Summaries of all articles

O. V. Animitsa, A. M. Gaifullin, A. A. Ryzhov, Yu. N. Sviridenko

Modelling in-flight refueling of an aircraft on a flight simulator

Mathematical modeling of aircraft's dynamics at in-flight refueling is studied taking into account the influence of a jet-vortex wake from the tanker. Single-type fighters are considered as the receiver aircraft and the tanker. The aim of this research is to create an online mathematical model to be used as part of flight simulator's software. The article presents methods of mathematical modeling for determining aerodynamic forces and moments that influence the receiver aircraft in the wake of the tanker. A detailed example of modeling the aircraft's automatic approach to the basket is developed to test the model and demonstrate how to incorporate it into flight simulator's software.

Key words: flight simulator, vortex wake, mathematical modeling, Navier-Stokes equations, artificial neural networks.

A. A. Balashov, G. N. Dudin

Flow along a plate in the regime of strong interaction in the presence of mass transfer

The flow in the boundary layer on a plate is investigated on the regime of the strong interaction in the presence of mass transfer on the surface. The systems of nonlinear differential equations for viscous and inviscid areas of the flow are deduced and solved collectively. The eigenvalue dependence on the plate's temperature, the adiabatic exponent, injection speed is studied. The strong influence of injection on the distribution of disturbances upstream in the boundary layer is identified.

Key words: hypersonic flow, strong interaction, mass transfer, temperature factor, eigenvalue.

I. S. Bosnyakov, A. A. Kornyakov, G. G. Soudakov

Carrier vortex wake calculations including ship motion, pitching and gradient surface wind effects

Calculations of the perturbed velocity field and induced turbulence due to the motion of the ship and its pitching in the atmospheric surface layer based on gradient wind are presented in this paper.

Key words: vortex wake, wind profile, ship, pitching, induced turbulence.

V. V. Vyshinsky, V. C. Ivanov, A. V. Terpugov

Simulation of difficult flight regimes on a flight simulator with account taken of the atmospheric turbulence effect

The brief description of the modified dynamic model of MiG-29K aircraft developed for RSC «MiG» simulating complex is presented in the paper. The model takes into account the natural and artificial atmospheric turbulence influence on the aircraft during difficult flight regimes execution.

Key words: orographic turbulence, flight safety, flight simulator, aviation risk factors.

V. V. Vyshinsky, Yu. S. Mikhailov

Aerodynamic characteristics of an aircraft during take-off and landing in rotor turbulence conditions

The iInfluence of rotor turbulence from the following aircraft and mountains landscape on the light aircraft model in landing and take-off configurations is investigated experimentally. The simulation of vortex structures in the wind tunnel test section is executed by a two-section wing with a differential deflection of the sections.

Key words: Keywords: rotor turbulence, flight safety, wind-tunnel experiment.

K. A. Zudov, M. A. Kudrov, V. V. Vyshinsky

On the flight operating safety in the mountainous zone airport

The necessity of the wake vortex turbulence (vortex wind structures behind the relief) simulation demonstrated. The essential problems needed to be solved within this project are marked. The main troubles of solving these problems are noted too. The experience the authoring team possesses is epitomized. The algorithm of the three-dimensional triangulated grid generation on the basis of the two-dimensional altitude map, also the method of the generated grid export into the ANSYS CFX data format is considered. The results of the computational simulation of the air flow on the prescribed relief in the predetermined conditions are demonstrated.

Key words: flight operating safety, wake vortex turbulence, trailing vortex, mountain relief, computational simulation.

R. M. Murzagalin, V. M. Kuvshinov, A. N. Vlasov

Development of control system algorithms for flying wing airplane

Development of control system algorithms for a flying wing aircraft A flying wing aircraft is studied. The mathematical model of the aircraft in MATLAB/Simulink is considered for analysis of dynamic characteristics. We also propose a method for selecting directional control system parameters of the aircraft with $m_y^\beta > 0$ based on assurance that the required speed of splitting eleven (SE) $\dot{\varphi}_{required}$ is minimal. Various ways of possible parameter $\dot{\varphi}_{required}$ reduction by computation influence are considered. The valuation of fineness loss for SE is realized.

Key words: flying-wing, synthesis of control systems, flight control system of directional mod, control system of flying wing.

A. A. Khokhlov, C. D. Bukharov

Naval and sea-based aircrafts under conditions of irregular perturbations on takeoff and landing regimes

Flight dynamics of the naval and see-based aircrafts is estimated under conditions of irregular perturbations typical of takeoff and landing regimes. The flight regimes are described and perturbations are analyzed. The new method is suggested to assess the aircraft dynamics during takeoff and landing. As basic characteristics, it is proposed to use the dynamic spectrum of the aircraft motion parameters as well as the control actions of the pilot. A typical example of these assessments is given.

Key words: flight safety, ship-based aircraft, sea-based aircraft, seaplane, takeoff, landing, seaworthiness, dynamics of flight, flight tests, spectral analysis.

E. M. Gabidulin, A. A. Grigiriev, N. I. Pilipchuk, I. Yu. Sysoev, A. V. Urivskiy, A. L. Shishkin

Subspace and rank codes – new trends in coding

Comprehensive analysis of present-day research status in new areas of coding theory concerning rank and subspace metric codes is given. Close relations between subspace and rank codes are revealed. Known tight upper bounds on code cardinalities and known constructions of optimal or almost optimal codes are presented. Encoding and decoding algorithms are discussed.

Key words: network coding, space-time coding, rank metric codes, subspace metric codes.

E. M. Gabidulin, N. I. Pilipchuk

Efficiency of subspace network codes

We consider two constructions of subspace network codes. One of them is Silva–Koetter–Kshishang codes (SKK-codes), the other is multicomponent codes with zero prefix (MZP-codes) by Gabidulin–Bossert. We get optimal parameters for MZP-codes and deliver the bound of cardinality. We analyze cardinality of these codes and compare them with the known upper bound of cardinality on subspace network codes. We show that cardinality of MZP-codes is higher than cardinality of SSK codes with any parameters. It can be considered as the improved lower bound of cardinality on subspace network codes.

Key words: rank codes, subspace code, cardinality, code distance, dimension, multi-component codes

A. I. Kolybelnikov

Comparison of statistical properties of asymmetric ciphers keys

The problem of formation of a statistically reliable sequence for information of the line code key from keys of asymmetric codes is considered.

Key words: Protection of information, ciphers, random number generator, statistical security.

A. E. Polyakov, A. S. Kuzmenkov, L. V. Srygin

PLL frequency synthesizers based on DDS in a feedback loop

This paper discusses the advantages and disadvantages of the one-loop PLL architecture based on the DDS in feedback loop. It presents mathematical model of phase noise sources with equations for its estimation taking into account the performance of present-day components. The paper also presents a spur-reducing approach based on the variable reference frequency. The equations for evaluating bad frequencies and spur offsets are given. As a measure of spur, the empirical cumulative distribution of $SFDR$ normalized to 1 GHz is used. It allows us to evaluate and compare the quality of different synthesizers regardless of their frequency range. Synthesizers with single and dual frequency reference are compared using this measure. The paper also considers the locking process of PLL based on DDS in the loop.

Key words: PLL, DDS, phase noise, spur, $SFDR$.

T. S. Babicheva

Numerical methods for modeling of traffic flows in research and optimization of traffic at signal-controlled road intersections

This article describes numerical methods of mathematical modeling of traffic flows to meet the challenges of optimizing the traffic light phases at signal-controlled road intersections. The flow of vehicles on multilane roads is described by the Poisson process. The paper introduces, justifies and calculates the «effective number of lanes»concept, characterized by a maximum flow of vehicles with different phases of traffic lights.

Key words: Transportation network analysis, traffic simulation, traffic flows, multilane roads, traffic lights, signal-controlled road intersections, optimization, distributed computing, computational science.

K. A. Rybakov

Optimal control of stochastic systems with impulses

The problem of optimal control of nonlinear stochastic systems given by Itô stochastic differential equation with a jump component, which describes the effects of random impulses, is considered. It is assumed that the time intervals between successive impulses can be described by mixed Poisson and Erlang distributions. Incomplete information on the state vector is used for control.

Key words: impulses, incomplete information, extension principle, optimal control, stochastic system, erlang process.

A. V. Shevchenko, I. V. Tsybulin, Y. I. Skalko

An optimization algorithm for solving the phase equilibrium problem

In the numerical simulation of multicomponent flows in many cases it is necessary to consider the possibility of phase transitions. In this paper, we deal with the phase equilibrium problem for mixtures of several components characteristics for hydrocarbon deposits (water, light and heavy oil). We assume that the phase equilibrium conditions are described in terms of the distribution coefficients (phase equilibrium constants). The phase equilibrium problem is to determine in what phases the mixture splits, their compositions and mole fraction, and the temperature, knowing molar concentrations of all components, pressure and molar enthalpy of mixture. We construct an algorithm which consistently solves problems of this kind on the basis of the method of logarithmic barriers. The comparison of the developed algorithm with its «standard» analogue is made.

Key words: phase equilibrium, method of logarithmic barriers, Gibbs potential, mathematical modeling.

A. M. Perepukhov, O. V. Kishenkov, L. I. Menshikov, A. V. Maximychev, D. A. Alexandrov

Development of the effect of anomalous diffusion in pore liquids

NMR methods are used for studying the effect of pore sizes on the nature of mass transport phenomena in porous media on an example of densely-packed granular porous media formed by glass beads. The relaxation of proton magnetization is studied in homogenous and gradient magnetic fields osing the Carr-Purcell-Meiboom-Gill pulse sequence with varying interpulse time intervals τ. It is found that if pore sizes are $d_P < 10\ \mu m$, the expression of the rate of the transverse relaxation of the proton magnetization contains a term, which is linearly increasing with the increasing τ and if $d_P > 10\ \mu m$ holds, the dependence becomes quadratic as in a normal bulk liquid. The theoretical calculation of the effect is given. It is shown that if $d_P < 10\ \mu m$, the super-diffusion occurs. the superdiffusion occurs. The molecules move along the bead surface due to short-time jumps to the bulk of liquid («bulk mediated surface diffusion»).

Key words: NMR, CPMG, relaxation, porous media, pore fluid, transport phenomena.