UDC: 681.5

WELL-POSED IDENTIFICATION OF NUCLEAR TYPE INFINITE AND MULTIDIMENSIONAL SYSTEMS

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Introduction: System identification problems have the feature that under certain conditions its solutions become highly sensitive to the errors in input data. Especially it takes place in multidimensional cases when even an appropriate model set of the original system is unknown. In such cases it is necessary to use different infinite-dimensional expansions as model set. Hence there is a problem of approximation infinite-dimensional linear system by finite-dimensional ones. Selection of model order is defined by the well-posedness which should ensure the solution sustainability.

Purpose: The purpose of research is to establish and study conditions, that define when system identification problems are well-posed and when solutions become unstable and therefore practically unfit for parametric-structural identification on the base of description in the form of infinite expansions.

Results: It was shown that solution high sensitivity is associated with ill-conditioned matrices that are used to estimate the coefficients of the model. For finite-frequency and subspace identification methods it was demonstrated that depending on the ratio of the input data error and the condition number of matrix the solution of identification problem can be both stable and unstable.

In multiple experiments with different system on the plane of these two parameters distribution of models by stability was obtained which allowed us to construct the stability domains. Further this domains can be used in regularizing procedure when selecting the model order.

Conclusions: Identification problems of infinite or multidimensional systems may be fully treated as essentially ill-posed. It is shown that this property is fundamental regardless what kind of method is applied.

Correct solution of identification problem is almost always requires the use of regularization procedures which imposes restrictions on the model dimension. Resulting reduced model approximate the real system with respect to output only so model parameters can differ from the same parameters of the real system.

Keywords: system identification, ill-posed problem, finite-frequency identification, subspace (4SID) identification, regularization.

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EXTERNAL ELLIPSOIDAL APPROXIMATION OF REACHABLE SETS OF DYNAMIC SYSTEMS

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Introduction: The methods for constructing the external ellipsoidal estimates of reachable sets of discrete and continuous dynamic systems (DS), susceptible to external bounded disturbances are proposed. Effectiveness of this method is illustrated by the example of the system control of a solid body angular motion.

The purpose: Development of constructive methods for constructing ellipsoidal estimates of reachable sets DS and obtaining guaranteed accuracy estimates of DS control systems in steady mode.

Results: Ellipsoidal estimates reachable sets of continuous and discrete DS obtained according to consistent methodological approach based on using the support functions apparatus of convex sets and methods of mathematical programming. The proposed methods are locally optimal by matrix trace criteria of estimating ellipsoids. Ellipsoidal estimates of limit sets of continuous linear DS with bounded external disturbances are obtained based on use known General direct Lyapunov method. As exemplified by control of a solid body angular motion, ellipsoidal estimates of limit sets and asymptotic estimates of reachable sets are complementary. The intersection of these sets is an improved estimate of steering control accuracy in the steady mode.

Conclusions: In order to obtain estimates of the accuracy of the DS control systems it seems to be reasonable using Lyapunov direct method and methods for constructing ellipsoidal estimates of reachable sets of DS.

Keywords: dynamic system, uncertainty, ellipsoidal estimates, reachable set, limit set.

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OPTIMAL CONTROL BY VIBRATIONS OF A RECTANGULAR MEMBRANE

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Introduction: In the theory of optimal control one of the central role rightly takes linear quadratic problem. For controlled systems with lumped parameters this problem was studied in sufficient detail that cannot be argued about a similar problem for systems with distributed parameters. In this article the linear- quadratic problem is investigated by the modern methods of variational calculus and mathematical physics. The purpose of this article is to study the linear- quadratic problem of optimal control of oscillations of a rectangular membrane, namely obtaining necessary optimality conditions and the derivation of the formula for

calculating the optimal control.

Statement of the Problem: Controlled process is described by a two-dimensional wave equation with partial derivatives. There are given the initial conditions and homogeneous boundary conditions. The cost functional is a quadratic. Admissible control which is implemented at least the cost functional is called optimal.

The main results: The author of the article obtains the necessary optimality conditions. At their bases derived a system of integro-differential Riccati equations with partial derivatives. The solution of this system provided an opportunity to write an explicit formula for calculating the optimal control.

Conclusions: In this paper a system of integro-differential equations with partial derivatives of the Riccati for linear quadratic optimal control problem of a rectangular membrane vibration process is obtained. The solution of this system provides the ability to write an explicit formula for calculating the optimal control. Promising for further study is to obtain similar results for the case of a circular membrane. Also of note is the advisability of generalization of the results obtained in this paper for the case of systems with fractional derivatives.

Keywords: optimal control, the method of Lagrange multipliers, Ruccato equasion.

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A WAY TO ORGANIZE EFFECTIVE DATA EXCHANGE IN NETWORK-BASED CONTROL SYSTEM FOR DYNAMIC OBJECTS

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Introduction: Perspective air traffic control and air traffic management systems will use global telecommunication structure based on multiservice network. The use of existing network protocols and communication channels in multiservice network for remote control of manned and unmanned aircrafts may be hampered by transmission delays and information loss.

Purpose: The purpose of the work is to give an analysis of existing and perspective network protocols and techniques in terms of suitability for use in multiservice networks for remote control of dynamic objects and estimate the impact of control data transmission delays on quality of remote control of dynamic object using the task of aircraft trajectory control as an example.

Results: The major factors that make an impact on quality of work of distributed in navigational computer network aircraft control system are the network delay that shifts in time data packets transmitted from an aircraft to the remote control system and transmission network delay for command packets from control system to the aircraft. It is shown that use of modern protocols and techniques makes it possible to significantly enhance speed and cut delays for transmission of control data over network structures within control system. Network transmission speed can be increased in times when small amount of redundancy is introduced in the network communication channel for given packet loss rate. Results of modeling of remote system for aircraft trajectory control shows that it is possible to build distributed control system that is invariant to control data transmission delays in a broad range of delays (100-700 ms) which are typical for real-world networks.

Conclusion: To build effective control system with distributed informational and executive resources one need to separate data exchange streams based on importance for control quality and acceptable data transmission delays. Data exchange protocols, channels and traffic routs should be selected based on properties of specific informational streams. Structures and protocols that provide redundancy and duplication of transmitted information should be considered. Selection of specific data transmission protocols and techniques can be combined and complemented with developed methods for control of high-speed dynamic processes and proper distribution of control components between controlled object and remote control system.

Keywords: network, network protocol, remote control, data exchange, FEC technology, distributed control system, aircraft control, high-speed cycles control.

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INFORMATION TECHNOLOGY OF PSYCHOPHYSIOLOGICAL MAINTENANCE OF OPERATOR'S ACTIVITY HIGH RELIABILITY

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Introduction: Human reliability is a complex parameter, which has to take into account semantic aspects, the pace of activity, complexity, intensity, and sequence of tasks, information overload arising from this; various external influences, as well as qualitative characteristics of activity. That is why technocratic understanding of psychophysiological mechanisms of ensure human activity reliability is limited in relation to human activity that requires the creation of medical information technology for complex foregoing problem solving.

Purpose: Creation of information technology for the implementation of psychophysiological ensure high reliability of operator activity.

Methods: Analysis of the results was performed using the following methods: nonlinear regression, cluster analysis, factorial ANOVA using the data analysis software system STATISTICA 6.1.478.0.

Results: The most important task for solving this problem is to build such information technology which would take into account the peculiarities of human-machine interaction. Therefore, it is advisable to use several approaches for its realization. The first approach is to use special integrated indicators, taking into account the fundamental characteristics of his organism (sex, age, severity of PVC, etc.) influence on working person behavioral responses. The second approach aims to determine the reliability of a possible reduction of the human impact on the characteristics of the job. It makes the technology more demanding but physiologically adequate in implementation when each operator is working at his best that extremely narrow degree of freedom in the solutions choice, limiting its effect on the solvable task parameters. The third approach is based on the using feedback test data and ignores the obvious fact that the operator can work correctly for a long time under low intensity presented tasks. To maintain the reliability of the operator's activity in information technology a special correction unit and monitoring unit psychophysiological qualities operator have been included. As a result of performed analysis, the information technology to maintain high reliability of operator activity has been created. It takes into account the information processes on different levels of hierarchically organized ergatic system human — machine — environment, and consists of several information blocks focused on assessing correction and monitoring the reliability of the operator's activity.

Conclusions: The fundamental causes of operator error based on the existence of objective contradictions between existing imperfection of human knowledge about controlled processes and its decision-making, as well as the incompleteness of the rules governing the operator's actions in specific, unusual situations leading to misinterpretation of the problems have been identified. A structural-functional hierarchical system of operator's activity reliability formation, taking into account the effect of various factors in the ergatic system on the quality of work has been proposed. The information technology of psychophysiological maintenance operator's activity high reliability consisting of several parts: the psychophysiological assessment of reliability of operator's activity integral characteristics, parameters of limited feasibility of activity and reliability profile of activity based on the allometric model characteristics; correction reliability of an operator using training occupationally important qualities; monitoring psychophysiological qualities has been .

Keywords: information technology, hierarchical information model, allometric model, operator's activity reliability.

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A FORMAL ANALYSIS OF MECHANISMS INCREASING ARTERIAL PRESSURE

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Introduction: Arterial hypertension (AH) is a multi-factor disease indicated by an elevation of end-systolic and end-diastolic peaks of arterial pressure (AP). Currently, AH's cure is symptomatic and palliative because our understanding of mechanisms controlling AP is not comprehensive.

The purpose of the paper is to propose an extended view of mechanisms regulating long-term level of mean arterial pressure (MAP).

Results: To reach this goal, the energy theory of reversible adaptation is used. The theory ensures that in vertebrates (in particular, in humans) there is a multi-scale energy megasystem (EMS) fighting against continuously lack of ATP in every cell. EMS is a complex system constituted of multiple partners. It is shown that cell-scale mechanisms balancing mean rates of ATP synthesis and consumption are functioning in two-side relationships with organism-scale mechanisms. The cardiovascular system (CVS) is a structural-functional part of EMS that materially provides both the mitochondrial respiration and mitochondrial enlargement (via hypertrophy/proliferation) in every cell. Under stable organism-scale physiology indicated in form of a stable energy consumption rate, the level of MAP inversely correlates with a total surface of cells mitochondria. On long-term scales, lung

ventilation, blood erythrocytes amount, and blood glucose are also in inverse correlation with MAP. These reciprocal relationships suppose that there will be an individual normal value of AP. This value does depend on relative investments of EMS's sub-units in providing of ATP synthesis.

Conclusions: An increase of MAP in CVS will appear every time when the remained partners in EMS cannot properly compensate the lack of material incomes into cell mitochondria. This general view of roles playing by CVS and MAP in organism suggest that AH is rather a compensatory response of entire organism to energy lack than a disease.

Keywords: arterial hupertension, energetics, circulation physiology, models.

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DESIGN FEATURES OF THE MEDICAL INFORMATION DECISION SUPPORT SYSTEM BASED ON DATA MINING

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Introduction: Tendency for data mining today is great. Often, in the datasets there is missing implicit knowledge that can be obtained with the help of modern information technologies and methods of data mining. Use of this information technologies allows automatization of processes for extraction of data that help to get interesting knowledge and regularities. The formalization of semistructured and unstructured tasks is no less important.

The integration of statistical methods and database management systems allows to create an effective decision support systems for various purposes.

Improving the efficiency of treatment can be achieved by applying data mining methods.

The purpose of this work is the description of the stages of design of information system based on data mining for prediction of complications and decision support.

Results and discussion: The developed information system consists of a database module, data mining module and generation decisions making module. The generation module of decision making presented as a custom application. The database module allows to organize and store information. The basis of the module of data mining is the algorithm that allows to calculate not only the prediction of complications, but also to determine the annual indicators of significant risk factors which is useful in making medical decisions. The first stage of the algorithm is the comparison of statistical methods to determine the most effective. The second is the construction of mathematical models to forecast the development of complications chosen method. The third is the comparison of risk factors and outcomes models. This provides the forecast of the development of complications. In addition, it provides the tools necessary for the correction of treatment. Under the previous comparative analysis revealed that the binary logistic regression gives a higher percentage of correct assignment, the sensitivity and specificity which is indicative of high quality of the resulting model. A method MDR helps to identify a hierarchy relationships between risk factors and systematic communication themselves. It gives the possibility to determine the direction, strength of influence and to which extent the factors with the help of entropy.

Conclusions: A medical information decision support system is developed. It allows to identify high-risk patients. A retrospective evaluation of prognosis of complications was also carried out that allows dynamically optimize the structure of the therapeutic measures to reduce the risk and severity of complications in the early postoperative period in patients with coronary heart disease after coronary artery bypass surgery.

Keywords: Medical information system, decision support, data mining, correction of the treatment process.

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