COMPUTATIONAL EXPERIMENTS WITH THE CONTINUOUS FORM OF THE MAXIMUM CONSISTENCY METHOD IN REGRESSION ANALYSIS

S.I. Noskov, Yu.A. Bychkov

Abstract: we considered the features of estimating the parameters of a linear regression model using the continuous form of the maximum consistency method (CMCM) between the calculated and actual values of the dependent variable. At the same time, the discrete form of such consistency is formally expressed by the sum of the number of coincidences of the signs of increments of these values on all pairs of sample observation numbers. We carried out computational experiments with four-factor and five three-factor versions of the model for the length of main gas pipelines and gas pipeline branches in a single-line calculation. The independent variables used were the volume of production of stable gas condensate and oil, explored and proven reserves of natural gas, explored reserves of gas condensate. As a result of the experiments, we studied the following questions: elucidating the influence of the values of the compromise parameter between the CMCM -estimates of the parameters and the estimates obtained by the method of least modules; identifying the ranges of change of the nontriviality point in a linear programming problem that implements CMCM; assessing the adequacy of model options

Key words: regression model, loss function, behavior consistency criterion, maximum consistency method, least modulus method, computational experiments

VOICE ASSISTANT TO CONTROL AN OPERATING SYSTEM

P.S. Skochko, V.F. Barabanov, N.I. Grebennikova, S.L. Kenin

Abstract: we considered a wide range of applications of the voice assistant. Recently, intelligent systems based on a speech recognition algorithm have become widespread, due to their functionality, simplicity and ease of use, as well as a wide range of areas where they can be used. The demand for such systems has led to the fact that speech technology specialists, conducting research, are trying to create conceptually new algorithms to expand functionality. Here we present the algorithm of the work and the modular structure of the software package of a voice assistant. The means of software implementation of the voice assistant are defined (Python programming language, the PyAudio library is used to read sound from the microphone, the SpeechRecognition library is used to decrypt speech, the Fuzzywuzzy fuzzy string comparison mechanism is used to encrypt text, the text-to-speech technology of the PyTTSx3 library is used to generate speech). To compare the lines in the work, a common algorithm is used - the Levenshtein distance. The main idea of the algorithm is to calculate the modulus of the difference between two sequences of characters. Using the selected implementation tools, a voice assistant has been developed for the user of the Windows operating system with a primary set of demonstration functions

Key words: voice assistant, speech recognition, command recognition, command execution, speech generation, Levenshtein distance, Windows operating system, artificial intelligence

CREATING AN INFORMATION SYSTEM FOR DISTANCE LEARNING AT A DEPARTMENTAL HIGHER EDUCATION INSTITUTION

A.V. Khorosheva

Abstract: the article discusses the process of developing a distance learning system for the effective organization of the educational process of a departmental university, based on the Moodle distance learning platform. In the course of solving the task, we developed the information structure of the electronic courses of the Vladimir Law Institute of the Federal Penitentiary Service of Russia, created new system user roles, which make it possible to make work in the system safer and more convenient, including from the point of view of controlling the educational process as a whole and the activity of each user. For professors, a typical structure of an electronic course is proposed, which makes it possible to conveniently place methodological materials on the disciplines taught, receive feedback from students, and carry out various types of control over the formation of students' competencies in accordance with the work programs of disciplines. Such a structure makes it possible to reflect the results of the current monitoring of the progress of students in the study log, which is a distinctive feature of the organization of education in a departmental university. For students, we proposed an author's algorithm for completing an electronic course, which can be implemented both in distance or blended learning formats, and in full-time learning. On the example of information support of distance learning for the discipline "Information technologies in legal activity", the process of forming a database of test items is described. Experimental testing, conducted by the author among students following the results of studying the discipline "Information Technologies in Legal Activity", showed the effectiveness of the chosen approach to organizing electronic courses in the electronic information and educational environment of a departmental university

Key words: e-learning system, distance learning, e-course, course completion algorithm, creation and distribution of roles in the system

CONFIGURABLE ANTENNA SYSTEM WITH SIW FOR 5G NETWORKS

S.M. Fyedorov, E.A. Ishchenko, K.A. Berdnikov, S. I. Derevyankin, E.V. Papina, N.B. Smolyanov

Abstract: the article proposes the design of a substrate integrated waveguide (SIW) for communication tasks in 5G n261 networks (27.5-28.35 GHz). Thanks to the proposed design, it becomes possible to form radiation in three directions for the best quality of communication with a cellular subscriber. The proposed design can be used to create mini cells that provide coverage with 5G access networks in small areas. Through the use of a thin dielectric, it is possible to achieve a low profile of the antenna system and control the use of a system of electromagnetic waves that extract the metal rods that form the waveguide. Removing the pins opens the channel for the propagation of electromagnetic waves, which in turn makes it possible to connect the selected antenna element. As a result, we found that the final system has a high efficiency, high radiation efficiency. The results obtained are confirmed by the pictures of the directional diagrams, the electromagnetic field, the graphs of the scattering matrix. The use of a highly stable dielectric ensures that the return loss level is less than -10 dB in the operating frequency range, and the transmission coefficients are not less than -3 dB, which makes it possible to achieve the most optimal characteristics of the developed antenna design with SIW

Key words: substrate integrated waveguide (SIW), 5G, beamforming

COMPARATIVE ANALYSIS OF THE RESULTS OF FLIGHT TESTS OF TRANSMISSION OF HIGH-SPEED TARGET INFORMATION WITH QAM AND OFDM MODULATION

D.G. Pantenkov, M.A. Zagnetko, V.P. Litvinenko

Abstract: currently, robotic systems (RS) and complexes of various bases, including unmanned aerial vehicles (UAVs), have become particularly relevant. At the same time, any robotic vehicle is equipped with a wide range of payloads (sensors), from which it is possible to transmit information about the environment to a remote operator in real time, which, through its analysis and interpretation, will make certain decisions. Taking into account the fact that modern sensors have very high resolution capabilities, the amount of information that is recorded in internal memory and transmitted to a remote operator via a radio channel can be hundreds of megabits or even units of gigabits. In this case, the task of optimal selection of the signal-code design of the radio signal in the channel of the target information reset becomes urgent, on which the achievable throughput mainly depends. This article reviews the results of flight tests in terms of transmitting target information from a flight-lifting vehicle (FLV) to a stationary ground control and information processing station (GCIPS), a promising method of modulation of a radio signal based on OFDM (multiplexing with orthogonal frequency division of channels), and also presents a comparison of the energy parameters of a radio line when transmitting target information using classical quadrature amplitude modulation of QAM and OFDM signal, when a set of subcarriers in a common band are modulated by modulations with different encoding rates

Key words: flight-lifting equipment, target information reset radio channel, radio signal, modulation, QAM, OFDM, target information transmission rate, radio signal spectral efficiency, energy reserves, flight test results, hardware implementation, antennas, microwave modules

QUALITATIVE ASSESSMENT OF THE RECOGNITION OF RADIO EMISSIONS DURING RADIO MONITORING OF SATELLITE COMMUNICATION LINES

R.I. Burov, V.V. Kapitanov

Abstract: when carrying out radio monitoring of satellite communication lines by the method of active diagnostics of their relay paths, it becomes necessary to solve a number of problems of searching, detecting and comparing diagnosed satellite communication lines with a repeater specified for monitoring in order to identify reliable information about the actual use of the allocated frequency resource and its compliance with the issued operating permits radio electronic means. In the presence of undocumented possibilities for changing the configuration of relay paths and the possible functioning of unauthorized radio electronic means, solving the problem of recognizing observed radio emissions becomes the most urgent task. The aim of the work is to determine at a qualitative level the potential possibilities of recognizing radio emissions during radio monitoring of satellite communication lines by the method of active diagnostics of their relay paths. The element of novelty of the presented approach is the compilation of a glossary of recognition features from the most informative parameters of radio emissions, which make it possible to trace the characteristic features of the controlled relay paths. We showed that by monitoring for a certain time the change in the parameters of the diagnostic signal, it is possible to achieve an unambiguous solution to the problem of determining whether the observed satellite communication lines belong to a controlled relay satellite. The proposed approach makes it possible to substantiate the rational requirements for the dictionary of radio emission recognition features in the radio monitoring of satellite communication lines using the method of active diagnostics of their relay paths

Key words: test signals, radio monitoring, repeater satellite, retransmission tract, electromagnetic environment

DYNAMICALLY CONTROLLED BI-QUAD ANTENNA BASED ON ACTIVE METAMATERIAL

K.A. Berdnikov, E.A. Ishchenko, Yu.G. Pasternak, V.A. Pendyurin, S.M. Fyedorov

Abstract: the paper considers a Bi-Quad antenna with an operating frequency of 2.4 GHz and two active reflectors based on a reconfigurable metamaterial with electronic control based on pin diodes. Thanks to the proposed design, it is possible to ensure the operation of the antenna in the following modes: transparent reflectors, when bi-directional radiation is formed; switching of the lower plate of the metamaterial and the absence of switching of the upper plate, which leads to the formation of directed radiation upward with an increased value of the directional action coefficient; the switching of the upper plate of the metamaterial and the transparent mode of the lower one - the formation of downward-directed radiation. Thus, the antenna operates in three modes with the possibility of fast dynamic rebuilding of modes based on the commutation of pin diodes in the cells of the three-dimensional structure of the metamaterial. We confirmed the results of the operation of the obtained structure by the results, we replaced the pin diodes in the active mode by lumped elements in the form of spice models, and in the off mode - by equivalent circuits. Thus, we obtained the results with the highest accuracy for the proposed antenna design, which illustrate all modes of operation when switching metamaterial plates

Key words: active metamaterial, active reflector, reconfigurable antenna

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METHODOLOGY FOR ASSESSING THE PROBABILISTIC CHARACTERISTICS OF DETECTION WITH PIECEWISE LINEAR APPROXIMATION OF THE SOLVING FUNCTION

V.S. Kostennikov, M.F. Volobuev, V.N. Nadtochiy

Abstract: we developed a method for calculating the probabilistic characteristics of detecting a radio signal with a random initial phase and amplitude. We obtained analytical expressions for the probabilities of correct detection and false alarm when using piecewise linear approximation in solving devices. We used a piecewise linear solving function in a threshold device, which, unlike binary, is most accurately suitable for describing the real transients of the components of the element base, due to the difficulties of implementing in practice instantaneous changes in the stable states of the solver for a number of reasons, which include the dynamically changing noise environment of the operating conditions of detection systems and the need for instant adjustment of their parameters. When the samples of the receiver's output effect fall into the uncertainty zone formed by the piecewise linear solving function, these samples undergo additional iterations, which will allow us, in a number of restrictions imposed on the reception conditions, to increase the efficiency of signal detection. We performed a simulation, based on the results of which the characteristics of detecting a signal with a random initial phase and amplitude under the influence of white Gaussian noise are constructed. The presented detection curves allow us to evaluate the consistency of the obtained analytical expressions and compare them with those available in the known literature

Key words: methodology, piecewise linear solving function, detection efficiency, statistical modeling

DEVELOPMENT OF FUNCTIONAL BLOCKS FOR LINEAR VOLTAGE STABILIZER

D.O. Lyalin, E.D. Alperin

Abstract: the article presents a variant of the implementation of the behavioral model of complex-functional blocks in the Verilog-A language. We developed behavioral models of a reference voltage source, an error signal amplifier, and a stable current source. Using these complex functional blocks, we developed a behavioral model of a linear voltage stabilizer with the required parameters. The article contains listings of the developed behavioral models, test schemes for checking the correct operation, shows graphs of input and output signals dependencies. One of the indisputable advantages of behavioral models is the minimum simulation time, which is several orders of magnitude less than the simulation time at the transistor level. To speed up design time, it makes sense to create a model description in Verilog-A for further use in other devices when designing microcircuits. With this hardware description language, a simulation of an analog device can be realized digitally. At the same time, you can easily change the parameters as needed in a particular device. The article presents the results of modeling complex-functional blocks and a linear voltage stabilizer are compared with the necessary parameters

Key words: complex functional block, behavioral model, Verilog-A, linear voltage stabilizer

REFLECTOR ANTENNA BASED ON SIW TECHNOLOGY

I.A. Barannikov, K.A. Berdnikov, S.I. Derevyankin, E.A. Ishchenko, K.V. Smuseva, S.M. Fyedorov

Abstract: the article discusses a reflector antenna developed on the basis of the "substrate integrated waveguide" (SIW) technology. We formed, an electrodynamic model of a horn radiator with a trapezoidal dielectric lens to improve the characteristics of the radiator to study the full characteristics as well as to determine the range of operating frequencies. The obtained results of modeling the emitter showed that SIW antennas have high quality indicators, as well as ways to ensure high efficiency in a wide frequency range. On the basis of the design of the horn SIW antenna, we formed a reflector SIW antenna with two types of design: a mono-board structure, when the antenna and reflector are located on a single dielectric rectangular substrate, and also a design with minimal use of dielectric. The resulting designs were investigated using electrodynamic modeling, which showed that SIW reflector antennas have high quality characteristics - high directivity, total efficiency, and also have a narrow directional beam of the main lobe of the directional pattern. On the basis of the obtained structures, we made conclusions about the possibility of using the SIW technology in reflector antennas of the millimeter range of radio waves

Key words: SIW horn antenna, reflector antenna, millimeter wave

AUTONOMOUS PORTABLE ELECTROENCEPHALOGRAPH BASED ON NVIDIA JETSON SINGLE-BOARD COMPUTER

A.B. Stepanov, D.V. Kozlov, A.V. Zapayshchikov

Abstract: the work is devoted to the implementation of an autonomous portable electroencephalograph based on an Nvidia Jetson Nano single-board computer and on an ADS1299 analog-to-digital converter from Texas Instruments. The electroencephalograph allows real-time recording and processing of 8 physical channels with sampling rates from 250 Hz to 16 kHz. The concept of this device is proposed, which consists of 3 main functional blocks: a data recording unit, a data processing unit, and a data visualization unit. We developed a modified algorithm for the operation of a portable electroencephalograph based on the calculation of wavelet coefficients and Welch's periodograms, which allows determining patterns of a certain shape corresponding to artifacts and pathological states of the brain, as well as evaluating the energy ratios of the main rhythms in the electroencephalogram. The developed algorithm uses the graphics processor of the Nvidia Jetson Nano singleboard computer, which makes it possible to use parallel computing and increase the speed of the proposed algorithm. We substantiated the choice of the hardware and presented its advantages. We developed a block diagram, a 3D model and assembled a portable electroencephalograph. The dimensions of the electroencephalograph are as follows: width 250 mm, height 72 mm, depth 111 mm. We give a detailed connection diagram of the hardware of the electroencephalograph. The developed electroencephalograph has a power supply unit that allows the electroencephalograph to function autonomously for a long time. We developed a graphical user interface that allows controlling the electroencephalograph using a touch screen. We tested the prototype. During the test, signals with eye artifacts that have a special shape. During the tests, all eye artifacts were unambiguously identified in the analyzed signals. We practically got that the proposed algorithm of the electroencephalograph operation is performed in 100 ms with an eight-channel EEG duration of 1 s and a sampling frequency of 250 Hz. The obtained results of algorithm execution show that there is a significant margin in terms of the computing power of the device, which will allow more complex EEG processing in the future

Key words: portable electroencephalograph, graphical processing unit, Nvidia Jetson, analog-to-digital converter, wavelet, time-frequency analysis

DUAL TYPE OF ELECTRIC FIELD SENSORS OF INCREASED ACCURACY

S.V. Biryukov, A.V. Tyukin, L. V. Tyukina

Abstract: the article analyzes the basic dual spherical electro-induction sensors of electric field strength in order to identify their design parameters and parameters of the interaction of sensors with the EP, affecting the error of its perception. We carried out optimization of the sensor's sensitive elements in order to identify the minimum error and the maximum of its spatial measurement range, in which its minimum error is ensured. Optimization made it possible to reduce the error of the basic sensors by approximately two times, i.e. from \pm 4.6% to \pm 2% and to offer three possible variants of the implementation of the sensitive elements of dual sensors. In the first variant, the angular size θ_{01} of the second pair of sensing elements is increased from 45[°] to 47[°]. This made it possible to reduce the sensor error to $\pm 2.1\%$ at the upper limit of the spatial measurement range a = 0.93. In the second variant, the angular size θ_{02} of the first pair of sensing elements is increased from 45^o to 47^o, with a constant size $\theta_{01}=90^{\circ}$ of the same pair, and the angular size θ_{01} of the second pair of sensing elements is also increased from 45° to 47° . This made it possible to reduce the error of the second version of the sensor to $\pm 2.1\%$ at the upper limit of the spatial measurement range a = 0.93. In the third version, the angular size θ_{02} of the first pair of sensing elements was reduced from 45° to 40°, with a constant size $\theta_{01}=90^\circ$ of the same pair, and the angular size θ_{01} of the second pair of sensing elements was reduced from 45[°] up to 35[°]. At the same time, the sensor error in the entire spatial range does not exceed $\pm 2\%$. Using dual sensors of three versions, it is possible to achieve a significant increase in the accuracy of measuring the strength of inhomogeneous EP in a wide spatial measurement range compared to basic sensors, while the third option is preferable

Key words: electric field strength sensor, dual sensor, dual sensor, electric field strength, field inhomogeneity error

DETECTING DEFECTS OF THE "PORES" TYPE IN STEEL WELDED JOINTS

M.N. Davydov, S.V. Safonov, V.V. Shurupov

Abstract: the work is devoted to the issue of detection of defects such as "pores" in steel welded joints made with full penetration of the root of the weld. We considered the classification of defects, the causes of their occurrence, as well as their influence on the performance of a part or structure. We described the factors that reduce the probability of detecting this type of discontinuity by ultrasonic testing, in particular, by the echo-pulse method. Welded joints made of Steel 20 with a nominal thickness of welded elements of 12 mm were used as the object under study. In these samples, according to the results of radiographic control, unacceptable internal defects were revealed in the form of porosity, accumulations and chains of pores. The purpose of the experiment was to determine the possibility of detecting such defects by ultrasonic testing. We describe the equipment used and the methodology for conducting the experiment. We determined the modes of control, scanning and selected the dimensions of the control reflectors in the tuning sample, which imitate a natural defect in the product, respectively, their size is equivalent to the maximum allowable single defect in the test object. During the ultrasonic testing, internal pores were fixed, but the amplitude of the echo signal from these defects was significantly lower than the rejection sensitivity level. We tabulated the results and plotted the indications found against sensitivity levels. None of the indications found during radiographic control exceeded the control level of sensitivity, i.e. fixation level

Key words: welded joints, defects, non-destructive testing, ultrasonic testing

DEVELOPMENT AND RESEARCH OF A DEVICE FOR STAMPING PARTS FROM HARD-TO-DEFORM ALLOYS

A.Yu. Botashev, R.A. Bayramukov, A.A. Aybazov

Abstract: we developed a device for use in small-scale production for stamping sheet parts from high-strength alloys. Stamping is carried out by the pressure of the products of combustion of gaseous fuel. The device contains a working cylinder with a piston and two combustion chambers: main and additional. The design feature of this device is the presence of a plate containing through holes and a check valve between the working cylinder and the combustion chamber. Due to this, the energy carrier is compressed and burned in the combustion chamber, as a result of which gas is generated with a pressure of up to 60 MPa and a temperature of 2100 ... 2200 °C, which deforms the workpiece. During the stamping process, combustion products are also compressed in the die cavity, which helps to prevent the workpiece from breaking. In addition, due to their compression, the temperature in the cavity of the matrix increases intensively and reaches 2600 ... 2680 °C. Due to this, a rapid heating of the workpiece is carried out, which, providing a significant increase in its plasticity, facilitates the stamping of parts of complex shape. By analyzing the working process of the energy carrier, the achievement of the maximum gas pressure acting on the blank being stamped. In particular, the optimal ratios of the volumes of the working cylinder and the combustion chamber, as well as the ratio of the volumes of the combustion chambers, were found. This device allows you to stamp a wide range of parts from high-strength low-ductility alloys

Key words: gas stamping devices, stamping of low-plastic alloys

APPLICATION OF REGRESSION ANALYSIS IN SOLVING THE PROBLEM OF DETERMINING SIGNIFICANT PARAMETERS FOR ELECTROCHEMICAL PROCESSING WITH A FIXED ELECTRODE-TOOL

A.I. Boldyrev, A.V. Perova, A.A. Boldyrev

Abstract: the article is devoted to solving problems of determining the most significant parameters for the anodic dissolution of a conductive material in the electrolyte medium, implemented according to the scheme with fixed electrodes. With such scheme for part processing, deviations from the required geometric parameters characterize both the accuracy and the quality of the surfaces being machined. The use of experiments planning method made it possible to establish the influence of several factors on electrochemical processing of samples made of steel 40X13 on the specific material removal, non-flatness and non-parallelism of the treated surfaces relative to the working end of the electrode-tool. The anodic dissolution of the cylindrical samples end surfaces with the diameter of 11 mm and height of 6 mm was carried out with a longitudinal electrolyte flow in the SEHO-901 serial machine-tool with adaptive processing modes. The factors to be studied were the following: the interelectrode gap, the voltage on the electrodes, the concentration of the electrolyte, the temperature and speed of the electrolyte flow, and the hydrogen index. At the same time, a series of experiments was planned in such a way that each of the factors varied at two levels, symmetrical with respect to the base one. The use of regression analysis in the planning of experiments made it possible, as a result of carrying out, to exclude insignificant factors and velocity of the electrolyte in the gap

Key words: electrochemical processing, fixed electrodes, experiment design, regression analysis

DEVELOPMENT OF MANUFACTURABILITY IN THE CREATION OF COMPETITIVE AEROSPACE TECHNOLOGY

S.V. Safonov, A.V. Mandrykin, M.N. Davydov

Abstract: the methodology of testing manufacturability of aerospace products is presented. It is most often required when launching new competitive products. We considered the indicators included in the assessment of the level of utility, as well as typical options for applying the utility criterion. We developed a methodology and procedure for criteria-based testing of the manufacturability of mastered products at the stage of their design, development of prototypes and serial samples. We showed that as a result of the development of manufacturability, the creation of promising products at the level of world standards, which have undeniable operational advantages, is accelerated. The application of the proposed methodology for testing manufacturability using the principle of utility allows you to quickly justify the choice of rational technological solutions. We propose a new methodology for the selection and assignment of non-traditional technological operations, allowing the use of the most advanced technological processes for the combined processing of critical parts of aviation and rocket-space technology using the principle of utility and similarity for technological systems. We showed examples of the application of the new methodology when launching the created promising products of technology. We established that the selection and criteria-based justification of the choice of processing methods in the process of developing manufacturability made it possible to improve the quality and performance characteristics of products

Key words: manufacturability, combined technologies, competitiveness, aerospace engineering