ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

FRACTIONAL STRUCTURE «MIXING – TRANSPORT» AS AN OPEN SYSTEM (p. 4-9)

Eduard Vadimirsky, Bahram Ismailov

In the context of a research area "open systems physics", fractional structure "mixing – transport" as an open system is proposed. The studies of power-law nonlocality and power-law memory, allowing to create mathematical methods, successfully used in transport (transfer) systems are considered.

Interaction paradigm of geoinformation space with fractional structure "mixing – transport" is proposed. It is shown that the interaction is crystallized into fractional structure "transport – mixing – transport", formalization of which is presented as an open system model. It is noted that due to the complexity of the open system, the formation of various structures, such as Levy processes and random walks in fractal time is possible in it.

A base for understanding anomalous transport, adequate to Levy flights, is an association with superdiffusion processes, considered in transport theory.

It is noted that in describing the properties of systems with fractal structure, representations of Euclidean geometry cannot be used. There is a need to analyze these processes in terms of the fractional dimension geometry. Systems with fractal feature are characterized by effects such as memory, complex spatial mixing processes and self-organization.

Using the new research area – open systems physics, which integrates the fields such as synergy, dissipative structures, deterministic chaos, fractal concept introduces a new level of understanding in implementing complex tasks at interdisciplinary level.

A new vision of the open system, which is characterized by coherent Lagrangian structure (stable and unstable manifolds of fixed points and periodic orbits) and finite-time Lyapunov exponent is shown.

Based on the ideology of the nonlinear recursive analysis and the Poincare theory, visual images of Poincare fractional-order diagrams for the cases of the interference component influence in various frequency ranges are first acquired. Moreover, numerical characteristics of the fractional-order fractal dimension d_f and the average Poincare recurrence time $\langle\tau\rangle$ are obtained.

Keywords: open system, fractional structure, Poincare recurrence time, fractality, visualization, exponent, interference, dynamics, Levy, Chirikov-Taylor

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SYSTEM APPROACH TO MATHEMATICAL MODELING OF THERMAL PROCESSES IN BUILDINGS (p. 9-12)

Alexander Kutsenko, Sergey Kovalenko, Vladimir Tovagnyansky

An approach to constructing a mathematical model of the heat supply process of building, consisting of interconnected premises is proposed in the paper.

The approach is based on replacing heat-conduction equations, describing heat transfer processes between the elements of buildings and the environment, by a finite-dimensional system of ordinary differential equations. Substantiation of the dimension of the approximating system, based on comparing the analytical solution of the heat-conduction equation and the results of the numerical integration of the approximate differential equation system is carried out. Numerical experiments have shown that for different values of the criteria with sufficient accuracy for

practical purposes one can content himself with the system of the 2nd order.

It is shown that the time constants of thermal processes of air of premises, partitions and filling of premises are by 2–3 orders lower than the time constants of the processes in the outer perimeter. This allows to replace the system of differential equations of heat balance for air, partitions and filling by static equations.

The obtained structure of the mathematical model of the thermal process in a complex system is a linear model of controlled processes. This allows to effectively adapt all the basic methods of analysis and synthesis of automatic control systems to the problems of heat supply management.

Keywords: thermal processes, heat supply of buildings, mathematical model, heat-conduction equation, differential equations.

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THE STATISTICAL MODELS OF MACHINERY MILKING DURATION BY GROUP MILKING MACHINES (p. 13-17)

Volodymyr Kucheruk, Yevhen Palamarchuk, Pavlo Kulakov

Based on the conducted theoretical and experimental studies, the statistical models that establish a functional relationship between statistical characteristics of the milking duration by the group milking machines "Yalinka" and "Parallel" for animal untied housing, and the parameters of milking machines, type of milking machine, statistical characteristics of the animal preparation time and the animal milking time.

The proposed models are based on the new approach to estimating the statistical characteristics of the animal preparation time and the animal milking time. This will increase the accuracy of determining the productivity of milking machines in their designing or upgrading, develop a methodology for designing data-measuring systems of the parameters of technological processes of milk production and automatic control of a farm, ensure further development of the theory of such systems.

The adequacy of the developed models is higher compared with the existing ones, as confirmed by determining the relative estimation of differences between the results of the theoretical calculations and the experimental data.

Keywords: milking, milking duration, animal preparation, statistical model, group milking machine.

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INFLUENCE OF PARAMETERS OF THE ANT COLONY ALGORITHM ON THE TRAVELING SALESMAN PROBLEM SOLUTION (p. 18-23)

Ihor Mohyla, Iryna Lobach, Oksana Yakymets

Transportation of many freights can be given as the travelling salesman problem, when freight is delivered from one distribution center to customers during one trip. There are used exact, heuristic and metaheuristic methods for the solving this problem. It was chosen the ant colony algorithm from metaheuristic methods because it is close to the statement of the travelling salesman problem at the expense of its physical resemblance. However, the control parameters of the algorithm influent on its efficiency. Therefore, investigation of the searching of control parameter values, by which the algorithm will look for the optimal route as soon as possible, was carried out.

The ant colony algorithm for the travelling salesman problem was implemented in MATLAB environment. At

the first step for the networks with 15, 20, 25 and 30 nodes, that answer to the real delivery systems, there was determined the set of values of the control parameters, which ensure the largest efficiency of the ant colony algorithm – α=1, β=5, ρ=0,2. At the second step, there was determined minimal amount of iterations needed for searching of the optimal route for these networks. At the third step there was determined that insertion of three elite ants enabled to decrease amount of iterations for the optimal route searching (for example, for 20-nodes network from 307 to 69).

Obtained results can be used not only for the travelling salesman problem solving but also for vehicle routing of small-batch trucking, when the ant colony algorithm considers additional conditions.

Keywords: routing of small-batch trucking, traveling salesman problem, ant colony algorithm, algorithm's control parameters.

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THERMAL PROCESS MANAGEMENT AT THE EXACT ACCOUNTING OF GEOMETRICAL INFORMATION USING S-FUNCTIONS (p. 23-28)

Anatoly Slesarenko, Yuri Zhuravlev

A new numerical-analytical method for solving thermal process management problems is proposed. The method is based on solving inverse problems of identification of management functions by the specified optimal thermal conditions in time. In determining the optimality degree of the given thermal modes, all necessary limitations on the distribution of temperature, its gradients and the rate of heating or cooling are taken into account.

Solving inverse problems of identification of management functions is reduced to solving variational problems for the corresponding pair functionals. The temperature of the heating medium or the power of internal thermal energy sources is used as management functions. Analytical or regionally-analytical structures for solving thermal process management problems, exactly satisfying unsteady boundary conditions of heat transfer on the surface of the structural element and accurately at an analytical level taking into account the indefinite management function as the temperature of the heating medium are built. Using S-functions allows accurately solve the corresponding inverse problems of analytical and differential geometry. This allows accurately at the analytical level describe the surfaces of structural elements.

The proposed new approach to solving thermal process management problems divides nonlinear process of solving corresponding inverse heat conduction problems into two linear processes. At the first stage, in the built structures for solving thermal process management problems, the coefficients of the basis functions of solution structures are determined. This allows for the first time to organize a second stage of identifying dozens and hundreds of parameters in real time by parallelizing the process of finding the above two groups of undetermined coefficients. This is the undeniable advantage of this approach to solving thermal process management problems compared to using numerical methods for solving these problems.

Keywords: management, thermal processes, numerical-analytical method, the structure of solutions, S-functions, functional, identification, model, parallelization.

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APPLICATION DECOMPOSITION IN SPACE WITH A GENERATIVE ELEMENTS FOR SOLVING PROBLEMS OF PROBABILISTIC DIAGNOSTICS (p. 28-35)

Serhii Zabolotnii

In spite of plenty developed methods for probabilistic diagnostics, obtaining the effective solutions for Non-Gaussian models of statistical data is an actual problem. In this article the application possibility analysis of decomposition in space apparatus with a generative element for the decision of detection and identification (recognition) tasks of random processes' disorder, described by higher-order statistics, is conducted. The offered approach is positioned as a semi-parametric variant of statistical analysis, constituted on a compromise between simple non-parametric and optimal realization-difficult parametric methods. The article tells about the systems' structure that is based on polynomial matched filter, designed for sequential detection and identification of disorder. The features of adaptation property implementation of such systems are analysed. The task of disorder's sequential detection on average and variance of Non-Gaussian random sequences is researched by statistical modelling as an example. Obtained results confirm effectiveness of the proposed approach for solving of the probabilistic diagnosis' tasks, which can be used to construct automated systems for monitoring and diagnosis of Non-Gaussian random processes in various application areas.

Keywords: disorder, matching, stochastic polynomial, Non-Gaussian processes, higher-order statistics.

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SUBJECTIVE RISK FOR SUBJECT AND RATING PREFERENCES (p. 36-41)

Vladimir Kasyanov

The principle of maximum subjective entropy is presented in the paper.

Two options of subjective risk are proposed, namely for subject alternatives and, subject preferences respectively, rating alternatives and, accordingly, rating preferences. In both cases, all subjective categories relate to a certain "individual carrier": a set of alternatives, distribution of preferences, maximizing functionals.

An additional assumption of the entropy space structure is introduced: entropy thresholds make the final area of changing the entropy on subareas so that the entropy transition from one area to another radically alters the behavior of the subject "decision maker." Also, thresholds for subjective risks are introduced.

The proposed theory can serve as a basis for improving the methods of active system management for self-government process analysis.

Keywords: subjective risk, entropy, subject and rating preferences, entropy thresholds, rating.

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MATRIXES LEAST SQUARES METHOD: EXAMPLES OF ITS APPLICATION IN MACROECONOMICS AND TV-MEDIA BUSINESS (p. 42-46)

Volodymyr Donchenko, Inna Nazaraga, Olga Tarasova

In the paper general framework of Least Square Method (LSM) on vectors and matrixes observation is represented. Also the results developing M-Ppi technique are submitted. Some principal examples are represented in the article. These examples illustrate the advantages of LSM in the case under consideration. General algorithm LSM with matrixes observations is proposed and described in step-by-step variant for linear and nonlinear scaled data. The examples of method applications in macroeconomics and TV-media business illustrate the advantages and capabilities of the method. Correspondent results are also represented below as well as illustration of its applications for predicting in macroeconomics of Ukraine and in estimating of TV audience. The proposed approach for finding predictive values indicators is competitive.

Keywords: Moore-Penrose pseudo inverse, regression, least squares method, macroeconomic, prediction, econometrics.

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MATHEMATICAL MODEL OF TRAFFIC NOISE (p. 47-51)

Iuliia Shevchenko

Reducing noise to acceptable levels is an environmental, social and economic problem of modern cities. To achieve this task, information about the noise conditions of the studied area should be accessible and detailed. That is why the integrated mathematical model for evaluating noise levels at a point of the receiver taking into account the dynamics of vehicles in the flow on the road section, noise reductioneffects, characteristic of modern cities, at its propagation from the source to the receiver and integration of noise levels at the receiving point was developed.This model has allowed taking into account the motion nature of vehicles in the flow depending on the studied road area, the impact of the rugged terrain on the propagation of sound waves from the source to the receiver depending on the position of the receiver, as well as integral evaluation of the noise load levels.The developed model was verified by comparing with the results of experimental studies of traffic flows in two cities. This has allowed to determine the application range of the model and motion features of vehicles in the flow depending on the lane. Mathematical model of traffic noise allows to evaluate noise levels, not only from transport flows on straight roads, but also to simulate the formation of sound fields when approaching traffic lights and intersections.

Keywords: noise pollution, road transport, macroscopic modeling, acoustic power, traffic flows

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MODELING CROWD BEHAVIOR BASED ON THE DISCRETE-EVENT MULTIAGENT APPROACH (p. 52-57)

Oleksiy Lanovyy, Artem Lanovyy

The crowd is a temporary, relatively unorganized group of people, who are in close physical contact with each other. Individual behavior of human outside the crowd is determined by many factors, associated with his intellectual activities, but inside the crowd the man loses his identity and begins to obey more simple laws of behavior.

One of approaches to the construction of multi-level model of the crowd using discrete-event multiagent approach was described in the paper.

Based on this analysis the subject area, the problems, associated with the crowd model development were identified and described in the work. Approach to the construction of a model that takes into account such phenomena as a sharp change in direction of the velocity vector of the local flow of people in the crowd under the influence of physical, psychological and social factors, interagentinteraction, the change in thecrowddensity was described:

- to form the simplified structure of the crowd model, it was proposed to use aggregative mathematical model that allows to divide all the objects, present in the crowd into the macro and micro-elements;
- agent-oriented approach in the work was used to construct models of individual agents of the system, taking into account their dynamics and the presence of "driving" forcesin the crowd for a more accurate simulation of the crowd development;
- using the detailing function of individual elements of the model in the work is designed to improve the adequacy of the model; it is made by the simultaneous introduction of macro-and micro-elements to the model with the ability to reassign their properties, jointlyform the conditions of boundary transitions through a single system of variables;
- ensuring compatibility between the different elements of the same model is provided by introducing a unified system of constraints and shared variables, which allows to significantly simplify the software implementation of the model.

Keywords: heterogeneous crowd, multiagent approach, streaming method, conformity, multiscaling

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