CONTENTS AND ABSTRACTS

RADIO ENGINEERING, RADAR AND COMMUNICATION SYSTEMS

Yu. N. Parshin, M. V. Grachev. MULTI-STAGE RECONFIGURABLE SIGNAL PROCESSING IN SPATIALLY DISTRIBUTED RADIO SYSTEMS

<u>Key words:</u> reconfigurable radio, signal processing, optimization, mutual coupling, spatial diversity, antennas.

Spatially distributed information systems, for example Internet of Things, make extensive use of network-centric principles of construction, which makes it possible to increase the efficiency of resource use. To implement overall characteristics, reconfigurable multi-stage optimization of spatial signal processing is proposed to be used. The aim of this work is to increase noise immunity of signal processing in the presence of interferences by spatial configuration of radio system receiving path. The spatial processing considered consists of the following stages: optimal noise-immune processing, optimization of receiving system spatial structure, optimization of load impedances of receiving antenna system. Various signal-interference situations cause the necessity to reconfigure possible types of processing in order to obtain maximum interference immunity with limitations of technical implementation. Optimization at various stages of spatial processing is carried out by both analytical method and numerical methods: gradient method, random search method, genetic algorithm. Noise immunity of a spatially distributed information system under the conditions of electrodynamics mutual influence of receiving systems in some reception points is investigated.

D. I. Popov. OPTIMIZATION OF MULTIFREQUENCY RADAR SIGNAL PROCESSING SYSTEMS

<u>Key words:</u> detection algorithm, probabilistic characteristics, minimax criterion, multifrequency signal, multifrequency passive interference, rejection filter.

Processing systems for multifrequency radar signals based on auto-compensator of the Doppler phase of the components of multifrequency passive interference and non-adaptive rejection filters are discussed, followed by incoherent integration and accumulation of remnant residuals in frequency channels. The aim of the work is parametric optimization of multifrequency radar signal processing systems based on minimax probability criterion that allows solving the problem of rejection filter weight coefficient vector optimization in a priori range of spectral parameters of passive interference. The developed method of processing system parametric optimization made it possible to minimize losses in threshold signal / noise ratio and achieve high detection efficiency of multifrequency radar signals over the entire range of passive interference spectrum width variation, avoiding the construction of complex adaptive rejection filters in frequency channels. As a result of the analysis for efficient detection of multifrequency signal against the background of passive interference, it is established that with inter-channel averaging of the Doppler phase estimates of passive interference, the losses due to errors in auto-compensation of threshold signal / noise ratio with a relatively small training sample size are less than one decibel.

C. H. Nguyen. DETERMINATION OF OBJECT MOVEMENT PARAMETERS IN PASSIVE SCANNING SYSTEM

<u>Key words:</u> passive observation system, scanning, moving objects, object movement parameters.

The problem of object movement parameter determination in a passive scanning system of vision is solved. The aim of the work is the development of approaches to this problem solution based on spatial processing of vector directions to objects in one and two scanning periods in the form of solving the system of equations in matrix form. The first approach allows finding estimates of object space position and the speed of its coordinates change according to one peri-

od of scanning in the system of three observers. The second approach allows finding estimates of the same parameters according to two scanning periods in the system of two observers. Simulation results showing the possibility of implementing the proposed approaches are given.

S. N. Grigoryev-Fridman. METHOD TO INCREASE PERFORMANCE AND ACCURACY WHILE ADJUSTING STANDING WAVE RATIO ON VOLTAGE AND UNEVENNESS OF AMPLITUDE-FREQUENCY CHARACTERISTICS IN MICROWAVE ATTENUATORS

Key words: standing wave ratio on voltage, amplitude-frequency characteristic non-uniformity, microwave attenuators, waveguide, electromagnetic wave, microstrip line, inductance, capacity, resistor, dielectric substrate.

This article is devoted to the solution of actual problem to increase productivity and accuracy of adjusting works in production, and safety precautions observance by manufacture, repair and options attenuators, built in measuring instruments of increased capacity. The aim of the work is to develop automated method to adjust SWRU and uneven frequency response in microwave attenuator. This article offers theoretical analysis of the offered model of microwave attenuator representing the system of adjustment block, controlled by computer and the block setting the values of standing wave ratio on voltage (SWRU) and attenuator transfer factor. The article describes the method to implement a given model representing a directed system made of attenuators and automatic adjustment node as well as the results of offered sample research. Also applied importance of technical application for the developed device to adjust standing wave ratio on voltage SWRU in microwave attenuators is considered.

MATHEMATICAL SOFTWARE SUPPORT
OF COMPUTER SYSTEMS AND NETWORKS

I. Yu. Kashirin, S. I. Lavrentyev, I. Yu. Filatov. OPTIMISING UNIFICATION OF COMPLICATED PROGRAMS

Key words: unification theory, formal software machines, algorithmic algebras, computer-aided design, equivalent transformation of programs, programming languages.

The concept of modern unification theory application to a multitude of terms of formal software machines, consisting of algorithmic algebras system is shown. This formalism gives the possibility of strict mathematical description of the known software language tools for analysis, automatic synthesis and optimization of program code. It is shown that a new modified unification algorithm is not inferior to the previously created algorithms, but has the possibility of its application in the design of complex software systems created using modern programming languages. The aim of the work is to construct a new unification algorithm of formal descriptions of the programs encoded on the basis of modern programming languages, and automatically optimized by unification algorithm.

A. I. Baranchikov, N. Z. Nguyen. RELATION DATABASE SCHEME COMPARISON ALGORITHM BASED ON SUBJECT AREA SEMANTICS ANALYSIS

Key words: comparative analysis, databases, key, experimental analysis, database research, functional dependency, relational database, database scheme.

The task of comparing database schemes obtained in two ways is considered: experimental analysis and research of existing databases. The aim of this article is to use an algorithm for comparing the equivalence of a database scheme obtained in two ways: experimental analysis and research of existing databases. An algorithm is proposed for comparing two sets of functional dependencies for equivalence. The results of applying this algorithm are given. The scientific novelty of this article is to use comparative results to identify inconsistencies in data bases. This allows you to reduce the time in designing databases that use old database, containing in its

structure information about subject area semantics. The practical application of this work can be used to design a relational database with a low probability of errors.

INTELLECTUAL INFORMATION SYSTEMS AND TECHNOLOGIES

O. N. Romashkova, R. S. Lomovtsev, L. A. Ponomareva. COMPUTER SUPPORT OF MANAGERIAL DECISION-MAKING FOR REGIONAL LEVEL EDUCATIONAL SYSTEMS

The aim of the work is to create tools for computer support to assist with management decision-making in a regional educational system. The authors studied the information processes in a regional educational system in order to develop an effective decision management system with the help of the developed information system of decision support (ISPR). The architecture of ISPR, which consists of four blocks, is described. The paper describes only two blocks: data and process analysis and visualization block. These units can function as stand-alone modules and can be connected to another information system. To assess the rating of educational organization (EO) the algorithm of neural networks was used. With its help, the classification of EO was carried out. With the help of algorithms of intellectual data processing, the list of indicators of schools ' activity was analyzed and the most significant indicators were selected for the rating like examination marks on the subjects and average points received in Unified state exam. Special kinds of algorithms were adopted and used because of the unusual nature of the data, which was described in the paper. Specific results of calculations are given. Examples of decision management are illustrated. The forecast for the school was made, and a suggestion on which indicators should be changed to increase the rating was proposed. All calculations are accompanied by graphs, which are created with the visualization module of ISPR.

V. T. Fam, V. V. Suskin. ALGORITHM TO OPTIMIZE THE PARAMETERS OF DESIGN OF PHOTO-ELECTRIC MODULE WITH COOLING

In this article the problem of optimization of parameters of a design of the photo-electric module with cooling is solved. The aim of this work is to develop an algorithm to optimize the parameters of design of photo-electric module with cooling functioning in the conditions of increased ambient temperature. The main criterion of optimization problem is the efficiency of photo-electric module representing the relation of developed energy in watts to expenses for its production in rubles. The algorithm of optimization is based on gradient descent method adapted for this task. In the work the calculation is carried out and optimum parameters of design of photo-electric module with cooling are received. Results of modeling show that the offered algorithm allows to determine optimum parameters of design of photo-electric module with cooling in order to achieve maximum efficiency of its functioning in the conditions of increased environment temperature.

G. V. Petrukhnova. ENTROPY CRITERION BASED ON BINARY MATRIX SYMMETRY MEASURE

The aim of the work is to solve the problem of optimizing the structure of a binary matrix. The relevance of entropy criteria usage in complex systems modeling of different nature is shown. The structural entropy concept is based on the symmetry concept. The symmetry reflects some orderliness of the object parts under study. Symmetry minimum allows you to get the maximum variety of object structural elements. The binary matrix structure invariance with respect to the

selected structural elements permutations is considered. A minimal unit of binary matrix partitioning in the constructed model is its row. Rows permutations among themselves and elements permutations in rows are considered. On the basis of performed binary matrix structuring, a measure of its symmetry is introduced. A symmetry measure allowed to synthesize quality entropy criteria. The efficiency of using the obtained simulation results in theory and practice of digital devices test control is introduced. A digital device model «black box» was considered. Based on pseudo-random number generator, digital devices tests covering single faults of «short circuit» and «constant» types were built. It was assumed that a fault of «short circuit» type can occur between any tested digital circuit control points, a «constant» type fault can occur at any control point. The experimental data analysis showed that the obtained entropy criteria allowed to reduce digital devices tests length.

SYSTEM ANALYSIS, MANAGEMENT
AND INFORMATION PROCESSING

Q. M. Vu. THE PROBLEM OF OBSERVABILITY «IN SMALL» FOR NONAUTONOMOUS LINEAR SYSTEMS AND ITS APPLICATION TO THE ANALYSIS OF SMALL SPACE APPARATUS MOTION

Key words: observability «in the small», controllability «in the small», linear non-stationary system, small spacecraft.

The concept of «observability in the small» for dynamical systems in case of nonautonomous (non-stationary) linear systems is systematically considered for the first time. A theoretical problem of principal observability «in the small» of a third-order linear non-autonomous system and its application for analyzing the observability of small spacecraft is considered. A special case of «observability in the small» of the general theory of control and observation meets physical and technical features of small spacecraft operation. The aim of the work is to solve the problem of observability of dynamic systems, in particular, small spacecraft under certain restrictive conditions, and demonstrate the effectiveness of the solution using a real example.

L. A. Demidova, N. A. Petrova. SCHEDULING OF SHOOTING SYSTEM APPLYING HYBRID EVOLUTIONARY ALGORITHM

Key words: optimization, parameter, genetic algorithm, algorithm of differential evolution, hybrid, system of shooting, subject to observation.

The problem of shooting parameter value optimization when scheduling a system of shooting is considered and the possibility to use a hybrid evolutionary algorithm for its decision is investigated. The aim of work is application of the evolutionary approach to the problem of shooting parameters optimization assuming development of program system integrating mathematical models and evolutionary algorithms of optimization and implementing the search of optimization problem parameter values to meet a set of requirements and restrictions at acceptable time expenditure. To solve a practical problem to optimize the coverage of observation subject by the system of shooting the idea of genetic algorithm and differential evolution algorithm hybridization was offered and implemented. The results solving a practical problem of shooting parameter optimization confirming expediency of the offered hybrid evolutionary algorithm application providing minimization of time expenditure for the solution of optimization task are given.

V. Ya. Tsvetkov, A. N. Shchennikov. APPROACH TO THE METHODS DEVELOPMENT OF COMPLEMENTARY INFORMATION PROCESSING

Key words: computations, quantum computations, complementary computations, complementarity, complementary relationships, complementary systems.

The aim of the work is to study the possibility of applying the principles and methods of quantum computing technology in the complementary processing of information. Paper describes the formulation of the problem of quantum computing. Paper analyzes the concept of a quantum

state. The relationship of the principles of complementary processing with quantum computing is investigated. Complementarity is investigated in the field of computational processing as one of the optimization methods. The article analyzes the concept of a complementary system. The article proves that there are two complementary systems in the field of optimization. The first system is the initial system of equations with the conditions of complementarity. The second system is the solution of equations and the complementary system itself. If we consider the conditions and solutions as one system, then the complementary system is one. If we consider the solution and condition as different systems, then there are two complementary systems. That solution has the properties of complementarity. The article shows that the organization of a qubit fully complies with the complementarity conditions in complementary systems.

A. A. Voevoda, K. M. Bobobekov. AUTOMATIC CONTROL SYSTEM OF AMMONIA SYNTHESIS PROCESS

Key words: interconnected control object, left / right mutually simple polynomial decomposition, transition from left to right decomposition, synthesis of multichannel regulators, polynomial synthesis, temperature stabilization, ammonia synthesis column, astatism.

The problem of temperature stabilization in the ammonia synthesis column is considered. The mathematical description of the object is given in the form of a matrix transfer function obtained in the identification process from the results of the experiment, which is then converted into a left matrix polynomial decomposition. The procedure of transition from left decomposition to right mutually simple polynomial decomposition is given. The regulator of a second order is selected with the property of astatism. Regulator parameters are calculated using the polynomial method. To determine the parameters of the regulator it is necessary to move from a polynomial equation to the so-called Diophantine equation with numerical matrices, which is solved using known methods. Block diagram of automatic control system and transient processes in the system when applying test signals are given. The aim of the work is to develop an astatic ACS temperature regime in the reaction zone of ammonia synthesis column at a given time of transient process, overshoot and provision of channel autonomy based on matrix polynomial method using the approximation of mathematical model of matrix process of transfer function of a low order in order to simplify the regulator compared to known results.

M. V. Zharov. IMPROVING AUTOMATED CONTROL SYSTEM OF TEMPERATURE-SPEED DEFORMATION MODES ON THERMAL-COMPRESSIVE TECHNOLOGY EQUIPMENT

Key words: control system; information signal; application software; measuring and control functions; heating temperature; thermal-compression equipment, deformation rate, deformation, the formation of defects.

The paper deals with the technology of solving the problem of measuring and controlling system inertia, which leads to a deviation from the specified deformation modes. The aim of the work is to improve the automated control system for temperature and speed deformation modes on thermocompressive process equipment. The developed system ensures precise compliance with temperature and speed parameters of deformation. The use of the developed automated system is advisable to control deformation modes for isothermal stamping and for stamping in the state of superplasticity of a metallic material.

PHYSICAL ELECTRONICS AND NANOELECTRONICS

N. V. Mukhin, M. V. Rudenko, N. V. Gaponenko, T. V. Gordinskaya, A. V. Ermachikhin, V. G. Litvinov. INVESTIGATION OF INTER-PHASE BOUNDARIES IN POLYCRYSTALLINE FILMS OF FERROELECTRIC OXIDES OF PEROVSKITE TYPE

Key words: interfaces, complex oxides, polycrystalline films, phase formation, nonstoichiometry.

Generalized model concepts describing the formation of dispersed inclusions of new phases of different stoichiometric composition at the interfaces in polycrystalline films of multicomponent ferroelectric oxides due to the processes of bulk diffusion, grain boundary segregation and interaction with the substrate are described. The aim of the work is an experimental study of the formation of inclusions of «impurity» phases in ferroelectric oxides on the example of polycrystalline films of lead titanate zirconate and strontium bismuth tantalate.

D. Q. Manh, B. A. Kozlov, M. T. Nguyen. RESOURCE OF SMALL-SIZED SEALED-OFF TEA-CO$_2$ LASERS

Resource characteristics of volume discharge in CO$_2$-laser mixtures at atmospheric pressure and resource characteristics of small-sized sealed-off TEA-CO$_2$ laser are investigated. Main processes which influence on the resource of volume discharge and laser are defined. Resource of TEA-CO$_2$ laser with graphite electrodes about 2000 hours is achieved. The aim of this work is to determine main processes which influence on the resource of small-sized sealed-off TEA-CO$_2$ laser.

S. V. Nelyubov, V. A. Voytenko. INVESTIGATION OF ABRASIVE GRAINS MOTION IN A SEALED LAYER DURING PIEZOELECTRICS PLATE POLISHING

The problem of piezoelectric plates fine-tuning to a given size by grinding with free abrasive is considered. The aim is to determine optimal parameters of grinding process. A mathematical model is proposed for studying the movement of free abrasive grains in a compacted layer between the grinding wheel and the processed piezoelectric plate. According to the results of a computer experiment, the dependences of velocities, accelerations of abrasive grains, forces and moments acting on grains are established as a function of grinding time for given combinations of compacted layer parameters and parameters of grinding process. The dependences obtained allow us to make an informed choice of compacted layer parameters and grinding process parameters according to the criterion of maximum residence time of free abrasive grains in a working layer at the surface of piezoelectric plate.

V. S. Bezkorovainyi, V. V. Yakovenko, S. N. Shvets. CALCULATION OF FERROMODULATION SENSORS MAGNETIC SYSTEMS

Elements of the theory of substantially non-uniform magnetic fields measurement by magnetomodulation sensors are given. Magneto-modulation sensors consist of two parts: source of constant magnetic field and measuring transducer. Calculation of sensor magnetic systems is based on K.M. Polivanov's theorem of reciprocity. The theorem of reciprocity is adapted for calculation of magneto-modulation sensor magnetic systems due to the use of scalar magnetic potential function and normal component of magnetization vector on modulator magnetic circuit surface. The method of magnetic field intensity calculation created by cores of the magneto-modulation sensor of rectangular and circular cross-section, based on the analytical solution of integrated equation is developed. The method of field magnetization vector calculation in ferromagnetic environment is offered. The aim of the article is the attempt to develop the elements of the theory of magneto-modulation measuring sensors considering parameters of magnetic field source.