

CONTENTS AND ABSTRACTS

RADIO ENGINEERING AND COMMUNICATION SYSTEMS

L. V. ARONOV. VERTICALLY ORIENTED UNDERWATER WIRELESS OPTICAL TELECOMMUNICATION CHANNEL

Keywords: underwater optical wireless communication channel, optical wireless communication, free space optic, underwater communication, optical communication line.

This article examines the issue of transmitting a video data stream in real time. The aim of the work is to analyze the vertical profiles of phytoplankton and take into account their impact on energy budget of vertically oriented underwater wireless optical communication channel. As a result of the work, vertical profiles of total attenuation have been obtained for water with surface turbidity of 0.4 mg/m³ and 3 mg/m³. The magnitude of the attenuation at the depth with maximum concentration of phytoplankton differs by 6 times. Simulation has shown that when using NDB4116 laser LED with a radiation power of 100 mW as an optical transmitter, the depth at which the received power falls below maximum photodetector sensitivity ranges from 12 to 70 meters at given turbidity. At the same time, the use of PCM allows the transmission of a video data stream at a speed of 4 Mbit/s to the depth of 9 to 39 meters.

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V. A. BELOKUROV, Q. T. NGUYEN. CALCULATING THE PARAMETERS OF STABILIZATION SCHEME OF FALSE ALARM LEVEL BASED ON ORDER STATISTICS

Keywords: order statistics, false alarm probability, logical scheme.

An algorithm for calculating the parameters of false alarm level stabilization scheme based on order statistics with the choice of «higher value» or «lower value» when segmenting the sorted array is proposed and investigated. The aim of the work is to derive an analytical expression for the dependence of false alarm probability on algorithm parameters, which determine the numbers of ordinal statistics, at each stage of sorting and entering «higher value» or «lower value» logic circuit. An analysis of obtained dependencies shows that the use of segmentation of a sorted array with two stages of sorting leads to difference in threshold signal-to-noise ratio from 0.6 dB to 1.1 dB compared to the algorithm for stabilizing the level of false alarms based on the use of order statistics without segmenting the sorted array. This provides a gain in the number of computational operations from 6,5 to 22 times when choosing sample size $M = 64$.

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V. E. DRACH, N. V. SAMBUROV, I. V. CHUKHRAEV. A MATHEMATICAL MODEL TO ANALYZE THE EFFICIENCY OF MOVING TARGETS INDICATION AND DETECTION

Keywords: mathematical model, MTI, MTD, radar station, passive interference, passive interference suppressor, hydrometeors, frequency selection, selection of moving targets, vector filter, doppler filter.

A mathematical model that uses a differential approach to assess detection quality in a wide range of target Doppler velocities is proposed. Based on the model, the authors consider complex efficiency of MTI and MTD application in processing ship survey radars when detecting aerodynamic targets in the conditions of natural passive interference, taking into account internal destabilizing factors of station. The aim of the article is to develop a mathematical model that uses a differential approach to assess detection quality in a wide range of Doppler target speeds, and based on it, to comprehensively assess the efficiency of MTD and MTI application for the protection against hydrometeors in ship-based airspace survey radars. When considering,

we limited ourselves to typical operating frequency ranges and common methods of frequency selection. A rain cloud of hydrometeors of medium intensity is accepted as passive clutter.

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V. A. VOLCHENKOV. METHODS FOR DETECTING PAUSES BASED ON NONLINEAR PROCESSING USING AUXILIARY SIGNALS

Keywords: pause detection, voice activity detector.

The problem of detecting pauses is considered, as one of the urgent problems of radio monitoring and detecting speech activity is still to increase the probability for correct detection of relatively short pauses lasting less than 40 ms, which will increase the probability of correct detection of pauses thus increasing the efficiency of using channel resource. The aim of the work is to increase the probability of correct detection and allocation of pauses based on segmentation using auxiliary signals. The information is provided on the developed methods for detecting pauses and their modifications, as well as the results of studying their operation under various parameters, as well as the comparison of their operation with some existing methods for detecting pauses. Pauses are detected in speech signals when vehicle noise with different levels of SNR is superimposed on them.

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V. A. GORYACHEVA. OPTICAL CHANNEL OF OBSERVATION SEARCH AND DATA-MEASUREMENT SYSTEM

Keywords: optical channel, observation search and data-measurement system, math model, television system, zoom lens, two-channel optical system, synthesis algorithm, calculation method.

The possibility of two-channel optical system to be replaced by one-channel one in observation search and data-measurement system with the possibility to decrease its weight and size parameters and increase its characteristics is studied. The aim is to increase characteristics of observation search and data-measurement system by means of television system with zoom lens. The math model, synthesis algorithm and suggested method of television system with n-component zoom lens calculation are proposed. Comparison characteristics of two-channel optical system and suggested television system with zoom lens being the parts of observation search and data-measurement system are given.

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MATHEMATIC AND SOFTWARE COMPUTER SYSTEMS AND COMPUTER NETWORKS

Y. A. USHAKOV, M. V. USHAKOVA. METHODS FOR OBTAINING PHYSICAL LEVEL DATA OF LATEST GENERATION NETWORKS TO INVESTIGATE CYBER INCIDENTS DURING ADVERSARY ATTACKS

Keywords: simulation, 6G, OMNeT++, adversarial attacks.

The latest generation of data networks, such as 5G and 6G, is used as part of technical means to provide the core of virtual networks and network functions, while some solutions went further and began to use machine learning to optimize functions including the physical level. Intelligent models used in machine learning are currently modified by adversarial attacks, which result in the removal of minor changes in input data, while the result of the model can be radically changed in contrast to what was expected. Many works are devoted to detecting adversarial attacks, but all of them require internal input information for analysis. Using machine learning in radio path to generate directional radiation in modern ultra-massive MIMO, reconfigurable smart interfaces and other technologies used in networks of latest generation to receive data

from the physical layers of sources, as well as subsequently process them due to their volume can be quite hard. The aim of the work is to create a simulation model combined with real machine learning applications to study the issue of obtaining attack data directly from industrial sources of service information.

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D. A. PEREPELKIN, K. V. ANISIMOV. MODIFIED PAIRED TRANSITIONS ALGORITHM IN SOFTWARE DEFINED NETWORKS BASED ON FUZZY LOGIC

Keywords: software defined networks, paired transitions algorithm, fuzzy logic, fuzzy inference, visual environment FuzzySDNDesigner, quality of service.

Currently, to ensure flexibility and reliability in managing computer networks, software-defined networking (SDN) technology has gained widespread popularity. The paper considers the problem of dynamic routing in a SDN with ensuring the quality of network service. A mathematical model of SDN is proposed to ensure quality of service based on fuzzy logic. Service quality is considered as a set of fuzzy values of communication channel parameters that satisfy a given quality criterion. The aim of the work is to develop a modified algorithm for paired transitions to ensure the quality of network service based on fuzzy logic. The work created a rule base for a fuzzy inference system to approximate the quality of service function and developed a visual environment FuzzySDNDesigner for studying dynamic routing processes in a SDN.

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K. I. NIKISHIN, M. A. MITROKHIN, K. A. ARTEMOV, D. D. GRIGORIEVA, E. A. MERENYASHEVA. TRAFFIC TRANSMISSION IN SOFTWARE-DEFINED NETWORKS USING AUTHENTICATION AND BITWISE ENCRYPTION

Keywords: software-defined networks, controller, switch, OpenFlow, Petri nets, CPN Tools, symmetric encryption, Diffie-Hellman algorithm.

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 SDN. Thus, the OpenFlow protocol successfully allows you to cope with the increased requirements for user traffic, priority. The relevance of the research is that there are 9 types of attacks on SDN, most of them are security-related and solved by encryption, the rest are traffic problems. The aim of the research is to transfer traffic in SDN using authentication and bitwise encryption on controller side to reduce man-in-the-middle attacks. The algorithm uses bitwise symmetric encryption with a key obtained by Diffie-Hellman algorithm. To research the algorithm, a simulation model was developed, including the use of the algorithm on the apparatus of Petri nets. Simulation results showed that the proposed traffic transfer in SDN using authentication and bitwise encryption on controller side made it possible to ensure secure transmission for man-in-the-middle attacks, calculate keys without allowing transmission over the network in open form, and also increase the speed of traffic encryption in SDN.

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K. K. OTRADNOV, A. S. ALESHKIN, V. N. KALININ. ADVANTAGES OF USING GRAPH DATABASES IN APPLICATION

Keywords: graph databases, graph database design, Python, Neo4j, social networks, transport networks.

The article provides an overview of the advantages of graph databases, the differences between graph and relational databases, the use of graph databases in various industries (including for media space analysis and transport network analysis), the libraries used and the model (diagram) of a relational and graph database are given to analyze social network data.

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I. E. TARASOV, D. V. LULYAVA, N. A. DUKSIN. DESIGN OF PIPELINE COMPUTING DEVICES CONSIDERING TOPOLOGICAL REPRESENTATION

Keywords: computing system, pipeline, architecture, FPGA, VLSI, register transfer level.

The problem of designing a pipeline computer to operate as part of a digital computing system is considered. The aim is to study the influence of pipeline computer architecture on the characteristics of its topological representation in order to optimize a computer according to selected optimality criteria. When designing high-performance computing systems, an important stage is the architectural design and decomposition of the system. In this case, the choice of operations for hardware acceleration depends on the characteristics of the accelerator obtained on existing hardware platform. Design at various levels: system, circuit and topological allows, on the one hand, to abstract from implementation details and increase development productivity, but on the other hand, the transition to implementation details clarifies the final characteristics of the designed accelerator for a computing system and can significantly worsen them relative to preliminary expectations. The article discusses a subclass of pipeline computing accelerators and the dependence of their size characteristics, signal propagation delay and power consumption on control system architecture. The possibility of partial compensation for the shortcomings of architectures that have simple topological implementation has been identified, at the expense of nodes that ensure pipeline integration into computing system. The authors propose to use optimization in discrete parameter space, for which a parameterized pipeline description is used.

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INTELLIGENT INFORMATION SYSTEMS AND TECHNOLOGIES

A. V. GORCHAKOV. METHODS AND ALGORITHMS FOR IDENTIFYING PROGRAM FRAGMENTS FOR MAKING RECOMMENDATIONS WITH THE AIM TO INCREASE THE SPEED OF SOFTWARE SYSTEMS

Keywords: static analysis, source code analysis, classification algorithm, Markov chains, abstract syntax trees.

Innovations in server architecture made it possible to create heterogeneous computing platforms for solving specialized problems. There is a need to accelerate software systems based on the capabilities provided by the heterogeneous computing platform on which the software system is deployed and run, in order to achieve the best software performance when performing specialized calculations. The aim of this research is the development of methods and algorithms for identifying program fragments during the process of intelligent static analysis in order to make recommendations for reworking a software system in order to increase its performance. The results of the research are: a new method for converting programs into vector representations based on Markov chains constructed for abstract syntax trees and definition use graphs; algorithm for searching fragments in abstract syntax trees by a program example based on the k-nearest neighbors method and the Jensen-Shannon distance function; a technique for identifying program fragments to make recommendations for improving the performance of software systems, based on the collection of a database of example programs and options for increasing their performance using accelerators available on a heterogeneous computing platform, followed by the use of the developed algorithm for fragments search in abstract syntax trees.

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I. YU. KASHIRIN. BINARY HIERARCHICAL NUMBERS TO CALCULATE SEMANTIC PROXIMITY OF NATURAL LANGUAGE SENTENCES

Keywords: binary hierarchical numbers, semantic proximity, generic taxonomy, intelligent data processing, knowledge base, semantic networks, natural language analysis, neural networks.

The article discusses a new technology for calculating semantic proximity of natural language sentences preprocessed by trained neural networks. For software implementation of semantic analysis, Spacy and WordNet tools are used. Automatic verification of political news materials was chosen as subject area.

The theory of binary hierarchical numbers is used to calculate numerical parameters of semantic proximity. Basic operations with hierarchical numbers are given. The principle of minimizing the tax-onomy complex semantic relations is considered. Hierarchical numbers are used when analyzing ge-neric taxonomy of subject area of natural language sentence. The experimental part of the research was carried out for test software implemented in Python v.3 (Anaconda 3). Source texts of news arti-cles made use of the materials from international publications such as WSJ, PBS News Hour, AC News and others.

The performed series of experiments makes it possible to evaluate the technology in question as a technology for calculating semantic proximity of sentences, which is not inferior in efficiency to exist-ing modern international analogues.

The aim of the work is to create a new technology used in automated calculation of semantic proximity of natural language constructions for the formation of thematic collections of elec-tronic news materials.

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N. I. TSUKANOVA, V. V. ALEKSANDROV, N. V. GOLOVKIN, O. V. SHURYGINA.
APPLICATION OF ARTIFICIAL NEURAL NETWORKS AND MACHINE LEARNING
TO ASSESS THE QUALITY OF COLLECTIVE AGREE-MENT ACTS IN THE FIELD
OF EDUCATION

Keywords: neural networks, text classification, flat classifier, hierarchical classifier, machine learning, sampling data for training, preprocessing of text data, Python language, Keras library.

The paper discusses the classification of fragments of organization's Collective Agreement (CA). The aim of the work is to solve the problem of classifying the fragment text of the Collec-tive Agreement (CA) to determine which section and issue of labor relations the fragment is de-voted to and whether it contains an additional level of labor rights and guarantees provided to employees through the CA, i.e. determine its Quality. This problem is proposed to be solved us-ing neural networks (NN) and machine learning. The article discusses three variants of classifier architecture, which take into account in different ways the relationship between characteristics section, question and quality. Experimental studies of classifier's performance were carried out depending on its architecture, methods of training sample preprocessing, and hyperparameters values. The article presents and discusses the results obtained during the research process.

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I. A. BULANOVA, A. N. PYLKIN. SEMANTIC MODEL OF THE MAIN PROFESSIONAL EDUCATIONAL
PROGRAM AND SOFTWARE FOR ITS CONSTRUCTION, VISUALIZATION AND ANALYSIS

Keywords: subject area formalization, semantic model, main professional educational program, curriculum of the discipline, re-credit of disciplines, graphs, Graphviz, software.

The article considers the problem of semantic modeling of the main professional educational pro-gram. The aim is to design and develop software for constructing, visualizing and analyzing the se-mantic model of the main professional educational program. The resulting semantic mod-el can be analyzed for various purposes, including deciding on the permissibility of re-crediting a course when transferring and reinstating a student. The article describes the process of soft-ware design and development, including the main algorithms for visualizing the semantic model and comparing the working programs of disciplines. The software is implemented as a desktop application in C#, MS SQL Server is selected as the DBMS and the library Graphviz is used to build graphs.

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L. A. DEMIDOVA, N. A. MOROSHKIN. ASPECTS OF THE DEVELOPMENT OF QUESTION AND ANSWER SYSTEM ARCHITECTURE FOR BIG DATA PROCESSING BASED ON NEURAL NETWORK MODELING

Keywords: visual question-answer modeling, multimodality, artificial neural networks, end-to-end architecture, stream data processing architecture.

The article discusses the aspects of neural network question-answer modeling based on visual data, which has recently become increasingly popular. The aim of this work is to develop and justify the architecture of a question-answering system in the context of working with streaming big data or end-to-end applications. Two architectures of a question-answer system are presented for end-to-end queries and for stream processing in the context of the problem being solved of neural network question-answer modeling based on visual data.

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A. I. BARANCHIKOV, E. B. FEDOSOVA. DATA MINING AND DATABASE REENGINEERING: THE ALGORITHM OF RELATIONAL DATABASES ATTRIBUTES CLUSTERING

Keywords: Data Mining, relational databases, clustering, attributes, k-means, cluster, reengineering, cluster analysis.

The article proposes a solution to one of the reengineering relational databases problems, in particular, combining specialized attributes into semantic groups – clusters. It's proposed to apply Data Mining methods to solve this problem. The aim of the work is development of an algorithm for clustering relational databases attributes. The Cluster_Define algorithm allows to divide existing attributes into clusters containing attributes that are similar in structure and semantics. Elements of cluster analysis and the k-means algorithm were used in this algorithm to select the optimal number of clusters, it is proposed to use (Silhouette Method). It's proposed to use Silhouette Method to select the optimal number of cluster. The simplest metric in the body of the k-means clustering algorithm is the Euclidean distance.

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PHYSICAL ELECTRONICS AND NANOELECTRONICS

M. V. DUBKOV, M. A. BUROBIN, V. V. IVANOV, K. A. VETSHEV, A. D. RUBTSOVA. STUDYING THE OPERATING FEATURES OF QUADRUPOLE MASS FILTER IN UPPER AND LOWER VERTS OF STABILITY QUADRANGLE IN THE PRESENCE OF ELECTRIC FIELD NONLINEARITY

Keywords: quadrupole mass filter, stability quadrangle, higher order components, mass peak, resolution, mass peak intensity.

The features of quadrupole mass filter operation in upper and lower vertices of stability quadrangle are studied under pulsed power supply and in the presence of higher-order components in potential distribution.

The aim of this work is to compare the influence of various higher-order components on the analytical characteristics of a quadrupole mass filter when operating at upper and lower vertices of stability quadrangle using pulsed power. Using numerical modeling methods, a comparison was made of the operating features of the quadrupole mass filter both in the absence and in the presence of higher-order components in the potential distribution. The research shows that with increasing resolution, the ratio of the intensities of mass peaks increases when working at lower and upper vertices, respectively. Also, if there are certain higher-order components in potential distribution associated with symmetrical distortions of electrode system, the resolution of mass filter increases, both at upper and lower vertices of stability quadrangle.

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V. V. TREGULOV, G. N. SKOPTSOVA, N. V. RYBINA, N. B. RYBIN. FEATURES OF BAND DIAGRAM OF SEMICONDUCTOR STRUCTURE WITH POROUS SILICON FILM FORMED BY METAL-STIMULATED ETCHING

Keywords: porous silicon, metal-assisted etching, thermal annealing, capacitance-voltage characteristics, traps, band diagram.

The results of studying frequency dependence of C-V characteristics of semiconductor structure with a porous silicon film grown by metal-stimulated etching are presented. A zone diagram model has been developed. The influence of thermal annealing modes on the nature of conduction inversion mode manifestation is investigated.

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N. V. RYBINA, N. B. RYBIN, V. D. STEPNOV. SURFACE DEFECTS ANALYSIS BY INFORMATION-CORRELATION CHARACTERISTICS

Keywords: surface, image analysis, method of detrended fluctuation analysis (2D DFA), average mutual information (AMI), information and correlation characteristics.

The methods of analyzing defects on the surface of solid-state materials from their images are considered. The results of processing images with various types of defects on the surface using fluctuation analysis and the method of average mutual information are presented.

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M. K. BURUKHIN, S. V. RYZHOV, D. V. ANDREEV, M. V. ROMANOV. ELECTRICAL IC TRIMMING METHOD USING POLYSILICON FUSES

Keywords: technological variation of parameters, IC trimming, polysilicon fuses, Symica DE.

This article provides a detailed overview of the method of trimming integrated circuits (ICs) using polysilicon fuse jumpers. The aim is to develop and apply a modified trimming method using burnt-out jumpers in reference voltage amplifier circuit. The use of trim to achieve the required reference voltage in opamp circuit is investigated and the corresponding calculations are presented. As part of the study, experimental tests were carried out with test modules, on which the jumper burnout mode was worked out and their resistance was measured. The results of the study confirmed the effectiveness of applying polysilicon burnout jumpers in trimming process. To facilitate calculations and analysis, a special calculator application has been developed. In addition, the results of modeling the trimming process for different initial values of parameters using Monte Carlo method are presented. The obtained results confirm the efficiency of the method proposed and its applicability in practice.

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