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RADIOENGINEERING, RADIOLOCATION AND COMMUNICATION SYSTEMS

S. N. Kirillov, P. S. Pokrovsky, A. A. Lisnichuk. THE PROCEDURE FOR MULTI-CRITERIA SYNTHESIS OF SIGNAL-CODE SEQUENCE TO ADAPT DATA COMMUNICATION RADIO SYSTEM TO NARROW-BAND INTERFERENCE

Key words: synthesis of signal-code sequences, synthesis of radio signals, adaptive data communication systems, cognitive data communication systems, multi-criteria optimization, radio narrow-band interference immunity increase.

The use of the known signal-code sequence in data communication radio system under the action of narrow-band interference leads to significant losses in radio noise immunity. The aim is to develop the procedure for multi-criteria synthesis of signal-code sequence to adapt data communication radio system to narrow-band interference. The vector of criteria for signal-code sequence synthesis includes elements to increase AWGN and narrow-band interference immunity as well as power and bandwidth efficiency. It is shown that a synthesized signal-code sequence increases radio narrow-band interference immunity by more than 21 dB (compared to TCM PSK-8 signal-code sequence)3

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Key words: data transmission system, error-correction coding, multithreshold decoder, optimum decoder, self-orthogonal codes, computer simulation, estimation of bit-error rate, additive white gaussian channel.

The aim of this work is the performance of multithreshold decoder (MTD) for self-orthogonal codes estimation for low decoder error probability. The problem is relevant because of large volumes of the experiment and huge time-consuming required for estimation of MTD bit-error rate via computer simulation in case with decoder error probabilities of the order 10^{-12} and lower. This article offers and describes combined imitation-analytical method for estimation of multithreshold decoder bit-error rate. This method provides estimation of bit-error rate for goal signal to noise ratio based on the statistics of bit-error rate in decoded blocks for higher signal to noise ratio. Presented results reveal that such method allows to receive goal results hundred or more times faster than using computer simulation10

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Key words: spectrum, spectral estimation, restoration of autocorrelation coefficients, autoregressive model, autoregression, power spectral density, MUSIC.

We proposed and investigated a method of restoring autocorrelation coefficients for unimodal random signal spectrum to build their autoregression models. The aim is to develop a compensation method of additive white Gaussian noise on measured coefficients of process autocorrelation to improve the accuracy of spectral estimation of useful signal with Gaussian shape of spectrum. The method is based on solving the system of equations which is used

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Key words: correlation matrix, eigenvalues, uncorrelated noise.

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Key words: mathematical model, numeric methods, integral equation, Hallen's equation, thin wire antenna, half-wave dipole, logarithmic singularity, thin wire kernel.

We have considered the problem of evaluating current distribution along cylindrical wires by integral equations method. The aim of the research was to explore wire kernel influence on Hallen's integral equation solution stability with different wire radii. The investigations of thin and thick wire were performed. We have evaluated resonance frequencies of half-wave dipole with different radii. We have shown that the usage of integral wire kernel based on asymptotic behavior elliptical integral of the first kind allows to obtain stable solution for wires with the diameter up to 20% from dipole length. The necessity to use thick wire mathematical model is explained. We have obtained input currents resonance curves from different wire radii. We have shown that the increase of wire radius leads to the decrease of half-wave dipole resonance frequency28

B. I. Filippov. DETERMINATION OF SLANT RANGE BETWEEN A SHIP AND A BOTTOM STATION

Key words: hydroacoustic channel, a ship, bottom station, inclined range, hydroacoustic beacon, autonomous ground station.

In the article determination of distance between the vessel and ground stations which is based on active methods measurement of time to distribute probing hydroacoustic signals from the vessel to the hydroacoustic ground autonomous station (HGAS) on inquiry - response system is considered. It is shown that for all practically important cases when the ratio of signal power to the noise exceeds 12 dB, the definition of slant range which is caused by the moment of error detection of measurement signals on bottom station and on the ship at speeds of 200 and 400 baud is equivalent to an error in determining the slant range equal to 32 and 16 cm, respectively. Therefore, the error of slant range definition depends only on the error in the determination of sound speed. Assuming that ships allows to define average speed of sound with an accuracy of 10^{-3} , the error in determining slant range will be approximately estimated by the value of 25m and the upper boundary estimate will be about 43m.....33

COMPUTER ENGINEERING, INFORMATION SYSTEMS AND TECHNOLOGIES

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Key words: artificial intelligence, program analysis, algorithmic algebras, programming tools, formal programming machines, program optimization, knowledge level, training and self-training, meta-level language tools.

The problem of formal research peculiarities of intelligent programming tools is studied. The aim is to find main features of programming tools of artificial intelligence systems revealing the possibilities to optimize corresponding formal programming tools. In the article the analysis of programming tools research is proposed, distinctive features which determine its applicability for resolving different classes of formal research problems are considered.

The most attention is devoted to optimization problem in formal expression of source programming code of intelligent soft systems. The following concepts of intelligent systems such as simplification of subject domain, logical programming, production systems, training and self-training, meta-level language tools, knowledge level, inductive reasoning are considered. First experiments of new formal approach to this problem showed efficiency in optimization expression of source programming code of intelligent soft systems. This approach is based on universal algebra sets called as programming machines.....41

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Key words: multiprocessor computing system, system architecture, mathematical model, performance, queuing system, NUMA architecture, SUMA architecture, probabilistic-temporal characteristics of computing systems.

In the article the problem of synthesis and investigation of models of "processor-memory" subsystem of multiprocessor systems is considered. The aim of this work is to study the architecture of "processor-memory" subsystem of contemporary high performance computing, calculate and compare the characteristics obtained, as well as to get the evidence on the impact of conflict over access to shared resources on overall performance of the whole system. The objects of study in this work are "processor-memory" subsystem of multiprocessor computing systems, existing types of this subsystem construction architecture. On the mathematical models offered the options for the implementation of "processor-memory" subsystem of multiprocessor computing systems with NUMA and SUMA are investigated. Models were considered with the application of queuing theory. The analysis of influence of various factors on the mathematical model under consideration is made. The research was a comparative analysis of systems with NUMA and SUMA. Their strengths and weaknesses are identified. All necessary conclusions of this work are given. The considered models allow to evaluate the performance of multiprocessor systems without building a real layout. Due to this the economic effect is achieved since the evaluation of designed system characteristics and the choice of optimal variants can be performed without building a real system.....55

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Key words: wireless network planning, base station location, evolutionary algorithm, optimization, metaheuristic, control parameters, tabu search, bee colony optimization algorithm.

The problem to find the optimal values of control parameters for metaheuristic algorithms using evolutionary approach is studied. The aim is to select the control parameters for tabu search algorithm and bee colony optimization algorithm during wireless network planning. The method based on a binary coding evolutionary algorithm is proposed. On the basis of the proposed algorithm the selection of control parameters for metaheuristic algorithms to solve the task of base station location was made by computer simulation. Comparison of bee colony optimization algorithm and tabu search for wireless network planning problem solving was implemented.....64

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Key words: train schedule, artificial neural network, variable learning rate, neuron links, error function, transport systems.

The article is devoted to the consideration of transport process schedule creating problem (including train schedule creation) by an artificial neural network approach. The goal of investigation is to develop network architecture and topology and to construct major principles of neural network functioning to create train schedule on two-track railway sections. Within the framework of this goal traditional methods and techniques are analyzed and interneuron connections are offered. During the computation of neural network output the authors use soft competitive principle to activate connections between layers of the network. A specific adapted learning algorithm with variable learning rate is described. Also the authors present the results of numerical experiments with neural network.....73

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Key words: natural language processing, mathematics, algebra, morphological level, syntactical level, semantic level.

We consider the subject of mathematical representation of natural language processing problems. The aim of the article is to analyse current mathematical methods for natural language processing problem solution and expose what methods are prospective in artificial intelligence language processing. Current mathematical methods do not make easy the solution of natural language processing problems and are used for formalization of problem area research and processes in it. So to develop new problem solution methods and to reveal prospective ones are actual tasks nowadays. One of such methods is an algebraic system. We demonstrate all natural language processing levels represented by algebraic system. We give different scientific work examples of natural language processing problem solution with the help of different algebra types. We conclude that natural language processing operation is necessary to be transformed into arithmetic calculations.....81

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Key words: three-dimensional modeling, reflection, roughness, color, light, glass, metal, gold, realistic image.

The problem of setting a realistic three-dimensional subject color surface on the border of two environments with a minimum number of settings for visualization software is studied. The aim of this work is the technique of three-dimensional color modeling of objects to build their images. Theoretical bases of formation of color and perception are considered. Fresnel formulas for calculating the reflection and refraction of light when monochromatic light wave is passing are analyzed. The classic way of illumination with three points for realistic three-dimensional object images modeling is considered. General guidelines for configuring color highlights and specular reflections of smooth surfaces based on the description of physical properties of metals and glass are provided. Individual cases of specular reflections of gold and copper are considered. The results of using techniques for rendering complex scenes with gold and glass items are shown.....87

SYSTEM ANALYSIS, CONTROL AND INFORMATION PROCESSING

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Key words: remote sensing, system software, programming techniques, interface, performance, software architecture, rapid application development, unification.

The architecture, principles of operation, programming methods and specifications of the software platform developed in “Foton” institute and used to create specialized data processing software for Earth remote sensing systems are considered. The goal is to create a rapid development technology of high-performance applications to process remote sensing data. Software platform is a set of components (templates and modules), binary interfaces and the integration rules of elements into a single system. High performance of software systems created by this platform is provided by technological and architectural solutions. The technology of quick application compilation is based on high unification of developed software (DLL-modules), interfaces, and the rules of integration..... 95

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Key words: videopositioning, videonavigation, urban area, digital map, area relief contours.

Required characteristics of an image processing algorithm of videopositioning system for the objects in urban environment, using the contours of area relief and a digital map are substantiated. The aim is to design the algorithm of video processing for the purpose of positioning in urban areas with the characteristics providing positioning error within 3 m. An algorithm of area relief contour detection in an urban environment image obtained by camera is offered. It is shown that the average angular edge detection error of urban area relief is less than 2 degrees, providing positioning error RMS in 3 m limits using the set of cameras with a summary angle of view equal to 360 degrees, without using data about orientation system in horizontal plane..... 104

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Key words: radio heat-location, radiometer, thinned-out matrix of supervision, images recovery, superpermission, matrix method, iterative method, Winer's filter.

The problem of objects images recovery based on data of radiometer with scanning antenna is considered. The step of scanning in a place corner is several times more than the step of scanning in an azimuth, and the matrix of supervision is thinned out along lines – the number of its lines is several times less than the number of columns. It leads to distortion of images and decrease in their resolution. The purpose of the work is the development of image recovery methods allowing to keep superpermission of supervision system in conditions of thinned-out matrix of radiometric supervision. Optimal matrix methods of restoration for cases of single-channel and two-channel processing of supervision matrixes are offered. The modification of restoration method by means of Winer's filter in the spatial frequencies field based on interpolation of supervision matrix is given. Results of algorithms work modeling based on the offered methods are given. The advantage on the accuracy of matrix restoration method based on two-channel processing is shown. 111

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Key words: time series, forecasting model, strictly binary tree, modified clonal selection algorithm, genetic algorithm, multi-objective optimization, Pareto-dominance, crowding-distance.

The problem of multi-objective optimization dealing with the development of forecasting models on the base of strictly binary trees is considered. The aim is to improve the search characteristics of a modified clonal selection algorithm which is applied for the development of forecasting models on the base of strictly binary trees by means of involvement in the process of selection of best forecasting models of two model quality indicators: the affinity indicator and the indicator of the tendencies' discrepancy. The accounting of two indicators of a forecasting model quality is carried out with the use of the notion «Pareto-set» which is applied in the formation process of new populations of forecasting models in a modified clonal selection algorithm. During the formation of new population of forecasting models for maintenance of its high variety it is offered to consider values of the crowding-distance of forecasting models. The results of experimental studies confirming the efficiency of the offered approach to improvement of the search characteristics of a modified clonal selection algorithm are given..... 118

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Key words: non-linear object, sub-optimal control, particle swarm optimization, bacterial foraging optimization, weight matrix, State-dependent Riccati equation (SDRE) method, SDRE controller, minimization of objective function.

We consider the problem of setting weight matrices of State Dependent Riccati Equation (SDRE) controller using bioinspired algorithms. Particular attention is paid to the particle swarm optimization algorithm (PSO) and bacterial foraging algorithm (BFO). The control object is a spherical tank with liquid which is a complex nonlinear object. So it is impossible to apply the conventional methods of nonlinear control to this object. Method of state-dependent Riccati equation (SDRE) is applicable to wide variety of nonlinear systems, and assures great flexibility of design by the choice of weighting matrices $Q(x)$ and $R(x)$. The aim of this article is to find the weight matrices of SDRE controller specified nonlinear control object, by bacterial foraging algorithm, particle swarm optimization algorithm and by the method based on hybridization of two considered algorithms. In conclusion, the proposed algorithms have been successfully applied for given non-linear object, and we present comparison of simulation results 131

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Key words: machine learning, classification, missing data, data preprocessing.

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Key words: integrated variety method, ordinary differential equations system, operator equation, dimensional reduction of phase space, control systems.

The problem is to find nonzero integrated variety of ordinary differential equations nonlinear finite-dimensional system where the right hand side is a periodic vector function using argument and containing parameter. Presumably, the system under investigation has trivial integrated variety with all parameter points while corresponding linear subsystem does not have exponential dichotomous attribute. The aim of the article is to find sufficient criterion in the neighborhood condition of nonzero integrated variety of less dimension than in original phase space. That is why on the base of integrated variety classic method ideas the operators which enable us to solve the problems of their fixed points search are made. According to the analyzed system specification, the integrated variety method of operator equations formation has been considerably modified..... 146

INSTRUMENT ENGINEERING AND INFORMATION-MEASURING SYSTEMS

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Key words: regulation problem, SDRE finite-horizon controller, two-arm robot, underactuated system.

In the last few years great interest has been shown in the development of control algorithms for underactuated mechanical systems. This interest is caused by the necessity in stabilization systems such as ships, submersibles, helicopters, airplanes, airships, hovercrafts, satellites, walking robots, robot manipulators, etc. The necessity for such algorithms is seen in many practical situations. The motivation is that the drives are often expensive and / or heavy, so sometimes they need to be avoided in the design of the system.

Regulation problem is considered for underactuated system with two-arm robot. The system is underactuated, because two-arm robot has two degrees of freedom (two swivel arms), but control has one signal only. The aim is to design a finite-horizon suboptimal controller based on state dependent riccati equation (SDRE) solution. Controller solves a regulation problem, which is translated by two-arm robot from the initial position to the position, where both arms are arranged vertically. Efficiency of the controller is shown by modeling in MATLAB..... 153

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Key words: electricity, energy modeling, technical losses, commercial losses, unbalance, stability, error correction.

Non-balance in system of power supply is defined as a difference between consumed and released electric power. The difference is attributed to losses including technical and commercial component. Commercial losses in essence are caused by errors of measuring complexes. More exact calculations of a commercial component allows to define objectively the structure of losses and action for their reduction. Relevance of work is in the fact that commercial losses can't be measured, they can be calculated with a certain error. The purpose of the work is to investigate an imitating model of measuring transformer of current with correction of an error from destabilizing factors using analytical methods to determine stability and speed of element and system in general. This research allows to draw the conclusion about speed and stability of an element in information and measuring system leading to the system constructed on its basis 160

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Key words: laser distance meter, triangulation, optical waveguide, optical fiber, recycle generator photodetector.

The principle of action and precise triangulation algorithm of recycle laser distance meter, the distance meter principle of operation of the control unit are considered. The aim is to study the frequency and power characteristics of a recycle generator with fiber optic delay line on the basis of semiconductor laser and identification of factors affecting the accuracy and the range of measured distance. The dependence of power and recirculation frequency from laser light angle input. The dependency of recirculation period from optical delay line length is studied and the dependency of recirculation rate from laser diode power is found..... 166

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Key words: optical coatings, optical strength, laser radiation, damage threshold, breakdown, energy density, the area of irradiation, sample.

This paper discusses methods of research radiation resistance of optical coatings with desired optical characteristics and high performance parameters. Methods for determining the strength of beam-based threshold energy density at which the destruction of coating material takes place are described and studied. The aim is to develop the best practices to study radiation resistance on the basis of proposed methods. The scheme of the experiment is to determine the strength of the beam using specially developed software. The analysis of the results of experiments to measure damage threshold of the sample is carried out. The conclusions about the causes of damage are made and recommendations to improve radiation resistance of the coating are given..... 172