

CONTENTS AND ABSTRACTS

RADIOENGINEERING, RADIOLOCATION AND COMMUNICATION SYSTEMS

A. A. Lisnichuk., S. N. Kirillov. ANALYSIS OF COGNITIVE RADIO SYSTEMS CHARACTERISTICS ADAPTING TO NARROW-BAND INTERFERENCE EFFECT BASED ON SYNTHESIZED FOUR-POSITION RADIO SIGNALS

Key words: multi-criteria synthesis of radio signal, cognitive radio system, multi-criteria optimization, noise immunity increase.

The aim is to analyze the characteristics of cognitive radio systems that perform multi-criteria synthesis of four-position radio signals for adapting to the action of narrow-band interference with different parameters. The analysis of cognitive radio systems characteristics adapting to narrow-band interference effect was carried out. In these systems, multi-criteria synthesis of radio signals is realized, taking into account the following quality indicators: noise immunity to the action of narrow-band interference and additive «white» Gaussian noise (AWGN); peak-factor (energy efficiency of signals) and the level of out-of-band radiation. The quality indices of cognitive radio systems adapting to narrow-band interference change are determined. Cognitive radio systems adapting to the most unfavorable (of the considered) narrow-band interference effect (central frequency was equal to carrier wave frequency of useful signal; spectrum width was 5 %) provide noise immunity at the same level as QPSK signal under the influence of only AWGN up to relation signal-interference - 7 dB. The radio systems without adaptation using known modulation types are inferior at this quality indicator up to 27 dB.

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A. A. Lisnichuk. MULTI-CRITERIA SYNTHESIS PROCEDURE OF DSSS SIGNALS FOR COGNITIVE RADIO SYSTEMS ADAPTATION TO COMPLEX INTERFERENCE ENVIRONMENT

Key words: radio signal synthesis, cognitive radio system, multi-criteria optimization, increase of noise immunity.

The aim is to develop multi-criteria synthesis procedure of DSSS signals for cognitive radio systems adaptation to complex interference situation. The article shows that the minimization of complex interference effect is recommended to be made by multi-criteria synthesis of elementary pulses set as well as code sequences ensemble. This fact makes it possible to increase interference immunity up to 10 dB (in comparison with QPSK signal with spreading of complemented M-sequences ensemble) in complex signal-interference environment while maintaining BER at QPSK signal level for only AWGN action.

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A. A. Kascheev, S. I. Gusev. CONSTRUCTION ALGORITHM FOR RADIO VISIBILITY ZONE OF GROUND RECEIVING STATIONS FOR HIGHLY RELIABLE SPACE RADIO LINKS

Key words: spacecrafts; ground receiving stations; on-board equipment; ground equipment; on-board storage device.

The article deals with the problem of constructing a zone of radio visibility for ground receiving stations (GRS), taking into account the reliability of radio link. The aim of the work is to estimate the geographical coordinates of radio visibility zone boundaries taking into account the reliability of radio link. The algorithm to calculate the geographical coordinates of boundaries has been developed. It is based on the comparison of current estimations of signal-to-noise ratio (SNR) at the input of GRS with SNR threshold at various information transmission bit error probabilities. Mathematical expressions are obtained for the conditions of spacecraft entry and exit, and also to estimate minimum angle of excess over the horizon for GRS, taking into account the fact of crossing zone boundary at different reliability of radio link. The influence of information transmission error probability and the main parameters of radio signal (type and speed of noise-correcting coding as well as phase manipulation index) on the size of radio visibility zone is studied. Recommendations for calculating the zone for radio links with varying degrees of reliability are given.

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V. A. Belokurov. FALSE ALARM LEVEL STABILISATION WHILE DETECTING AN OBJECT IN THE BACKGROUND OF NON-GAUSSIAN NOISE

Key words: characteristic function, numerical integration, rectangle method, probability distribution density and distribution function, gamma distribution.

The task to calculate threshold detection level in the conditions of multi-frame accumulation of signals reflected from a small object in the background of non-Gaussian noise is considered. The aim of the work is to develop an analytical algorithm for calculating a detection threshold for multi-frame accumulation. The apparatus of characteristic functions to calculate the distribution density of sufficient statistics at the input of threshold device is proposed to be used. To assess the effectiveness, we compared detection thresholds calculated by the proposed algorithm and the thresholds calculated using simulation modeling for various values of non-Gaussian noise and false alarm probabilities.

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B. I. Filippov. THE CHOICE OF SIGNAL SEPARATION METHOD IN HYDROACOUSTIC CONTROL CHANNEL

Key words: hydroacoustic channel, discrete modulation, methods of transmission and reception, digital receivers.

One of the main issues in the development of hydroacoustic communication channels (HACC) is the choice of the ensemble of signals and the method for separating the signals of control commands between bottom stations (BS) and pop-up modules of satellite communication system (PM SCS). In principle, any of the known methods of channel separation can be used to separate the signals between hydroacoustic autonomous station (HBAS) and PM SCS: time, frequency and code (in the form of signals). The aim of this work is to justify that the signal exchange between the vessel and the bottom station is carried out by sessions and begins with the transfer of command from a ship. At HBAS there is no known time for the commencement of control command transfer from the vessel. If binary sequences are used as a start signal, address signals and commands, then a simple device consisting of a binary signal receiver can be used to receive them, the output of which includes decoders and other decoders corresponding to the received signals. The results of comparative tests of the considered digital DFM and DRPM receivers showed that they have similar characteristics of noise immunity. The use of DRPM signals provides a small, about 1.5 dB, power gain and cost savings for the implementation of equipment in comparison with the usage of DFM signals, which makes it possible to recommend the use of DRPM signals for the implementation of HACC equipment.

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V. S. Parshin. DISTRIBUTION LAWS OF STATISTIC INVARIANT TO SCALE PARAMETER IN SPECTRAL REGION

Key words: unknown scale parameter, spectral density, invariant statistic, distribution law, functional transformation, approximation.

The aim of the research is to show approximation of distribution laws invariant to scale parameter in spectral region for two classes of random variables. For stationary stochastic processes, exact distribution law of invariant statistics in spectral region was obtained and its approximation by a simpler expression was carried out. It is shown that distribution approximation is beta distribution. Accuracy of this approximation was estimated. Also, we obtained distribution law of invariant statistics in spectral region for random pulse signals. It was assumed that statistical characteristics of random variables which determine appearance time and amplitude of pulses are independent from implementation number. Besides we obtained approximated distribution of invariant statistics. It was shown that in this case approximated distribution of invariant statistics is also a beta-distribution.

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V. E. Kvitka, A. V. Korkh. LIGHTNING DETECTOR CREATION FOR INTERNATIONAL SPACE STATION

Key words: remote sensing, lightning detector, ISS, high-speed camera, low earth orbit, lightning flashes detection.

The article describes the main problems of lightning space detector creation. This device is designed to detect lightning flashes from the board of International space station. The aim of the work is determination of key characteristics of scientific equipment complex and modeling of its work. Frame

frequency and working spectral range of high-speed optical-electronic camera are proved. The problems of choosing photodetector, determination of requirements to a lens and narrow-band interferential light filter are considered. The description of high-speed algorithm of lightning flashes detection is provided. The technique of computer simulation of images and algorithm of their processing is tested and described.

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COMPUTER SCIENCE, INFORMATION SYSTEMS AND TECHNOLOGIES

V. M. Glushan, I. A. Dubrovsky, O. I. Krasnyuk. PRACTICAL IMPLEMENTATION OF HIERARCHICAL CLIENT-SERVER VLSI DESIGN SUBSYSTEM

Key words: homogeneous, hybrid hierarchical client-server architecture, VLSI, scheme partitioning, placement, routing.

The results of development and research of real VLSI design subsystem prototype built on the basis of a multi-level hierarchical client-server architecture are given. The aim of this work is by means of practical realization to demonstrate the fact that distributed subsystems on the basis of hierarchical client-server architecture provide more significant VLSI design speed increase than one-level distributed subsystems. During subsystem research, real integrated logic gates were used. To investigate the performance quality of the subsystem, basic schemes containing from 500 to 2000 functional gates were generated with random specification of circuit parameters. Only homogeneous subsystems were used in the research since heterogeneous subsystems gave negative result in the very first experiments. The detailed studies of homogeneous subsystems gave almost positive results, but bottlenecks were also identified, the elimination of which should lead to more significant results in terms of speeding up design process.

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I. V. Tiunov, D. A. Zheleznykov. DEVELOPMENT OF LOGICAL RESYNTHESIS METHODS FOR FPGAS BASED ON LOGICAL CELLS WITH BUILT-IN TRIGGER

Key words: technology mapping; logic synthesis; design flow; Field Programmable Gate Array (FPGA); Computer Aided Design (CAD).

A method of logical architecturally-oriented resynthesis at the stage of technological mapping is proposed. The method is intended for digital circuits design flow for field programmable gate arrays (FPGAs). The aim of the work is to develop methods for digital circuit logical resynthesis with an emphasis on area optimization as well as integration of these methods into existing digital circuits design flows for FPGAs. FPGA architecture where programmable logic cell contains a block with programmable lookup table and a trigger connected to it is considered. The proposed logical resynthesis method for the cell in question allows to reduce the area occupied by the designed circuit of the FPGA. The method is implemented as a software module (the algorithm of which is described in the text) and tested on a set of test circuits ISCAS'89. The obtained results indicate a significant (with an average of ~ 20 %, and up to ~ 38 %) reduction of the resulting occupied area. The method is integrated into existing domestic digital circuit design flows for FPGAs.

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S. S. Mamonov, I. U. Klochkova. MODELING OF PARACHUTIST MOVEMENT ON OPEN PARACHUTE

Key words: mathematical model of parachutist jump, regression analysis, equilibrium state, skydiver trajectory, correlation coefficient, parachutist trajectory, skydiver landing speed.

We consider a mathematical model describing the fourth stage of parachutist jump – the decline of open parachute. The aim of the article is to create the system of differential equations, which describes the trajectory of a parachutist as accurately as possible, based on real data of three jumps obtained with the help of a special program installed on the mobile device of parachutists. The original system of differential equations defines the relation between the acceleration of a skydiver from the speed for each of the three coordinates of space. The coefficients of this system of differential equations are obtained by means of regression analysis. The composed system of differential equations is investigated on the basis of stable equilibrium states. On the basis of the obtained equilibrium states, a comparison of real landing speed of a parachutist and a theoretical one is made, conclusions are drawn. As a result of transformations, the system of differential equations describing the dependence of three coordinates on parachutist's speed is obtained. On the basis of the received system a theoret-

ical trajectory of a parachutist is constructed, its comparison with actual trajectory is carried out, conclusions are drawn.

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A. I. Novikov, A. V. Pronkin. COMPARATIVE ANALYSIS OF DISCRETE GAUSSIAN NOISE FILTRATION METHODS IN IMAGE PROCESSING

Key words: images, additive model of image, smoothing filter, kernel smoothing operator, linear filters, sigma-filter, bilateral filter, image blur.

This research of the work is dedicated to smooth properties and simultaneously to a degree of border blurring of linear and nonlinear filters while processing images. The aim of this work is generation of practical recommendations for selection of filters that suppress discrete Gaussian noise, suited for work in airborne computer under the conditions of severe limitations to processing speed of algorithms. In airborne systems of computer sight the processing of images must be carried out in real-time mode. For the majority of systems this corresponds to 25 frames per second. The problem of noise suppressing is a low-level one and therefore must be processed much faster than high-level ones. In this article the results of comparative tests of groups of linear and nonlinear filters of discrete Gaussian noise are stated and modification for bilateral filter, permitting to speed up image processing up to 10 times is proposed.

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V. V. Belov, A. K. Lopatin. APPLICATION OF GENETIC ALGORITHMS FOR THE FORMATION OF ALGORITHM CHAINS FOR IMAGE IMPROVING

Key words: genetic algorithms, image processing, algorithms compositions, set of algorithms, image filtering, edge detecting.

The task of forming gradient images of products located on a conveyor belt in the process of implementing automatic verification of their geometric dimensions is considered. The aim of the work is to develop a method for automatic synthesis of an algorithm for obtaining high-quality gradient images. The algorithm is synthesized as the chain of necessary procedures (operators) used in practice of solving image processing problems. Structural and parametric identification of the synthesized chain is carried out automatically using a modified genetic algorithm. Input parameters of the synthesized chain are: the image of inspected product in RGB format and binary image-standard. The synthesized chain adapts to shooting conditions (camera type, its resolution, surface illumination), the image formed by it is intended for the subsequent selection of product edges in order to evaluate its geometric parameters. In the process of chain synthesis, the vector of its operators and their parameters is formed.

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V. O. Bryukhnova, N. I. Tsukanova. ENSEMBLES OF NEURAL NETWORKS WHEN FORECASTING VOLUME OF SALES IN TRADING NETWORK

Key words: forecast, time series, regression, machine learning, model ensembles, running, boasting, learning error, generalization or testing error.

The questions of neural networks ensemble application to the decision of a problem of sales volumes forecasting in trading network are considered. Two methods are used to form the ensembles of neural networks, based on bugging and boosting methods. The aim of the work is to study the effectiveness of using neural network ensembles to solve the problem of sales volumes forecasting in trading network, to develop programs in MatLab environment that implement various algorithms for training ensembles of neural networks. The paper considers the following issues: the formulation of the problem to predict time series with the help of neural networks ensemble, model of neural networks ensemble in the form of individual neural network models composition, learning and prediction algorithms based on the ensemble of neural networks in bugging and boosting methods, comparison of various algorithms in accuracy and stability of the forecast. The results of the research obtained with the help of the developed programs are given, on their basis recommendations on their use in forecasting sales volumes in sales network are given.

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D. V. Kornienko. FIELDS OF VALUE STORAGE TYPE APPLICATION FOR STORING IMAGES AND IMAGE FILES

Key words: platform, configuration, value store, database, object, facsimile, props, directory, module, procedure.

The article is devoted to the description of the algorithm to work with the object of storage of built-in 1C language. This type of object is used to store values of different types in serialized form. An important feature of value store is that the data is stored in a compressed form. This makes it possible to primarily reduce the amount of stored information for large objects. The storage of values allows you to store in a special format both standard system objects and non-standard objects for which the type is not provided in the platform. This capability provides flexibility in the use of value storage. The aim of this work is to demonstrate the use of an object of the value storage type for storing various objects in information database. One of the main ways to use value storage is to store images. This allows you to store photos of employees, goods, documents, seals, signatures and more in the database.

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INSTRUMENT MAKING AND INFORMATION MEASURING SYSTEMS**A. I. Bobikov, O. N. Burkina.** DIGITAL SDRE-CONTROLLER OF LIQUID LEVEL FOR OBJECTS OF PETROCHEMICAL INDUSTRY

Key words: state-dependent Riccati equation, digital control, sampling period, emulation, Lie series, Lyapunov input / function matching, Lie derivatives, order of approximation.

A modification of continuous SDRE-controller based on Lie series expansion, by introducing constant coefficients in the terms of control law to simplify computational operations and eliminating rounding errors, as well as further optimization with the help of two methods: optimization of introduced coefficients by means of Simulink Response Optimization packet and MATLAB system Optimization Toolbox usage is proposed. The aim of the work is to redesign a continuous regulator into a digital controller for a nonlinear system using the Lyapunov control / function matching technique. The main idea of the Lyapunov control / function matching method for a nonlinear digital system is to find a digital state controller such that its efficiency in terms of the closed loop Lyapunov function is the same as for the desired control strategy for a continuous system with state feedback. The approach proposed gives an approximate 38 times decrease in integral quadratic error value for a synthetic control object, and for a real object in the form of a spherical reservoir – an approximate 1,23 times decrease.

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A. A. Voevoda, B. V. Polagushkin, Y. P. Filoso. APPLICATION OF INVERSE MODEL METHOD FOR ASYNCHRONOUS MACHINE CONTROL SYNTHESIS

Key words: AC electric drive, asynchronous machine, minimization of reactive power, inverse model method, aperiodic nature of electromagnetic torque formation, Lagrange method in Pontryagin form.

The paper presents a method of inverse model for the synthesis of multidimensional control of an asynchronous machine with a short-circuited rotor, where electric machine is considered as a multidimensional object, characterized by the existence of two input control actions and two output values, nonlinearly related to controlled variables. Using inverse model method with linearization by output the formation of electromagnetic torque is said to be aperiodic and is implemented in the conditions of simultaneous control of reactive power to its minimum value. Using the Lagrange method in Pontryagin form, electromagnetic torque is changed and reactive power is regulated to its minimum value at minimum time. Due to the lack of preliminary magnetization, control with minimization of reactive power of medium-power asynchronous machine can improve integrated assessment of the efficiency during the transition process to (4-6) %

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V. T. Fam, V. V. Suskin. INVESTIGATION OF THERMAL MODE OF PHOTOELECTRIC MODULE WITH COOLING BY FRAME RADIATOR

Key words: Photovoltaic panel, photovoltaic converter, process of convective transfer, coefficient of efficiency, temperature gradient, solar radiation, thermal conductivity, differential equation.

The problem of increasing the efficiency of a photoelectric module operating at increased ambient temperature is considered. The aim of this work is to investigate the thermal state of a photoelectric module with cooling by a slot radiator. The problem of constructing a mathematical model of thermal regime of a photoelectric module with slot-radiator cooling operation at increased ambient temperature is considered. Its experimental investigations were carried out at various initial data. The results showed that the temperatures of photovoltaic module body, obtained on the basis of both simulation and calculation, approximately coincide. At the same time, the proposed model makes it possible to solve the problem of lowering the temperature in the body of a photoelectric module functioning at increased temperature of surrounding environment.

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T. V. Gladkikh, L. A. Korobova. DEVELOPMENT OF DECISION SUPPORT BASED ON STATISTICAL DATA RESEARCH FOR DISEASE DIAGNOSIS

Key words: computer system, diagnostics, diseases, information process.

The aim of the work is to develop a computer-based decision support system based on the processing of medical statistics for the diagnosis of diseases. The objectives of the research is to study the diagnosis of diseases as an information process, analysis of statistical data, description, structuring and systematization of data using elements of fuzzy sets and the development of a mathematical model using inference rules. To simulate the process of disease diagnosis IDEF design methodology was used. The result of the research is the information that determines the degree of belonging to the class of diseases.

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A. V. Alpatov, M. S. Ashapkina. METRIC DEVELOPMENT FOR EXERCISE RECOGNITION IN REMOTE REHABILITATION SYSTEMS

Key words: rehabilitation, knee, distance metrics, dynamic time warping algorithm, trajectory of movement, waveform, inertial sensors, mobile app.

The problem of developing quantitative metrics for automated recognition of the types of exercises performed within the system of remote control over the process of physical rehabilitation is studied. The aim is to develop metrics for assessing the correctness of physical exercises, allowing to obtain quantitative characteristics of the correctness of following the protocols of rehabilitation exercises in order to increase objectivity and reliability of remote control. The goal of controlling the correctness of rehabilitation exercises implementation based on the assessment of similarity measure of real trajectories with model representation is found. Comparative analysis of metrics characterizing the distance between two implementations is carried out, using the example of model trajectories. It is concluded that it is necessary to use the metric being invariant to the deformations of trajectory form and time. It is proposed to use dynamic time warping algorithm with additional metrics that localize the properties of the function to minimum strain path.

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L. R. Grigoryan, N. M. Bogatov, A. L. Grigoryan. DEVELOPMENT OF SPECIFIC MEASURER SOIL RESISTANCE

Key words: circuitry, meters, earth resistance, grounding, current spreading, transient processes.

In this article the problem of constructing a soil resistivity meter is considered. The aim of the work is to find the optimal circuitry of the soil resistivity meter taking into account both the current spreading in the soil and the transient processes occurring in. Based on the theory of electrical prospecting the initial concepts of measuring soil resistivity are considered and the requirements for selecting the frequency of the sounding signal of the instrument are determined. The structure of the soil resistivity meter is proposed, the features of which are the total galvanic isolation of the current terminals of the test signal generator from potential terminals of the device, the use of synchronous detection and the sigma-delta of the analog-digital converter of the measuring signal. Instrumental and methodological components of the device error are considered, methods for their minimization are proposed.

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