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STRUCTURE OF NETWORK SIMULATOR FOR TRAINING AND RETRAINING OF OPERATORS OF CONTROLLED TECHNOLOGICAL OBJECTS OF OIL AND GAS INDUSTRY

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Abstract

On the basis of requirements formulated by developing the structure of a computer simulator, designed to hold group session aimed at fostering the skills of collective controls of complex technical and technological objects. As an example of technological objects were taken oil and gas industry, which operate in the oil, gas and gas condensate fields in the Tomsk region (Russia).

***Keywords*:** Multilevel computer model; technology of oil and gas industry; simulator; client-server applications.

1. Introduction

At management the difficult technical and technological objects some experts who are carrying out supervision over various output variables of the technological object of management (TOM) and making certain impacts on actuation mechanisms can be involved at the same time. Particular relevance in this respect acquire technological objects oil and gas industry operated on oil, gas and gas condensate fields, including those in the Tomsk region. Characteristics of processes proceeding in such TOM are in strong dependence on structure and quality of processed raw materials (the extracted oil, gas and gas condensate) and characteristics of environment (air temperature, temperature of a subsoil, atmospheric pressure, etc.). Also these processes make various technogenic impacts on objects of surrounding natural and social environment which lead to violation of ecological balance and increase of growth of population diseases caused by existence of harmful and polluting substances in environment.

For prevention pre-emergency and emergency situations on objects of increased danger and acquisition of skills of prompt action in the conditions of these situations the operating personnel of the enterprises has to gain theoretical knowledge, pass a practical training. The purpose is the joint management of TOM acquiring skills under the circumstances, liquidation of emergency situations arise, and bringing the object to the regulatory regime of functioning. Carrying out these activities at existing industrial objects is unacceptable for many reasons:

1. Carrying out occupations on the functioning equipment will lead to decline in quality of output production, both for the period of carrying out occupation, and after its end.
2. Complexity of a conclusion of TOU after the end of occupation on industrial level.
3. Unforeseen technogenic impacts on environment.
4. Loss of production profitability.

The best way to conduct activities aimed at increasing competence of management personnel and fostering the skills of teamwork in regular, abnormal, pre-emergency and emergency modes of equipment operation is the use of packages of computer modeling, allowing building models of TOW with occurring in multyphysical, energy and multicomponent flows and implementation on their basis of network computer simulators. These should allow multiple employees working on a number of computers connected to a local area network, to manage one model, the analysis of which is carried out on a dedicated server

with sending test results to customers and received from control actions on the model. Such simulators, hereinafter called network simulators, should be implemented on the basis of standard "client-server" architecture based on universal system of distributed computer simulation, which includes a library of component models of networking.

2. Requirements for the client –server architecture of computer simulator

The client-server architecture of computer simulator should be focused on an unlimited number of users carrying out work with the simulator in two modes - "Teacher" and "Student". Local computer network, which operates simulator, must allow the transfer of large amounts of information through the narrow two-way channel (from client to server and from server to client).

The server part should be presented in the form of computer simulation environment enable to produce dynamic analysis of TOM models with circulating between its elements of information, energy and real multicomponent flows. The TOM model may be presented in decomposed form (in the form of interconnected component, as a self-realized executable file (* .exe) or dynamic link library (* .dll). Such models should interact with different kinds of databases, which store the history of changes in the parameters of each user, as well as information on the physico-chemical properties of substances.

The client part must be carried in accordance with the real mnemonic schemes of operator-technologist workstation at the existing production and to provide all the functions required in the workplace. Images of the components of the technological scheme should have an attractive design and essentially correspond to the actual unit. Technological networks (pipes, valves, automation systems), sensor readings of the process equipment (separators, settling tanks, heat exchangers, furnaces, etc.). should be reflected. The client application needs to communicate with the model being analyzed on the server, changing its topology and values of its constituent components. It should also display the values of parameters and characteristics of the process system in real time, and also provide the ability to transmit control actions at any time.

The network simulator should provide two types of client application: teaching and student. In teacher client the possibility of effects on several models analyzed on the server should be realized, for purpose of creating emergency situations, monitoring and reporting the students' performance of appropriate actions to prevent the arising situation. Also possibility of creation of work recording scheme, preservation and import of reports to office applications (MS Word, MS Exel) has to be realized. Teaching client should have possibility of varying forms of conducting classes using modes: separate task for everyone, a common task for all, and learning mode "look at me".

The client application must be versatile and able to adapt to whatever the technological system developed in the constructor. Functional of client applications is opening of created in the constructor scheme and interactive control with the ability to download the necessary libraries located on the server. In such libraries models of object, algorithmic and visual components of which schemes server and client parts of model are formed can be realized.

The designer of models has to represent the environment of fast development of models of visual technological schemes with which users work. It has to allow users-teachers following:

1) to create a new mnemonic diagram visualization and control belonging to the simulator, with the aim of their subsequent use in teaching and student applications;
2) to form conducting classes scenarios, including scenarios of situations and scenarios of TOM management;
3) to form the templates of the student logging operations, which will be filled with student applications and display in teacher client;
4) to make tasks to students and to generate various abnormal, pre-emergency and emergencies for their transfer in student's appendices and in the model functioning on the server.

3. Structure of network computer simulator

As a basis of realization of the network computer simulator the environment of multi-level computer modeling MARS was chosen [1]. It is intended for automation of natural and computing experiments with models of technical and technological objects with information, power and multicomponent material streams [2]. For visualization of measurement and modeling results, and also management of components parameters values, sources and generators of real signals, within the modeling environment MARS the system of virtual tools and devices [3] was developed. This system allows forming the computer model of the virtual device including the interface communications with the studied object or its computer model in the form of multilevel structure [4] which includes the following levels:

– *visual level* at which there is visual panel of device created from graphic components of measurement and modeling visualization results and controls for model parameters, generators and measuring devices;
- *logic level*, comprising the algorithms of experiment involving the processing units results, job parameters and calculating the values of components, as well as means for preparing and transmitting the results to visualization components;
- *object level* where the interface of interrelation with the studied real object or its computer model presented in a format of a method of component chains [5] or some separate library realized in any language of modeling is formed.

The presented multilevel structure of computer model for realization of the network computer simulator is divided into two parts: server and client (fig. 1).

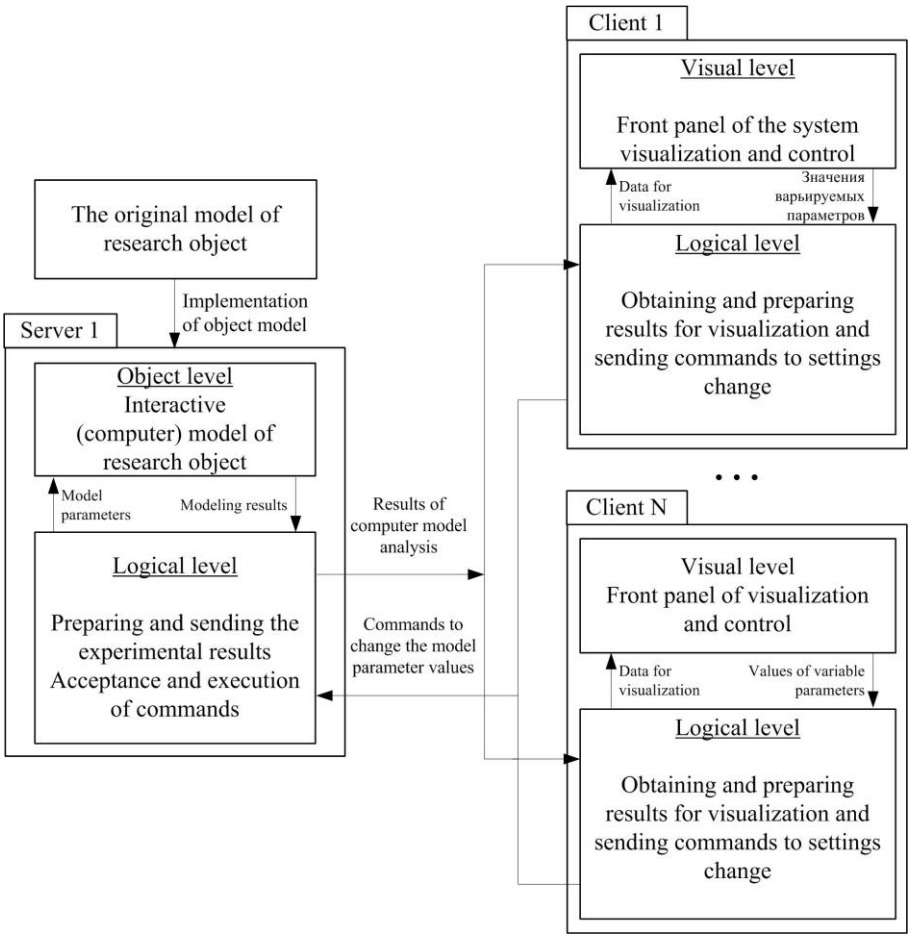

Figure 1 Multilevel network structure of computer simulator

The server application implemented on the basis of multi-level environment of computer simulation MARS involves two interrelated level model: the object and logical. On the object level an interactive computer model of study object is implemented. Its interactivity is caused by changes of topology and values of parameters of components commands for

change which the server application receives from client at the logical level. As client applications virtual devices which are created in virtual tools and devices [6] are used and can be opened by a special cursor of MARS-Engine [7] which allows to open virtual devices as stand-alone programs, not loading thus all difficult interface of the environment of modeling MARS. Such applications are virtual devices (Fig. 2), through which users (both teachers and students) can see the corresponding results of simulation and change the component parameters analyzed on the server computer model, and teachers - and its topology using special switching components. Interaction of network and client applications is carried out by using components of "transmitter» (Fig. 3a) and "receiver" (Fig. 3b).

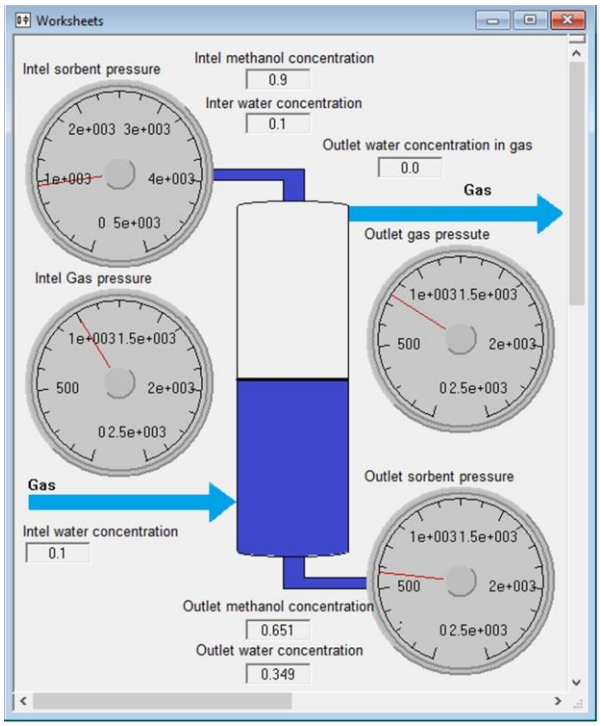

Fig. 2 Client part of the network computer simulator

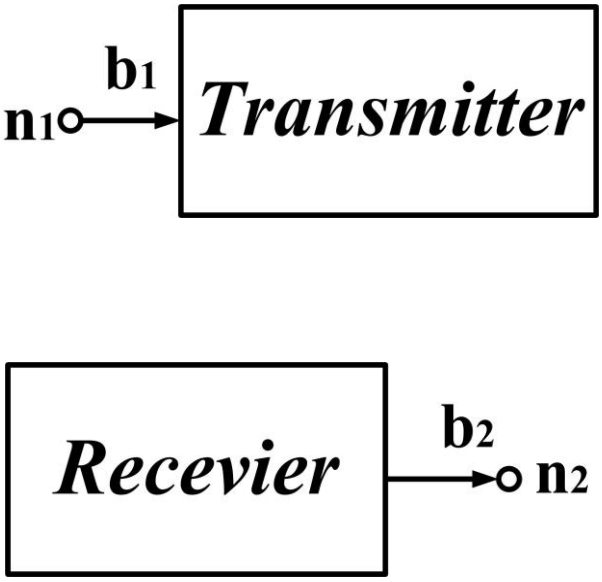

Fig. 3. The components of interaction of server and client applications of computer network simulator; a) component "Transmitter"; b) components "Receiver"

Component "transmitter" carries out sending data received by communication S1 = (b1, n1), on the local area network computer which IP-address is specified as a parameter of the component. The component "receiver" receives messages on a local area network with the specified parameters in the IP-address and transmits the data presented in the communications component connected to the connection S2 = (b2, n2).

4. Conclusions

To conduct computer training aimed at acquiring skills of group control of technological equipment of oil and gas industry with working for personnel in emergency, pre-emergency and emergency conditions, it is proposed to use a computer network simulators. They are implemented on the basis of a multi-level environment of computer simulation MARS realized it networking components [8]. On the server application the analysis of computer model of the studied object presented in format of method of component chains with non-uniform vector communications or realized in the form of dynamically loaded library is carried out. These models allow for the change of its topology and varying the parameters of their constituent components. By means of such exercise machines it is possible to give classes in elaboration of actions in various industrial situations without conclusion of the real equipment from technological process and without endangering objects of surrounding environment and the living population [9-11].

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