ECONTECHMOD. AN INTERNATIONAL QUARTERLY JOURNAL – 2017. Vol. 6. No. 2. 9–14

Model of operator activity in computer systems image processing

R. Kaminsky [1], Ya. Borovets [2]

[1]Lviv Polytechnic National University, Lviv, Ukraine; e-mail: kaminsky.roman@gmail.com
[2]Lviv Polytechnic National University, Lviv, Ukraine; e-mail: jarborx@gmail.com

Received February 18.2017: accepted May 20.2017

Abstract. The described Human-Operator model concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. Analyzed state of using computer simulation and hardware you need to work with it.

Key words: human-operator, operator model, operator system.

INTRODUCTION

To date, operator training personnel is critical. The growth of the application of computer and information technology can be found in virtually any subject area. Tasks performed yesterday by hand or with simple hardware today include computers and using special information technology. The combination of computer and human normal production was serving or link to almost any professional activity.

Traditionally, management difficult human process called operator activity, and the man himself styled term “human operator.” Obviously, the tradition comes from control objects with high responsibility, nuclear and thermal power, metallurgy complex processes, communications and so on. However, the human operator activity on a computer can also be highly responsible, although in most cases the effects are much smaller scale losses. The content of this activity is often enough to identify the images in real situations and the tasks of various objects of attention and decision-making. This type of activity can be attributed to defects in material search image on the monitor in the X-ray analysis, processing of financial information submitted spreadsheets, image analysis on Earth satellite images, find the right information papers, found by search engines databases.

The effectiveness of such activities largely depends not only on the possession by the computer but also on the knowledge, skills and experience of the operator. To do this, depending on the tasks carried out professional selection, education, training and certification of candidates for the operators of the profile.

There are many different techniques and copyright typical training personnel carrier using computer simulators, which are mainly composed of a single workstation, a computer and software. Software provides up to monitor real or stylized image of hypothetical situations and appropriately captures the results. Evaluation, as found in numerous bibliography, mainly engaged in the time of passage of test tasks and the number of errors, using the most common indicators of descriptive statistics and almost not found construction of mathematical models.

Recently, particularly in the analysis of time series of increasingly wider use of fractal analysis, phase portraits, recurrent diagrams that greatly expand the information about a particular user of the training and give rise to the unique construction of the model.

ANALYSIS OF THE CURRENT STATE OF THE USE OF COMPUTER SIMULATORS

In [1], as the main type computer architecture simulator training for industrial uses three levels of representation of a client-server architecture. According to this model the functionality of the simulator is localized at three different levels, namely level customer level application server, data server level.

The task of developing integrated training and fitness tools based on advanced information technologies, virtualization and data center for the integration of a single complex, an information polygon for training and employment, the implementation of a continuous process of training specialists considered [2].

In [3] addresses the quality of training of operators and capabilities of computer training systems intended for operational staff of professional knowledge, skills and abilities.

In [4] the analysis of existing automated training equipment operators and selected theoretical and practical approaches to the construction of this type. A, built and described in terms of problem-situational approach of automated circuit simulator operator. An example of the use of problem-situational approach.

To register operator success after repeated passage of one and the same control knowledge [5] is seen using tables belonging. The description of this table reveals origin and destination of the elements used and described in the table dimensions. The process of filling in the following table affiliation knowledge control results described step by step. Showing calculating differences between the results of control of processes related knowledge, and this information is stored in the auxiliary table. Done description association supporting tables and their properties, and also the calculation of the change of operator expertise for each of the key problems. In [6], the same author, consider using multidimensional tables belonging to successful registration of operator's aircraft simulator. A principle of registration success is based on the distribution of each exercise scenario elementary task presented with a list of elementary operations that can be performed with tables belonging.

In [7] shows that computer simulations are often used to train operators to manage the system and as a way to safely examine the behavior of the system. If the model of human operators can be used to model these, it should help identify potential problems in the system design more cost-effective way than to use real operators. We are developing a common approach to cognitive models can learn to control any simulation that has a user interface written using a specific set of tools. This approach is based on using reliable cognitive architecture and user interface development tool. We define a set of common requirements, models must meet. The original model, which satisfies a number of them, modeling simple controls air traffic management task. The model finds when performing tasks online and reflecting on the job later.

TECHNICAL SUPPORT

All but the simplest mechanical control systems using more than one computer. Computers can be organized in a hierarchical structure or "flat" one computer or entire population.

Hierarchical organization prevalent in production facilities or other large systems where coordination of individual machines is through information management systems to ensure the efficient functioning of the system.

Flat architecture used where several computers work together to control one machine (or a single physical system). In any case, the design software for real-time control mechanical system often requires an understanding of multi-computer architectures, and how these affect the architecture of system performance management.

Properly designed communication interfaces are a critical element in ensuring a reliable system that can be implemented predictably.

As in the case of operator interfaces, portability is a major problem in the design and implementation of managing multiple computers. In the near future, the level design and the design process all the management system is likely to be run on the same computer. How are these phases will depend on the architecture of the systems? In each of these stages, any number of network technologies can be used for computer communications. There may even be some point and network communication technologies that exist simultaneously in the final production system. And to all this variety of software development, which dictate changes as possible do to the software when switching from one configuration to the other work the same way.

MODEL OF OPERATOR ACTIVITY

Nowadays the use of computers for training personnel carrier different function and responsibility of one of the many important areas of social and information for the preparation of highly qualified personnel in various sectors of the economy. In various areas of human activity to train skilled workers and extensive use of computer software. Widespread variety of software tools for knowledge assessment in schools and local training, the main activities are related to routine work directly on conventional or specialized jobs. These experts usually solve specific problems, having at its disposal as a source of information only monitor and the computer database, which include:

– edit any text (formatting information, detecting and correcting errors, misprints, critical analysis of content, etc.);

– to find the right information in various data tables, the selection of specific objects, work with numeric data from a variety of documents to find the right information in the relevant databases and data warehouses, etc.;

– processing of images in terms of identifying them, often localized randomly attention given class facilities such defects, inclusions, cracks on the surface of materials, abnormalities on radiographs, examination of old search for identical objects, etc.;

All of these operator tasks is virtually sedentary and information may include various types of noise, which include: poor quality of letters, scanned material contains spots vague contours of the object of attention, partial closure of desired objects other more. In addition, the operator workplace is not always comfortable, there is often noise, vibration, temperature changes and light, often turns attention to other objects or situations and so on. Al., Which in turn causes, especially on the deficit time, discomfort and tension, which leads to changes in the functional state of the operator, and hence to errors and untimely action taken. Formally, this human activity operator can be represented using a set-theoretical apparatus [1].

Let $X = \{x_1, x_2, \mathbf{K}, x_n\}$ – set sequence of events in this real or hypothetical scenarios, which is the operator. The emergence of these events regularly or randomly distributed in the time interval between the appearance of two adjacent events shown on the monitor can be constant or its duration is divided by a given law. Through hardware transformation $A(t)$ a sequence displayed. If the occurrence of events counted is set X can be represented as a set of time-dependent objects:

$$X = X(t) = \{x_1(t), x_2(t), \mathbf{K}, x_n(t)\} = \{x(t_1), x(t_2), \mathbf{K}, x(t_n)\}.$$

If the event among themselves independent, they formally served as a certain amount:

$$X(t) = \sum_{i=1}^{n} x_i(t) = \sum_{i=1}^{n} x(t_i).$$

Analyzing displayed in the monitor event $x_i(t)$.The operator uses for some time $t_i^{'}$, A psychological, physiological, physical and intellectual resources to identify his body, perception, identifying the object of attention in this event (or the event). After identification of the facility operator spends some time again $t_i^{''}$ to choose appropriate solutions, the analysis of its consequences and select commands and operations for its implementation. As a result, a plurality

$$Y(t)=\{y_1(t), y_2(t), \mathbf{K}, y_m(t)\}=\{y(t_1), y(t_2), \mathbf{K}, y(t_m)\},$$

chooses, makes and sells at the moment $y_j(t)$ appropriate solution in this situation $y_j(t)\in Y(t)$.

Total time $t_i^{'}+t_i^{''}$. Is the duration of processing operator of *i* events and even time since its introduction t_i to the decision t_j.

That is the difference $t_j-t_i=t_i^{'}+t_i^{''}=\Delta t_i$. Various researchers found and confirmed by our research [beta] that the value of this time Δt_i is a random variable that has a predominantly single-mode, asymmetric distribution is shifted relative to zero for large values. Value of time Δt_i much also depends on functional status of the human operator that reflects the intellectual activity and psychomotor function concerning the conditions of the working environment and responsibility for decisions. Therefore, to organize activities and equipment operator jobs, and thus ensure adequate working comfort is paramount.

Formally, functional status $C(t)$ the human operator can be described as the set of his local levels $C(t)=\{c_1(t), c_2(t), \mathbf{K}\, c_k(t)\}$ from normal psychophysiological a significant neuro-psychological condition, with different duration, but with a dedicated amount equal working time.

The difficulty of establishing functional state is simultaneously conduct measurement directly in the workplace is almost impossible, since most of them are integrated and require appropriate, sometimes very complex and lengthy procedures. Also, an important point to consider functional state is that for some events change state is virtually absent, while for others it may be significant, stressful and require significant mobilization of intellectual resources and mental stress as reflected in [12]. Therefore, taking into account possible changes in the functional state during the organization of the recipient on a computer simulator is extremely important. Obviously, in such call them stressful, situations return to normal will take some time, so the time interval between complex "stressful" and the next event in this scenario should increase.

Consideration of the human operator and computer simulator in the sense of an integrated system gives rise submit them formally as an integrated system in the sense of [8] is a dynamic system;

$$S\subset X\times Y,\ t\in T,$$

for which there is some set C functional status and there are features:

$$R(t)=\{r_t : C_t\times X_{tt'}\to Y_{t'}\ \&\ t\in T\};$$

$$P(t)=\{p_{tt'} : C_t\times X_{tt'}\to C_{t'}\ \&\ t, t'\in T\ \&\ t'>t\},$$

which can be interpreted as follows: function $R(t)$ – a response system S. That in time *t* is in some state of a plurality of local C_t. On the provided input information as an image of set events X_t as a result of the current processing time for $t'-t$ input information $X_{tt'}$ take a moment t' decision $Y_{t'}$; function $P(t)$ – responsible transition system S to another state indicates that as a result of processing input information $X_{tt'}$ over time $t'-t$ the system has not taken any decision, but only changed its state of C_t on $C_{t'}$.

Under real conditions, operating can also be formalized in the form of such a dynamic system [9], including the processing image based on visual perception. Here, the term "image processing" means the absence of any person or his treatment program, but only intelligent (visual) analysis to obtain semantic information to make the best decision [14].

Since the implementation of the decision made on the psycho-motor level, by appropriate controls, mainly the keyboard and various buttons, switches, Lever sound teams, the analysis of the content, nature picture a particular event occurs at the semantic – intellectual level. Imaging at this level in terms of processes of perception and cognition that belongs to the perceptual action provides for such operations [10]:

- identification of structural organization of image elements forming a complete image;
- distinction – the selection of individual features;
- authentication – identification of a benchmark in memory;
- identification – referring to the corresponding category.

Therefore, given the image on the monitor events $x_i\in X$ can be taken as model input data $M(X(t))$ to "input" operator. Operator using individual recognition algorithms, depending on the situation, working status and professional skills step by step, comparing $X(t)$ with an appropriate benchmark $X^*(t)$ such an event for this situation is preserved in his memory as a model $E(X^*(t))$standards developments for different situations. As a result of this comparison, it builds a conceptual model of the situation $K(X(t_i)\,\mathbf{I}\,X^*(t_i))$, which is used to select the appropriate solution and its implementation through a set of commands.

During processing $M(X(t))$. The result of comparison is the differences between the information $M(X(t_i))$ and reference $E(X^*(t_i))$ models of information completeness, clarity and strict compliance with this situation, determine the appropriate conceptual model building $K\left(X(t_i)\,\mathbf{I}\,X^*(t_i)\right)$. This process not only depends on the image quality $x(t)$ and the state of the working environment, but also on the operational status of the human operator that fully defines the nature and speed of cognitive and motor components of the visual analyzer, memory, brain.

Analyzing the racing situation in the process of building for her conceptual model $K\left(X(t_i)\,\mathbf{I}\,X^*(t_i)\right)$ human operator in his mind, mostly refers to different and unique set $Y(t)$ possible solutions y_j. Stored in his memory, to select or create appropriate solutions and set $U(t)$ control commands $u_t \in U(t)$. Corresponding to this conceptual model. In addition, the operator in mind "peeps" and examines the possible consequences of the adoption of the selection decision. Therefore, an adequate conceptual model created $K\left(X(t_i)\,\mathbf{I}\,X^*(t_i)\right)$ is a fundamental characteristic of human intellectual activity operator. The main estimates of characteristics that can be directly determining during training or during his work is the number of mistakes and efficiency, expressed as the duration of time from an event until the implementation of the decision.

The processes of analyzing, selecting and implementing solutions for highly skilled operator in the qualitative aspect can be considered efficient and reliable (best), but in the quantitative aspect of these operators usually do not admit mistakes, but all of them take place some time spent on selection and decision making. Therefore, the processing of the image carrier specific to each individual situation is the indicator of its intellectual activity [13].

In training personnel carrier widely used in various scenarios, which in some way mimic its real activity, mainly specific management process. The peculiarity of this simulation has a large number of critical situations and is submitting images as real or stylized mostly hypothetical situations in which objects are exposed to different types of attention distortion. These distortions can be: imposed on him various intensity noise with different noise shape and size elements, closing parts other objects as a result of the destruction of some of its morphological elements and circuit, and others. In such cases, a formal presentation operator activity will look like this set-theoretic model [20].

The use of computer simulator to train personnel carrier based on tasks can be very different – professional selection processes, development of skills, certification, review of new activity, exercise routine, so why work operator using simulator training will take call, understanding this term various activities.

In general, most types of operator activity can apply this model. Let $Z(t)$ – a hypothetical process, controlled by the operator within a specified period of time, which is a set of discrete regular or random points $T=(t_1, t_2, \mathbf{K}, t_q)$, Which appear critical events or objects of attention. To manage this process developed specific guidance materials (manuals, guidelines), which includes a plurality $G=(g_1, g_2, \mathbf{K}, g_p)$ the set values of objects and attributes. Compliance with these instructions operator provides the normal flow of the process. However, in the process, there are various critical situations that may not be much, or vice versa is very important to change the value of controlled parameters. In all such cases the operator is immediately resume running quickly a decision and implement it. Such critical situations are simulated in different ways: imposition of the noise partially closing the object of attention, changing instrument readings. In general, they are already included in the model of the process and serve as test tasks related to the training of operators is ordered by forming a plurality time points $G^*(t)=\left(g^*(t_1), g^*(t_2), \mathbf{K}, g^*(t_q)\right)$.

Consequently, operations in the simulator can give a generalized model that formally reflect the real or hypothetical work situation, given the impact of inconvenient forum factors given set $\Pi(t)$ And presents them as appropriate data conversion paths to the formation and transmission of images $x_i \in X$ system of maps [11]:

$$a : Z(t)\times G\times\Pi\times T \to G^*\times T,$$

$$w : G^*\times T \to X^*\times T,$$

$$m : X^*\times T \to M\left(\left(X^*\,\mathbf{I}\,G\right)\times T\right),$$

$$k : M\left(\left(X^*\,\mathbf{I}\,G\right)\times T\right)\times E\left(\left(X\,\mathbf{I}\,G\right)\times C(t_k)\right) \to K\left(\left(X^*\,\mathbf{I}\,G\right)\mathbf{I}\left(X\quad\mathbf{I}\,G\right)\right)\times T$$

$$v : K\left(\left(X^*\,\mathbf{I}\,G\right)\mathbf{I}\left(X\quad\mathbf{I}\,G\right)\right)\times Y\times C(t_k)\times T \to U\times T,$$

$$r : U\times T\times\Pi \to G\,\mathbf{I}\,G^* = \varnothing,$$

where a – a reflection that takes into account the influence of factors inconvenient forum $\Pi(t)$ the process $Z(t)$, Resulting in critical situations G^*; w – Display critical events of the specified characteristics of a plurality G^* as images of the events scenario.

Thus, a plurality of time points and conditions $\{T\}$, $\{C\}$, A pair of sets $\{X, X^*\}$, $\{G, G^*\}$, $\{Y, U\}$model $M(X(\mathbf{g}_i, t_i))$, $E\left(X^*\left(\mathbf{g}_i^*, t_i\right)\right)$ and $K\left(X(\mathbf{g}_i, t_i)\,\mathbf{I}\,X^*\left(\mathbf{g}_i^*, t_i\right)\right)$ display a – hardware changes; w – visualization options G; m – information perception operator; k – the creation of a conceptual model; v – the choice of vector commands U and r – implementation of the decision describing the general structure of man-machine interface control system technology $Z(t)$.

In the representation is displayed k and v include the plural C working conditions of the operator, that its implementation is exclusively the prerogative of the operator. They define performance, and high reliability and efficiency of technical means, almost completely determine the effectiveness of human-machine interface control system. Therefore, for highly critical systems, taking into account the human factor is very important and demonstrates the need for an individual approach to optimization and quality control operator activity.

In this model, all sets are finite, and it organizes computer training personnel carrier is the basis for the formulation of appropriate experimental research.

According to the submitted model of experimental research can be made such strides:

– analysis of the operator;
– development of visual material;
– creation scenario;
– forming test images bank events;
– choice of methods of processing.

Each of these points can in principle be realized. Or rather requires for its realization certain information technology.

CREATING VISUAL MATERIAL

For each task, which in one way or another, but with maximum probability plays, simulating, modeling workflows real or hypothetical situations for training purposes usually developing specific visual material. In other words, make up the image of all possible relevant tests of real or hypothetical events and environments as separate copies of their images. Obviously, for this purpose fully be used various video technologies that allow outside interference in individual frames, ie overlapping cursor control image characteristics, such as luminance, contrast, sharpness, etc.

Development of the script operator activity. Its essence is that the scenario unfolding in real time similar to the workflow, but important in terms of training and operator control events follow a much more specific and forward manner unknown to him. The main requirement here is to ensure that the number of occurrence of such events within the time duration of activity of the recipient [19].

Development of visual material, ie images with specified events is to provide the appropriate “metrology” quantitative assessment of the operator. In fact, the activities of the operator can directly estimate only two parameters, namely by choosing the right set of solutions and alternatives largest choice of time of this decision and its implementation. For a more detailed evaluation of alternative solutions set can be represented through their rating and deciding linked to its visual complexity of the image [15].

Selection or development of information technology data is the use of existing methods of mathematical statistics requires data submission normal distribution law. We know that choosing solutions or reaction time for the event in this situation, or “lifetime” event – from the moment of its occurrence until its elimination operators have single modal asymmetric cut at low values distribution law. This requires finding new effective methods of data.

COMPUTERIZED TRAINING WITH SIMULATION

Task problems in gaining skills concerning specific specialization requires review, and sometimes even quite detailed, with current advances in the organization of training using computer simulators, typical approaches to copyright and recipients, build scripts, developing test images defining for this type of activity events, and includes professional selection of training participants and their certification as a process. And after its completion. Analysis of the situation and the formulation of the task in the sense of developing a particular scenario of human operator involves splitting process activities into separate elements, operations, determine their significance and features, and specify the order in which they are provided. You also need to set the parameters controlled manufacturing process to be used for making operator decisions. Basically, any activity of the human operator can be compared to the process control. In this respect, it is about creating a virtual working environment within the existing capacity. As computer and human operator form a single interface between multiple indicators of facility operations and management set of tools to implement its decision all the attention is focused on the operator display and keyboard, as well as the surrounding environment can be almost arbitrary.

The important point for the formulation of the problem is about how to use computer technology and agreement with her various hardware and necessary equipment.

CHARACTERISTICS OF THE SYSTEM

The defining characteristic of any system requirements for real-time synchronization system must not only react to inputs, it must do so within a certain period of time. These requirements can usually be categorized as:

1. The absolute requirement where the reaction should occur during certain periods
2. The relative claims, where the reaction should occur over a period of time after the event.

Consequences satisfactory terms to describe the system in real time as

1. Hard real time when the failure of the deadline leads to failure any response, even if correct, after the expiration does not matter;
2. The form in real time when the failure of action in time will not lead to failure no response until after the deadline has not, but this rejection will degrade the quality of service;
3. Soft real-time response when the value after the passage of the deadline, was not wasted.

The first two cases, if time can be determined a priori when the deadline would not be satisfied. More complex real-time systems, will likely consist of subsystems from each of these three categories.

Most of the software you’ve used to date has been interactive: it responds to your commands. Interactive software is always subject to delays. Surely you have experienced that feeling of waiting over a second for a word processor to respond to you entering a single keystroke, or the mouse taking a split second longer to respond than would make it seamless [18]. We will define such systems as follows: Definition: General-purpose systems (hardware and software) are tangible and intangible components of computer systems where operations are not subject to performance constraints. There may be desirable response characteristics, but there are no hard deadlines and no detrimental consequences other than perhaps poor quality of service if the response times are unusually long [16].

In contrast with general-purpose systems, real-time systems are meant to monitor, interact with, control, or respond to the physical environment. The interface is through sensors, communications systems, actuators, and other input and 2 output devices. Under such circumstances, it is necessary to respond to incoming information in a timely manner. Delays may prove dangerous or even catastrophic. Consequently, we will define a real-time system as one where

1) the time at which a response is delivered is as important as the correctness of that response, and

2) the consequences of a late response are just as hazardous as the consequences of an incorrect response.

Real-time systems are not meant to be fast. Instead, they should be just fast enough to ensure that all functional requirements, constraints, and timing requirements are satisfied.

The system in real time is always interacting with the physical world and the real-time model, as described by M. Jackson, includes the system itself, the environment and interface. Connecting the system and environment administration, output and bi-directional flow of information. These components are always physical in nature and, thus, while providing information on the system, they are also part of the environment. This high-level approach is shown in Fig. 1.

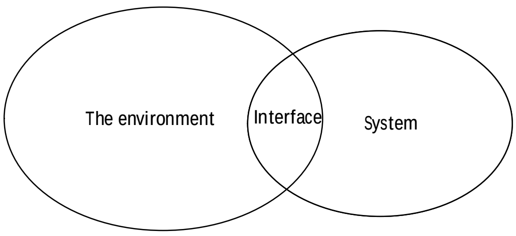

Fig. 1. A simplified diagram of the system

CONCLUSIONS

Thus, the use of a conventional personal computer as a simulator for the proper organization of experimental research and actual teaching personnel carrier providing objective and meaningful assessment of a particular operator. The potential of human operators to interact adequately with and to coordinate an automated system in normal and in critical conditions depends on the assessment and prediction of the operator's mental state. Operator activity can be described by mathematical tools has been done. In article were also describes the main characteristics of real time, which is the operator.

REFERENCES

1. **Frolov D. A. 2013** Architecture and scenarios of a computer simulator for the training of personnel of industrial enterprises / Vestnik SSTU. No. 4 (73) Information Technologies Saratov State Technical University, 2013.
2. **Shukshunov V. E. 2013** Basics of development and creation of integrated training and training complexes for equipping training centers for management specialist's Dynamic objects // V. E. Shukshunov, V. V. Janjushkin, Software products and systems, No. 3, pp. 3–10.
3. **Rabenko V. S. 2004** Computer simulators as a means of improving the quality of the professional preparedness of operators / Ivanovo State Energy University, "Vestnik IGEU", 2, 2004, p. 19, 27.
4. **Petrenko T. G** Problem-situational approach to the construction of an automated simulator of an operator / T. G. Petrenko, Yu. S. Reznichenko, Shtuchniy telecom., 2008, No. 4, p. 483, 492.
5. **Borsuk S. P. 2012** Registering "floating" performance of operators using the membership tables / S. P. Borsuk, Aerospace Engineering and Technology, No. 10 (97), p. 187, 191
6. **Borsuk S. P. 2012** Multidimensional tables for registration of progress on simulators / Borsuk SP, Electronics and control systems, No. 1 (31), pp. 155, 159.
7. **Bass E. J**., **Baxter G. D., Ritter F. E. 1995** Creating Models to Control Simulations: A Generic Approach. AI and Simulation of Behaviour Quarterly, 93, pp. 18–25.
8. **David M**. **Auslander and Cheng H. 1990** Tham. Real-Time Software for Control: Program Examples in C. Prentice-Hall, 231 p.
9. **J Consortium**. **2000** International J Consortium Specification Real-Time Core Extensions. www.jconsortium.org.
10. **Kaminski R. M 2002** Analysis, modeling and evaluation systems will operate rapid image recognition / proc Int. Conf. on inductive modeling, "MKIM 2002". Lviv: State Research Institute of Information Infrastructure, Vol. 1, Part 2, p. 228, 234.
11. **Zinchenko T. P 1981** Identification and coding., Leningrad: Leningrad State University, 183 p.
12. **Kaminski R. M 2000** The mathematical approach to the organization of the human-machine interface processing visual information / RM Kaminsky, technical news, 1 (10) 2 (11), p. 43, 46.
13. **Semenets V., Natalukha Yu., Taranukha O., Tokarev V. 2014**. About One Method of Mathematical Modelling of Human Vision Functions. ECONTECHMOD. An international quarterly journal,Vol. 3, No. 3, pp. 51–59.
14. **Brytik V. I., Zhilina O. Yu., Kobziev V. G. 2014.** Structural Method of Describing The Texture Images. ECONTECHMOD. An international quarterly journal Vol. 3, No. 3, pp. 89–98.
15. **Greg Bollella, Ben Brosgol, Peter Dibble, Steve Furr, James Gosling, David Hardin, and Mark Turnbull 2000.** The Real-Time Specification for Java. Addison-Wesley, 45 p.
16. **J Consortium 2000** International J Consortium Specification Real-Time Core Extensions,. www.jconsortium.org.
17. **Burns Alan, Wellings Andrew 2001** Real-Time Systems and Programming Languages (3rd ed), Addison Wesley, 302 p.
18. **Kopetz, Hermann 1997** Real-time Systems: Design Principles for Distributed Embedded Applications, Kluwer Academic Publishers, 123 p.
19. **Joseph, Mathai 2001** Real-time Systems: Specification, Verification and Analysis, 6 p.
20. **Damveld H., Beerens G., Paassen M. van, Mulder M. 2010** "Design of Forcing Functions for the Identification of Human Control Behavior" Journal of Guidance, Control, and Dynamics, 33 (4), pp. 1064–1081.