CONTENTS AND ABSTRACTS

RADIO ENGINEERING AND COMMUNICATION SYSTEMS

V. I. KOSHELEV, N. H. TRINH. FAST FOURIER TRANSFORM ALGORITHM OF NONEQUIDISTANT PULSES SEQUENCES

Fast Fourier transform algorithms are well developed and successfully used in applied problems of radio engineering, in particular, for the implementation of multi channel Doppler filtering in systems for radar signals primary processing. In case of non-equidistant pulse sequences, matched filtering algorithm must take into account the law of change in signal sample repetition periods, which leads to a modification of the fast Fourier transform algorithm. Fast Fourier transform algorithm for processing non-equidistant pulse sequences with two different repetition periods is known and considered in this paper. In this work, modified and combined fast Fourier transform algorithms for processing non-equidistant pulse sequences with three different repetition periods are obtained and analyzed.

The aim of the work is to synthesize the structure of modified fast Fourier transform algorithm under the conditions of processing an echo signal consisting of bursts of three-stage non-equidistant pulses, as well as the optimization of its parameters using the criteria for signal-(noise + interference) ratio improvement coefficient averaged over frequency channels and the average probability of correct signal detection against the background of white Gaussian noise and narrowband noise.

V. G. ANDREYEV, E. A. ZHIRKOV. METHODS OF LIGHT REFLECTIONS ANALYSIS DURING LASER SENSING OF ATMOSPHERE

A modified method for analysing light reflections during laser atmosphere sensing is proposed and studied. The aim of the work is to increase the plausibility of time delay estimation of reflected light signal by introducing a multifactor detector model that takes into account the dynamics of changes in several parameters of random variable distribution law. The proposed modified method gives greater (if compared with known methods) probability of correct detection of reflected signal by taking into account the totality of its statistical character-istics. The indicators of speed and plausibility of the results for the considered methods of disorder detection in the process of light reflections are compared. Experimental studies have shown that by using the proposed modified method to search for atmospheric inhomogeneities, the probability of correct detection is achieved, two or more times higher than that of known methods with the same signal-to-noise ratio of 10 dB. The pro-posed modified method is efficient in the tasks

of detecting the moment of decomposition at small (10..20 counts) sizes of sliding window (training sample).

MATHEMATIC AND SOFTWARE COMPUTER SYSTEMS
AND COMPUTER NETWORKS

A. A. KARANDASHEV. RELIABILITY OF COMPUTER NETWORK DYNAMIC CHARACTERISTICS MODELING

Keywords: dynamics, information flows, reliability of modeling, routing, dynamic characteristics, computer networks, tolerance, errors.

When developing modern programs for designing networks and evaluating their dynamic characteristics, it is necessary to analyze the reliability of the simulation being carried out. The study of a computer network as a control system, the blocks of which are dynamic models of network nodes, can help improve the quality of computer data transmission networks modeling. The aim is to analyze the reliability of the results for the modeling of data accumulation processes dynamics in the nodes of computer networks. The paper presents a dynamic model of special computing network of (n x m)-lattice type. A dynamic model of possible routes of the network under study is described. A diagnostic sign is used to organize the control of the model. For the first time, a method for assessing the reliability of modeling a specialized computer network of (n x m)-lattice type is proposed. The considered example of modeling a small computer network of (2 x 1)-lattice type confirms the correctness of the proposed methods. The results of the study can be used in the design of computer networks in specialized software.

A. I. MARTYSHKIN. POSSIBLE HARDWARE IMPLEMENTATION ON PROGRAMMABLE LOGIC INTEGRATED CIRCUITS OF NODES IN RECONFIGURABLE COMPUTER SYSTEM

Keywords: hardware implementation, speed, task manager, operating system, performance, reconfigurable computing system, synchronisation, FPGA.

This paper is devoted to an experimental study of a reconfigurable field-programmable gate array based computing system. The main aim of the study is to conduct experiments on the control of reconfigurable nodes of this computing system. The paper describes a reconfigurable computing system based on four reconfigura-ble processors implemented on field-programmable gate array. To solve the problems associated with loss of performance in software implementation of task scheduling function, its hardware implementation is pro-posed. This improves performance and reliability of operating system, as the responsibility for software func-tions is removed from processor nodes. The paper also considers modeling of control nodes, including task manager of a reconfigurable computing system, taking into account modern element base. In order to verify the efficiency of the algorithm and the analysis of time diagrams an experiment was carried out on a prototype of a reconfigurable computing system using digital logic analyser which provided detailed information on the signals in a system and ModelSim-

Altera 10.0c simulation environment which gave accurate and reliable results. The printed circuit board schematic developed by the author is presented to create a prototype of a reconfigurable computing system. It has been designed with modern requirements in mind, ensuring stable and efficient operation of the system. Thus, the experiment and the presented circuit board scheme allowed to get accurate results of the analysis of time diagrams of reconfigurable computer system, as well as to create a prototype which meets current requirements and has high stability and efficiency. According to experimental results, it was concluded that the proposed algorithm works as a task manager. In the final part of the article main conclusions and recommendations for further development of this scientific direction are presented.

INTELLIGENT INFORMATION SYSTEMS AND TECHNOLOGIES

I. YU. KASHIRIN. CORRECTION OF COVARIANT DRIFT OF THE CONCEPT FOR ENSEMBLES OF MACHINE LEARNING MODELS

<u>Keywords:</u> concept drift, ensembles of machine learning models, big data, prediction accuracy, knowledge base, ontological knowledge models.

The article discusses a new approach to detect and correct one of data drift types in machine learning models, namely covariant conceptual drift. The approach assumes that machine learning model is designed as a set of models of various levels. The method of collecting the ensemble is a compositional begging method.

The Begging method first uses weak models of the same type as ensemble components, then a number of iterations are used to increase the accuracy of resulting model to a certain level acceptable for solving a forecasting problem in terms of accuracy and computational complexity.

Various drift formulas of the concept based on conditional and unconditional probabilities of obtaining the target variable depending on feature vector data in input dataset are studied. The notions of positive and negative drift of the concept are introduced depending on their belonging to the corresponding class used in forecasting.

A new approach uses a conceptual knowledge base of subject area, which allows a priori classifying the elements of feature vector in the form of generic taxonomy. A classified feature vector is a hierarchical structure that allows using bootstrap algorithm to form subsamples of features (folds) for preliminary training of weak models of the first and second levels. In this case, the folds can be ordered and then a resulting order can be used to identify and compensate for co-variant drift of working model concept.

As an example for experimental research, the subject area of air transportation services from the Kaggle international repository is taken. Software implementation was performed using Spider v.4 toolkit in Python v.4. The results of the experiments show the effectiveness of a new approach to correct concept drift.

The aim of the work is to obtain a new approach to identify and correct a covariant concept drift, which makes it possible to correct the drift in ensembles of machine learning models.

D. V. GORBUNOV, K. L. TASSOV, S. V. TELEGIN. MODIFICATION OF ASSOCIATIVE GAUSSIAN MIXTURE MODEL IN EXPERT ASSESSMENTS

The idea of ensemble training is to organize such a pool of experts that will allow them to be combined into a common system. Various prediction algorithms including neural networks can be considered as an expert. The essence of ensemble methods is that each of the experts provides its own response which can then be used by a generalizing algorithm. One of the generalizing algorithms for classification is the associative Gaussian mix-ture model. One expert for one class determines the result in only one area that is a disadvantage. Therefore, a modified method of associative Gaussian mixture model is proposed where one expert determines the result in several areas at once. Within the framework of the method an algorithm is proposed that includes the following steps: input data normalization, model training based on normalized input data, finding output values. The method can serve in any areas in which «local experts» are used and where it is necessary to rank experts. The article discusses the unification of associative Gaussian mixture model and Rumelhart perceptron, input data preprocessing, training and prediction using a modified method of associative Gaussian mixture model, the results of obtained output values are presented.

K A. GULYAEVA, I. L. ARTEMIEVA. TECHNOLOGY OF AUTOMATED CONCEPT SYS-TEM AND KNOWLEDGE BASE FORMATION PROCESS FOR APPLICATION DOMAINS WITH COMPLEX-STRUCTURED OBJECTS

The problem of knowledge base construction that are based on application domain on-tologies is studied. The aim is to create the technology of automated concept system and knowledge base formation process for application domains with complex-structured ob-jects. The application domain class the objects of which are systems with complex structures is defined. The process of system metagraph creation is formalized. The au-tomation of concept system elicitation process happens with the help of the developed system meta-graph vertex neighborhood examination procedure and meta-concept set introduction. Case categories emerging during system meta-graph vertex neighborhood examination procedure are derived. Initialization templates that depict inner structure of system property groups are defined. The technology allows the expert to generate in-termediate ontology concepts in a systematic manner. Part of argument types of knowledge base functions and predicates created by expert is generated automatically based on metaconcept. Other argument types are chosen from a finite set of alternatives. The developed technology can be utilized at knowledge base editor creation phase for application domains with complex-structured objects. These design solutions help to ob-tain knowledge base schema design technologies of practical use.

YU. L. LEOKHIN, T. D. FATKHULIN. DEVELOPMENT OF METHODS AND ALGORITHM FOR FORMAL-IZING A TEXT REQUEST TO ONLINE SERVICES GENERATING IMAGES THROUGH NEURAL NETWORK TECHNOLOGIES

Keywords: neural networks, service, image, generation, recommendations, technique, algorithm, request, methods.

The problem of studying the influence of a text request compiled by a user on image quality generated by neural network online services is considered. The aim of the work is to develop methods for compiling a formalized request to neural network services and an algorithm, that allow obtaining correct results of image generation. The relevance of the work is due to the growing interest in the use of neural network technologies in various areas of human life. Domestic online services «Shedevrum» and «Kandinsky 2.1» are considered, which implement diffusion and generative-adversarial generation technologies of image generation, respectively. A technique is given that allows to formalize a request for image generation by neural networks and an algorithm implementing it. The approbation of developed methods and algorithm is given by entering human language requests and formalized requests and analyzing images generated by neural networks. In conclusion, the results of the analysis are presented and the findings are shown.

O. A. POPOVA. ANALSYSIS OF TEXT DOCUMENTS VECTORIZATION METHODS

Keywords: Vectorization, BinaryBOW, Bag of words, TF-IDF, Word2Vec, Skip-gram, softmax, corpus, neural network, vector.

The article deals with the problem: analysis of methods for vectorization of text data. The data are presented as an optional and variable part of medical training courses. The purpose of the work is to choose the optimal method for vectorizing textual data on medical topics. The urgency of the problem of choosing a vectorization method is based on the need to improve the quality of the recommendation system for the selection of educational content for students. The selected method will be recommended as a text pre-processing procedure for the recommender system in the future. The paper presents 4 vectorization methods: BinaryBOW, Bag of words, TF-IDF, Word2Vec. According to the results of the experiment, the success of the application of the method based on neural networks - Word2Vec - was established. Its algorithm is based on the predictability of the result, based on the semantic proximity of words, machine learning and vector representation of words. The article presents the choice of hyperparameters of the vectorizer of the machine learning model in accordance with the set of text data.

A. E. BOYKO, T. V. SAVITSKAYA, D. S. LOPATKIN. DATA SCIENCE TOOLS FOR ANA-LYZING A LARGE SAMPLE OF STU-DENTS TESTING DATA IN MOODLE

Keywords: learning analytics, learning methodology system, LMS Moodle, data analysis, Python, Seaborn library, Matplotlib library, descriptive analytics, diagnostic analytics, higher education.

Due to the intensification of processes for building online-courses by national universities using LMS Moodle, where collection, storage, monitoring, and processing of educational data is carried out, the formation of a unified approach to the implementation of descriptive and diagnostic educational analytics that can meet the objectives of quality management system (QMS) in terms of the presenting testing data for the purposes of internal and external quality control of education becomes an urgent task. The aim is to expand the possibilities of monitoring, presenting and visualizing educational data from LMS Moodle related to various forms of testing students using data science tools to optimize educational processes and improve the quality of learning. Results: the paper considers the process of preparation and further processing and visualization of data on diagnostic testing of second-year students in D. Mendeleev University of Chemical Technology of Russia (more than 900 people) in two disciplines. Various options for data aggregation are considered: by groups at the faculty, heterogeneous class, within the educational program, at the level of entire university. Various options for visualizing the results of comparing the academic performance of groups and the tested/total quantity of students are proposed; visualization options and parameters for analyzing distribution «structure» of test scores in study groups at a selected faculty, etc. Practical significance: the results of the study will help teachers and administrators of LMS Moodle to make more informed decisions based on data; the tools proposed can become a starting point for the implementation of basic adaptive approaches in teaching.

MATHEMATICAL AND COMPUTER MODELING

S. V. SKVORTSOV, V. I. KHRYUKIN, T. S. SKVORTSOVA. DETERMINATION OF MATING PARTS PARAMETERS FOR SMOOTH CYLINDRICAL JOINTS BASED ON STATISTICAL MODELING

The interrelated tasks of determining the parameters of mechanical components of structures are considered, taking into account the probabilistic nature of mating parts dimensions. The aim of the work is to develop design procedures that ensure determination of tolerances in parts connection (direct task) and the selection of standard fits that meet the requirements for the accuracy of mating elements connection (inverse task). When developing design procedures, standard calculation methods and original approaches based on statistical modeling of mating parts dimensions to determine their maximum dimensions and connection parameters were used. On the basis of the proposed design procedures, an electronic reference book on the System of Fits and Tolerances has been developed. Its application provides the user with reference data according to the standards of the System of Fits and Tolerances, and also allows automating the solution of direct and inverse problem of determining mating parts parameters for smooth cylindrical joints, including limit calibres and rolling bearings, during electromechanical devices design.

V. P. KORYACHKO, V. A. MINAEV, A. O. FADDEEV. MODELING OF SEISMIC STABILITY OF DILATANT STRUCTURES

The article presents a mathematical model designed to assess the seismic stability of territories that differ in their geological genesis and structure. The aim of the study is to create a model focused on identifying dila-tant structures that are an indicator of possible development of seismic instability of geological environment. Special attention is paid to quantitative reassessment of stress fields due to the manifestation of concentrated force of natural (earthquake) or artificial (induced seismicity) origin in geological environment. The results of practical implementation of the model developed for assessing seismic stability are considered on the example of identifying dilatant structures in the vicinity of the earthquake that occurred in Turkey in February 6, 2023.

SYSTEM ANALYSIS, MANAGEMENT
AND INFORMATION PROCESSING

B. V. KOSTROV, A. I. BARANCHIKOV, N. N. GRINCHENKO, A. A. VYUGINA, S. N. BARANOVA. ANALYSIS OF THE EFFECTIVENESS OF METHODS FOR RESTORING GROUP DISTORTIONS ON BIT PLANES

Currently, images make up most of the transmitted information that needs to be stored and processed. The aim of the work is to compare the approaches of restoring the values of transmission vector distorted by group interference, formed on the basis of bit planes, by analyzing the neighborhood of bits on bit plane and calculating the trend of neighboring values. The task of the study includes modeling of data transmission with a vector formed on the basis of bit planes, theoretical study of approaches to distortion recovery and conduct-ing an experiment. As a result of the experimental part, it was found that the method of analyzing the neigh-borhood of bits on bit plane has high speed, but determines distorted bits worse than the method of calculat-ing the tendency of neighbors. At the same time, both approaches give the result sufficient for visual percep-tion of content part. Artifacts that occur during restoration do not have strong impact on obtaining infor-mation about an image.

M. D. NOVICHKOV, D. A. ORLOV. ACCELERATE ARITHMETIC OPERATIONS IN RESIDUE NUMBER SYSTEM USING SCALING

The problem of reducing the time spent to obtain a result in high-precision calculations by using methods and algorithms that perform arithmetic operations on the numbers represented in residue number system (RNS) is considered. The aim of the work is to reduce execution time of non-modular operations in RNS. Within the framework of this work, the task was to develop a modification of the method for performing the arithmetic operation of division in RNS, using such a positional characteristic of numbers in RNS as a rela-tive value. An analysis of block diagram features for hardware implementation of the considered method for dividing numbers in RNS was carried out. This analysis allowed to identify the ways to improve the process of forming a quotient represented as a sum of numbers each being equal to two by exponentiation with variable exponent. To solve this problem, an approach is proposed which allows speeding up calculations using the analyzed method to a required extent by introducing redundancy in terms of equipment volume. Comparison of the time spent on the calculation by SRT method, traditionally used in most processors for dividing num-bers, and a new accelerated method developed by the author and working in RNS is made. The comparison was carried out using simulation modeling. Execution time of division operation was measured in discrete model time, the unit of measurement being clock signal. An example is given showing that in the worst case for SRT and the proposed method, the latter will have an advantage.

BIOMEDICAL INFORMATION SYSTEMS

T. A. KUCHMENKO, L. A. KOROBOVA, I. A. MATYTSINA, I. A. MURAKHOVSKY, D. A. MENZHULINA. SOFTWARE AND ALGORITHMIC SUPPORT TO ASSESS HUMAN HEALTH BY GAS PIEZOSENSOR SIGNALS

The issues of using a bioscanner device for medical research are considered. An algorithm is proposed, according to which, on the basis of chronofrequencyogram obtained as a result of the work of non-invasive diagnostics, health indicators are calculated, which describe the general state of human health. The aim of the work is to study the possibility of obtaining information about human health by analyzing a section of sorption curve using classification and dimensionality reduction methods. On the example of the analysis of human skin smell, the possibilities of the developed software are demonstrated. Algorithms are presented for calculating the rate of change in volatile substances molecules mass on the sensor to determine the marks of person's state. The software includes the calculation of characteristics and visualization of their sets for easy perception by untrained users. The software allows you to quickly process the data from the device, to present the possible reasons for state deviation from average statistical norm. Untrained users easily perceive infor-mation without complex processing of multidimensional data.

PHYSICAL ELECTRONICS AND NANOELECTRONICS

D. S. LOGINOV, T. A. KHOLOMINA, V. G. LITVINOV, A. V. XENDZOV. APPLICATION OF THE ALLAN VARIATION METHOD TO STUDY LOW-FREQUENCY NOISE MAGNETICALLY CONTROLLED CONTACTS

Keywords: low-frequency noise, Allan variation, measuring unit, spectral power density.

The results of applying Allan variation method to the study of low-frequency noise spectra of low-impedance electronic equipment objects are presented. The results obtained in the work allow us to assert that in a limited frequency range, which takes place in practice, the process of generating low-frequency noise can be considered stationary with the possibility of applying appropriate methods of processing the results. Using Allan variation method in conjunction with the Fourier transform, it is possible to obtain more complete information about the object under study.

It is shown that rapid diagnostics using low–frequency noise spectroscopy with a duration of less than 5 minutes allows obtaining information about the object under study with the reliability of at least 90 % compared to longer diagnostics.

The aim of this work is to apply Allan variation (deviation) method to the study of low-frequency noise spectra of low-resistance electronic equipment objects and to identify the conditions under which noise exhibits the properties of random stationary process.