

CONTENTS AND ABSTRACTS

RADIOENGINEERING, RADIOLOCATION AND COMMUNICATION SYSTEMS

V. K. Klochko, S. M. Gudkov. ALGORITHMS OF TWO-STAGE RECOVERY OF RADIO THERMAL IMAGES

Key words: scanning radiometer, radio thermal image, restoration algorithms, two-stage restoration, matrix methods, Wiener's filter, modeling.

In case of the decision of tasks of radio thermal images recovery received by means of scanning radiometer of wave lengths millimeter range there is a need to increase restoration speed. There are two ways speed increase: due to the increase of scanning step in a place angle and more rational organization of computing process. We offer to realize these two directions simultaneously in case of restoration algorithms creation. The aim of the work – to elaborate the algorithms of two-stage recovery of radio thermal images allowing to solve problems of restoration in the conditions of raised scanning step in a place angle with the smallest number of computing operations. The algorithms offered in operation are based on optimum and suboptimum methods of images recovery and presented in the form of two-stage procedures allowing to reduce the number of computing operations. Algorithms are expected to operate in the conditions of increased scanning step in a place angle. Comparing of algorithms is carried out by method of computer modeling. The largest accuracy of restoration in the conditions of modeling was shown by the algorithm based on the optimum matrix approach. The results of full-scale test of operation of the algorithm based on Wiener's filter are given.

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O. N. Makarova. COMPARATIVE ANALYSIS OF IMAGE RECOVERY ALGORITHMS IN TWO-CHANNEL RADIOMETER

Key words: radiometer, dual-channel processing of signals, image recovery, radiometrical observations, recovery accuracy, recovery algorithms, passive radiolocation, signal accumulation time, millimeter range.

Comparative analysis of objects image recovery algorithms in a dual-channel radiometer under the conditions of missed rows and matrix columns of radiometrical observations by means of mathematical modeling is made. It is shown that recovery accuracy loss due to the absence of observations in one-channel radiometer can be compensated with dual-channel processing. The aim of the research work is the comparative analysis of object image recovery algorithms on the basis of scanning radiometer dependent from the number of channels processing the received signals and observations conditions. Matrix methods and the method of Wiener filter for systems with single- and dual-channel processing with interpolation of matrix rows under observation and without it at different direction pattern width of antenna radiometer with different signal-to-noise ratios are reviewed. Modeling results confirm the possibility of recovery accuracy raise in the conditions of missed rows and matrix columns observation with the help of parallel usage of two scanning antennas in orthogonal directions.

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V. K. Klochko, YU. R. Polikanov. ESTIMATION OF SURFACE REFLECTING ELEMENT COORDINATES IN A BOARD DOPPLER RADAR STATION

Key words: coordinates estimation, board radar station, multi-channel Doppler radar station, separation of spectral countings, monopulse method, phase method.

The description of board multi-channel Doppler system to estimate spatial coordinates of separate reflecting surface elements is given. Estimation of each element coordinates is carried out on the basis of several spectral countings having passed the path of preprocessing in several receiving channels and corresponding to one Doppler frequency. Oscillations of Doppler frequency due to the signals received by several aeriels lead to the appearance of false spectral countings and change of their amplitude. There is a problem of exact separation of spectral counting in several receiving channels corresponding to the same reflecting surface element. The aim of the work – to improve an algorithm of spectral counting separation taking into account possible oscillations of frequency and to research the operation of spatial coordinates estimation algorithms. The algorithm of spectral counting separation based on the method of optimum classification is offered. On the basis of mathematical model of spectral countings the description of estimation algorithms based on monopulse and phase methods is given. The results of computer modeling of algorithms operation are provided. The influence of spectral counting separation errors on the coordinates estimation accuracy is studied.

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K. A. Batenkov, V. R. Kravchenko, A. N. Oreshin, A. E. Mironov, A. A. Melnikov. THE FORMATION OF TRANSMITTED OFDM SIGNAL ENERGY UNDER KNOWN COEFFICIENT OF ATTENUATION IN COMMUNICATION CHANNELS WITH LOGNORMAL FADING

Key words: attenuation coefficient, error probability, pre-emphasis, OFDM, lognormal fading, signal energy, signal-to-noise ratio.

With constant and exactly known attenuation coefficient the probability of error for M-position Orthogonal Frequency Division Multiplexing (OFDM) signal with a quadrature amplitude modulation is defined. Some reduction in the requirements for energy ratios can be achieved using pre-emphasis, that is, by applying the preliminary formation energy of the transmitted signal under known attenuation coefficient.

The aim of this work is to reduce the probability of bit error by introducing amplitude pre-emphasis of transmitted OFDM signals, which involves the use of direct power ratios between sub-carrier ones in a broad-band signal as the parameter to be changed. The number of dependencies illustrating the effect of intensity of signal fading on the error probability is received, and the optimization problem of preliminary energy formation of a transmitted signal under the known attenuation coefficient is solved. The obtained results allow to make a conclusion about expediency of signal energy redistribution in the region of small values of attenuation coefficient, simultaneous increase of allowable energy of transmitted signals leads to increasing share of energy being redistributed in the region of small attenuation.

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V. V. Zolotarev, G. V. Ovechkin, P. V. Ovechkin. THE PERFORMANCE OF BLOCK IMPLEMENTATION OF VITERBI ALGORITHM

Key words: communication system, error-correction coding, Viterbi algorithm, convolutional codes, block codes, quasi cyclic code, cyclic trellis, decoder complexity.

The article deals with optimal methods for decoding of error-correction codes allowing to improve reliability of data transmission through noisy channels. The aim of this work is improving the performance of decoder for short block codes. A simple modification of decoder for quasi cyclic block codes based on short convolutional codes is submitted. The proposed decoder uses the Viterbi algorithm which doesn't consider block structure of a code but decodes it as if infinity sequence. The analysis of submitted decoder performance is fulfilled and the decoder complexity is estimated. It is shown that the submitted Viterbi decoder for a block code may provide

a bit error rate similar to a bit error rate for Viterbi decoder of appropriate convolutional code at two or three time complexity increase only.

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A. JU. Narbekov. RANDOM SIGNAL DETECTION CHARACTERISTICS IMPROVEMENT UNDER THE INFLUENCE OF UNCORRELATED NOISE

Key words: correlation matrix, eigenvalues, energy detection, Karhunen–Loewe transform.

Analysis of random signal energy detection under the influence of uncorrelated noise is implemented. The aim is to gain the signal to noise ratio in processing system output. A comparison of proposed system with known and optimal systems is implemented. The dependencies of correct detection probability of signal to noise ratio were obtained with fixed false alarm probability. The proposed method allows to increase the average rate of improvement of signal-to-noise ratio in 5 times in comparison with the known system.

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B. I. Filippov, G. A. Chernetsky. CHOICE OF SIGNALS FOR HYDROACOUSTIC COMMUNICATION CHANNELS

Key words: hydroacoustic channel, efficiency of discrete information transmission systems, discrete messages transmission modems, noise proof coding.

The aim of the work is the choice of such technical solutions which would allow really to receive given probabilistically – time response characteristics on an output of an information transmission system on hydroacoustic communication channels. In the work the comparative analysis of modems efficiency for the discrete communication channel, methods of transmission of discrete messages in hydroacoustic communication channels with limited bandpass range is made. It is offered to use generalized information characteristic of modems considering at the same time both noise immunity, and information transmission rate which is their assessment on specific relation $h = P_s/P_p \cdot \gamma_m$ (γ_m – specific information transmission rate) for a certain equivalent probability of an error $p_{eq} = p/\log_2 m$ (m – the code base). This characteristic allows to compare the modems which use codes with different base and having different noise immunity. It is shown that application of signals of lattice code modulation (LCM) which combines multiposition signals and noiseproof codes allows (in case of set speed of signal transmission and probability of erratic reception) to reduce necessary power line energetics and frequency band. Such signals are considered to be the most efficient ones therefore this type of modulation can be recommended also for hydroacoustic communication systems.

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COMPUTER ENGINEERING, INFORMATION SYSTEMS AND TECHNOLOGIES

I. YU. Kashirin, O. I. Kashirina. THE CONCEPTUAL INTEGRITY OF PROGRAMMING LANGUAGES

Key words: conceptual integrity, programming languages, programming analysis, algorithmic algebras, programming tools, formal programming machines, program optimization, meta-level language tools, syntax and semantics of language constructs.

The most important task of language programming design tools such as programming language aiming at conceptual integrity provision is considered. Special attention is given to the question of syntactic structures optimizing while programming tools development. As a basic mathematic apparatus we offer to use theoretic concept of formal programming machines being the ordered multitude of applied universal algebraic systems. Conceptual unity is considered as fundamental complex characteristics of tool apparatus formed from different programming language elements closely connected with each other and allowing to view the tool set from functionally different points of view. The aim of the work is to analyze the peculiarities of formal

language tool research of known programming systems finding optimizing possibilities of corresponding formal programming machines.

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V. G. Psoyants. METHODOLOGY OF SOFTWARE PROJECT PROCESSES STABILITY TO RISKS IN FUZZY CONDITIONS

Key words: risk stability, software project, quality criteria, network flow, data-flow optimization, fuzzy network model, fuzzy graph.

We consider the problem of risk management of the processes to develop software engineering project sustainability. The aim of the work is the formalization of approaches to reduce project processes quality risks and the formation of the principles of project stability risk in the conditions of uncertainty of input data. An approach based on the theory of fuzzy sets (FS), fuzzy logic and streaming optimization directional network is offered. The developed method performs the analysis and quantification of risk events based on vector-limiting performance and ensures the stability of risky software project quality criteria. The advantage of the developed approach is the possibility of balancing the requirements for the content, the time and cost of the project, which affect the quality of development process and final product.

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S. V. Vantsov, A. A. Khalyavina. AUTOMATIC CHECK OF AUTOMATED CONTROL SYSTEM FUNCTIONAL BLOCKS STATUS AND COMPLEX DEVICES DIAGNOSTICS

Key words: diagnostics of complex devices, automated control systems, algorithms, avionics systems, types of control, combined control method, control program.

The article describes the main problems faced by developers in addressing issues of control and diagnostics of complex devices. Improvement of avionics systems due to the increasing demands to their functionality leads to an increase in structural complexity and, consequently, monitoring and diagnostics complexity. The issues of ensuring efficiency of such systems and reducing the complexity of the implementation of control and diagnostic tasks while improving their efficiency are becoming increasingly important. This is possible with an integrated approach when choosing methods, as well as a certain degree of automation of control procedures and diagnostics. The aim of this work is to find solutions that reduce the complexity of diagnosis and the influence of human factor on the process of diagnostic procedure. The article also investigated the ways of improving the quality of diagnostics of complex devices.

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S. F. Tyurin. FEATURES OF RADIATION HARDENED FPGAS MAJORITY VOTE CIRCUITS

Key words: triple module redundancy, majority vote, minority vote, 3-state buffer.

Radiation resistance onboard equipment aerospace is one of the urgent tasks of the present stage of digital technology. An example of such equipment may be a control system of the Mars rover NASA Curiosity. In order to increase the radiation resistance the expensive manufacturing technologies of integrated circuits, for example, Silicon-on-insulator, SOI, are used. Furthermore, extensive use of structural redundancy, such as triple redundancy hardware takes place. In addition, as a method of providing radiation resiliency – RHBD (Radiation Hardened by Design) structural redundancy, for example, triple redundancy of equipment (Triple Modular Redundancy, TMR) is widely used. Programmable logic integrated circuits (FPGA- field-programmable gate array) due to the large number of configuration memory cells are not vulnerable to the effects of radiation. In this connection, once-programmable FPGA (e.g., Actel company) are used, but flip-flops must also be reserved. In multiple programmable FPGA chip of Xilinx series by Virtex™ company triple structural redundancy (backup majoritarian voting for most, the choice of 2 of 3) is used. The majority vote circuits based on 3-state buffers with Pullup resistors and Minority Vote Circuits, implemented by setting LUT (Look Up Table) are used. However, the sources of available products, some technical details are not disclosed.

Aim: To study features of majority circuits peculiarities used in programmable logic integrated FPGA Virtex circuits from Xilinx and not being disclosed by the manufacturer in detail, as well as to develop improved circuit variants.

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P. A. Gavrilov, K. A. Maykov. COMBINED METHOD FOR CORRECTION OF INITIAL DATA IN CLASSIFICATION TASKS

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

The combined method for inputting missing data has been proposed. The aim of this work is to investigate features and limitations of this method used for solving classification tasks with missing data. The results of comparative analysis of the developed method and a number of input methods have been presented using the algorithm of k-nearest neighbor as a classifier. The quality of a classifier is evaluated by stratified 10-fold cross-validation. The results of conducted numerical experiments showed the expediency of application of developed method for inputting missing data in the process of dealing with important classification tasks.

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A. V. Prutzkow, D. M. Tsybulko. ALGORITHMS AND SOFTWARE FOR NATURAL LANGUAGE CARDINAL NUMBER PROCESSING AND ITS RESULTS

Key words: computational linguistics, natural language processing, cardinal number translation, cardinal number processing algorithms, Internet network, Internet-application, working results of Internet-application.

We research an urgent problem of conversion and translation of natural language cardinal numbers. The research aim is to develop algorithmic and software provision of a natural language cardinal number processing. According to the method all numerals are processed via an intermediate step formalized by three-level abstract model of numeral. We develop algorithms for every kind of numeral conversion. The conversion algorithms are used in an Internet-application for cardinal number processing. Every Internet-application user request is stored in its working log. On the basis of the 200 000 record log analysis we come to a conclusion that the largest user query amount is related to the Spanish cardinal numbers. The largest user query number was sent by Internet-application from the USA and the Russian Federation. For Internet-application working log record processing we use special software tools with flexible language of data selection.

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SYSTEM ANALYSIS, CONTROL AND INFORMATION PROCESSING

S. M. Larionov, A. A. Selyaev. OBJECT LOCATION DETECTION IN DIFFICULT VISION CONDITIONS BASED ON TEMPLATE MATCHING METHOD

Key words: object localization, template matching method, difficult vision conditions, object, non-uniform background, criterion function, partial object occlusion, brightness gradient.

The problem of object location detection in image sequence in difficult vision conditions is studied. The aim of the work is modification of template matching method in the case of possible partial distortion of viewing object and in the case of presence of background areas, similar by brightness to the viewing object, in region of interest. As a result of study appropriate methods of relevant problem solution are received. Method of the object points sorting by the distorted and undistorted is offered. Maximum permissible degree of distortion/occlusion of interest object is measured. Modified criterion function, that considers brightness variations, is studied. The results of experimental studies of proposed algorithms are given. Practical recommendations on their use are given.

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M. T. Teryokhin, Y. E. Belova. RESEARCH OF CONTROLLABLE MATHEMATICAL MODEL TO DEVELOP THE ECONOMIC SYSTEM WITH FUNCTIONAL OF CONSUMPTION

Key words: consumption level, the amount of productive fund, the vector of consumption, initial volume, the volume of investments, fundamental matrix, rank of a matrix, minor, operator.

The method of creation and methods of studying of controllable mathematical model of multi-sector economic system which efficiency of development is estimated by functionality of consumption are offered. The possibility of an economic system to allocate parts of funds for accomplishment of charitable and social programs is researched. The aims of work are determination of a condition in case of which accomplishment a necessary consumption level in case of change at least of one of amounts such as initial or investment, stays invariable, an economic system can provide in advance set consumption level; finding of border of amounts of means within which the economic system can render assistance in accomplishment of programs. As a result of researches a number of theorems as about conditions under which the economic system can provide accomplishment of programs and about conditions under which the economic system can't do this are proved. The specific mathematical model of an economic system is rather in detail researched, dependence between initial amount and the volume of investment in case of which the economic system can provide in advance set consumption level is determined, exact borders of amounts of means within which participation of an economic system in accomplishment of charitable and social programs is possible are established.

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V. V. Mironov, YU. S. Mitrokhin. TECHNOLOGICAL APPROACH TO THE RESEARCH OF DYNAMIC SYSTEMS STABILITY: SYSTEM ANALYSIS OF DYNAMIC PROCESSES STABILITY

Key words: system analysis, dynamic processes, stability, Lyapunov type functions, Lyenar, Van der Paul, La-Sall's system.

In the system analysis of dynamic models an essential role is played by the questions connected with the analysis of dynamic systems balance provision stability, and in their mathematical models – stability of equations systems solutions. Technical «stability» is a capability of system to return to an equilibrium condition after third-party indignation or management. The direct method of Lyapunov remains the major one for the research of dynamic systems stability. However, heuristic creation of Lyapunov function isn't connected directly with structural properties of the researched system and therefore there are no exhaustive general methods of its creation on the set system model yet. It is the most serious lack of Lyapunov methodology. In the work this shortcoming is overcome: two fundamental problems of the system analysis of dynamic systems are considered: creation of Lyapunov type functions according to a system model and assessment on this basis of stability area (asymptotic stability) of a dynamic system.

The work aim is to offer technological, algorithmically implementable method of creation of functions of Lyapunov type for the analysis of real dynamic systems stability on their models. Properties of the offered approach are considered. The method is approved on the systems described by Lyenar, Van der Paul, La-Sall's equations and showed the outstanding performance.

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V. V. Mironov, YU. S. Mitrokhin. CONSTRUCTIVE APPROACH TO THE RESEARCH OF DYNAMIC SYSTEMS STABILITY: APPLIED PROBLEMS

Key words: system analysis, dynamic processes, stability, Lyapunov type functions, Lyenar system, Van der Paul system, La-Sall system.

The questions related to the behavior of equilibrium points of dynamical systems analysis, and in their mathematical models – systems of equations solutions stability were systematically considered in the work. «Stability» is understood as the ability of a system to return to equilibrium after third-party disturbance. The construction of the Lyapunov function is not associated with the structural properties of the system, there is still no comprehensive general methods of its construction for a given model of the system. This drawback was overcome in the first part of the paper, and there were solved two fundamental problems of the system analysis of dynamic

systems. They are 1) building a Lyapunov type function by system model, and 2) evaluating the region of stability (asymptotic stability) of the dynamic system.

The aim of the second part of work: to approve the technological method offered in the first part of work for the analysis of real dynamic systems stability on Lyenar, Van der Paul, La-Sall models and their modifications and to show efficiency of the method.

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INSTRUMENT ENGINEERING AND INFORMATION-MEASURING SYSTEMS

H. N. Dao, V. V. Klimakov, A. V. Molchanov, M. V. Chirkin. GAS DYNAMICS IN ACTIVE MEDIUM AND BIAS INSTABILITY OF LASER GYROSCOPE

Key words: ring laser, laser gyroscope, bias instability, bilateral discharge, positive column, Penning ionization.

The paper presents the analysis of nonstationary gas flows inside the ring helium-neon laser in connection with the bias instability of laser gyro. Asymmetric perturbations of a bilateral glow discharge make it possible to investigate gas density oscillation in laser active medium. Instabilities in the emission of contamination atom from discharge channel wall to gas mixture disturb Penning ionization frequency. Oscillations in ionization rate lead to electric power fluctuations, which are dissipated inside the positive column. As a result internal temperature variation changes the gas flow along the ring cavity axis even if discharge currents and environment temperature are stable.

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A. I. Bobikov, T. S. Bubnova, A. A. Popova. CONTINUOUS IMMUNE SELF-ADJUSTING PID-CONTROLLER OF AN OBJECT WITH DELAY

Key words: continuous systems, objects with delay, Smith's predictor, immune controllers, PID-controller.

One of the most important tasks of management theory is the development of effective control methods. In this article, in order to enhance the quality of the object control system with delay we propose to use a combination of traditional PID controller and immune controller, which makes it possible to increase speed control. This method of control is associated with the replacement of conventional PID controller into self-adjusting indecipherable PID controller. The proposed method integrates the advantages of self-adjusting and immune controllers. The effect of object delay decreases by applying a modified Smith's predictor. The aim is to develop and study the control system with continuous immune self-tuning PID controller that has greater speed and being less sensitive to the influence of disturbances in comparison with control system with self-tuning PID controller.

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ELECTRONICS AND NANOELECTRONICS

A. A. Kornilovich, V. G. Litvinov. THE METHOD OF CONTACTLESS DETERMINATION OF QUANTIZED HALL RESISTANCE OF 2D SEMICONDUCTOR NANOSTRUCTURES

Key words: methods of diagnostics, quantum Hall effect, 2D-gas, Landau levels, microwave radiation, LS-coupling.

The method for contactless determination of 2D electron gas transport parameters in nanostructures by magnetic quantum effects is described. The aim of the work is the development and testing of contactless method for determining the quantized Hall resistance of two-dimensional semiconductor nanostructures. The dependence of the power of microwave radiation passing through GaAs 2D-layers from quantizing magnetic field was investigated. Obtained periods of Shubnikov's oscillations of microwave radiation passing were used for free electrons concentra-

tion finding. The quantized Hall resistance of 2D-GaAs layer and the Landau levels filling factor are determined from the values of magnetic field corresponding to extreme values of microwave power absorption. The relationship between the filling factor and the Landau level number, resulting orbital and spin quantum numbers interacting in LS-coupling of electrons is obtained.

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V. S. Ivanov, V. A. Ponomarev. METHODS FOR IMPROVING THE EFFICIENCY OF ENERGY SUPPLY OF INDUSTRIAL ENTERPRISES

Key words: energy efficiency, power, reactive power compensation, harmonic filters, transformers, filter-devices, power loss, thyristor, power cables.

Methods of increasing the efficiency of energy supply systems are considered. Particular attention is paid to the suppression of higher harmonics in a power supply system and the introduction of active-adaptive networks. The reasons causing significant technological losses that reduce the efficiency of functioning of industrial enterprises of power system development are given. The modernization and reconstruction of existing power systems is a necessary solution to this problem in terms of the national industry of increasing competition for a reliable and uninterrupted production of end product on the market.

The aim is a comprehensive analysis of technical and economic indicators and affordable ways to improve energy industries, energy audits of existing networks for electricity savings.

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V. A. Pushkin, O. V. Rozhkov, A. A. Fefelov, I. V. Gurov. PROBLEMS OF OPERATION ENGINEERING INFRASTRUCTURE HOUSING COMPANIES OF RURAL SETTLEMENTS

Key words: energy audit, energy inspection, energy efficiency, temperature graph, heat networks, thermal imaging survey, thermogram.

On the basis of comprehensive energy audits of a number of enterprises of housing and communal services in rural settlements of municipal districts of the Ryazan region identified the main problems of operation of the engineering infrastructure of the enterprises.

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