ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

DEVISING STATISTIC MODELS OF MILKING DURATION ON THE CONVEYOR MILKING MACHINES (p. 4-8)

Volodymyr Kucheruk, Yevhen Palamarchuk, Pavlo Kulakov

As a result of theoretical and experimental research, our statistic models of milking duration determine a functional connection between statistic parameters of the duration of conveyor milking machines operation, statistic parameters of preparing and milking a cow, parameters and varieties of milking machines, and the number of animals in the herd.

The suggested models are based on a new approach to the estimation of statistic parameters of preparation and milking time. The models permit a more precise estimation of milking machines productivity at the stages of their design and modernization. The findings facilitate working out methods for designing information and measurement systems of milking technology parameters and automatic farm management systems and underlie further development of a theoretical background for such systems.

The increased adequacy of the devised models in comparison with the current ones is proved through determining a relative estimation of the divergence between the theoretical findings and experimental data.

Keywords: milking duration, preparation time, statistic model, milking machine, conveyor machine/equipment.

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A COMPARATIVE ANALYSIS OF CLOTHES DESIGN METHODS FOR FURTHER AUTOMATION (p. 9-15)

Anna Safonova

The paper considers current problems of automated clothes design. The study aims at determining which clothes design method—whether it is (1) basic calculation and graphics, (2) proportional calculation, (3) calculation and analysis, or (4) anthropocentric—would be the most suitable solution of the specified problems. To achieve the objective, we had formulated quality criteria and analyzed the methods that would be suitable for automation in computer-aided design (CAD).

The research proved that few elements of the first methods of calculation and graphics can be applied in modern CAD of clothes. The main disadvantage of proportional calculation methods is dependence of deviations in the proportional ratio of measurements upon the conditionally accepted normal figure. The methods of calculation and analysis are appropriate for mass production of clothes, whereas anthropocentric methods require detailed measurements or intuitive experience in determining linear dimensions of figures.

Comparison aided by fuzzy logic showed that CAD of clothes by anthropocentric methods of a product base design is the most suitable for small enterprises, particularly those engaged in custom tailoring.

Keywords: calculation and graphics, proportional calculation, calculation and analysis, anthropocentric, design methods, quality criteria, analysis, comparison.

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THE MAXIMUM ENTROPY PRODUCTION PRINCIPLE IN THE EVOLUTION OF THE MACROSYSTEMS: SOME NEW RESULTS (p. 16-23)

Nikolaj Delas

Closed non-equilibrium macrosystems, which are in the process of evolution to the equilibrium state, subject to the maximum entropy production principle are considered in the paper.

A procedure for direct calculation of entropy production in an arbitrary step of evolution is developed. In accordance with the maximum entropy production principle, the nonlinear equations of the distribution dynamics in the non-equilibrium closed system are obtained. It is shown that the development trajectory of such system is entirely determined by the nature of the initial distribution and distribution in the equilibrium state. Far from the equilibrium state, a decisive role in the evolution equation is played not by the difference between these values, but the difference of their logarithms.

The definition of "internal" system time is given.

A theorem, which states that distribution of elements by the phase space cells, which keeps a sum of the logarithms of their number constant is implemented at each time point for the closed non-equilibrium system, developed in accordance with the maximum entropy production principle is proved. Its formulation for the case of continuous distributions is given. The connection with the Liouville's theorem is shown.

Dynamic invariant of the evolution of closed systems, evolving in accordance with the maximum entropy production principle is defined.

Keywords: maximum entropy production principle, Ziegler's principle, evolution of complex systems, macrosystems.

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OPTIMISATION OF LARGE INFORMATION SYSTEMS WITH DIAGONAL-DOMINANT MATRICES OF KEY PERFORMANCE INDICES (p. 24-29)

Yaroslav Toroshanko, Volodymyr Shmatko, Maxim Vysochinenko, Anna Bulakovska

The choice and justification of the number and specific characteristics of key performance indices in complex technical systems is a very urgent task and an important part of the general problem of optimizing such systems. Besides, complexity and contradictions of the target functions within multi-conditional optimization of complex technical systems require prioritizing the selected key performance indices. Therefore, solution of the problems of quantitative assessment as well as analysis and comparison of key performance indices is especially important for designing such systems and controlling their operation.

While numerous scientific works—articles, monographs as well as materials of scientific and technical conferences—present results of a qualitative approach to the above-listed tasks, the present article focuses on quantitative aspects of solving the listed problems.

The major task within the general objective of the research is to analyze the main peculiarities of the matrix of key performance indices for evaluation of the parameters and the state, optimization and management of the service quality, and control over the information system. Multiple correlation and regression analysis laid the basis for methods of flexible evaluation and optimization of the system parameters. We have suggested methods of evaluating partial correlation coefficients and presented the results of calculations based on the typical matrix of correlation between key performance indices. We have analyzed the statistic correlation between the main parameters of an efficient system and a high-quality service. It has been determined that coefficient matrices of normal equations for calculating minimal root-mean-square (RMS) estimations are close to matrices of a diagonal-dominant form. The diagonal-dominant form of matrices facilitates and precipitates iterative search for solutions. The findings can be used in solving problems of optimal design and control of complex technical systems with variable parameters as well as random external and internal perturbations.

Keywords: information system, key performance indices, parameter evaluation, optimization, service quality.

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MODELLING OF THE RELATION OF IMPLICATION WITH USE OF THE DIRECTED RELATIONAL NETWORKS (p. 30-37)

Vitaly Bulkin

Models of the directed relational networks of relation of implication that can be used to represent knowledge in intelligent parallel action systems were developed in the paper. A relational network that implements the implication operation was created. The method of binary decomposition of the predicate of the modeled object is used for the relational network construction. The original n-ary predicate is represented as a conjunction of binary predicates. Testing of step-by-step operation of the relational network for all sets of values of object variables in the forward and inverse direction was carried out. An example of the relational network model operation for the relational network arc using a linear logical operator was considered. A method of constructing directed diagrams of the relational network was described. Directed diagrams of the relational network (forward and inverse) were built. Unification of the forward and inverse directed diagrams of relational networks was performed. Directed diagrams of relational networks can be used in creating knowledge bases to make up production rules. Directed diagrams of relational networks can become an important part of parallel knowledge bases and inference.

Keywords: theory of intelligence, predicate algebra, algebra-predicate structures, directed relational networks, linear logical operators.

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HYBRID MATHEMATICAL MODELS AND METHODS OF TIME SERIES FORECASTING TAKING INTO ACCOUNT EXTERNAL FACTORS (p. 38-58)

Vitalii Shchelkalin

The paper presents mathematical models of non-stationary time series forecasting, taking into account external factors and structural identification methods based on the joint use of a multidimensional variant of the "Caterpillar"-SSA method and SARIMAX models, expanded for time series forecasting with several seasonal components and taking into account several exogenous variables.

Structural and parametric identification of the transfer function, connecting the forecast and exogenous time series is performed in the proposed hybrid mathematical models, using formulas for L- or K-continuation of a multi-dimensional variant of the "Caterpillar"-SSA method. Decomposition approach to time series forecasting based on multi-dimensional variant of the "Caterpillar"-SSA method and SARIMAX models lies in decomposition of initial forecast and exogenous time series by the "Caterpillar"-SSA method into mul-

tiple time series with simpler structures; forecasting decomposition component data from SARIMAX models and calculating the total forecast, combining forecasts of the constructed simplified models.

The proposed models were tested on electricity and natural gas consumption time series, and the results of their forecasting were compared with the results, obtained by probabilistic SARIMAX models. Experimental results show the high efficiency of the proposed forecasting models in selecting suitable structural parameters in comparison with SARIMAX models.

The results lead to the conclusion that for effective forecasting, it is necessary to perform the decomposition of the studied time series and combine various models, describing both statistical and deterministic components of the time series, which provides better forecasting quality.

Keywords: forecasting, structural identification, decomposition model, Box-Jenkins method, "Caterpillar"-SSA method.

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