CONTENTS AND ABSTRACTS

RADIO ENGINEERING AND RADAR

V. G. Andreyev, V. A. Tran. PARAMETRIC SPECTRAL ANALYSIS OF PIECEWISE-STATIONARY RADIOENGINEERING SIGNALS

Key words: piecewise-stationary noise, non-stationary noise, weight vector, adaptive algorithm, autoregressive model, change-point, spectral estimation, power spectral density.

We proposed and investigated a method for the spectral analysis of processes when they are observed on the background of additive piecewise-stationary noise. The aim of the work is to increase computational efficiency of analysis algorithms and the accuracy of radio engineering signal spectral estimation on the background of piecewise-stationary noises. Based on the estimation of weight coefficient w_2 optimal value the method proposed makes it possible to take into account fragments of a piecewise-stationary random process distorted by noise in order to reduce the influence of non-stationary noise and improve the accuracy of spectral estimates. The qualitative indicators of modified spectral analysis method proposed are compared with conventional autoregression method. Experimental studies have shown that the method proposed makes it possible to reduce the discrepancy between control and estimated spectra by 4.1...6.9 times in comparison with the known methods of spectral analysis, in particular with the autoregressive method. When comparing efficiency with conventional autoregressive model, the decrease in the order of p can reach 2…2.5 times. It is confirmed that to analyze the spectrum of narrowband radioengineering signals studied, relative deviations ΔF of the estimate of dominant frequency are significantly (up to 5 times) reduced by using the proposed modified method in comparison with autoregressive method. Winnings are achieved through the use of a priori information about time-varying power of interfering process.

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D. V. Zhukov, O. V. Grigorieva, A. G. Saidov, K. A. Spesivtseva, E. V. Kharzhevsky. ALGORITHM FOR TARGET OBJECT ORIENTATION ON PRE-SEGMENTED IMAGES

Key words: decoding satellite images, pattern recognition, contour orientation, principal component method, wave skeletonization.

The article considers an original algorithm to unambiguously determine the orientation of a localized segment on a binarized image which ensures accurate combination of the contours in recognized image and in existing standard. This operation is important for successful application of methods for classifying artificial objects in images based on correlation and feature methods. The algorithm proposed consists of two stages. The first includes three consistently applied methods for determining the main segment axis: along its axis of symmetry; along the vector of the first main component; along the longest segment of the straight line obtained as a result of segment skeletonization. The second stage consists in choosing the direction of segment orientation along the axis, based on comparing contour sections related to conventionally upper and conventionally lower parts of an object, as well as identifying stable differences in them. The algorithm developed has been tested on objects of land, marine and aviation equipment and has shown stable operation with a linear resolution of shooting materials better than 3 m.

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S. N. Razinkov, A. V. Bogoslovsky, S. A. Gordienko. EXPERIMENTAL DETERMINATION OF RADIO EMISSION SOURCES LOCATION USING HIGHLY MOBILE DIGITAL DIRECTION FINDER DETECTOR

Key words: pilotless complex of monitoring, panoramic detector direction finder, assessment of location of an object, mean square error of direction finding.

Experimental studies of root-mean-square errors to determine the location of radio transmitters with fixed and programmable operating frequencies in the range of 30... 3000 MHz were carried out by multiple measurements of signal arrival directions by a digital direction-finding device located on board a highly mobile carrier at various points in space. Changes in accuracy of estimating the coordinates of objects under various modes of operation, types and parameters of radiation, as well as trajectories of detector-direction finder motion are investigated. Errors were found in determining the location of radio emission sources in conditions of high a priori awareness about the areas of deployment, when the motion of detector-direction finder is carried out along the routes in the form of arc with a 120° given maximum angle of bearing marking and closed trajectory of "box" type. The analysis of possibilities to minimize standard errors of radiators location during the movement of detector-direction finder along spiral with heading angle determined by variances of posterior estimates of signal arrival directions in adjacent turning points of route is carried out.

The aim of the work is to study the influence of types, frequency-time parameters of signals and operating modes of radio transmitters on the accuracy of estimating their location at various trajectories and elevations of highly mobile detector-direction finder above the ground surface.

It is shown that minimum root-mean-square errors of location, amounting to 2,2...8,4% of the range, were obtained for simulators of continuous radiation sources based on generators of standard signals with fixed frequency.

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MATHEMATICAL AND COMPUTER SYSTEMS SOFTWARE AND COMPUTER NETWORKS

K. I. Nikishin. MODELING OF TRAFFIC TRANSMISSION IN SOFTWARE DEFINED NETWORKS

Key words: Software Defined Networks, controller, switch, Ethernet, OpenFlow, Flow Table, time-outs, Petri Nets, CPN Tools.

Traffic and criteria management in Software Defined Networks (SDN) is performed by a controller in conjunction with a switch that operates using the OpenFlow protocol. The OpenFlow protocol is the main part of the SDN network. Thus, the OpenFlow protocol successfully allows to cope with the increased requirements for user traffic, priority. The aim of the work is to research and model the transmission of heterogeneous user traffic in the OpenFlow switch of SDN based on colored temporary hierarchical Petri nets and using CPN Tools modeling package. The objectives of the research are the development and construction of subnets for reading a given traffic, comparison with frame rules in flow tables, traffic classification and processing of subsequent actions with input traffic in the switch. The hierarchical model on Petri nets allowed us not only to investigate SDN network functioning and behavior, but also to investigate the proportion of lost real-time frames in a network, as well as latency.

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K. I. Nikishin. RESEARCH AND MODELING OF FLOW TABLE IN OPENFLOW SWITCH AND SOFTWARE DEFINED NETWORKS

Key words: Software Defined Networks, controller, switch, Ethernet, OpenFlow, Flow Table, time-outs, Petri Nets, CPN Tools.

Modern networks are becoming very cumbersome, the speed of traffic transmission over the network is required, and for these purposes Software Defined Networks (SDN) have been introduced. The main data transfer protocol in SDN networks is OpenFlow. The distribution of control and data in SDN networks is considered, data transmission from a controller via OpenFlow is described. The aim of the work is to investigate and research the OpenFlow protocol and switch, flow tables for correct transmission of frames in SDN net-works based on color time hierarchical Petri nets and using CPN Tools modeling package. The objectives of the research are to consider various formats of frames and flow tables, to develop algorithms for the functioning of flow table and moderating time characteristics of frame transmission through these tables, taking into account specified timeouts. The models allowed us to investigate the functioning of flow table as well as flow temporal characteristics in OpenFlow switch for further investigation of heterogeneous traffic transmission in SDN networks.

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L. A. Demidova, P. N. Sovietov, A. V. Gorchakov. CLUSTERING OF PROGRAM SOURCE TEXT REPRESENTATIONS BASED ON MARKOV CHAINS

Key words: source code analysis, program code analysis, clustering algorithms, Markov chains, cluster profiling, abstract syntax trees, online education.

Static analysis of program sources using machine learning algorithms has been successfully applied to solve a number of common problems, including the search for duplicate code fragments, intelligent generation of hints, and the search for plagiarism. The aim of this study is to develop a method for clustering software solutions to typical tasks sent through the web interface of Digital Teaching Assistant (DTA) system to identify and analyze the most common approaches to solving the tasks. Notably, it is necessary to take into account the peculiarity of DTA system, in which each student receives unique automatically generated variants of typical tasks. The method proposed for preliminary transformation of program sources into vectors based on Markov chains for abstract syntax trees allows taking into account the mentioned peculiarity of DTA system and performing clustering based on the approaches used to solve the tasks, not based on task variants. The application of the developed method made it possible to assess the gaps in skills and knowledge of students of the RTU MIREA Python programming course in spring semester 2022.

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MATHEMATICAL MODELING

E. N. Evdokimova, M. V. Kupriyanova, I. P. Soloviova, I. P. Simikova. MATHEMATICAL MODELING OF DIGITALIZATION PROCESS IN ECONOMIC SYSTEMS

Key words: mathematic modelling, digitalization, an economic system, the Cobb-Douglas production function, the technological paradigm, the Solow model.

The article is focused on the problem of applying mathematical and instrumental methods of modelling the digitalization process. The aim is to develop a mathematic model of digitalization in economic systems. The key idea is to apply the multiplicative production function to analyze and forecast dynamics of economic development under the

conditions of digital processes. The economic and mathematic model of the digitalization process is presented in the form of a system of algebraic-differential equations based on the Solow model. The mathematic model served as the core for a computer simulation model. Tested on historical data, the simulation model has proved the hypothesis that digitalization of the manufacturing sphere works as a positive factor in the economic, social, and ecological aspects.

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PHYSICAL ELECTRONICS AND NANOELECTRONICS

M. V. Dubkov, M. A. Burobin. INVESTIGATION OF THE INFLUENCE OF COMPONENTS HIGHER ORDERS OF POTENTIAL DISTRIBUTION ON THE CHARACTERISTICS OF THE QUADRUPOLE MASS FILTER WHEN WORKING IN THE SECOND STABILITY ZONE

Key words: quadrupole mass filter, higher-order components, mass peak, resolution, intensity of mass peak, quality factor.

The features of the operation of a quadrupole mass filter when operating in the second stability zone in the presence of higher-order components in the potential distribution are studied. The aim of this work is to study the influence of various higher-order components on the analytical characteristics of a quadrupole mass filter when operating in the second stability zone. The dependences of the resolution, mass peak intensity, and quality factor on the magnitude of the higher-order component of the potential distribution were studied by means of numerical simulation. It is shown that the introduction of small symmetrical distortions of the electrodes, leading to the appearance of the corresponding higher-order components in the potential distribution, makes it possible to improve the shape of the mass peak, increase the magnitude of the peak shape factor, and improve the isotopic sensitivity of the quadrupole mass filter.

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A. N. Vlasov. ON ADDITIONAL INDUCTION HEATING OF PLASMA IN PULSED PLASMATRON

Key words: pulsed plasmatron, electric explosion of metal, quasi-spark discharge, induction discharge, plasmoid, autonomous plasma formations.

The possibility of additional induction heating of plasma in a pulsed plasmatron with induction discharge containing semi-open cylindrical chamber in which a cathode and an anode are installed near the ends and electrically exploding copper wires are located near the side wall. The operating principle of plasma torch is based on the creation of dense plasma between cathode and anode during electric explosion of wires, because of which quasi-spark discharge is formed, creating pulsed toroidal magnetic field that excites main induction discharge. Additional induction plasma heating is carried out by means of additional induction discharge excited by pulsed poloidal magnetic field created by exploding copper wires installed at some angle to the side wall of a chamber. It has been experimentally shown that with this method of energy input into plasma, a short-lived plasmoid is formed, after the explosion of which autonomous plasma formations with abnormally long afterglow time of 75 ms arise. The aim of the work is to evaluate the parameters of polar magnetic field required for additional plasma heating in a pulsed plasma torch with induction discharge, and to experimentally verify the operability of layout for such pulsed plasmatron.

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V. K. Bazylev, V. A. Korotchenko, A. M. Zhidkov. WIDE-RANGE PRESSURE GAUGE CONVERTER BASED ON ELECTRON SCATTERING GAS MOLECULES

Key words: pressure gauge converter, gas pressure, electron scattering, crossed electric and magnetic fields, photocathode, modeling.

The results of studying wide-range gauge converter based on electron scattering by gas molecules in crossed electric and magnetic fields are presented. The converter is made in the form of a cylindrical magnetron, in which the electron source is located on one of the end electrodes. A tungsten thermocathode or photocathode based on a gallium film, resistant to air at atmospheric pressure, was used as an electron source, which emitted electrons under the action of ultraviolet radiation from LED with wavelength of 265 nm. The pressure measure was the current of electrons scattered by gas molecules and collected by the anode. The electrons that did not experience scattering were captured by a special collector. The results of modeling the motion of electrons in a converter are presented. Experimental dependences of anode current on nitrogen pressure are obtained, which mainly correlate with the calculated ones, correspond to theoretical concepts and confirm the possibility of measuring gas pressure in a wide range from 10^{-7} Torr to 760 Torr.

The aim of the work is to create a pressure gauge converter for pressure range of 10^{-7}–760 Torr, based on the scattering of electrons by gas molecules.

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