CONTENTS AND ABSTRACTS

RADIO ENGINEERING AND RADAR

D. V. Avramenko, **V. G. Andreev.** ANALYSIS OF RADIATION SPECTRUM FROM THE ASTRONOMICAL OBJECT OF ARTIFICIAL ORIGIN BY BILATERAL PRONY'S METHOD

Key words: two-sided Prony's method, spectral parametric estimation, digital signal processing, redefined system of Yule – Walker equations, quasi-inverse matrix, minimization of average error square, weight vector.

The problem of spectral estimation of light reflections from the artificial satellite of the Earth «Iridium» with its simultaneous observations in different ranges of electromagnetic waves is considered. The aim of the work is to improve the quality of spectral evaluation of brightness changes of multi-frequency reflections from space objects by the bilateral Prony's method. The analysis of the technique to describe the data observed by the sum of exponential functions in the conditions of short time samples in comparison with the autoregressive method is carried out. It is shown that ΔF values are significantly reduced (up to 8,4 times) using the two-way Prony's least squares method for spectral analysis, which smoothly changes its intensity of **Y** process of light reflections from a space object.

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V. A. Belokurov. APPLICATION OF AUTOCOVARIANCE LEAST-SQUARES METHOD IN INVARIANT ANGULAR ORIENTATION SCHEME

Key words: micromechanical sensing elements, angular orientation system, roll, course, pitch, kinematic equations, Rodrigo-Hamilton parameters, invariant blocking scheme, adaptation, noise estimation

The problem of synthesizing adaptive noise measurements and noise process of Kalman filter process used in angular orientation system constructed on the basis of invariant integration scheme is considered. The aim of the paper is to investigate the possibility of applying the least-squares autocovariance method for estimating linearly varying process noise parameters and measurement noise. This method is modified to be used in an invariant integration scheme. Evaluation of the effectiveness of the proposed method was carried out experimentally. For this purpose, an experimental sample of angular orientation system was created on the basis of integrated inertial module ADIS16405. The readings of gyroscope, accelerometer and magnetometer triads were recorded. The initial exhibition was held on the testimony of accelerometers and magnetometers. After that, post-processing was carried out. It is shown that as lag length increases, the accuracy of estimating noise matrix elements increases with the evaluation of autocovariance matrix.

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D. I. Popov. ADAPTIVE INTERPERIOD PROCESSING OF MULTIFREQUENCY SIGNALS

Key words: adaptive processing, analysis, Doppler phase, correlation coefficients, multifrequency signals, adaptation errors, clutter, processing efficiency.

The structure and efficiency of adaptive interperiod processing of multifrequency signals on clutter background are considered. The aim of the work is to analyze the efficiency of multifrequency signals processing, establishing the relationship between threshold signal-to-clutter ratio at system input and the structure of adaptive rejection filter (ARF) construction in frequency

channels, as well as adaptation errors of Doppler phase shifts and ARF weights to unknown clutter parameters - Doppler phase and interperiod correlation coefficients. In this case, asymptotic properties of maximum likelihood estimates and linear approximation of ARF weight coefficient dependencies on the estimation of interperiod correlation coefficient are used under the assumption of the known shape of clutter function correlation envelope. The results and the graphs showing the dependencies of threshold signal-to-clutter ratio loss obtained as the result of the analysis allow us to choose the training sample size depending on adaptation loss set value, clutter spectral-correlation properties, and ARF construction structure.

DOI: 10.21667/1995-4565-2018-64-2-17-22 17

V. K. Klochko, S. M. Gudkov, X. K. Nguyen. COMPARATIVE ANALYSIS OF METHODS TO ESTIMATE OBJECT COORDINATES IN PASSIVE RADIOVISION SYSTEM

Key words: two-position system, passive radiovision, mutual orientation, conjugate vectors, estimation of ranges.

The two-position passive system of radiovision intended for observation over objects in the millimetric range of lengths is considered. For such system the comparative analysis of the offered and the alternative methods of coordinate system mutual orientation and estimation of ranges to objects is carried out. The aim of the work – is a comparative research of the offered and the alternative methods of objects spatial coordinates estimation in the specified system. The method offered earlier as well as the known alternative method of coordinate estimation is considered. Modification of the alternative method is offered. The quantitative characteristics of the algorithms realizing the methods are received. The advantage of modification according to the accuracy of coordinate estimates and high-speed performance in comparison with the alternative method is shown.

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B. A. Atayants, V. M. Davydochkin, V. V. Ezerskiy. INFLUENCE OF PARASITIC FREQUENCY MODULATIONS CAUSED BY ECHO SIGNALS ON FREQUENCY RANGE FINDER ERROR ESTIMATING DIFFERENCE FREQUENCIES BASED ON PHASE ADDITIVES METHOD

Key words: frequency range finder, measurement error, phase additives method, influence of parasitic frequency modulation.

The error of distance measurement caused by parasitic frequency modulation due to the echo signals reflected from useful and interfering objects which influence the generator is considered for frequency range finders measuring difference frequency using phase additive method. The aim of the work is to analyze the influence of parasitic frequency modulation on the distance measurement error made by frequency range finder using phase additives method as well as the comparison of this method with weight and spectral ones. The ratios allowing to make numerical simulation are given. The influence of single interfering factors is considered. The error component caused by parasitic frequency modulation is shown to be one-three orders lower than the analogous one in weight and spectral methods. This error component can be further decreased by choosing the distance to the devices sealing antenna-waveguide channel multiplied by the value of signal element with frequency modulation in the process of frequency range finder design.

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COMPUTER ENGINEERING, INFORMATION SYSTEMS AND TECHNOLOGIES

M. M. Gourary, M. M. Zharov, S. G. Rusakov, S. L. Ulyanov. REDUCED BEHAVIORAL MODEL OF LINEAR DYNAMIC BLOCK FOR CIRCUIT SIMULATION PROBLEMS

Key words: linear dynamical system, multiport blocks, implicit multistep integration formulae, transfer function, differential equations, delay differential equations, circuit simulation, electromagnetic interactions, net-list.

The problem of the circuit simulation of electronic networks containing linear multiport blocks with rational or delayed-rational frequency domain transfer functions is considered. The aim of the work is the development of mathematical methods, software tools and methodological guidelines for the inclusion of arbitrary linear blocks into the set of circuit simulator components. The relevance of the study is resulted from the necessity for electromagnetic interactions analyses in integrating circuits design. The results obtained in investigations are the following. The system of differential equations with respect to input and output variables of rational transfer function is formulated using state space method. Similar system is given for delayed-rational transfer functions and both systems are embedded into the circuit equations. Proposed numerical method to solve delayed differential equations by the application of implicit linear multistep formulae does not restrict the stepsize by the minimal delay value. Developed method to eliminate internal variables of linear blocks reduces the system order to the same value as for frequency independent transfer factors. The update of the SPICE3 source code and its net-list structure provided the description of basic two-port networks with arbitrary delayed-rational transfer function. The technique to represent an arbitrary multiport linear block as the connection of basic two-port networks is developed. The numerical experiments performed confirmed the validity of proposed approaches.

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O. V. Druzhinina, O. N. Masina, A. A. Petrov. ALGORITHMS DESIGN FOR THE CONTROLLED SYSTEMS PARAMETERS MODELS VALUES SEARCH TAKING INTO ACCOUNT THE FUEL CONSUMPTION MINIMALITY CONDITION

Key words: mathematical modeling, controlled technical systems, differential inclusions, variability, multivaluence, optimization, algorithms, artificial neural networks, gradient descent method, genetic algorithms.

The aim of the work is the design of generalized mathematical models of studied systems, the subsequent approximation of the models using the methods of intelligent control, and the elaboration of the optimal parameters search algorithms of the controlled systems models taking into account the fuel consumption minimality condition. Interpretation of computing experiments on the basis of the created software package is given. The initial two-dimensional model without taking into account the variability of the motion endpoint is generalized for cases of three and six variables. The optimal trajectory for the three-dimensional model taking into account the variability of the endpoint position and multivaluence is found and also numerical optimization algorithms based on a modified gradient descent method and evolutionary computations are detailed. The developed algorithms can find application in designing the problems of the technical devices, in the motion control problems of unmanned aerial vehicles, in robotics.

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M. N. Guryeva. MODERNIZED ALGORITHM OF CLUSTERING WITH KOHONEN NEURAL MAP IN THE PROBLEM OF PROCESSING HYPERSPECTRAL IMAGES

Key words: clustering, hyperspectral images, neural map, filtration, remote Earth sensing.

The problem of improving the results of clustering a hyperspectral image for the possibility of subsequent identification of objects is considered. As a method of optimal clustering, a neural map of Kohonen with an automatic determination of object class number is presented. The results of the influence of several types of filters on the quality of clustering are presented. The aim of the work is to find the optimal method for pre-filtering channel plane section of a three-dimensional array of data. Quality indicators include the speed of presetting and building a map, the number of automatically detected groups of objects.

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MANAGEMENT IN SOCIAL AND ECONOMIC SYSTEMS

A. D. Zaltsman, A. S. Alyoshkin. ALGORITHMIC SUPPORT AND SOFTWARE FOR MODELING SOCIAL PERCOLATION PROCESSES IN RANDOM NETWORK STRUCTURES

Key words: algorithms for constructing random networks, algorithms for modeling network clustering and percolation, software for percolation modeling.

This work provides a short review of the existing methods of modeling and description of processes in social networks, shortcomings of the existing methods of network analysis are depicted. In particular, it was shown that these methods do not allow to reveal influence of networks density on the values of thresholds of percolation and their clustering to separate subgroups. Modeling and analysis of information processes occurring in social networks with a random structure is possible with the use of methods of the theory of percolation. In order to carry out this type of research by means of specialized software, authors developed and offered a number of algorithms as well as algorithmic software for creation of randomly composed network structures and research on their percolation processes.

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K. K. Otradnov, V. K. Raev. EXPERIMENTAL STUDY OF TEXT DOCUMENTS VECTORIZATION TECHNIQUES AND THEIR CLUSTERING ALGORITHMS EFFICIENCY

Key words: clustering efficiency, quality metrics, processing time, clustering algorithms, vector document representation models.

The aim of this work is the experimental comparison of quality and speed of processing textual information using various methods of their vector representation (document - the term with TF-IDF frequency metric with and without n-gram, the document is an associative-semantic group with TF-IDF frequency metric; document-theme using Latent Dirichlet Allocation (LDA)) and text clustering algorithms («K-means», «DbScan», «Affinity Propagation», «Agglomerative Clustering» and «BIRCH»). In assessing the quality and efficiency of document processing, the criterion of the amount of processing time for the test sample of documents (10,000 texts) was used on the existing hardware platform, and the quality metrics: «V», «Adjusted Rand Index» (ARI), «Silhouette», «Expert Assessment». The experiments showed that the best quality with the shortest operating time is shown by non-hierarchical algorithms of clustering – «K-means» and «Affinity Propagation» using the «document-term» model with TF-IDF without N-gram and «document-lexical-semantic group» with TF-IDF.

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A. V. Gigolaev, N. I. Tsukanova. ANALYSIS OF WORDS SEMANTIC CLOSURE WITH KOHONEN CARDS

Key words: text, words, context, clustering, Kohonen map, metric, neural network, fuzzy sets and fuzzy relations, fuzzy graph.

The questions of Kohonen maps application for text word organization into groups according to context are considered. It is suggested to use the matrix of words succession frequency as one model of document text. The aim of the paper is to investigate the applicability of Kohonen self-organizing maps for the clustering of words of the text in terms of meaning, on the basis of the characteristics of words connection among themselves, to develop a program taking into account the characteristics of the problem being solved. The paper considers the following issues: presentation of the text in the form of a fuzzy graph (fuzzy relation), ways to determine the strongest path between the vertices of the graph and, therefore, the strongest connection between words, the formation of «objects – signs» matrix for solving the clustering problem, the choice of the metric for evaluation of closeness of clustering objects. The results of the study obtained with the help of Kohonen mapping program are presented.

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A. G. Smychkova, E. G. Andrianova. ANALYSIS AND PROCESSES MODELING OF GROUP BEHAVIOR BASED ON THE SYSTEMS OF DIFFERENTIAL KINETIC EQUATIONS AND THE METHOD OF ALMOST PERIODIC FUNCTIONS

Key words: group selection; social systems; modeling of voters' behavior; kinetic differential equations; election campaign; transition diagram; almost periodic functions; forecasting.

The aim of this work is to develop methods for analyzing and modeling group behavior and managing user actions in complex social systems, based on systems of differential kinetic equations and the theory of almost periodic functions. To compare the obtained theoretical results with the observed data an electoral campaign for distributing the votes of voters during the pre-election race of 2015 – 2016 to the post of US President between Donald Trump and Hillary Clinton was chosen.

This paper presents a diagram of the transitions between voters' preferences with attitude towards to candidates to describe the electoral campaign, on the basis of which kinetic differential equations describing the change in moods over time were obtained. In addition to the proportionality factors that affect the transitions between voters' states, the times of change of their views were included in the model. Processing of existing sociological data using the method of almost – periodic functions allow to determine the numerical value of a number of parameters of the proposed model. In particular, the average values of the times for changing the views of voters were determined.

The selection of the coefficients in kinetic differential equations based on observations of social behavior of the voters makes it possible to obtain good correspondence between theoretical results of the model and the observed data. This suggests that the description of group behavior of users in social systems based on differential kinetic equations may allow solving an inverse kinetic problem and determine the coefficients of equations from the observed data. In this case, a model for predicting and changing the preferences of group selection participants can be developed.

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L. A. Ponomareva, O. N. Romashkova, I. P. Vasiljuk. ALGORITHM OF EVALUATING THE EFFICIENCY OF UNIVERSITY STRUCTURAL UNITS FOR MANAGING ITS RATING ESTIMATES

Key words: structural subdivisions of the university, efficiency evaluation, calculation algorithm, discriminant analysis, rating, department, efficiency boundary.

The relevance of the study: during the restructuring in the system of higher professional education, new requirements arise for evaluating the activity of the university for developing effective management decisions and assessing the situation on the market for paid educational services.

The aim of the study is to create tools for conducting an internal assessment of the effectiveness of the PFUR divisions on the basis of mathematical methods and algorithms. An estimation algorithm is proposed. On the basis of the experimental indicators, the efficiency boundary of the departments is calculated, which divides the investigated objects into two classes. The equation of the discriminating feature is constructed. The equation contains only significant factors. With the help of the equation, it is possible to classify and evaluate the work of the departments.

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V. YA. Tsvetkov, V. V. Oznamets. TASK OF SPATIAL OBJECT ACCOMMODATION BASED ON THE USE OF FUZZY INFORMATION SITUATION

Key words: fuzzy sets, soft calculations, spatial analysis, information situation, fuzzy information situation.

The problem of locating a spatial object under fuzzy information is considered. The aim of the work is the development and presentation of placement method through the application of a model of fuzzy information situation. The article reveals the problem of placement. The paper introduces new concepts: fuzzy information situation and fuzzy spatial information situation. The difference between clear information situation and unclear information situation is shown. The article describes the relationship between linguistic variables and information situation. It is shown that the search for an optimum is based on the intersection of fuzzy sets. The article provides the solution to the problem in two versions: subject to the equivalence of placement criteria and under condition of their inequality. The conditions and limitations of this method are described. The article recommends the use of the term «expediency» in soft calculations instead of the term «optimality». The method allows for spatial analysis with a sufficiently large number of criteria.

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ELECTRONICS AND NANOELECTRONICS

Do Quang Manh, B. A. Kozlov. GENERATION CHARACTERISTICS OF SMALL–SIZED TEA–CO_2 LASER AT TEMPERATURES ATCOOLING UP TO –28 ^{0}C

Key words: small-sized sealed-off TEA–CO_2 laser, generation characteristics, pumping efficiency, temperature regime of laser active element, laser radiation pulse parameters, laser radiation energy in pulse, pulse radiation duration, pulse power.

Influence of temperature of active medium on small–sized TEA–CO_2 laser generation characteristics in range –28 ^{0}C ÷ +60 ^{0}C are studied. Variation of active medium temperature in range –28 ^{0}C ÷ +60 ^{0}C lead to decrease of laser radiation energy from 45 ÷ 60 mJ to some mJ (depending on initial gas composition). Substitution of helium in CO_2:N_2:He mixtures on hydrogen leads to the increase of laser radiation energy in 1,4 ÷ 1,8 times, but gas composition with hydrogen doesn't provide long-time work of small –sized TEA-CO_2 laser in sealed–off regime. Maximum laser radiation peak power up to 1,5 ÷ 2 MW is achieved at pulse duration up to 25 nanoseconds. The main aim of this work is to study experimentally the influence of active medium temperature on small-sized TEA–CO_2 laser generation characteristics in range –28 ^{0}C ÷ +60 ^{0}C.

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Do Quang Manh, B. A. Kozlov. INFLUENCE OF XENON SMALL ADDITIONS ON VELOCITY OF «ELECTRICAL WIND» IN CO_2–LASER MIXTURES AT ATMOSPHERIC PRESSURE

Key words: pulse repetition rate, average radiation power, «electrical wind» effect, unipolar crown discharge, gas addition, transverse gas blowing, gas dynamic method of gas flow velocity measurement, dynamic pressure**.**

Influence of xenon small additions in CO_2–laser mixtures at atmospheric pressures on the velocity of «electrical wind» in closed volume were investigated. Xenon additions with partial pressures up to 30 Torr lead to the increase of «electrical wind» velocity on 30 – 33 %. Maximum increase of «electrical wind» velocity was established in working mixture CO_2:N_2:He = 1:1:3. The main aim of this work is to study the influence of xenon small additions in CO_2–laser mixtures at atmospheric pressures on «electrical wind» velocity.

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V. A. Stepanov, A. I. Kudyukin, E. N. Moos, N. B. Rybin, A. T. Rott, K. E. Seregin. MODIFICATION OF ELECTRODE SURFACE BY VACUUM ARC DISCHARGE

Key words: vacuum arc, arc-extinguishing camera, issue, multicomposition alloys, atomic and force microscopy, surface relief, cathode spots.

In recent years the tendency to use electrodes from different alloys in vacuum arc-extinguishing camera with the purpose to find the best option of longevity and quality has been observed. It is connected to the fact that requirements to contact materials are too contradictory and it isn't possible to find a uniform metal suitable for vacuum arc-extinguishing chamber contacts. We decided to clarify what happens to composition and structure of electrodes in case of their operation. The aim of the work is the analysis of essential spatial redistribution at melt moment in a concentration profile of copper atoms from the center of plasma arc influence to peripheral zones with lower temperature. Change in surface relief help to explain the redistribution of sample element composition under the influence of vacuum arc discharge.

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A. I. Kudyukin, M. N. Makhmudov, E. N. Moos, A. T. Rott, K. E. Seregin, V. A. Stepanov, L. F. Sjatisheva. TECHNOLOGY MODE OF SOLDERING AND EXHAUST TUBELESS PUMPING OF CERAMIC-METAL ARC EXTINGUISH CHAMBER

Key words: hydrogen furnace, vacuum, arc extinguishing chamber, temperature gradient, metal ceramics, mode, computer graphics, pumping, vacuum furnace, components, section, technology.

Temperature conditions of exposure and soldering ceramic-metal high-voltage arc extinguishing chambers (AEC) on hydrogen furnaces are described and analyzed. The existence of temperature gradient on the section of hydrogen furnace camera which decreases in case of temperature increase is shown. At the same time step-by-step temperature increase and more uniform warming up of all component components of the camera takes place. Exhaust tubeless technology reduces time of pumping and increases labor productivity. The aim of the work is to use the opportunities of computer control systems for technological process of soldering of ceramic-metal products in modern hydrogen and vacuum furnaces for establishment and dynamics of real temperature conditions of equipment operation.

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V. A. Korotchenko, V. K. Bazylev, V. E. Skvortsov, A. M. Zhidkov, T. N. Andreasyan. DESIGN AND RESEARCH OF ORBITRON IONIZATION MANOMETRIC CONVERTER

Key words: orbitron vacuum sensor, computer modelling, motion of electrons.

The electrode system was developed, the electric mode was determined, and an experimental sample of ionization manometric converter of orbitron type with low (up to 300 V) anode voltage and high vacuum sensitivity was performed. Using numerical simulation, it was shown that at cathode potentials 10 – 50 V the characteristic values of retention time of electrons in orbitron trap are 0,1 – 1 μs, but there are cases of retention for a long (up to 33 μs) time. Data about

mechanism of electron trap formation and electron motion characteristics are presented. It is shown that a steady-state mode of motion occurs approximately after 5 μs. In the interval 5 – 33 μs, the radius of shuttle spiral stabilizes on 6 ± 0,3 mm level, and the energy is 95 ± 7 eV. Single pass time of an electron around an anode is 6,5 ns, the axial oscillations period is 120 ns, lead of a spiral is 4.6 mm, number of rotations is about 5000, path length is about 200 m. The ability of the developed orbitron to record gas pressure in the range 5 – 35 μTorr at average value of orbitron gauge sensitivity is 2200 $Torr^{-1}$, which is approximately two orders of magnitude greater than for a widely distributed PMI-2 ionization manometer has been experimentally verified. The aim of the work is to improve ionization vacuum sensors by increasing their manometric sensitivity, reducing the level of gassing in sensors and reducing ionic pumping of gases during the operation of gauges.

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E. V. Maraeva, V. A. Moshnikov. PHYSICO-CHEMICAL CHARACTERISTICS OF NANOSTRUCTURING PROCESSES IN POLYCRYSTALLINE PHOTODETECTOR GRAIN INTERFACES BASED ON LEAD CHALCOGENIDES

Key words: Lead chalcogenides, photoconductivity, phase equilibrium, triangulation method.

The article discusses the results of a comprehensive thermodynamic analysis of phase equilibria in the system Pb-So by the methods of diagrams of partial pressures and triangulation, the selection of technological conditions for obtaining photodetectors based on lead chalcogenides with high speed and experimental data on realization of photosensitive structures. The aim of the work is to create a model explaining experimental results and illustrating the reasons for choosing technological conditions to receive high speed photo detectors. The formation of high-speed recombination centers in grain interfaces is explained.

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