

DEVELOPMENT OF A SYSTEM FOR RECOGNIZING CUSTOMER SERVICE QUALITY USING ARTIFICIAL NEURAL NETWORK TECHNOLOGY

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Abstract: virtual automatic telephone exchanges are widely used by companies to communicate with customers and ensure sales of goods and services. However, the success of the company's work directly depends on the work of those employees who contact directly with the client: their productivity, understanding of the client, the absence of factors contributing to a decrease in customer loyalty. In this article we will talk about virtual PBX (hereinafter – VPBX). There is a VPBX with implemented speech analytics, but the question arose about its implementation through the use of machine learning technologies and artificial neural networks in particular. In modern business, VPBX is a comprehensive solution for the organization of office telephony, as well as an effective tool for establishing the sales process, improving customer service and optimizing business processes. In addition, VPBX allows you to solve the problem of remote employees and establish communication between all branches and divisions of the company, even if they are located in different countries. The article discusses the methods used for processing the text received as input, the process of cleaning and preparing data, the layers of the neural network used, as well as mathematical solutions working as part of the network. As a result of the work, an artificial neural network model was obtained that accepts a text vector as input and returns the identification number of a sign of poor service/sales at the output

Key words: speech analytics, topics of bad service, machine learning, neural networks, long-short time memory, natural language processing, PBX, HostedPBX

DEVELOPMENT OF SCALABLE CROSS-PLATFORM QML APPLICATIONS WITH INTEGRATION OF THE OPEN CASCADE GEOMETRIC CONSTRUCTIONS MODULE

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Abstract: this paper considers the development of scalable cross-platform applications implemented using QML with the integration of the Open CASCADE geometric constructions module. QML (Qt Meta-Object Language) is a declarative programming language that allows you to create user interfaces on various platforms. Open CASCADE, on the other hand, provides powerful tools for geometric modeling and analysis. The study also describes the architecture of scalable applications and the advantages of cross-platform development using QML. In addition, the paper suggests ways to integrate the Open CASCADE geometric constructions module into QML applications, providing opportunities for creating complex three-dimensional models and performing geometric operations. As a result, examples of the application of the developed applications are presented, demonstrating their scalability and functionality. The considered method of application development can be used in various fields, such as engineering modeling, architectural design and medical imaging. The implementation is made for Windows operating systems with 64-bit architecture

Key words: QML, OpenCascade, scalable application, MVC, module integration, platform, cross-platform

THREE-LEVEL HIERARCHICAL REGRESSION MODEL OF CLINKER PRODUCTION PROCESS

A.P. Shcherbakov

Abstract: the paper considers the problem of constructing and evaluating the adequacy of a two-level and three-level hierarchical regression quasi-linear model for predicting clinker quality. Clinker in cement production is obtained by firing raw flour. The quality of clinker depends on the chemical and mineralogical composition of the raw flour. The main quality indicators are modular characteristics – silicate module, alumina module and saturation coefficient. Quality indicators are calculated on the basis of chemical analysis before and after firing, that is, for the initial raw flour and for clinker. Based on the available experimental data, it can be concluded that the relationship between the indicators before and after firing is highly nonlinear. In this paper, the nonlinear dependence of the clinker alumina module on the chemical composition of raw flour is described using a hierarchical quasi-linear Lebesgue model. In general, such hierarchical models were defined earlier in the work of the author and co-authors. The scheme of their construction has some similarity with the scheme of constructing the Lebesgue integral, when instead of splitting the domain of definition of a function (as in the Riemann integral), the partition of the domain of values of this function is considered. The adequacy of the constructed model of the dependence of clinker properties on the chemical composition of raw flour is confirmed by a significant reduction in the total error and the approximation of the autocorrelation function of the model residues to the white noise level

Key words: quasi-linear models, residual data, clustering, hierarchical partitioning, Lebesgue scheme

CONTACTLESS DIAGNOSTICS OF WORKING AUTOMATED PROCESS EQUIPMENT

V.L. Murzinov, Yu.V. Murzinov, P.V. Murzinov, D.V. Kocherzhenko

Abstract: the issues of using a non-destructive method of monitoring its technical condition for working automated equipment are considered. The possibility of using the acoustic method for diagnosing automated industrial facilities is shown. One of the tasks to be solved is to obtain information about the presence of defective areas in the structure, working equipment. The peculiarity of the acoustic method is that, using an acoustic sensor that perceives very quiet sounds, it receives high-quality information about the presence of defects in the technical condition of industrial equipment. A mechanical sealing of the sound stream occurs in the Acoustic sensor. The mechanical sensor is the primary converter in the control system. Mechanical sealing of the sound stream is based on the use of parabolic reflectors. The sound stream from the operating equipment is an acoustic signal containing information about the technical condition of this equipment. This signal is sent to the vibration sensor, which converts the acoustic signal into an electrical signal, and feeds it to the analyzer. The analyzer sends the received information to the software package "Contactless diagnostics of technological equipment". The software package contains a neural network processor for processing an audio signal and an automated workstation. The received information on the presence of a deviation from the normal operation of automated equipment contains data on the local location of the defective area and notes the degree of the defect. The efficiency of using parabolic reflecting surfaces in the design of an acoustic sensor to obtain high-quality information about the technical condition of automated industrial equipment is shown

Key words: automated equipment, diagnostics, acoustic sensor, auscultation

THE STRUCTURE OF THE MICROCLIMATE REMOTE MONITORING SYSTEM BASED ON CELLULAR TOPOLOGY

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Abstract: considering that choosing the optimal architecture of a wireless network and its parameters is an extremely difficult task, this article discusses one of the methods for constructing a cellular network architecture, which provides for connecting devices to the Internet to exchange data between themselves and with other systems using secure network communication protocols. The task is relevant because its solution creates new opportunities for data collection and processing, management and automation of processes, as well as improving the convenience and comfort of people's lives. The use of wireless network technology is considered. A study was conducted to compare the "classical" work with sensors in LAN and work using MESH technology. An application was created that works with a mobile group of nodes to send data to an aggregating server, to which a native Android application will connect. As a result of the conducted research, it was concluded that the choice between a standard connection of sensors to a Wi-Fi network and a mesh topology using Mesh Wi-Fi depends on specific needs and limitations. The comparison of wireless network technologies was carried out based on the results of the weather monitoring application. This project will ensure the uninterrupted operation of the application, which allows organizing a microclimate monitoring system based on a Wi-Fi network from specified zones

Key words: Java, Kotlin, Mesh topology, Wi-Fi mesh network, Mobile App, ESP, Raspberry Pi, IoT

DIFFERENTIAL MODEL OF BACTERIAL COMMUNICATION DURING THE EVOLUTION OF DAUGHTER COLONIES: FINITE ELEMENT IMPLEMENTATION

Shuai, A.G. Maslovskaya

Abstract: the current level of interdisciplinary research allows us to consider and formalize the processes occurring in microbial communities. In particular, the most important property of many bacterial species is the ability to communicate or interact with each other and collectively respond to external influences. The paper reports the results of finite element simulation of the key characteristics of cell-to-cell communication in the evolution of bacterial colonies. The basic deterministic mathematical model is formalized as an initial-boundary value problem for a system of semi-linear equations of reaction-diffusion type. The model is modified by introducing a mechanism for the formation of mobile daughter colonies in the process of bacterial colony evolution with general multiphase dynamics: lag-growth, log- growth, relaxation and degradation. The finite element solution of the problem was obtained using the COMSOL Multiphysics software. A series of computational experiments was performed to assess the change in the spatial-temporal concentrations of chemical compounds characterizing the bacterial quorum sensing for the *Pseudomonas putida* species. The computations indicate that the separated sub-colonies do not lose the communication with the mother colony, although the quorum within the newly formed colony is much higher. On the contrary, Lactonase enzymes act locally and cause quorum degradation in compact domain occupied by actual daughter or parent colonies

Key words: bacterial community, evolution of a bacterial colony, reaction-diffusion model of bacterial communication, finite element method, computational experiments

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PERFORATION OF THE STABILIZING DIVERGENT «SKIRT» FOR IMPROVING AIRCRAFT AERODYNAMIC CHARACTERISTICS

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Abstract: the paper considers the results of experimental and numerical studies of subsonic flow around aircraft with two types of stabilizing aerodynamic skirts: solid and perforated. These stabilizing devices are presented in the form of truncated conical surfaces located in the bottom region of the cylindrical apparatus. Variants of hemispherical and end bluntness are considered as the head part of the apparatus. The obtained dependences of the aerodynamic coefficients are analyzed in a wide range of angles of attack and the structure of the flow around models with hemispherical and end blunting of the head part. Experimental studies were carried out in a subsonic wind tunnel with an open test section of the Moscow State Technical University. N.E. Bauman at an oncoming flow velocity of 25 m/s. To measure the aerodynamic forces acting on the models during blowdowns, a six-channel strain-gauge balance was used. Numerical simulation was carried out in the FlowVision software package in accordance with the experimental conditions. As a result of the conducted studies, the influence of the shape of the head part of the aircraft body and the perforation parameters of the stabilizing aerodynamic skirt on the flow structures and aerodynamic characteristics of the studied bodies was revealed. It was found that the form of blunting significantly affects the flow structure and aerodynamic characteristics of aircraft with a skirt. Perforation, on the other hand, has a negligible effect on the aerodynamic characteristics and flow structures of the aircraft at its considered degree of 10%. The use of perforated stabilizing skirts allows you to reduce the weight of the aircraft, while providing aerodynamic characteristics equal to the characteristics of the device with a solid skirt

Key words: aircraft, stabilizing skirt, hemispherical bluntness, end bluntness, perforation, subsonic wind tunnel, FlowVision

IMPLEMENTATION OF 3D ANIMATION CREATION PROCESSES FOR DIGITAL PRODUCT LAYOUTS BY MEANS OF OPENCASCADE

A.I. Akhlestin, A.N. Yurov, M.I. Chizhov

Abstract: 3D modeling and animation are necessary in modern production processes, especially when creating digital product layouts. However, despite the extensive capabilities of the Open Cascade software in the field of 3D modeling, there is no animation creation in the functionality of the geometric core. The paper considers techniques that allow to implement the processes of creating 3D animations using the auxiliary software - Qt. The creation of animation is based on the need for a constant final representation of the object. This means that every change in the scene- whether it's moving an object or changing its properties-requires immediate display on the screen. This is a task that requires significant computing power and optimization of rendering algorithms. Additionally, an important aspect of the process of creating 3D animations for digital product layouts is the synchronization of work between Open Cascade and Qt. These tools were chosen for their flexibility and functionality. However, their interaction requires detailed control and management. The article provides examples of difficulties that have arisen in the course of work, and suggests possible ways to solve them. This includes issues related to data compatibility between the two systems, differences in 3D model processing methods, as well as difficulties in visualizing and creating smooth animations. The importance of implementing a stable and efficient algorithm for the final representation of digital model images is also emphasized, which is critical for achieving realistic and smooth animation reproduction. The article discusses various approaches to solving this problem, including the use of buffering and performance optimization methods. The implementation is made for Windows operating systems with 64-bit architecture

Key words: 3D modeling, animation, digital product layouts, Open Cascade, Qt, rendering, synchronization, integration, visualization, rendering algorithm, performance optimization

THE CONCEPT OF GENERALIZED DYNAMIC STATES IN THE EVALUATION OF FORCED MOVEMENTS OF MECHANICAL OSCILLATORY SYSTEMS

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Abstract: the work is aimed at developing a systemic approach within the framework of the methodology of structural mathematical modeling to solve problems related to ensuring the safety and efficiency of technical objects, whose calculation schemes can be represented by mechanical oscillatory systems with concentrated parameters. The structural approach involves solving problems based on the comparison of mechanical oscillatory systems with structural diagrams of equivalent automatic control systems in dynamic terms. The approach involves breaking down the object into component parts and determining their connections. The elements of the system are solid bodies and springs, while connected force oscillations act as external disturbing factors. The evaluation of the system's state is based on dynamic compliance, which depends on the frequency of external disturbances. It is shown that in mechanical oscillatory systems, the set of generalized dynamic states, which depend on the coefficients of connection of external force disturbances and the coordinates of points determining dynamic correspondence, can be expressed in the form of a map of dynamic invariants. One of the key results of the work is that the task of evaluating, controlling, and forming the dynamic states of the system can be carried out by decomposing the full set of states into a finite number of classes of dynamic states that have fixed dynamic invariants. This allows for a systemic approach to evaluating the system taking into account multiple parameters

Key words: structural methods of mathematical modeling, dynamic damping of vibrations, dynamic malleability, connectivity of force perturbations, solid body oscillation, generalized dynamic states, dynamic invariants

DEVELOPMENT OF LEVEL REGULATOR IN THE PRESSURE COMPENSATOR OF THE NPP FIRST CIRCUIT

V.L. Burkovsky, I.A. Boldyrev, U.A. Shcheglova, A.S. Kozhin, A.A. Golikov

Abstract: in modern industries associated with a high degree of labor safety and environmental safety, there is a certain conservatism in the approaches to designing automatic control systems (ACS), which does not allow penetration into this area not only of modern theoretical developments, but also limits the use of modern element base. Such industries include nuclear energy, which was formed in the second half of the 20th century and retained the ideological approach of that time. This article presents the structure of the implemented and still functioning automatic control system used to maintain the level in the pressure compensator of the primary circuit of the nuclear reactor of the Balakovo NPP (BalNPP). Also, the paper proposes and substantiates a mathematical model of the control system for maintaining the level in the pressure compensator of the primary circuit of the BalNPP nuclear reactor, built using modern methods of automatic control theory and with the possibility of its implementation on a modern element base. Parameters and limitations are determined that show the possibilities of the proposed automatic control system, within which the proposed ACS gives a deterministic quality of transient processes, but does not go beyond the already established technology of sensors and actuators. The result obtained in the work takes into account the features and complexity of the operation of control systems at facilities with increased danger and minimizes the commissioning part of the work, which is the basis for further replication of this approach on systems with high requirements for the quality and safety of ACS

Key words: pressure compensator, automatic control system, Balakovo NPP, condition for the implementation of the control law, negative feedback, positive feedback

QUALITY CONTROL OF METEOR COMMUNICATION RADIO LINK ON ULTRASHORT WAVES

V.I. Doroshenko, Yu.G. Ksenofontov, V.L. Martynov

quality assessment of meteor radio communication line at ultra-short waves. It is that the operational technological quality assessment of the high-frequency analog communication channel should be worked out within a few microseconds, and the formed discrete data transmission channel – within a few milliseconds. As process is multiphase, time of development of integral criterion of suitability of meteor communication radio line for telecommunication and possibility of its use in infotelecommunication is strictly limited in each phase of this process, therefore operational technological control and comprehensive quality assessment allow to develop an integral assessment for the minimum possible time with the minimum possible error. The article proposes a variant of the structural and functional diagram of the meteor communication radio line on ultrashort waves, which provides fragmentation-defragmentation of the stream of transmitted information data. The authors also focus on such a qualitative parameter as noise immunity of radio line, which directly influences on the channel bandwidth, ratios are given, from which it follows that the probability of error at a given transmission rate can be reduced by more than an order of magnitude or the average transmission rate can be increased by the same number of times at a given interference immunity

Key words: infotelecommunications, meteor communication radio line, rapid complex quality assessment of communication, system approach, indicators and criteria of communication quality, noise immunity, error probability

BANDGAP REFERENCE VOLTAGE SOURCE FOR A DOMESTIC TECHNOLOGICAL PROCESS

A.V. Rusanov, L.V. Sopina

Abstract: this paper describes a reference voltage source that generates a stable voltage of 1.259 V for a 8.6-15 V power supply. The reference voltage source generates a thermostable output voltage that is independent of input voltage fluctuations. Since the parameters of complementary metalloid semiconductor devices strongly depend on temperature, the only way to reduce it is a combination of devices with temperature dependence coefficients of different sign – the addition of a voltage with a negative temperature coefficient (STAT). It can be the base-emitter junction of a bipolar transistor in diode switching (U_{BE})) with a voltage with a positive temperature coefficient (PTAT) (a current source whose current increases in direct proportion to the temperature). In order to obtain a zero temperature coefficient of the reference voltage source (RVS), it is necessary that the temperature coefficient of the PTAT generator is equal in modulus to the temperature coefficient of the transition U_{BE} . An important advantage of the developed RVS is the extremely low values of the temperature instability coefficient in the range from -60 to 125 ° C and the voltage instability coefficient. The development of the scheme and modeling were carried out on a domestic technological process with design standards of 3 microns, the topology of the scheme was also developed. The simulation was carried out in the computer-aided design (CAD) system for the development of integrated circuits

Key words: reference voltage source, IP block, integrated circuit, microcircuit, RVS

DEVELOPMENT OF A HIGH-PERFORMANCE LDPC DECODER WITH PIPELINED DATA PROCESSING

A.V. Bashkirov, M.V. Khoroshailova, K.D. Tsipina

Abstract: this paper develops an efficient sum-of-products (MSPA) decoding algorithm that not only reduces the critical path delay, but also improves hardware utilization and decoder throughput while maintaining decoding algorithm error. The min-sum (MS) algorithm and its variants replace the complex control node (CN) calculations in SPA with simple addition and comparison operations, but this results in a performance loss of up to 1 dB compared to SPA for higher codeword lengths, code rates, and powers node. Three fully parallel low-density decoder architectures based on the projection geometry (PG) structure of the Galois fields of LDPC codes are presented. These designs differ in bit node (BN) and control node (CN) architectures. A 9-bit fixed-point quantization scheme is used to achieve better error correction performance. Another significant contribution of this work is the pipelining of proposed decoder architectures to further improve overall throughput. These parallel and pipelined architectures are implemented for 73-bit (rate 0.616) and 1057-bit (rate 0.769) regular structure PG-LDPC codes on the Xilinx Virtex-6 LX760 field-programmable logic integrated circuit (FPGA). The proposed designs are also flexible in terms of quantization, node degree, parallelism factor, and codeword length

Key words: Low Density Parity Check (LDPC) Codes, Simulation, Sum Product Decoding Algorithm (SPA), FPGA, Galois Fields (GF)

HYBRID MULTI-HOP RF-FSO SYSTEM WITH SPATIAL DIVERSITY

R.P. Krasnov

Abstract: the article studies a model of a multi-hop radio-optical atmospheric communication system using cooperative diversity with several relays in each channel. A radio channel is used as a backup, which is activated when the signal-to-noise ratio drops below a specified threshold in all optical channels. The choice of the working channel made based on the analysis of the channel state information according to the min-max criterion. With a further decrease in the signal-to-noise ratio to the limit threshold, a system outage condition occurs. The exponential Weibull model is used to describe the statistics of optical channels, and the Nakagami m-distribution is used for the radio channel. Expressions for calculating the bit error rate and the probability of failure of the hybrid system and FSO are given, the generalized Gauss-Laguerre quadrature function is used for the calculation. The expressions for the radio channel based on the calculation of the coefficients of the polynomial expansion are similarly presented. The dependences of the bit error rate on the average signal-to-noise ratio in the channels for various atmospheric transmission conditions, as well as for various combinations of the number of channels and relays in each of them are shown. The conclusion is made about the prevailing influence on the quality of communication of the number of repeaters in the channel compared to the total number of diversity channels. Dependences of the probability of failure of the hybrid system and FSO are given. The conclusion is made about the possibilities of improving the quality of communication in systems of this type

Key words: hybrid system, free space optics, radio channel, outage probability, bit error rate

EQUIVALENT HYBRID DIPOLE MODEL OF ELECTROMAGNETIC INTERFERENCE ESTIMATION BASED ON ARTIFICIAL NEURAL NETWORK

M.A. Romashchenko, D.V. Vasilchenko, D.A. Puhov

Abstract: the article proposes propose a new equivalent hybrid dipole model with artificial neural network (ANN) to estimate electromagnetic interference (EMI) generated during device operation. The traditional dipole model usually does not take into account the effects of multiple reflection and diffraction between the electromagnetic interference source and its nearby components, which in some cases leads to inaccurate calculation results. In the proposed method, the Green's dipole function is taken as input data and the emitted electromagnetic field is taken as output data of the ANN. The application of powerful ANN processing capabilities is necessary to modify the matrix-vector multiplication between the Green's function in free space and the dipole moments in the traditional dipole model, so that a new mapping between the equivalent dipoles and their emitted fields is established. This approach improves the efficiency of near-field electron scanning hardware-software complex (NHC) experiments by accelerating the work and improving the accuracy of data processing. Subsequent improvement of the algorithms will make it possible to expand the area of application of the software developed based on the described technique

Key words: electromagnetic interference; dipole; neural network; near field scanning; hybrid

LOW-ELEMENT ANTENNA ARRAY WITH INCREASED COVERAGE AREA

A.V. Lukyanchikov

Abstract: the intensive development of modern society requires the presence of modern communication systems, in particular fifth-generation networks. The use of unlicensed Wi-Fi spectrum as the "last mile" of 5G networks can accelerate their implementation. However, the system's throughput may become a bottleneck as it depends on the signal-to-noise ratio in the radio channel. To increase the radio channel budget, antennas with controllable directional patterns can be used, which are usually implemented using phased antenna arrays. A low-element array can be used to provide maximum communication speed in a Wi-Fi system, while requiring a minimum number of elements to control the directional pattern. In this work, the radiator of such an array is chosen and its geometric parameters are determined. Also, as a result of the study, the optimal distance between elements and discrete phase differences between inputs are selected, which allowed increasing the coverage area by 76%. A relatively simple excitation scheme and a structural diagram of the excitation device based on two discrete phase shifters and two power dividers are also proposed

Key words: directional pattern control, printed radiator, diagram-forming scheme, discrete phase shifter, voltage standing wave ratio (VSWR)

IMPROVING THE QUALITY OF PARTS MADE OF LOW-MELTING MATERIALS BY COATING CAST IRON

A.V. Norman, V.P. Smolentsev, A.V. Norman, M.V. Kondratiev

Annotation: the possibilities of coating highly loaded aluminum alloy parts with refractory cast iron are considered. The problem of preserving the geometry of parts without thermal destruction is solved due to their coating, which creates heat-protective properties on the surface of the product by erosion-chemical pulse hardening with cast iron electrodes. The mechanism of formation of heat-resistant joints of parts for assembly of assemblies with high wear resistance, low coefficient of friction of movable structural elements, lightened by 20-25% compared to parts made of gray cast iron, is disclosed. Recommendations on the composition of fluxes for combined coating processes are given. The influence of the use of fluxes on the adhesion of the coating is shown. The mechanism of obtaining a high-quality coating with minimal porosity of the surface layer is described. The use of a combined erosion-chemical method of hardening, fabrication and restoration of the operational properties of parts previously made of cast iron made it possible to reduce labor costs and the cost of parts up to two times when processing products in the field using the minimum amount of technological equipment. The possibility of applying high-quality cast iron coatings by the electroerosion-chemical method to aluminum alloys, where the layer resistance is maintained by forming a transitional diffusion nano layer after chemical flux removal of the oxide film from the surface of the joint of the part base, is proved

Key words: quality, coating, low-melting materials, cast iron, mechanism, fluxes, erosion-chemical treatment