CONTENTS AND ABSTRACTS

MATHEMATIC AND SOFTWARECOMPUTER SYSTEMS AND COMPUTER NETWORKS

D. A. Perepelkin, A. N. Saprykin, M. A. Ivanchikova, S. S. Kosorukov. DEVELOPMENT OF SOFTWARE FOR BUILDING A DISTRIBUTED CLOUD DATA STORAGE OF AN EDUCATIONAL INSTITUTION

Key words: distributed computing, cloud computing, data storage, cloud platform, software component.

The increasing of number of devices connected to the Internet, the exponential growth of information volumes, the development of network and cloud technologies are the latest trends that are changing all areas of activity. The aim of the work is to develop a software component for building a distributed cloud data storage of an educational institution. Architecture and software tools for distributed processing and storage of data owned by users of the cloud platform of educational institution are proposed. Main class diagrams of the developed cloud platform and the principles of interaction of its main components are described in detail. The functioning and the peculiarities of building a network infrastructure of the developed cloud platform for distributed data storage are considered. Cloud platform proposed in the work implements a modular principle of interaction, allowing us to quickly connect and deploy new digital services through the use of a wide range of software components and open APIs.

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A. N. Ivutin, A. G. Troshina. PETRI-NET BASED METHOD OF PARALLEL PROGRAMS FORMAL VERIFICATION

Key words: Petri net, parallel program, equivalence of the nets, verification, semantic relations.

The problem of parallel programs formal verification using mathematical apparatus of the theory of Petri nets is considered. The aim of the work is to formalize methods of parallel program analysis to automate their verification. Correct source sequential program code requires additional verification in connection with the distribution of commands and operations between parallel threads, their coordination and synchronization. The result of incorrect conversion of sequential code to parallel is unpredictable behavior of the program. Thus, the main objective of the work is the development of verification methods, as well as error correction in parallel programs. Based on the theory of Petri nets with additional semantic relations, theorems on the equivalence of parallel and sequential algorithms are formed and proved, error correction methods in parallel algorithms are developed.

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S. A. Lesko, **D. O. Zhukov**, **A. S. Aleshkin.** STOCHASTIC MODEL OF BLOCKING OF COMPUTER NETWORK WHEN GENERATING AND TRANSMITTING LARGE MALICIOUS TYPE DATA

Key words: generation and transmission of big data of malicious type; network nodes blocking; transition diagram; stochastic dynamics of nodes blocking; percolation threshold of network; network density.

This article deals with the problem of predicting networks failures during generation and transfer of large amounts of malicious data. The aim is to construct a stochastic model of blocking information-computing networks in the formation of big data of malicious types. Rapid development of Internet of Things (IoT) leads to the emergence of tens and hundreds of millions of new devices with their IP – addresses in a short time in the global network that, in case of infection, can form large scale malicious networks (botnets). A model created on the basis of probability diagram of transitions between possible states (share of infected devices) of computer network, describing the logic of processes taking place is described. Based on the approach used, a non-linear differential equation of the second order is developed, allowing us to formulate and solve boundary tasks to determine the dependence on time of probability density functions to observe a certain state of the system. The model created allows you to estimate the time to reach the state in a computer network with a limit on proportion of potentially infected devices or, for example, reaching a threshold of its percolation. A percolation threshold is a minimum proportion of blocked nodes, in which the entire network as a whole loses the properties of information transmission (there is no free path between any randomly selected nodes). Using a percolation theory approach it was possible to link structurally-informative characteristics of networks, such as dependence of their percolation threshold on the average number of links per node (network density) with dynamic characteristics of their blocking (time to reach a percolation threshold). Comparison of theoretical calculations based on the created model with actually observed dynamics of virus epidemics such as Code Red, Nimda, Sapphire/Slammer and Conficker showed that the created model describes recorded epidemics very well.

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P. S. Drugov, E. E. Usina. A SPECIALIZED METHOD OF TEXT RECOGNITION FOR AUTOMATIC PROCESSING OF PASSPORT DATA

Key words: text recognition, OCR, Tesseract, optical character recognition, OpenCV, image processing, domestic passport, smart environment.

Smart environments, being developed for further implementation within existing enterprise architectures, require a crucial prerequisite to be met: adding of identity data of new visitors into enterprise database. The aim of this paper is to develop a method for text recognition on the pages of internal passport of the Russian Federation. The aim of the developed method presented here consists in the processing of page content (on the example of Russian internal passport) including, particularly, the following operations: image magnification, object (passport page) segmentation, image processing with filters and text recognition. To test the method a vertical stand with space for placing a document on top was designed accompanied by a relevant source code in Python programming language. The tests performed within this research revealed, that the highest success rate in text recognition is achieved when the distance from a camera to a document is 250 mm (88,8 %); whereas by camera focus adjustment and distance increase the recognition outcomes were significantly worse, 66,7 % and 22,2 % respectively. Implementing such solution into enterprise operation would allow avoiding human mistake factor in data transfer (caused by poor attention or fatigue of employees) and to optimize the input of customer data into database.

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INTELLIGENT INFORMATION SYSTEMS AND TECHNOLOGIES

V. V. Martynov, A. I. Salimova, D. N. Shavaleeva. FORMALISM OF ENTERPRISE ARCHITECTURE DESIGN IN TERMS OF SET THEORY

Key words: Enterprise Architecture, EA, enterprise information architecture, metrics, measurement, design, representation, business processes, business systems, architectural views.

The article deals with the formation of rational enterprise architecture. The description of existing approaches to the creation of EA structures, which, in turn, are aimed at the development of models and appropriate solutions for implementation, but have no strict formal metric representation, is presented. The complex of metrics to describe and measure enterprise architecture is offered. With the help of set theory, enterprise architecture is represented as a tuple of 8 elements, which includes sets of requirements, business processes, business systems, data elements, applications, technologies, constraints and business rules, as well as a set of indicators and their values. The set of main components of enterprise architecture is defined and indicators of their measurement are set. The introduced formal bases allow us to compare different variants of enterprise architecture as well as to make a rational choice according to certain criteria. In perspective, it is necessary to develop a set of invariant indicators being in several architectural representations, to be used in the analysis of compromise solutions for EA measurement.

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K. V. Bukhensky, A. N. Konyukhov, A. B. Dubois, A. S. Safoshkin. A RAPID ALGORITHM OF FUZZINESS INDICES CALCULATION FOR UNIMODAL LR-TYPE FUZZY NUMBERS

Key words: fuzzy set, membership function, LR-type fuzzy number, measure of fuzziness, fuzziness index, fuzzy inference system.

The aim of the work is to design rapid algorithm of fuzziness indices calculation for unimodal LR-type fuzzy numbers (FN). The sphere of application: fuzzy inference systems for devices using fuzzy control. The formulas of four known indices for fuzzy sets (FS) with discrete support were extended to continuous case. The table of fuzziness indices values for most commonly used sample FS described by their membership functions was calculated. It was shown that indices values appeared to be specific for each sample set and independent of FS's support length. Revealed properties of indices made possible to design a simple algorithm of fuzziness indices calculation for unimodal LR-type fuzzy numbers. It uses the table of indices and evaluates contribution of shape functions weighted by support length to overall fuzziness. The approach is also applicable for the solution of inverse problem of forming fuzzy number with predefined index of fuzziness value.

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A. S. Alyoshkin, D. O. Zhukov, S. A. Lesko. INFLUENCE OF TRANSPORT NETWORK CONNECTIONS DENSITY ON THEIR CONDUCTIVITY WHEN BLOCKING NODES AND COMMUNICATIONS

Key words: transport network, network link density, network percolation threshold, increased reliability, increased throughput.

The aim of the work is to demonstrate the study of reliability and fault tolerance in the operation of transport networks using methods and approaches of percolation theory.

Ground transportation infrastructure can be represented as a planar or almost planar graph. For a real transport network, almost planarity will be associated with the presence of overpasses and multi-level interchanges. In the theory of percolation, we consider the solution of problems to find the shares of blocked nodes and blocked connections, in which they break up into unrelated areas, that is, they lose the property of transmitting road traffic. The fraction of non-blocked nodes (in a node problem) or unbroken bonds (in a connection problem), where conductivity arises between two arbitrarily selected network nodes, is called percolation (flow) threshold. A percolation threshold value depends on the average number of connections per network node (density), and is a criterion for reliable operation. Real transport networks have a topology closer to random networks than regular structures. Blocking threshold for regular networks is generally higher than for planar networks constructed at random. With the same network density, a random planar network (if possible loss of performance) is only slightly inferior to regular structures. An increase in the density of transport networks communications increases their reliability and throughput. Using the map of city transport network, you can determine an average number of connections per node of such a network, and then calculate blocking threshold. Similar calculations can be used in design and modernization of road infrastructure in order to calculate the required number of additional links.

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A. V. Moiseev, A. Yu. Kindaev. ALGORITHM OF INSURANCE RATES MANAGEMENT IN CONDITIONS OF INCOMPLETE INFORMATION

Key words: management algorithm, insurance rate, effective management, risk, correlation, dependent and independent data.

The problem of optimal control in the conditions of insufficient statistical information for decision-making is considered. The aim of the work is to build an algorithm for managing the insurance rate in the conditions of incomplete information. Statistical data are collected for 4 regions of the Volga region (Saratov, Penza, Ulyanovsk and Samara) on yields of such crops as: winter wheat, spring wheat, spring barley and winter rye for the period from 1980 to 2015 in the context of municipalities. The cluster analysis of municipalities on productivity of agricultural crops for allocation of clusters is carried out. On the basis of correlation analysis the objects of insurance field with pairwise independent indices of productivity and high dependency in crop cultivation are singled out. The algorithm of portfolio management including both objects of insurance being pairwise independent on the yield as well as the objects with a significant share of interconnectedness is proposed. The portfolio constructed in this way takes into account correlation of losses under individual contracts when calculating the risk, which will help to increase the stability of insurance company.

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RADIO ENGINEERING AND COMMUNICATION SYSTEMS

S. M. Kadantcev, P. A. Kazak, N. S. Korzh. IMPLEMENTATION OF THE PYNDIAH-CHASE ITERATIVE DECODING ALGORITHM FOR HAMMING BLOCK TURBO CODES

Key words: iterative decoding, Hamming code, block turbo code, noise immunity, decoding algorithm, Pyndiah-Chase algorithm, SNR, likelihood ratio, soft decisions, suboptimal algorithm, 4FSK modulation, DMR standard, digital radio.

The work studying noise immunity of Hamming block turbo code (195,99) for the case of its application in the standard of digital radio mobility DMR is carried out. We focus on the processes of channel decoding, the formation of symbolic array, as well as iterative decoding of signal-interfering mixture of adopted implementation. Special attention is paid to the subject of probabilistic determination of bit solutions with non-trivial signal-code construction. The relevance of the study is dictated by the need of a comprehensive study of DMR signal noise immunity. The aim of the work is to describe the features of soft 4FSK signal reception procedure using a logarithm likelihood ratio, compare decoding results of code structures using Pyndiah-Chase algorithm with an algebraic syndromic method, determine the optimal number of turbo code decoding operations in low SNR.

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D. S. Bogdanov, I. A. Bogdanova, A. N. Volnykin. RADIATION TOLERANCE OF AN ELECTRONIC DEVICE UNDER EXPOSURE TO SPACE RADIATION

Key words: radiation tolerance, total irradiation dose (TID), TID effects, single event effects (SEE), Van Allen radiation belt, solar energetic particles, high energy protons, HZE particles, single event upset (SEU), failure rate.

The article gives an examination of estimation routine for fulfilling requirements to radiation tolerance of an onboard electronic device under exposure to space radiation. The article aims to conduct an example of estimation procedure of radiation tolerance and its correspondence to given requirements (for TID and SEE). The article also aims to reveal certain estimation aspects which are to be corrected. The article shows an example of practical application of estimation methods for correspondence of calculated values and given requirements for such types of ionizing radiation as: electron and proton flows of Van Allen radiation belts, solar energetic particles, HZE particles and high energy protons. The article gives several examples of components which are potentially sensitive to space radiation. For these examples the article shows possible hardening measures. The conclusion shows the necessity and sufficiency of exact actions.

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SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING

S. V. Spitsyn, A. V. Tovpeko, S. A. Tikhomirov. ALGORITHM FOR TRAJECTORY MEASUREMENT PROCESSING WHEN CARRYING OUT ROCKET LAUNCHES

Key words: information and measurement support of launches, system of measurement information collection, onboard navigation consumer equipment, TMI.

A generalized algorithm to process and present digital trajectory parameters of onboard navigation equipment which is used to conduct rocket tests (field tests) is considered. The aim is to find a generalized algorithm to process digital parameters of on-board navigation equipment (BNAP) which is used in field tests of complex rocket and space technology products. The algorithm contains the stages of parameters preprocessing, digital parameter codes convertation into physical units, forming output BNAP structures, stages of primary and secondary values determination needed in trajectory problem solution, and also the stage of forming of unified digital trajectory measurements representation flow which is used to transfer BNAP parameters processing results to graphical representation environment.

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E. R. Muratov. SCALING OF GROUND TRUTH FOR STEREO TASKS

Key words: depth maps scaling, downsampling ground truth, dense depth map, depth map accuracy, BAD error estimation metric, image scaling, scaling algorithms comparison.

The article proposes an algorithm for reducing the resolution of depth maps and ground truth, estimating and comparing error metrics resulting from a reduction size of ground truth and images for various scaling algorithms. The aim of the work is to estimate the accuracy of scaling ground truth by the proposed algorithm. The need for scaling stereo dataset arises in the task of obtaining data sets with uniform parameters of a stereo system, one of which is sensor resolution, from existing different of stereo datasets. A generalized data set with the same parameters of stereo system is required for designing more accurate hybrid stereo vision algorithms with the elements of artificial intelligence.

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S. L. Blumin, N. Yu. Zhbanova, S. A. Zhbanov. FOUNDATIONS OF BASE MODELS` ADAPTATION TO ANALYZE FINITE FLUCTUATIONS

Key words: adaptive models, analysis of finite fluctuations, compressed regression, filtering, self-similar processes.

The article demonstrates well-known and new adaptive models and algorithms allowing to analyze processes in the systems with complex structure, and may be used as base models for analysis of finite fluctuations (AFF). The aim is to describe existing adaptive methods, and to design modification of Boyd method with idempotent metrics. The assessment of input finite fluctuations impact on output finite fluctuations being the basis for AFF is an actual problem related to the modeling of dynamic processes, that characterize complex technological and organizational systems. On the first stage we must design base models for AFF, via the research of considerated dynamic process. The promising way is to complete standard modeling methods of the least squares and least modules with regularization component, which allows including adaptive properties in the models.

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A. V. Bratulin, M. B. Nikiforov, A. I. Efimov. MODIFIED METHOD FOR REAL-TIME COMPUTING DENSE OPTICAL FLOW ON FPGA

Key words: optical flow, FPGA, video, pixel, correlation algorithm, criterion function, pattern, search zone, pattern window, absolute difference, pipeline, SAD, shift register.

One of the important problems in the field of vision systems is the problem of implementing the functions of detection and selection of moving objects on the video image of high definition in real time. These functions are implemented using the concept of optical flow. The article deals with the method of hardware calculation of dense optical flow in the rate of arrival of pixels on the basis of correlation-extreme algorithm on high-definition video image. The aim of the work is to develop a modified version of the method for calculating the dense optical flow based on the correlation-extreme algorithm in real time on a high-definition video image. This modified version of the method should have no less performance than the original, but it takes less hardware costs. A more optimal variant of the device of the unit for calculating the sums of absolute differences for each installation point of the standard window is proposed. This version contains a smaller internal memory size and fewer shift registers. The principle of parallelization and pipelining, which allows to minimize the amount of calculations, is con-

sidered in detail. Hardware costs are analyzed when implementing the method on XILINX zynq Ultra Scale + FPGA from the MPSoC zcu102 Evaluation Kit debug Board.

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PHYSICAL ELECTRONICS AND NANOELECTRONICS

V. A. Korotchenko, V. E. Skvortsov, V. K. Bazylev, V. V. Praded, A. M. Zhidkov. CREATION AND RESEARCH OF MINIATURE IONIZATION VACUUM GAUGE OF ORBITRON TYPE

Key words: orbitron vacuum gauge, numerical simulation, computer modeling, motion of electrons, residual gas pressure measurement.

A miniature ionization vacuum gauge of orbitron type was created and studied. Diameter and length of ion collector is 16 and 32 mm, of anode – 0,5 and 30 mm, filament – 0,07 and 9 mm. Anode- collector voltage is 300 V, filament-collector – (10 – 30) V. Numerical simulation of electron motion has shown that particles travel along anode at spiral-shuttle trajectory with radius (1 – 6) mm, step ~ 9 mm, time on turn ~ 5 ns, shuttle period ~ 30 ns. Motion time is about 7 μs, number of turn is about 1500, path length ~ 1000 cm. We have experimentally proved that created orbitron gauge permits to measure pressure of gases in the range vetween (0,1 – 20) μTorr at filament emission current 5 μA and sensitivity 2000 $Topp^{-1}$, being three orders of magnitude higher than for ion manometer PMI-2, having working volume essentially (in 2,5 time) less. Gauge high measurement limit has shown to increase to 7 mTorr if screen potential rises from zero to 100 V. The aim of the work is to create miniature ionization orbitron gauge with high sensitivity and experimentally estimate its test vacuum sensor characteristics.

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B. A Kozlov, Mai The Nguyen. ABOUT VOLUME DISCHARGE LOCALIZATION MECHANISM IN SMALL-SIZED SEALED-OFF TEA-CO_2 LASERS

Key words: volume discharge, field emission of electrons, TEA-CO_2 laser, resource, cathode surface microstructure, plasma-chemical reactions, chemical composition of working mixtures.

The structure of electrode surface and their auto-electronic characteristics were studied before exposure to volume discharge plasma and after a certain time of interaction with volume discharge plasma in atmospheric pressure CO_2 laser mixtures. It was found that under the influence volume discharge plasma, the microstructure of electrodes working surfaces and their field emission properties change. The mechanism of the pumping volume discharge localization as a result of local increase in field currents from cathodes surface is substantiated. The aim of this work is to establish the causes and possible localization mechanism of self-sustained volume discharge at atmospheric-pressure CO_2 laser mixtures under conditions of prolonged interaction of volume discharge plasma with working surfaces of electrodes.

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A. R. Semenov, M. V. Golovanova, V. G. Litvinov, D. G. Gromov, S. P. Oleynik, T. A. Kholomina, A. V. Ermachikhin. RESEARCH OF CHARGE TRANSFER MECHANISMS IN METAL-ZNO-SILICON HETEROSTRUCTURES

Key words: charge transfer mechanisms, heterostructure, ZnO, band diagrams, I-U-characteristics, C-U-characteristics.

Results of the study of charge transfer mechanisms in thin films of zinc oxide on the example of metal-ZnO-silicon heterostructures under the action of electric field based on experimental current-voltage and high-frequency capacitance-voltage characteristics were considered. Obtained results have shown the significant influence of surface defects and electron traps on electrophysical parameters and energy bands of Me/ZnO/Si based heterostructures. The aim of this work is to study charge transfer mechanisms of metal-insulator-semiconductor structures based on ZnO/Si heterojunction as well as to determine their band structures. ZnO films were grown by pyrolytic decomposition method at different annealing conditions. Electrical properties of the structures were studied by the methods of high-frequency capacitance-voltage characteristics and current-voltage characteristics.

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V. S. Bezkorovainyi, Y. V. Livcov, V. V. Yakovenko, N. A. Shatova. DEVELOPMENT OF MATHEMATICAL MODEL OF THE OUTPUT SIGNAL FORMATION OF FERROPROBE UNDER SINGLE-POLARITY PULSE EXCITATION

Key words: sensor, core, magnetic permeability, field winding, differential equation, conversion function, winding, signal polarity.

The article considers a mathematical model of the forming output signal of ferromodulation sensor using single-polarity pulse excitation. One of the main requirements upon applying ferroprobes as sensors of mechanical quantities (rotational speed, gears integrity, etc.) is noise immunity in the presence of a high level of electromagnetic interference. The aim of the article is to obtain conversion function of the sensor that allows you to determine the parameters of output signal and their dependence on the amplitude of excitation pulse, as well as on magnetic and geometric parameters of the cores. The results of numerical experiments indicate the possibility to increase conversion coefficient of the sensor with unipolar pulsed excitation. As a result, we make the conclusion that unipolar pulsed excitation of ferromodulation sensor can significantly simplify the circuit of excitation generator and the circuit of signal processing.

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