$=$ **THEMATIC ISSUE** $=$

Introduction Address by the Program Committee of the Conference "Management of the Development of Large-Scale Systems"

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Abstract—This special issue features selected papers from the 14th International Conference "Management of the Development of Large-Scale Systems (MLSD 2021)" held on September 27–29, 2021.

Since 2007, the conference, organized by the Trapeznikov Institute of Control Sciences of the Russian Academy of Sciences, has served as an annual scientific forum to promote dialogue between Academy scientists, university researchers, industry experts, and the public sector.

The conference program has been constantly expanding. At the moment it covers 16 sections. Among them, ten sections are focused on industry-level issues:

– transnational companies, state holdings, and state corporations;

– digital economy;

– banking and financial systems;

– fuel and power systems and infrastructure systems;

– transport systems;

– aerospace and similar complexes;

– regional and municipal systems;

– nuclear power;

– health care and biomedical systems;

– social systems.

Another six sections deal with the development of tools:

– imitation and optimization;

– management of investment projects and programs;

– nonlinear processes and computational methods;

– information and software;

– processing and intellectual analysis of large amounts of information;

– monitoring in development management.

Since 2017, the conference has been held with the information support of the IEEE Russia section. The MLSD publication policy provides for the electronic publication of papers indexed in

the RSCI as well as the placement of selected papers in the IEEE Xplore electronic library indexed in the Scopus bibliographic database.

The proceedings of the MLSD 2021 conference included 255 reports, and 153 articles were indexed in the Scopus bibliographic database.

The thematic issue is devoted to development management problems for large-scale systems in the modern conditions of management globalization and digitalization. The issue includes articles by authors who have repeatedly delivered plenary and sectional reports at this conference.

The program committee of the conference pays special attention to fundamental problems of mathematical modeling of the development of large-scale systems and the construction of complexes of complementary models based on aggregative-decomposition and design-programming approaches. This issue presents a number of the most interesting results related to various applied areas and ensuring the achievement of significant socio-economic effects. The article by I.B. Yadykin, I.A. Galyaev, and Yu.A. Vershinin studies the matrix continuous differential and algebraic Lyapunov equation, which plays an important role in control theory. The authors present a new solution of the generalized Lyapunov matrix equation for a continuous bilinear time-varying MIMO control system. The fundamental novelty of the approach lies in the diagonalization of the dynamics matrix of the bilinear system and in the transfer of iterative calculations from the solution matrix to the calculation of sequences of its entries at each iteration step. This solution permits obtaining a sufficient condition for the stability of the bilinear system.

The article by A.D. Tsvirkun, A.F. Rezchikov, A.A. Samartsev, V.A. Ivashchenko, A.S. Bogomolov, V.A. Kushnikov, and L.Yu. Filimonyuk deals with blocking the spread of fire and evacuating people from premises, which is a topical and actively developed problem in Russia and abroad. The authors set the task of forming a generalized mathematical model of multifactorial processes with their subsequent interconnection to obtain trajectories of self-organized motion of people in complex one- and multi-storey buildings.

The main components of the models are:

– planar cellular structures of the spatial and temporal spread of fire in the cells of which combustible and noncombustible materials are located;

– distribution of heat and smoke taking into account local combustion processes;

– complex models of the motion of individuals and the flow of people in rooms at different floor levels.

The paper by S.A. Gakh, S.P. Podkoval'nikov, and O.V. Khamisov explores the use of dual estimates of the development of electric power systems in the form of Lagrange multipliers. In contrast to the approach that has become classical, where short-term estimates are calculated, the authors focus on the calculation of long-term dual estimates. The new perspective is extremely important for analyzing the development of dynamically changing smart grids. In particular, the long-term estimates obtained in the dual model permit one not only to analyze the efficiency of the generating sources and transmission lines under consideration but also to determine how efficient they are without additional special studies of each of them.

The article by A.V. Akhmetzyanov and A.V. Samokhin presents new important theoretical results for nonlinear equations of hydrodynamics that have great practical prospects in the control of oil production processes. The paper presents spatially one-dimensional and two-dimensional non-

linear mathematical models of sawtooth waves. These are traveling disturbance waves whose profile contains both discontinuities and smooth sections. In a medium without dispersion, any periodic disturbance turns at large distances into a "saw with triangular teeth." Each period contains a discontinuity and an almost rectilinear section of the profile. With further propagation, only the peak values of the disturbance change. Detection and control of sawtooth processes can lead to an increase in oil recovery up to 10-15% even in already depleted fields due to the additional recovery of residual reserves. The use of such technologies in the future will be equivalent to the discovery of new large deposits.

The paper by V.V. Tsurko and A.I. Mikhalskii is devoted to estimating the statistical relationship between random variables via mutual information. The main part of the article presents the mathematical statement of the problem and several ways to solve it. The prospects of the mathematical technique proposed are associated with its possible use for the selection of informative features at the preliminary stage of data analysis and training. As an example of application of this method, the results of feature selection in predicting the stability of the spatial configuration of proteins formed by five amino acids are presented.

In the article by D.A. Gubanov, the problem of analyzing the spread of information influence in network structures is studied. The author develops an actional approach that provides for network member actions such as writing a post, commenting on it, reposting, liking, etc. Each action is characterized by three parameters: the network member, the action type, and the action time; this permits the author to determine the agents' action influence in the network from the viewpoint of a certain governing body. Three examples of practical use of the technology proposed are given.

The first example is related to the assessment of the impact and information security of users of the social network VKontakte. The second deals with the study of the influence of connections between agents based on the concepts of network and individual significance. The third is focused on identifying information communities.

The article by F.I. Ereshko, A.Yu. Mushkov, N.I. Turko, and A.D. Tsvirkun deals with project management problems for a mixed economy. Following a systematic approach to the development of large-scale projects, the authors propose conceptual mathematical models that describe the procedure for synthesizing the Center management structure in hierarchical systems. Formal descriptions of the mechanisms underlying the procedures for coordinated decision-making by the Center and subordinate systems are given. The principles of using aggregated mathematical models and their adaptation to specific industry problems are outlined. Based on the formalized representations of game theory and operations research, it is proposed to analyze the experience in the creation of holding structures and identify the advantages of their operation.

The strength of the paper is in the applied part related to the analysis of legal foundations of strategic planning.

The article by I.V. Chernov considers the results of research on formalization and development of a scenario approach to vulnerability analysis in the management of a complex system aimed, in particular, at preventing emergency situations. The hierarchy of concepts characterizing the vulnerability of a complex system is considered. Formal statements of problems for analyzing the vulnerability of a complex system under the conditions of propagation of disturbances during the implementation of threats are being developed. On the basis of mathematical research, basic

scenarios for the development of a dynamical system and the adoption of efficient decisions on the management of complex socio-economic systems are identified.

The scenario system considered by the author is a complex of interrelated components that allows one to proceed to formalized descriptions of the most important elements of a complex system: the subject area in which significant events are identified, state transformation models, uncertainty formation models, and rules for selecting scenario elements. In general, the scenario model describes the joint behavior of an object and its environment.

Chairman of the MLSD'2007–MLSD'2021 Program Committee,
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