

Summaries of All Articles

A. I. Kolybelnikov

Overview of Wireless Technology

The review of the current technologies of wireless networks, their security and prospects for the use in the field of secure communications.

Key words: Keywords: wireless technologies, protocols, information security, encryption.

D. Yu. Dmitriev, A. V. Kletsov

Application of transceivers based on ultrawideband chaotic pulses to a positioning problem

The problem of positioning with ultrawideband chaotic radio pulses is considered. The method for determining the time difference between the signals arrival on the basis of the cross-correlation function of the chaotic radio pulses envelope signal is proposed and studied. It is shown that this approach provides the accurate estimate of the time difference of arrival proportional to the frequency band of the radio pulse envelope signal. The method stability to noise is increasing with the chaotic radio pulse base.

Key words: UWB chaotic radio pulses, time difference of the signal arrival, cross-correlation functions of chaotic radio pulses envelope signal.

M. A. Dunaeva

Constant-amplitude chaotic signal generator

A new generator of chaotic signals with constant amplitude is proposed. The principle of proposed generator operation is based on the nonlinear dependence of the charge transfer sense amplifier output delay of the input differential signal. The dynamic modes of its operation are studied by numerical simulations of the generator mathematical model and by the simulation of the oscillator circuit at the transistor level.

Key words: chaotic signal generator, chaotic signal oscillator, charge transfer sense amplifier.

E. B. Ipatov, E. A. Palkin, V. I. Chivilev, D. E. Ipatov

Numerical simulation of radio signals characteristics in a locally perturbed inhomogeneous anisotropic ionosphere

The problem of modeling the effect of the acoustic wave impact on the characteristics of radio signals propagating on the short wave trace in an inhomogeneous anisotropic ionosphere is studied. The results show the presence of Doppler frequency shift when passing the signal through a moving acoustic disturbance, which is confirmed experimentally.

Key words: ionosphere, regularly inhomogeneous medium, radio wave propagation, numerical simulation, by-characteristics methods, caustic singularities.

A. E. Polyakov, L. V. Strygin

2-Tone IP_2 and IP_3 Measurement Technique

This paper contains the definition and measurement technique of RF-path nonlinearity parameters - 2-tone 2-nd and 3-rd order intercept points, including the case of unequal tone levels. Some recommendations on operation modes of the measuring equipment and its impact on the measurement results are also discussed. The described technique is primarily intended for use with widely available test & measurement equipment such as spectrum analyzer and analog signal generators. The paper can be useful for training RF designers and R&D researchers in the field of RF design.

Key words: intermodulation distortion, IP_2 , IP_3 , 2-tone, RF-path nonlinearity, IMD.

K. A. Tomyshev, V. A. Bagan, V. A. Astapenko

Distributed fiber-optic pressure sensors for application in oil and gas industry

This paper shows the current state of measurement systems in oil and gas industry. The advantages of fiber-optic sensors over the classical ones are demonstrated. The possibility of creating a system of distributed fiber-optic pressure sensors is considered. It is proposed to use the physical properties of optical fiber and the impact of cable microbending on the back reflection effect. The ways to increase the attained laboratory layout specifications are set out.

Key words: fiber-optic pressure sensors, distributed sensing systems, back reflection effect, sensing systems in oil and gas industry, laboratory layout.

M. A. Babin, S. O. Kuznetsov

On Links between Concept Lattices and Related Complexity Problems

Several notions of links between contexts, viz. intentionally related concepts, shared intents, and bonds, as well as interrelations thereof, are considered. The algorithmic complexity of the problems related to respective closure operators is studied. The expression of bonds in terms of shared intents is given.

Key words: formal concept analysis, shared intents, complexity.

S. L. Babichev, K. A. Konkov, A. K. Konkov

Using Petri nets to detect synchronization issues in computer shared memory systems

This paper deals with aspects related to the use of Petri nets to detect synchronization issues in concurrent programs using shared memory. Transformation patterns to convert basic synchronization primitives into the Petri nets model are given. Siphons are used to determine the activity of Petri nets. The problem of deadlocks absence in Petri nets reduces to a mathematical programming problem.

Key words: multithreaded programming, Petri nets, synchronization primitive, deadlocks absence, mathematical programming.

Y. N. Volkov, O. V. Dremova

Modeling the effect of project investments on the regional economic dynamics by macromodels

We develop dynamic imitation and optimization macromodels for regional economic dynamics. Calculations are made on the basis of Tver regional economy. The imitation model is used to investigate the effect of the specific project and import investments on the fundamental regional macroeconomics indexes. The optimization model is used to investigate the effective volumes import investments in the specific project region.

Key words: economics macromodels, production function, region income, project investments.

A. V. Gasnikov, E. V. Gasnikova, O. S. Fedko

On possible dynamics in Google's PageRank and a new model for a correspondence matrix

In this paper, the basic technique for research of macrosystems dynamics at large time values is developed. In the core of the dynamics lies the ergodic markovian chain with a huge number of states. At large time values the macrosystem distribution over macrostates is close to a stationary one. With growth of macrosystem dimension (the number of markovian chain states), the stationary distribution is concentrated in a small vicinity of the most probable macrostate accepted for the given macrosystem equilibrium. As an example of application of the described formalism, we give the derivation of the static Google's PageRank model and the modernized gravitational model for calculating a correspondence matrix from the «reasonable» (individually favorable) dynamics of residences exchanges. At the end of the paper we describe the general scheme of macrosystem equilibriums investigation. This scheme allows us to increase the dimension of macrostates space when the number of agents increases.

Key words: Ergodic theorem, Lyapunov's function, entropy, Google's PageRank, gravitational model for correspondence matrix, concentration of invariant of (stationary) measure phenomena, canonical scaling, dynamic balance condition, detailed balance principle.

V. M. Ipatova

Problem of initialization for the atmospheric general circulation model

We consider a two-layer quasigeostrophic model of the general atmospheric circulation, the main variables of which are barotropic and baroclinic components of a stream function. It is assumed that there are field measurements of air velocity. These observations are used for determining the unknown initial state of the model. The discrepancy between the observed values and the simulation results is measured by the cost function value. We prove the solvability to the optimization problem for positive values of a regularization parameter. The original model is approximated by a semi-explicit spectral-difference scheme with respect to which the discrete problem of initialization is posed. We obtain a theorem on the convergence of numerical solutions of the inverse problem to its exact solutions.

Key words: models of the atmospheric dynamics, inverse and variational problems, numerical methods, spectral-difference schemes.

I. G. Pospelov, A. A. Zhukova

Stochastic model of illiquid asset trade

This work studies the behavior of a consumer who seeks to allocate his welfare optimally between risk-free saving and a risky illiquid asset. The risk of the illiquid asset emerges from inability to trade it at an arbitrary moment of time. Instead, the illiquid asset may be traded at random discrete moments of time. It is assumed that the trader receives a certain utility from the amount of the illiquid asset he owns. A stochastic optimization model of the trader behavior is proposed and analyzed. This analysis is applied to modeling a market with multiplicity of traders. It is shown that even under conditions of perfect foresight, the equilibrium price dynamics may have a shape characteristic of a «financial bubble».

Key words: Stochastic optimization, optimization, Lagrange multipliers, Markov control, optimal consumption, market equilibrium.

T. T. Vu, V. V. Vyshinsky, N. T. Dang

Research of the effect of heat transfer on the aerodynamic characteristics of a rectangular wing model at subsonic speeds

This paper presents the results of parametric calculations and experiments of the influence of the surface heat exchange on the wing model's integral aerodynamic characteristics at subsonic speeds. Based on the results of mathematical modeling, the illustrative explanation of the observed phenomenon is given.

Key words: heat exchange, aerodynamic characteristics, calculation, experiment, wing.

E. A. Dubovikov

Influence of composite wing elasticity parameters on structure weight

A new algorithm for a composite wing optimization procedure is presented, with account taken of constraints on structure elasticity characteristics. The optimal strength and stiffness parameters of the composite wing are determined by using the analytical beam model of the wing and the parametric finite element model of the airframe structure. At the first stage, the problem of weight optimization is solved by the classical beam model. The obtained optimal values of stiffness parameters are transferred to the data base of the FEM model. Additional constraints on the finite elements stiffness are based on these values. According to the calculations these constraints are active for the lateral parts of the wings. Then the classical problem of determining the optimal structure parameters is solved by the FEM model to satisfy minimum weight criteria. The use of this algorithm at the initial stage of designing allows us to substantially reduce the time-consuming calculations and obtain the reliable estimates of the elasticity effect on the structure weight in terms of linear FEM models.

Key words: aeroelasticity, composite wing, two-model approach, structure weight, finite element model.

N. E. Zubov, E. A. Mikrin, S. S. Negodyayev, V. N. Ryabchenko, A. B. Lapin

Synthesis of control law for spacecraft optimal pole placement

We consider the problem of spacecraft orbital stability. The method provides the solution of the optimal pole placement of a closed system. Using this method, the synthesis of control law with feedback for the orbital stabilization of the spacecraft is realized.

Key words: orbital stabilization of spacecraft, feedback, optimal pole placement, decomposition, orthogonal zero divisor.

A. I. Milanich, A. A. Baranov

The limit of resolution in optics

This paper discusses quantum and classical limits of resolution in optics. The corresponding limits of optical resolution are estimated. Possible methods for enhancing optical systems resolution are analyzed. The quantum-mechanical aspect of limiting resolution for optical systems is considered and it is about 10 times smaller than the classical limit. Applicability of the Huygens-Fresnel principle to numerical simulations is considered too.

Key words: diffraction, resolution, optical systems, quantum-mechanical limit, optics, Huygens-Fresnel principle.

V. L. Semenenko

Parametric instability in a double-carbon-nanotube nanoelectromechanical detector of modulated terahertz radiation based on two parallel carbon nanotubes

In this paper, we investigate the conditions for excitation of parametric instability in a resonant detector of modulated terahertz radiation based on a system of two coupled (plasma and mechanical) resonators that are a quarter-wave two-wire line section of two identical elastic nanotubes with metallic conductivity. Continuous plasma and mechanical resonators reduce to lumped coupled oscillators. The threshold value of the variable potential amplitude applied to the system under which the parametric instability arises is calculated.

Key words: carbon nanotube, plasmon, terahertz radiation, parametric instability, detector.

A. A. Shcherbakov, A. Yu. Vasil'ev, A. V. Tishchenko

Generalized source method in three-dimensional reciprocal space

The generalized source method of rigorous solutions to the light scattering and diffraction problems is formulated for the basic solution as a homogeneous isotropic medium Green's function in three-dimensional Fourier space. We obtain equations allowing us to formulate a numerical method of linear complexity with respect to the number of calculation mesh nodes. Possible applications of the method are discussed.

Key words: generalized source method, light diffraction, photonic crystal, Fourier transform.

A. S. Rukhlenko, O. A. Dudchenko, K. E. Zlobina, G.Th. Guria

Threshold activation of blood coagulation as a result of elevated wall shear stress

The processes of blood coagulation cascade activation in stenosed vessels are investigated in a wide range of Reynolds numbers ($Re \in (50, 350)$). In regions of high wall shear stress the vessel wall permeability increases. This leads to the infiltration of procoagulants into a blood flow and blood coagulation activation. The results of numerical simulations demonstrate that the blood coagulation cascade can appear not only as a result of the blood flow rate decrease, but also as the activation result of its increase. The relevance of obtained results to clinical practice is discussed.

Key words: mathematical modeling, blood coagulation, wall shear stress atherosclerosis.

S. V. Trankov, Y. V. Yavorsky, M. Borodovsky

Analysis of the effectiveness of a family of GeneMark algorithms for the genomes annotation

In this paper, we critically survey a family of GeneMark algorithms used for automatic annotation of new prokaryotic, particularly, bacterial genomes without using comparisons (alignment) with known genes and proteins. It is shown that the GeneMark algorithm is arguably the best among others in the class of ab initio gene prediction algorithms. Still, the algorithm could be improved by a more in depth consideration of the regulatory sites located near translation initiation sites as well as by taking into account the local variations of the genomic GC composition frequently related to events of horizontal gene transfer from other microbes.

Key words: GeneMark, genome annotation, bacterial genome, family of algorithms, Hidden Markov Model, Viterbi algorithm.