

## Introductory Remarks to the Special Issue Devoted to MLSD 2023

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This special issue of *Automation and Remote Control* presents selected papers of the 16th International Conference on Management of Large-Scale System Development (MLSD 2023). The conference was held on September 26–28, 2023, in Moscow, Russia.

MLSD is an annual event organized by the Trapeznikov Institute of Control Sciences, the Russian Academy of Sciences (ICS RAS). The Proceedings of MLSD'2023 in Russian include 20 plenary and 224 sectional papers indexed by the Russian Science Citation Index (RSCI). With the technical support of the IEEE Russia Section, the full-text English versions of 177 papers were placed in the IEEE Xplore digital library and indexed by Scopus. In addition, according to the publication regulations of the conference materials, a special issue of *Automation and Remote Control* was prepared, which contains nine papers reflecting the most relevant development directions of control science.

According to the analysis, six papers among them significantly contribute to implementing the concepts of Smart Energy, Smart Field, Smart Enterprise, Smart Transport, and Smart Army.

A topical problem of Smart Energy is the continuous control of the technical and economic state of equipment, including frequency and voltage regulation for energy sources. Effective approaches to solving this problem include the apparatus of gramian matrix structures and monitoring and control technologies.

This special issue includes two papers presenting the latest results in the corresponding area of research.

In the paper “Spectral Decompositions of Inverse Gramian Matrices and Energy Metrics of Continuous Dynamic Systems,” I.B. Yadykin presents new spectral decompositions of gramians in the form of Hadamard products. They are used for solving algebraic and differential Lyapunov equations of linear time-invariant (LTI) multi-input multi-output (MIMO) systems.

The paper “Structural Spectral Methods of Solving Continuous Generalized Lyapunov Equation” (I.B. Yadykin and I.A. Galyaev) is a continuation of the authors’ publications devoted to this topic. The main result is a new spectral decomposition method for the Volterra matrix series to calculate gramian and energy functionals of a bilinear system and the  $H_2$  norm of a bilinear system.

Against the background of significant successes in the practical implementation of the Smart Field concept, many digital modeling problems remain unsettled. One such problem is related to the modeling of mobile oil extraction technologies from hard-to-recover hydrocarbon reserves in complex geological and physical conditions. This topic is considered in the paper “Wave and Physical-Chemical Methods for Managing the Development of Oil Fields with Anomal Reserves” by A.V. Akhmetzyanov and A.V. Samokhin. The approach proposed therein is conceptually based on the theory of periodic waves in a viscous medium. The authors justify the adequacy of cylindrical acoustic wave impacts on natural deposits that increase the oil recovery factor by 10–15%.

New principles of operational support and risk management for large-scale systems are associated with the concept of casual artificial intelligence (Causal AI). One implementation of this concept

is the apparatus of hybrid system dynamics, which provides an ontological model of big data infrastructure to support the life cycle stages of search causal neural networks. The apparatus is based on decision-making in cases and situations requiring the comprehension of deep causes behind a result. Two papers, focused on the projects of Smart Enterprise and Smart Transport, address this approach.

In the paper “Optimization and Simulation Approach to Determining Critical Combinations of Company Parameters,” A.D. Tsvirkun, A.F. Rezhikov, O.I. Dranko, et al. propose a risk analysis and forecasting method focused on the assessment of business resilience to different challenges. Practically, this method implements a data fabric that continuously identifies and connects information from disparate applications to identify unique management-relevant interconnections. The corresponding approach allows running various applications, including those intended to identify key risks, debug response strategies, test the business model, and manage financial risk mitigation.

The current implementation stage of the Smart Transport concept can be characterized as the completion of the first stage related to the creation and adoption of information, communication, and management technologies embedded in the vehicle or road infrastructure. Nowadays, the emphasis is placed on controlling the influence factors of crash risks unique for each particular section and area of the road transport network. This problem is discussed by A.D. Tsvirkun, A.S. Bogomolov, O.I. Dranko, et al. in the paper “System Dynamics Models for Control the Road Transport System of a Mega City.” The authors’ model can be used to assess the adequacy of certain management actions.

Decision technologies based on the Lanchester–Osipov model are crucial for implementing the Smart Army concept. This model describes the attrition dynamics of two confronting armies depending on their combat effectiveness indicators and has various modifications depending on the type of combat operations. I.D. Laryushin and Y.A. Koltchenko further develop it in the paper “Extended Lanchester–Osipov model for Accounting of Combat Units in Strategic Computer Games.”

This special issue also includes papers that develop original approaches to methodological and instrumental support of model-based digital management scenarios for large-scale scientific research and production and organizational processes.

In the paper “Hierarchical Games and Computational Procedures in the Linear Case,” M.A. Gorelov and F.I. Ereshko continue the cycle of their research works on the modern mathematical theory of operations research in the digital economy. This paper is devoted to organizational systems with the fan structure, numerous active participants, internal dynamics, and various forms of interaction between players. Hierarchical games are also called the model of unequal participants, e.g., the state and its citizen or the head of a firm and its employee.

The method of hierarchical games consists in modeling interactions between players distributed in layers, where each current layer receives data from the previous layer and supplies its decisions to the next layer.

When applied to the digital economy and management of large-scale system development, hierarchical games provide a uniform formalization of various problems. Examples include the search for weight coefficients in deep learning or strategic planning, identification of the limits of targeted influence on strategic development, etc.

E.N. Khobotov’s paper “Models of Equipment Selection for Modernization of Enterprises with Conveyor Assembly of Products” deals with the digitalization of the routine changeover support process for flow production. The set of aggregated scheduling models proposed by the author is a promising example of basic data infrastructure components for the development of intelligent systems that can independently make decisions, learn, and optimize their work in real time.

The paper “On Samples of Satellite Measurement Data for Constructing a Global Model of the Magnetic Field of Mars” (A.M. Salnikov, A.V. Batov, I.E. Stepanova, and T.V. Gudkova) is a continuation of a series of high-class R&D works on modeling the magnetic field of Mars. The topicality of this scientific direction can hardly be overestimated. Its results are important for solving fundamental problems of planetary geophysics, obtaining the detailed distribution of non-hydrostatic stresses in the interior of Mars, and further studying the internal structure of Mars numerically.

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