

CONTENTS AND ABSTRACTS

RADIO ENGINEERING AND COMMUNICATION SYSTEMS

S. N. Razinkov, A. V. Bogoslovsky, D. N. Borisov, E. V. Syomka. ANALYSIS OF ANTENNA ARRAY CONSTRUCTIONS FOR RADIO ENGINEERING UNMANNED AVIATION COMPLEXES

Key words: antenna array designs, analysis algorithm, analytical and numerical calculations, unmanned aerial vehicle.

An algorithm has been developed for analyzing the directivity characteristics of antenna arrays (AA) used in target loads of unmanned aerial vehicles (UAV) from the composition of radio engineering unmanned aerial complex (UAC). The features of algorithm structure are revealed, physical and mathematical justification for each stage of its implementation is given with the selection of areas for analytical and numerical calculations.

Using the software for three-dimensional electrodynamic modeling CST MWS – Computer Simulation Technology Microwave, directional diagrams (DD) were obtained and directivity coefficients (DC) of vibrator arrays placed on metal cylinder of finite dimensions with dielectric coating were calculated.

The aim is to analyze AA structures with assessment of their DD and DC, placed on aircraft-type UAV of radio-technical BAC using electro-dynamic modeling software.

It was found that when a zero with the depth of – 20 dB is formed in side lobe of 7-element antenna array for design option № 1, directivity loss does not exceed 1,5 dB from initial value. With the decrease in the number of vibrators to 6 when considering the 2nd version of AA, its directivity was 8,4 dB, in the case of reducing the number of vibrators to 4 while maintaining the total length of grating, directivity reached 8,6 dB.

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V. A. Belokurov. ALGORITHM FOR DETECTING A HOVERING HELICOPTER

Key words: likelihood ratio, signal reflected from rotating blades, F-distribution.

An algorithm for detecting a hovering helicopter against the background of clutter interference is considered.

The aim of the work is to synthesize and analyze the algorithm for detecting a hovering helicopter using airborne radar operating in high pulse repetition rate mode. The possibility of incoherent accumulation of the signal reflected from helicopter blades is considered. The influence of rejection and whitening algorithms for passive interference on detection characteristics is analyzed. The authors show that it is expedient to use a whitening filter. This ensures the persistence of false alarms and the gain in signal-to-noise threshold. It is also shown that the distribution of decision rule corresponds to F-distribution. The results of the simulation show that the use of a white filter provides a gain in signal/(clutter + noise) threshold ratio of up to 1 dB with a filter order of 8.

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V. T. Dmitriev, A. A. Baukov. MULTICRITERIA SYNTHESIS OF THE ALGORITHM FOR DETECTING RAIN PARTICLES ON VIDEO IMAGES IN DIGITAL TELEVISION SYSTEMS

Key words: video processing, raindrop detection, classification, pixel intensity distribution, local thresholds, quality criteria, multi-criteria synthesis, normalized error levels of the first and second kind.

The problem of reducing the visibility of precipitation traces on video sequences is considered. An important component of solving this problem is the detection of precipitation particles in a frame. The aim of the work is to create an algorithm for detecting raindrops on video images in digital television systems when shooting with static cameras. Time distributions of pixel intensity values exposed and unaffected by rain particles have been studied. An algorithm for detecting rain particles is proposed, which is a three-stage pixels of a group of n frames classification into areas with moving objects (cars, people, etc.), rain and non-rain areas, as well as rain areas pixels of current frame into rain (distorted by a drop) and non-rain with the ability to automatically select local threshold values based on accumulated information. The method of multicriteria synthesis was used to select the optimal value of number of accumulated frames. It is established that the application of proposed algorithm with optimal values of 100 and 130 frames when detecting drops on video images with high and medium intensity rain, respectively, reduces normalized error levels of the first and second kind to 2,7 % and 3,1 %. The gain of the developed algorithm in comparison with known ones up to 1 % and by 4 %...9 % is obtained according to these quality criteria.

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MATHEMATIC AND SOFTWARE COMPUTER SYSTEMS AND COMPUTER NETWORKS

D. A. Perepelkin, V. T. Nguyen. RESEARCH AND ANALYSIS OF MULTIPATH ROUTING AND DATA FLOWS LOAD BALANCING PROCESSES IN SOFTWARE DEFINED NETWORKS BASED ON GENETIC ALGORITHM

Key words: software defined networks, multipath routing, load balancing, OpenFlow protocol, genetic algorithm.

Currently to ensure the quality of network services and applications, a new technology of computer networks has gained wide popularity – software defined networks (SDN). SDN provide flexibility in managing data flows through a centralized view of the entire network and the ability to program net-work services. To ensure the quality of service of multimedia content, voice, video traffic and other highly loaded applications, the most effective mechanism is the use of methods, principles and algorithms of multipath routing and load balancing in the network. The aim of the work is research and analysis of the processes of multipath routing and data flows load balancing in software defined net-works based on a genetic algorithm. The conducted studies show that the use of a genetic algorithm in the SDN makes it possible to increase the efficiency of multipath routing and data flows load balancing processes, as well as to reduce jitter and transmission delay in the network.

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S. V. Skvortsov, V. I. Khryukin, T. S. Skvortsova. SELF-DIAGNOSIS PROCESS OPTIMIZATION FOR MULTIPROCESSOR SYSTEMS WITH ACTIVE FAULT TOLERANCE

Key words: multiprocessor system, fault tolerance, technical condition, fault function table, diagnostic graph, unit check, diagnosability measure, structural diagnostics model.

The task of self-diagnosis process optimization for multiprocessor systems with active fault tolerance is considered. The aim of the work is to develop an approach to the organization of mutual failure checks of computing units to determine technical condition of a system. It is shown that the task is reduced to constructing a diagnostic graph that describes a set of unit checks performed in system control cycle. A procedure to synthesize a diagnostic graph with extreme characteristics is proposed being reduced to finding the cover of a Boolean matrix and minimizes the number of unit checks or reduces total computational costs in case of active fault tolerance of a multiprocessor system. When obtaining a diagnostic graph, such fault tolerance measure of multiprocessor system is provided which should be achieved for a given structural diagnostics model used in decrypting the results of mutual failure checks of system units.

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D. A. Perepelkin, A. M. Pham. MATHEMATICAL MODELS OF PLANNING AN ORDERED SET OF OPERATIONS FOR DISTRIBUTION OF HETEROGENEOUS RESOURCES IN INDUSTRIAL TELECOMMUNICATION NETWORKS

Key words: industrial telecommunications networks, heterogeneous resources, ordered set of operations, distribution law, random variable, Chebyshev's inequality, maximum flow, GERT-network model.

Currently, an urgent problem is the task of planning and distributing resources in industrial systems and networks. The aim of the work is to develop mathematical models of planning an ordered set of operations for distribution heterogeneous resources in industrial telecommunication networks. Several cases of connection between operations and processes in industrial network are considered. Mathematical models to find the probability of determining a pair of operations performed by one resource unit are proposed. A technique for determining the probability of two operations using mathematical expectation value and the variance of random variables according to the Chebyshev inequality has been developed. To calculate the number of ordered sets of operations, the paper proposes to use the method of solving maximum flow problem. To confirm the effectiveness of the proposed approaches, experiments were carried out in an industrial network based on the GERT network model with several parallel processes. The results of the experiments performed allow us to optimize the amount of allocated resources with a certain probability of process completion.

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M. M. Zozulya. FEATURES OF USING BAYESIAN GRAPHICAL MODELS FOR SOFTWARE TESTING

Key words: bayesian graphical models, expert assessments, knowledge gathering, software reliability, software testing, statistical methods, test development.

The article describes an approach to the problem of software testing. The approach is based on Bayesian graphical models and presents formal mechanisms for logical structuring of software testing problem, probabilistic and statistical processing of uncertainties that need to be eliminated, the process of developing and analyzing tests, as well as the inclusion and application of test results. The aim of the work is to provide a mechanism for dynamic representations of software testing problem based on the construction

of models. They can be used to develop tests, answer «what if» questions, and provide decision support to managers and testers. The models reflect the knowledge of software tester for further use. The experience of using this approach in case studies is briefly discussed.

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INTELLIGENT INFORMATION SYSTEMS AND TECHNOLOGIES

I. Yu. Kashirin. DATA MINING USING HIERARCHICAL NUMBERS IN RETROSPECTIVE DIAGNOSIS

Key words: Data Mining, supervised algorithms, medical diagnostics, retrospective analysis, ICF ontology, hierarchical numbers, semantic proximity, clustering.

A new concept of designing data mining algorithms (Data Mining) using a knowledge representation model in an ontological form is presented. For retrospective analysis of data dynamics in the field of medical diagnostics, the calculation of semantic similarity of concepts and features is used using applied ICF ontology. An algebraic system of hierarchical numbers is used to analyze the semantic proximity of features and concepts. Software implementation is based on learning data analysis algorithms. The experiments performed using Python v.3 (Anaconda 3) tools show the effectiveness of the proposed approach.

The aim of the work is to create a science-intensive technology for designing Data Mining algorithms with training to solve the problems of diagnostic nature.

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SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING

A. I. Novikov, D. I. Ustukov. METHOD FOR DETECTING OBJECTS WITH ADDITIONAL SEMANTIC SIGNATURE

Key words: noise variance estimation, sigma filter, edge detection, line detection, method of second derivatives, contour autocorrelation function.

The aim of the work is to develop a method for detecting objects in the image of Earth underlying surface which have additional semantic feature in the form of one or more rectilinear sections as part of object contour on contour image. The presence and the type of additional feature made it possible to develop the technology for processing a raster image with minimal computational complexity. The proposed technology consists of four main stages: nonlinear filtering of discrete white noise using a modified version of sigma filter which allows the boundaries of objects to be preserved without blurring; selection of object contours; search for straight sections as part of contour lines followed by piecewise linear approximation of nonlinear part of closed contours; detection and identification of objects of interest based on calculating contour autocorrelation function.

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S. A. Tkalich. INSTRUMENTAL METHODOLOGY TO FORECAST EMERGENCY SITUATIONS IN TECHNOLOGICAL PROCESSES

Key words: forecasting, emergency, technological process, compositional model, integral criterion, chemical water cleaning, real-time mode, dynamic graphing.

The problem of choosing tools for constructing a compositional model of forecasting process accidents is considered. The aim of the work is to develop an instrumental methodology for predicting emergency situations of technological processes. The forecasting model is a composition of thermodynamic, linguistic and neural network components. An integral criterion for accident-free control of technological processes is used, which is a functional that simultaneously takes into account not only the current values of process parameters, but also the time reserves available to accident-free control system for bringing a critical parameter to its nominal limits. The justification of the choice of tools for constructing the model is given. Two tools of mathematical and visual construction are used: MATLAB and MICROSOFT VISUAL STUDIO. A method of integrating MATLAB and MICROSOFT VISUAL STUDIO is described. Block diagram of forecasting system is presented. An example of a compositional model for emergency forecasting of chemical water cleaning process is considered. The computational experimental research of the model is presented. Conclusions about the operability of proposed instrumental methodology for multicomponent models of technological processes emergency forecasting and its perspectives for modernization of automation systems are made.

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PHYSICAL ELECTRONICS AND NANOELECTRONICS

A. N. Vlasov. FEATURES OF MAGNETIC FIELD OSCILLATORY MODE GENERATION IN PULSED PLASMATRON

Key words: pulsed plasmatron, metal electric explosion, plasma clot, pulsed gas discharge, pulsed magnetic field.

The possibility of using oscillatory mode to generate magnetic field that initiates induction discharge in pulsed plasmatron to produce autonomous plasma formations is shown. To do this, the authors propose to use discharge current circuit with pulse gas discharge in a plasma clot in semi-open cylindrical chamber where a cathode is installed on the side of chamber closed end and an anode is located on the side of chamber open end. In this case, a plasma clot is created due to metal electric explosion in the form of copper wires installed on chamber sidewall. The aim of the work is to calculate the parameters of discharge current circuit and the magnetic field created by it, and experimentally verify calculation results on a simplified plasmatron structure.

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E.E. Zharova, S.V. Kazakov, V.B. Nasedkin, O.G. Pyanov, E.G. Chulyaeva. RESEARCH OF HELIUM-NEON TUBES WITH INCREASED BEAT FREQUENCY

Key words: Beat frequency, magnetic field strength, refractive index dispersion.

The aim of the article is to research physical factors affecting beat frequency and radiation power in He-Ne tubes of Zeeman lasers in a longitudinal magnetic field. The possibility of increasing beat frequency and radiation power by optimizing magnetic field and the characteristics of optical resonator are investigated.

The dependence of beat frequency on magnetic field strength showed that once magnetic field strength exceeds a certain value, difference frequency disappears.

Magnetic field is shown to have insignificant effect on radiation power.

The data on the insignificant influence of magnetic field on radiation power are given.

The effect of optical resonator length and mirrors transmission coefficient on beat frequency is studied. The authors show that beat frequency above 4 MHz can be obtained on short active elements with relatively high transmittance of output mirror, but at the same time radiation power decreases.

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A. E. Malyutin. RELIABILITY OF IDENTIFICATION METHODS IN CHROMATOGRAPHY-MASS SPECTROMETRY

Key words: chromatography-mass spectrometry, mass spectrum, identification methods, identification reliability, substance detection threshold.

The aim of the work is to study various methods for identifying substances in gas chromatography-mass spectrometry and to establish methods being optimal for automatic identification of toxic substances. Various algorithms for comparing spectra in library identification method, criteria for making a decision on identification, types of errors arising in this case, and criteria for identification reliability are considered. A comparative study of various algorithms for identifying small amounts of substances is carried out, taking into account the factors that distort mass spectra, such as statistical nature of mass spectrum formation as well as systematic and random background. Optimal identification criteria and detection thresholds for substances are determined.

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A. N. Shesterkin. PARAMETER ESTIMATION OF GAS DISCHARGE INDICATORS IGNITION DELAY TIME DISTRIBUTION

Key words: discharge delay time, exponential distribution, distribution parameter estimation, sample size, order statistics, parameter estimation devices.

Methods to compute the estimates of mathematical expectation and time displacement of ignition delay time when describing it by exponential distribution are considered. The aim of the work is to analyze methods for calculating statistical estimates of ignition delay time. Classical methods of calculating exponential distribution parameters – method of moments and maximum likelihood method are analyzed. It is proposed to censor measurement results (sampling) of delay time in conditions of strong ionization on the left and to evaluate distribution parameters based on other, uncensored measurements. The article offers to calculate average delay time based on right-censored sample while investigating delay time in the modes when statistical delay time can be time-consuming. Various ways of estimating mathematical expectation of delay time based on order statistics are analyzed. The possibility of approximate estimate of average value based on a histogram is considered. The information about the devices implementing proposed methods of parameter estimation is provided. The accuracy of considered methods of computing exponential distribution parameter estimates is confirmed by statistical modeling.

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A. A. Mikerin, M. E. Ilyin. MATHEMATICAL MODEL OF LINEAR GENERATOR

Key words: autonomous power supply system for low-power consumers, linear reciprocating motion generator, magneto-mechanical, magneto-electric processes, magnetic spring A mathematical model of linear generator for power supply of low-power devices that converts the energy of mechanical vibrations into electrical energy is constructed and investigated. The peculiarity of the model is that the law of motion of generator magnetic system is imposed by external conditions. The aim of the work is to study the influence of linear generator design features and the conditions of its excitation on output parameters.

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