ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

COMPARATIVE ANALYSIS OF NEIGHBORHOOD-BASED APPROACHE AND MATRIX FACTORIZATION IN RECOMMENDER SYSTEMS (p. 4-9)

Oleg Chertov, Armelle Brun, Anne Boyer, Marharyta Aleksandrova

Unlike other works, this paper aims at searching a connection between two most popular approaches in recommender systems domain: Neighborhood-based (NB) and Matrix Factorization-based (MF). Provided analysis helps better understand advantages and disadvantages of each approach as well as their compatibility.

While NB relies on the ratings of similar users to estimate the rating of a user on an item, MF relies on the identification of latent features that represent the underlying relation between users and items. However, as it was shown in this paper, if latent features of Non-negative Matrix Factorization are interpreted as users, the processes of rating estimation by two methods become similar. In addition, it was shown through experiments that in this case elements of NB and MF are highly correlated. Still there is a major difference between Matrix Factorization-based and Neighborhood-based approaches: the first one exploits the same set of base elements to estimate unknown ratings (the set of latent features), while the second forms different sets of base elements (in this case neighbors) for each user-item pair.

Keywords: collaborative filtering, neighborhood-based recommendations, matrix factorization-based recommendations, feature interpretation.

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COMPARATIVE ANALYSIS OF METROLOGICAL CERTIFICATION METHODS OF MATHEMATICAL MODELS (p. 9-16)

Andrei Tevyashev, Yuri Asaenko, Anatoly Kobylin

Additional selection criteria of mathematical models for use in real-time systems based on the metrological certification results were considered in the paper. This allows not only to select adequate models, but also the models that provide the minimum width of the uncertainty intervals of the dependent variables (calculation results) at a given initial data uncertainty. The comparative analysis of the two classical methods for metrological certification: simulation method, statistical linearization method and three variants of the real interval method: classical interval mathematics method, Kaucher interval mathematics method, centered interval method was given.

It was shown that metrological certification results by the considered methods are virtually identical for the considered models, and the centered interval method is the most efficient.

Keywords: stochastic models, linear plot, linearization method, modeling, real intervals.

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DEVELOPMENT OF ALGORITHM AND EMBEDDED SOFTWARE FOR SEPARATION OF INTERSECTION POINTS OF QUADRICS (p. 16-20)

Tetyana Marusenkova, Denys Horman

The relevance of developing the re-used functions for separation of solutions to nonlinear equations to apply in embedded software of intelligent sensors was shown in the paper. Analysis of existing mathematical libraries has revealed the lack of a single approach to separation of solutions to equations and software implementations of root location algorithms. Testing of existing library functions for clarification of solutions to nonlinear equations and their systems using numerical methods (Newton, chords and dichotomy), the results of which confirm that the possibility to find all solutions with a given accuracy depends on the initial approximation was performed. The algorithm for the separation of intersection points of quadrics (second order surfaces), equations of which are often used to describe field characteristics of sensors, included in intelligent sensors of vector quantities was proposed. The algorithm is implemented as a function by the C language in compliance with the MISRA C standard for the STM32F407VG microcontroller, included in the STM32F4Discovery debug board. Testing of the function developed has shown that it allows to find all the numeric fields, containing the intersection points of quadrics, after which approximate solutions can be clarified using one of the known methods. Developed function can be used to extend mathematical libraries for solving nonlinear equations adapted to ARM family microcontrollers.

Keywords: intelligent sensors of vector quantities, microcontroller, location of roots, separation, quadric, ARM.

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CREATION OF MATHEMATICAL MODELS FOR ORDERING GRAPH EDGES OF THE PIPELINE DISTRIBUTION NETWORK (p. 21-25)

Nicolay Samoilenko, Irina Gavrilenko, Tatiana Senchuk

The paper describes the analytical calculation method of functional reliability in pipeline systems. The proposed method allows to determine the relative time period during which a particular user of the distribution pipeline system is able to obtain the desired product, depending on the structure of the pipeline network and reliability of its individual elements. The method is focused on the pipeline networks that, by their structural complexity, are commensurate with the complexity of pipeline transportation systems that operate in different sectors of the economy. The method includes seven successive stages. The paper considers the second stage regarding the transformation of the initial data, presented in the normal production form, into the form that provides the best conditions for the numerical simulation of the whole calculation. The set-theoretical models for ordering graph edges, allowing, on the one hand, to preserve their arbitrary numbering, on the other – to provide algorithmic ease of software for the automated calculation were developed. The corresponding software for free use, implementing the process of ordering the sequence of graph edges in accordance with the proposed mathematical models in unlicensed programming language DevC++ was created.

Keywords: pipeline network, emergency repair zone, functional reliability, pipeline network graph.

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ASSESS ELECTRICITY QUALITY BY MEANS OF FUZZY GENERALIZED INDEX (p. 26-31)

Sergiy Tymchuk, Oleksandr Miroshnyk

Most of branching and length of distribution networks, unstable and heterogeneous nature of the load, low observability of electric networks, lack of information about the topology and load during the period of time do not allow the operating personnel to obtain reliable values of quality of electric energy and therefore accurately determine the degree of influence of poor electricity on the mode of operation, the service life of specific groups of consumers. The uncertainty of the initial information needs to be revealed. The existing calculation methods are mainly deterministic and do not allow to take into account the uncertainty of the initial information.

To accomplish this task are invited to submit indicators of quality of electric energy in the form of triangular fuzzy numbers and quality standards – in the form of trapezoidal fuzzy intervals. Fuzzy quality score is determined based on the processing of measurement results, and the fuzzy quality standards are based on the permissible range given in the regulations. The degree of conformity of fuzzy values of the fuzzy index of electricity quality standards proposed for the area to assess the figure formed by the intersection of the membership function.

Considering the characteristics of the individual groups of loads, it is proposed to assess the quality of electricity for these groups separately by fuzzy integral indicator.

Expressions are given for the determination of the integral indexes of electricity quality for different types of loads. In particular, we present integrated indexes of electricity quality unbalance and for non-sinusoidal motor, lighting load, and devices with a microprocessor control unit. The importance of these results is that the first time it is possible to improve information quality assessment of electricity in the uncertainty of the initial information. And, most importantly, if you know the type of load, it is possible to consider only the quality parameters of electric energy, which adversely affect the operation of a particular electroreceivers.

Keywords: electricity quality, load type, fuzzy sets, integral index.

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IDENTIFICATION OF SHIP MATHEMATICAL MODEL PARAMETERS FOR SUPPORT OF AUTOMATIC CONTROL IN VOYAGE CONDITIONS (p. 32-36)

Sergei Ivanov, Pavlo Oliynik, Vasil Teut

An approach to identifying the ship motion mathematical model and disturbance parameters in voyage conditions is presented in the paper. The approach is intended for use under constraints during the voyage, i.e., under off-course restrictions and during the voyage in the appointed limited-width corridor. To determine the ship model parameters and static disturbance moment value, it was proposed to use spectral analysis of the angular velocity signal. The formulas and test procedure for identifying the model parameters, along with practical recommendations on the approach implementation were given in the paper. The simulation results show that the accuracy of parameters allows to use these data for the autopilot controller synthesis and adjustment. Thus, the rudder deviation angle may be of about one degree, so the ship deviates from the course only by a small angle during the identification process. Tests on the high seas have proved that the proposed approach can be practiced.

Keywords: ship motion model identification, disturbance parameters identification, spectral analysis, ship motion restrictions.

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DEVELOPMENT OF A TECHNIQUE FOR IDENTIFICATION OF MODEL PARAMETERS OF HIGH-PRESSURE DISCHARGE LAMP (p. 37-45)

Oleksii Yakunin

The technique for identification (determination of the parameters) of the model of high-pressure discharge lamp by comparing the simulated and experimental data was developed. Searching for the model parameters is divided into two main stages: 1) determining the degree of influence of each parameter change on the model output; 2) directly searching for the minimum functional divergence. Divergence evaluation is carried out by determining the value of the functional - the sum of the squares of divergences during the studied time period. When searching for minimum divergence, a corresponding set of model parameters is determined. The technique for determining the parameters of the mathematical model of high-pressure discharge lamp was designed to determine such parameters of the model, which allow to describe it with the necessary precision. Trial computational experiment showed the performance of the model parameter determination program, developed using the technique.

It was found that the models that are based on the current-voltage characteristics of lamps are promising. The need to determine the model parameters is caused by the requirement for the accuracy of the research, and the availability of regular deviations in characteristics of lamps of the same type from different manufacturers, batches and even between units in batches from that of manufacturers and general. Ensuring the model accuracy is also important in developing and creating complex control systems that can be realized with microprocessor control, where the model is used for calculating the control object behavior and selecting control signals.

Keywords: identification, determination, model, parameter, discharge, lamp, high, minimization, sensitivity.

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DEVELOPMENT OF FUZZY LOGIC CONTROL SYSTEM OF THE MOBILE ROBOT (p. 45-53)

Vitaly Bulkin

A mathematical model for the mobile robot control system based on fuzzy algorithms under rapidly changing dynamic environment was developed in the paper. The mathematical model is a system of algebra-predicate equations. Based on the equations obtained, AP-structures, which are associative-logical converters (ALC), were developed. Values of membership functions of input and output linguistic variables at intermediate points in the area of the carrier of linguistic values were found. Fuzzy subsets of input and output linguistic variables are presented as corresponding equations of the predicate algebra. Based on the algebra-predicate equations, the AP-structures of recognizers of fuzzy subsets of input and output linguistic variables were constructed. When developing the knowledge base of the fuzzy logic control system for the mobile robot, production rules were formalized using the mathematical apparatus of the predicate algebra. Based on the equations obtained, the AP-structures, implementing these rules as ALC were constructed. As a result of the research, it was found that the AP-structures obtained can be reconfigured to recognize various domain objects. Therefore, such structures can be classified as flexible, reconfigurable structures of parallel data processing, operating in real time. The results obtained are important from the theoretical and practical points of view since the functional-structural method allows to develop mathematical models for the human intelligence functions in the language of predicate algebra. Based on such models, creating the AP-structures that have functional-structural similarity with the human intelligence is possible.

Keywords: fuzzy algorithms, predicate algebra, algebra-predicate structures, associative-logical converters.

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