a computer class or the researcher in the course of the educational occupation. Existence in a program complex of management of this system of library of modules for formation of the program of carrying out an experiment and the interpreter of mathematical expressions considerably expands possibilities of setting up the program of carrying out experiments for the required conditions. Operational data are transferred to clients under the TCP/IP protocol and displayed in a tabular and graphic form. Import of the obtained data to other (external) software packages of processing is provided in system.***

Keywords: ***laboratory remote practical work, hardware and software, real time, program of carrying out experiment, interpreter of mathematical expressions.***

INTRODUCTION:

Remote education (RE) involving resident, correspondence and external studies is based on various methods, tools and forms [3].

Generally, the tools of new information technologies comprise "… software and hardware tools and devices functioning on the basis of microprocessor equipment, modern tools and telecommunications systems of information exchange, audio-video equipment and other tools providing operations on information collection, generation, accumulation, storage, processing and transfer" [1].

A particularly specific feature of RE practices are remote laboratory practical works. This form of studies is especially significant for training of specialists in the field of industrial equipment and technology that require obtaining specific practical skills of laboratory research in addition to theoretical courses [2].

The organization of remote laboratory practical work is based on the development of integrated software-hardware systems in specific thematic areas intended for training of students, retraining of specialists and research activities. Such systems can be collectively used by numerous distant clients using telecommunication technologies.

Real time operational management of an experiment can be performed in both manual mode, and automatically by means of a multichannel regulation subsystem according to programs received from remote workplace computers of the users. The software carries out complex computer support of all laboratory practical work: training, modeling of the studied processes, task of experimental conditions, initiation of its execution, receiving and comprehensive analysis of results.

Thus, the development of hardware-software systems of remote educational and research complexes is an essential and economically reasonable problem.

This paper relates to the development of the computer educational research system allowing a remote real time setting the program of performing experiments using industrial/commercial installations to obtain data from sensors located on the installation, transfer these data to the server (central processing computer) and provide them to local users (students or researchers) via the web upon requests for processing and decision making on the experiment management.

To address the considered problem, a remote educational and research system is suggested with the general hardware scheme illustrated in Figure 1.

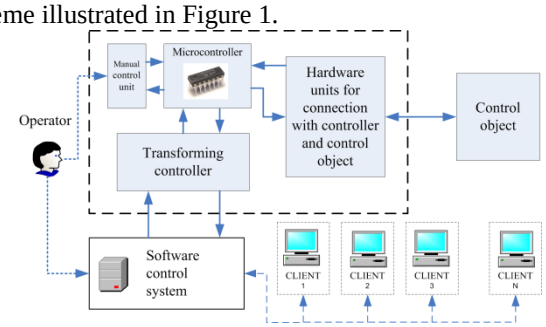

Figure 1 – General structure of the remote educational and research system hardware

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The structure of the developed system includes the following components:

- *manual control unit* (different hardware tools to generate control signals for the microcontroller, i.e. buttons, regulation handles, etc., indication of the current values of parameters);
- *transforming controller* (provides computer – microcontroller chip connection on hardware and software levels, implements the required connection);
- hardware modules of interface to the controller – an object (digital-to-analog and an analog – digitizers, measuring instruments of current and tension, operational amplifiers, sensors, etc.);
- software control system (provides the system adjustment for the required mode of the entire educational - research complex operation mode)

The whole system is based on the software implemented as tool adjustable to various experimental installations and different modes of performing experiments.

A general functional chart of the developed laboratory software system is shown in Figure 2.

RESULTS & DISCUSSIONS

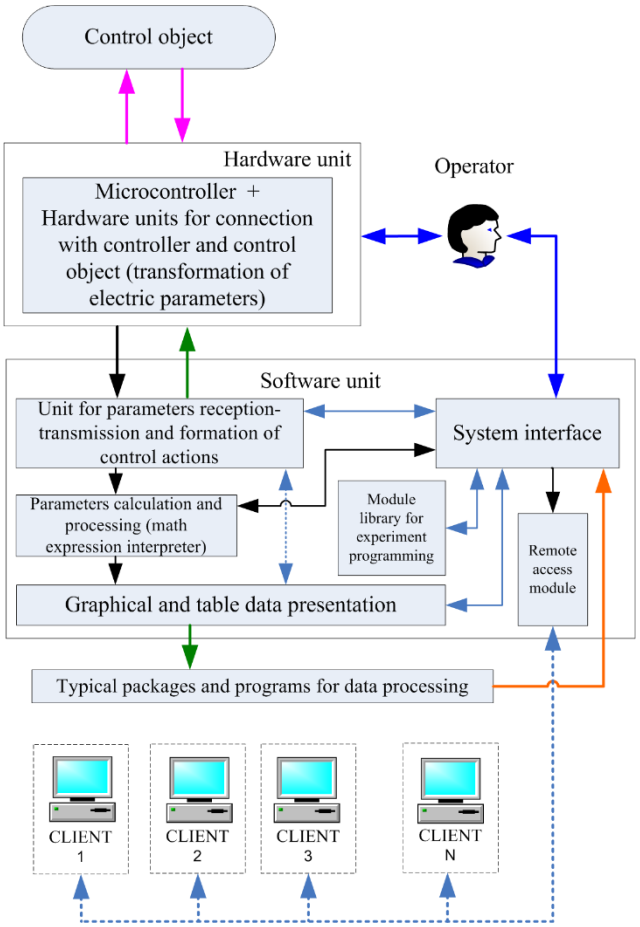

Figure 2 – General functional chart of the developed laboratory software system

It should be noted that remote clients can either process the data obtained from the installation in real time mode or work with earlier obtained data. This approach affords both performing students' laboratory works in a simulation mode and carrying out additional analysis of earlier obtained data for researchers.

During a remote laboratory practical work, this system allows students located in a computer class to monitor the work of a remote installation with processing and analysis of the data in according with the studied course and current tasks.

The flexibility of this software product is provided by two original modules:

- math expressions interpreter;
- module library for experiment programming.

Math expressions interpreter allows the researcher to enter mathematical formulae required for processing of the data received from experimental installation and present the corresponding computation results both in the database and on the screen in the form of diagrams and tables thus extending and enhancing the experiment potential and possibilities.

The module library for experiment programming contains an extendable set of programming block with the corresponding graphical image and tuning properties that allows setting (constructing) experiment performance programs directly on the display screen.

A tentative set of control blocks is shown in Figure 3 and an exemplary system interface with an experiment program constructed from separate blocks is presented in Figure 4.

Block No.	Pictogram	Module name	Controlled parameters
1	+	Set "+"	No adjustable parameters Runtime: 1 s
2	−	Set "–"	No adjustable parameters Runtime: 1 s
3	U_X	Set voltage	Initial voltage (V)
4	T	Time delay	Delay time (s)
5	U⇅	Voltage change	Time: overall time of voltage change from the initial to final value Interval: Discreteness of voltage change over time Initial voltage: set the required value (V) Final voltage: set the required value (V)

Figure 3 – Control blocks

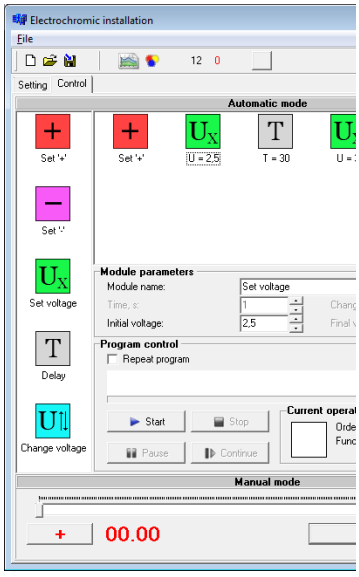

Figure 4 – Operator interface (exemplary experiment program)

The experimental results are displayed on screen in the real time mode and data arrays are stored in relating files.

The system is open and affords modification, adjustment and variation of methods, algorithms and programs depending on specific features and properties of the controlled technological object. The system also provides the obtained data import to other software packages of processing (block "Standard Packets and Programs of Data Processing").

The first version of the developed complex was tested in a laboratory workshop on "Automated process control systems" course using a plasma generation installation.

The laboratory complex allows a remote monitoring of the object state and remote control of technological process parameters (e.g. gas-discharge plasma temperature) [4, 5].

Testing of the second version of the complex is currently performed at a research installation for studying of electrochromic effects and devices.

The obtained testing results generally allow us to conclude that the developed complex provides a considerable extension, enhancement and intensification of both scientific research and educational activities.

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