STRUCTURE OF THE DECISION SUPPORT INFORMATION SYSTEM BY THE NPP OPERATOR

M.E. Ushkov, V.L. Burkovskiy

Abstract: we considered the structure of the information support system for decision-making by the NPP operator in operational conditions. We analyzed the functional capabilities of the operator information support system (SIPO) using the example of the Novovoronezh nuclear power plant (NV NPP). This system provides the operator managing the distributed complex of NPP technological facilities to carry out high-quality analysis and processing of large volumes of complex structured information and make timely adequate decisions in real time. In addition, we considered the control object and its structure and made recommendations aimed at increasing the functionality of the SIPO based on artificial neural networks. One of the many functions of the SIPO is to predict the state of the control object based on the implementation of the software and technological complex of the power unit model. However, the existing model is not able to take into account all the factors influencing the production process. An alternative here is an artificial neural network, which in the learning process can form the required dependencies between a large number of parameters of the control object and get a more complete and reliable forecast. The proposed structure of an artificial neural network based on a fuzzy inference system, which implements the capabilities of neural networks and fuzzy logic

Key words: operator information support system, ANFIS, prognostication, safety, functionality

SOFTWARE DEVELOPMENT
FOR RENDERING THREE-DIMENSIONAL SURFACES IN A WEB BROWSER

K.G. Reznikov, S.N. Medvedev

Abstract: the article presents the implementation of software for rendering 3D-surfaces using ray tracing, running in a web browser of computers or smartphones. The web application approach has become widespread in recent years due to the development of the Internet. Modern web browsers have enough processing power to run complex web applications and are not limited to just websites. During the development process, various methods for constructing surfaces and visualization methods were analyzed to choose the most optimal solution for web applications. We analyzed and presented basic methods of creating 3D surfaces. We highlighted the key differences between wireframe and polygonal methods of surface definition. We considered several models with dynamic surface computation. We described the kinematic method of surface formation in detail and the developed algorithm for transforming kinematic models into a surface using a polygonal mesh. We described in detail the rendering process and ray tracing method. We demonstrated a way of working with a video chip and parallelizing computations to optimize a web application using the GPU.js library. We presented the structure of a web application with a description of the main project directories. The project structure is based on the Vue.js framework. The framework allows one to endlessly expand the functionality of a web application. The article presents how the web application works and example of step-by-step creation of a kinematic surface and rendering on a scene using graphic effects such as shading and lighting. Also it contains an example of rendering many objects on a scene

Key words: 3D-modeling, rendering on surfaces, kinematic models, ray tracing, web application

DEVELOPMENT OF A DISTRIBUTED INFORMATION AND COMPUTING CONTROL
SYSTEM FOR THE NUCLEAR UNIT AT NOVOVORONEZH NPP

D.S. Sinyukov, A.D. Danilov, A.A. Samodeenko, A.A. Ivannikov

Abstract: nuclear units of nuclear power plants have a long service life, which leads to a situation when, during the operation, the technical and software tools of control systems no longer meet the current modern requirements in terms of reliability and safety of their use. As a result, in order to extend the validity period of the nuclear unit, mandatory modernization of the information and computing system (ICS) of management is required. This article presents the results of such work carried out at Unit 4 of the Novovoronezh NPP. When choosing the equipment to create a new ICS of the upgraded power unit, we implemented the principle of unification. The software of all components of the ICS software and hardware complex, including the functions of systems for providing security parameters and in-reactor control, is implemented on unified software tools. The representation of signal parameter values at all workstations of the software and hardware complex of the information system, the interfaces of human-machine interface interaction and navigation through video frames are identical, which takes into account the requirements for optimal interaction of the man-machine system. The system meets the requirements for ensuring reliability based on redundancy, independence, diversity, taking into account failures for a common reason. For this purpose, we implemented the ICS in the form of a two-channel information system. The main and backup channels of measurement and data processing in the ICS software and hardware complex function simultaneously in full. The developed information and computing system made it possible to extend the service life of 4 power units of the Novovoronezh NPP for 15 years

Key words: information and computing system, client-server architecture, parameter control, object interface device, data archive

VISUALIZATION TECHNOLOGY OF AUGMENTED REALITY OBJECTS, DEPENDING ON GEOINFORMATIONAL DATA

A.A. Korotysheva, S.N. Zhukov

Abstract: displaying navigation information in the form of a projection onto the windshield of a car or the glass of a motorcycle helmet ensures its perception by the driver without switching attention from the road to the dashboard, thereby increasing road safety. The currently used information visualization technologies for the navigation equipment of a car or motorcycle are quite expensive and not widely used, therefore, the creation of simple and inexpensive open-source software that increases the efficiency of information processing and display seems to be relevant. The article proposes an architecture for building such a navigation system using the technology of prompting the driver in the form of augmented reality objects and using open geoinformation services. We considered the structures and types of data used in technology, as well as a possible set of hardware for visualization of navigation information. We implemented algorithms for visualization of dynamic objects of augmented reality and processing of geodata in the program code in the Python language. We developed an interactive interface that has an integrated effect of combining the advantages of navigation systems and geoinformation data services. We give the results of testing the code when visualizing the direction of movement along a given route in real time

Key words: augmented reality, visualization, geoinformation systems, route construction

PARAMETRIC IDENTIFICATION OF THE DIFFERENTIAL MODEL OF HEAT EXCHANGE IN A GASIFIER

S.V. Borodkin, I.L. Bataronov, A.V. Ivanov, V.I. Ryazhskikh

Abstract: we formulated the problem of parametric identification of the model based on measurements on the standard equipment of an industrial gasification plant on the basis of a one-dimensional differential model of heat transfer in a closed-type gasifier. The model includes an additional integral condition and a self-consistently defined movable boundary separating the icing zone of the evaporator tube. Using the method of smoothing the singularity, we developed an algorithm for iterative solution of the model equations, using the end-to-end counting method to solve the transfer equation in one iteration. We used a mixed strategy for parametric identification of the model. We determined some of the identified parameters (evaporator heat capacity, heater power, mass pump capacity, heat transfer coefficient to the environment) on the basis of specially organized measurements: heating of the evaporator without pumping supercritical fluid, gasification under conditions of thermal insulation of the evaporator body, gasification in stationary operation. We identified the remaining parameters (heat transfer coefficients to the coolant and supercritical fluid) in passive measurements with different pump capacities. We noted that due to the poor conditionality of the problem and the limited variation of coefficients, the use of regression methods in this model is ineffective. Based on the ballistic method, we developed an identification method, which consists in determining parameters by measurements with marginal performance with the construction of a functional relationship between the identified parameters, followed by verification on intermediate measurements. We tested the method on the example of a standard gasification plant SGU-7KM-U

Key words: gasifier, differential heat transfer model, parametric identification, mixed strategy

SATELLITE SELECTION ALGORITHMS FOR POSITIONING, NAVIGATION AND TIMING USERS

V.O. Zhilinskiy, L.G. Gagarina

Abstract: the article provides an overview of methods and algorithms for forming a satellite constellation as a part of the navigation problem for the positioning, navigation and timing service. The emergence of new orbital constellations and the development of past GNSS generations increase both the number of navigation satellites and radio signals emitted by every satellite, and therefore the proper solution of satellite selection problem is an important component of the positioning, navigation and timing service. We considered the works devoted to typical algorithms of working constellation formation, as well as to modern algorithms built with the use of machine-learning theory elements. We present the relationship between user coordinates errors, pseudorange errors and the influence of spatial location of satellites and the user. Three directions of researche among reviewed algorithms are outlined: 1) finding the best satellite constellation that provides the minimum geometric dilution of precision; 2) finding quasi-optimal satellite constellation in order to reduce the computational complexity of the algorithm due to the large number of visible satellites; 3) possibility to work in a combined mode using radio signals of multiple GNSS simultaneously. The article presents the features of the algorithms' implementations, their advantages and disadvantages. The conclusion presents the recommendations to change the approach to assessing the performance of the algorithms, and concludes that it is necessary to take into account both the satellite geometric configuration, and pseudorange errors when satellite constellation is being formed

MULTIFUNCTIONAL DATA COLLECTION SYSTEM FOR MONITORING THE STATE OF TECHNICAL FACILITIES

G.V. Petrukhnova, I.R. Boldyrev

Abstract: we present a set of technical means for creating a data collection system. We carried out the formalization of the processes of implementing the control functions of a technical object. The multifunctional data collection system consists of functionally complete devices that perform certain functions in the context of the system operation. This system, on the one hand, can be one of the nodes of a distributed data collection system, on the other hand, it can be used autonomously. We show the relevance of the system creation. The development is based on the RISC microcontroller STM32H743VIT6, ARM Cortex-M7 family, operating at a frequency of up to 400 MHz. The main modules of the system include: a 20-input voltage distributor; a power supply and settings module; a digital control module; a module for analyzing, storing and transmitting data to a control computer. We considered the composition and purpose of these modules. A chain of devices is responsible for data collection in the system under consideration: sensor – matching circuit – ADC – microcontroller. Since the system includes not only an ADC but also a DAC, an object management system can be implemented on its basis. The choice of sensors for taking information is due to the characteristics of the object of control. It is possible to manually measure the electrical parameters of the communication circuits, including checking the power supply of IDE and SATA devices. The presented data collection system is a tool that can be used to automate the processes of monitoring the condition of technical facilities

Key words: data collection, technical control, control system, switching connector, voltage regulator, sensor, analog signal, digital signal, ADC, DAC

SYSTEM FOR PROVIDING AUTOMATIC NAVIGATION OF AN UNMANNED AERIAL VEHICLE IN THE VICINITY OF AN AIRFIELD

D.A. Smirnov, V.G. Bondarev, A.V. Nikolenko

Abstract: the article discusses the development of a system capable of providing automatic navigation of an unmanned aerial vehicle in the vicinity of an airfield without the use of additional sensors. We considered an algorithm for solving this problem using an onboard monocular vision system operating in the range of 1.55 microns. To ensure navigation, the unmanned aerial vehicle is equipped with an information exchange system, and in the area of the take-off and landing point, we propose to use semiconductor lasers with incoherent radiation with a wavelength of 1.55 microns, which ensure the operation of the system in simple weather conditions, as ground sources (beacons). By measuring the azimuth angle at two points of the trajectory of the unmanned aerial vehicle, we calculated its location coordinates relative to the runway, as well as the course angle necessary to reach the starting point of the descent glide path. Since measurement errors are caused by errors in measuring the azimuth angle, course and flight speed, we neglected errors in measuring time intervals in this work. The obtained graphs show that the errors in measuring the coordinates of an unmanned aerial vehicle are minimal when flying in front of the lighthouse and increase sharply when moving away from it, which is due to the error in measuring azimuth and range. At the same time, the measurement of the location of the unmanned aerial vehicle must be carried out at a minimum distance from the lighthouse

Key words: navigation, unmanned aerial vehicle, airfield surroundings, semiconductor lasers, vision system, laser beacons

USING BLOCK PSEUDOREVERSION IN SEQUENTIAL DATA PROCESSING

E.P. Trofimov

Abstract: the paper proposes an algorithm for sequential data processing based on block pseudoinverse of full column rank matrixes. It is shown that the block pseudoinverse formula underlying the algorithm is a generalization of one step of the Greville's pseudoinverse algorithm in the nonsingular case and can also be used as a generalization for finding weights of neural network function in the LSHDI algorithm (linear solutions to higher dimensional interlayer networks). The presented algorithm uses the pseudoinversed matrixes found at each step, and therefore allows one to reduce the computations not only by working with matrixes of smaller size but also by reusing the already found information. Examples of application of the algorithm for signal and image reconstruction are given. The article deals with cases where noise is static but the algorithm is similarly well suited to dynamically changing noises, allowing one to process input data in blocks on the fly, depending on changes. The block pseudoreverse formula, on which the described algorithm is based, works well in the case of ill-conditioned matrixes, which is often encountered in practice

Key words: block pseudoreverse, data processing, Greville's algorithm

APPLICATION OF PLASMA ANTENNA TECHNOLOGY TO IMPROVE RADIO COMMUNICATION STEALTH IN VHF BAND

I.A. Barannikov, E.A. Ishchenko, S.M. Fyedorov

Abstract: the article discusses a plasma dipole antenna, which is designed to operate in the VHF band at a frequency of 140 MHz. Plasma dipole antennas differ from conventional dipole antennas in that the metal conductor is replaced by plasma in the discharge tube. The plasma dipole created by the discharge in the tube is capable of turning on and off in times of the order of microseconds. The use of a plasma antenna makes it possible to provide two modes of operation: active, when the plasma induces a conductive surface, and hidden, when the antenna becomes practically invisible to electromagnetic waves, and the plasma cloud is absent. We used electrodynamic modeling to determine the characteristics of the antenna. The results show that the characteristics of the plasma dipole antenna are close to those of the equivalent metal dipole, while the length of the plasma antenna is shorter. To determine the efficiency of the hidden mode of the antenna, we compared the characteristics of radar cross-section of the plasma antenna with the plasma cloud turned off and the equivalent metal dipole. The results obtained show that the plasma antenna has a high radiation efficiency, directional patterns similar to an equivalent dipole antenna, and significantly lower RCS values in the off mode

Key words: plasma dipole antenna, radio communication stealth

MODERN APPROACHES TO DIAGNOSTICS AND REPAIR OF LOW-POWER SWITCHING POWER SUPPLIES

M.A. Romashchenko, A.V. Gudkov

Abstract: the article considers the issues of optimization of technological processes for troubleshooting low-power DC-DC converters manufactured by company AEDON. We listed the most typical malfunctions that occur in low-power switching power sources. We considered the main methods of troubleshooting used in the process of diagnostics of pulse converters. We propose an approach based on the combination of various diagnostic and repair methods, which allows one to increase the efficiency of troubleshooting of pulsed DC-DC converters. The considered approach allowed us to increase the efficiency of technical diagnostics and repair in the conditions of mass production, and was also effectively used in training of young specialists of the adjustment and testing subdivision. As an example, we present the procedure for finding and eliminating the causes of increased idle voltage in low-power switching power sources. We considered the reasons for the appearance of the defect both in single modules and in the entire batch. We carried out an experimental study of the effect of feedback on the output voltage of the module in the idle mode. We showed the influence of possible failures. As a result of the application of this procedure, we performed diagnostics and repair of a low-power switching power supplies in a short time and adjusted the voltage feedback

Key words: switching power supply, technical diagnostics, DC-DC converters

METHOD OF FINDING LOSSES IN THE THROTTLE WINDING AS A RESULT OF THE SKIN EFFECT AND THE PROXIMITY EFFECT

A.A. Moiseenko, S.M. Fyedorov

Abstract: here we present a method for using computational methods and modeling magnetic fields in two-dimensional space to find high-frequency losses in the winding of winding products, such as a choke or transformer. We analyzed the literature on this topic, as well as the issue of optimization and adaptation of analytical formulas for the case of using round-section conductors and winding having a non-uniform distribution of layers in the core window. We discussed the analytical finding of the length of the winding wire of the winding with a different number of layers and a variable number of turns used in this case. To automate the calculation using formulas, we wrote a script that builds the dependence of the resistance to alternating current relative to the frequency using analytical formulas. In addition, we wrote a program for automatically setting the initial conditions and boundary values of the modeling parameters, the process of modeling electromagnetic fields itself, analyzing the data obtained, as well as forming an array for plotting the resulting dependence of resistance on frequency. This method uses freely distributed software for both mathematical calculations and modeling of electromagnetic fields. The result of this work was a comparison of the results obtained, which showed good convergence and continuity of the stages of this method

Key words: proximity effect, finite element method (FEM), FEMM, skin effect, Smath Studio, Dowell formula

DEVELOPMENT OF CALIBRATION MODULES FOR A COMPLEX OF ASSESSING THE IMPACT OF ELECTROMAGNETIC INTERFERENCE ON ELECTRONIC DEVICES

D.A. Pukhov, A.V. Suvorin, D.V. Vasil'chenko, M.A. Romashchenko

Abstract: in the modern world, with the desire of all mankind to miniaturize electrical products without loss of power, one of the significant problems is the influence of electromagnetic interference on the stable functioning of devices. This article presents the calibration modules used in the software and hardware complex (SHC), which allows one to assess the influence of electromagnetic interference (EMI) on electronic means. The practical distortion of signals is inevitable since the cause of interference can be their mutual influence on each other, as well as the configuration of the printed circuit board pattern itself. The paper considers modules that allow identifying a number of errors based on previously obtained results and providing calibration of the complex in order to increase the accuracy of estimating the effect of self-induction and transmission line impedance on the introduced signal distortion in various configurations of the PCB trace. The use of this software and hardware complex can significantly reduce the development time and conduct tests that require financial costs since it allows one to conduct a number of experiments at the stage of prototyping electrical products

Key words: printed circuit board, electromagnetic interference, transmission impedance, electromagnetic compatibility, calibration modules

MULTIPATH ANTENNA SYSTEM OF THE VHF BAND BASED ON A LENS MADE OF GRANITE RUBBLE

V.I. Nikolaev, Yu.G. Pasternak, V.A. Pendyurin, S.M. Fyedorov

Abstract: we propose a design of a surface multi-beam antenna array based on a lens of crushed granite, which makes it possible to simultaneously form up to several tens of beams in the long-wave region of the VHF wave range. We estimated the effective dielectric constant of crushed granite using the Lichtenecker formula for fine mixtures; its value is approximately equal to 3. To estimate the magnitude of the deceleration of surface waves in the lens, we used a technique to analyze the dispersion characteristics of a mirror dielectric waveguide; at a lens height of 1.8 meters, the effective dielectric constant of the equivalent mirror dielectric waveguide is 2.1. As irradiators of the lens - asymmetric electric vibrators located on a circle around the perimeter of the lens, the diameter of which is 30 meters; the diameter of the underlying steel surface is 40 meters. The proposed antenna system is characterized by a loss in rubble of about 3 dB with a lens diameter of about 3.8 wavelengths; the directivity of each beam can be about 15.5 dB, with the width of the main lobe in the azimuthal plane at half power level of about 10 degrees

Key words: ground antenna, lens antenna, multipath antenna system

COMBINED TECHNOLOGIES FOR MANUFACTURING PARTS IN SOLID ELECTROLYTES

V.P. Smolentsev, A.A. Izvekov

Abstract: we considered the issues of manufacturing open and semi-open cavities in difficult-to-machine parts by using solid electrolyte applied to the workpiece before installing the removable insert. We show the features of the process of anodic dissolution of the allowance at a static state of the working medium. Such studies have been performed for the first time. We developed and tested in practice the processing modes for the implementation of the process for the manufacture of standard parts. We show that solid electrolytes have prospects for further use in the design of technological processes for the manufacture of complex-profile products from metal hard-to-machine materials, including those introduced on the created samples of rocket and space technology. They expand the technological capabilities of combined methods, in which one of the influencing factors is an electric and electromagnetic field with a high concentration of power in a pulse. For the first time, the ability to separate assembly units by forming a gap between mating parts without access to the processing zone of a liquid working medium has been achieved, which determines the possibility of local removal of the allowance at the mating point and removal of a layer of material sufficient for disassembling the units. We laid the foundations for the use of additive technologies for applying solid electrolyte by building up uniform layers before assembling the product. The proposed technology is promising for the manufacture of prefabricated structures with limited tool access to the operation area. In addition, the new technology can be successfully applied in the process of car repair

Key words: technology, solid electrolyte, anodic process, application area

ANALYSIS OF TECHNOLOGICAL POSSIBILITIES OF TWO-CHAMBER IMPULSE DEVICES FOR SHEET STAMPING

A.Yu. Botashev, A.A. Musaev

Abstract: we carried out the analysis of technological capabilities of two-chamber devices for sheet stamping with one and two combustion chambers. In devices with one combustion chamber, the stamping process is carried out in the cold state of the workpiece by the action of an elastic medium on it, using the kinetic energy of the piston accelerated by the combustion products of the gaseous fuel mixture. In devices with two combustion chambers, the stamping process is carried out with the heating of the workpiece by the action of the hot gas formed during combustion in the upper chamber of the pre-compressed fuel mixture. In this case, the mixture is compressed due to the energy of the combustion products formed in the lower chamber. We established that devices with one combustion chamber are expedient to be used for stamping parts of various shapes with a thickness of up to 4 mm and from plastic non-ferrous alloys with a thickness of up to 8 mm from ductile steels. Devices with two combustion chambers are advisable to be used for stamping parts from low-plastic grades of aluminum, titanium alloys and other hard-to-deform alloys. Two-chamber devices for sheet stamping have wide technological capabilities and can be effectively used in small-scale production for stamping parts of various shapes

Key words: sheet stamping, double-chamber stamping device, stamping process, workpiece heating

IDENTIFICATION OF THE INFLUENCE OF THE SPATIAL ORIENTATION OF THE DEPOSITED LAYERS, AS WELL AS THEIR OVERLAP COEFFICIENT ON THE SURFACE SHAPE ERROR DURING ADDITIVE SHAPING BY AN ELECTRIC ARC

A.N. Grechukhin, V.V. Kuts, P.S. Shcherbakov

Abstract: the article is devoted to the study of the issues of managing the process of additive shaping of products. The paper presents the results of a study of the process of additive surface shaping by an electric arc in a protective gas medium. We analyzed the error of the shape of the surfaces obtained with different filling layers. We confirmed experimentally that such process parameters as the orientation of the layers, their overlap coefficient are significant. Thus, the error of forming samples of surfacing layer on layer in the vertical direction is higher compared to other methods of surfacing implemented in the experiment. The average values of the sample shape error are 0.75 mm, 0.88 mm, 1.15 mm, respectively, for methods of surfacing layer to layer on a horizontal surface with an overlap coefficient of 0.3, layer to layer on a horizontal surface with an overlap coefficient of 0.5, layer to layer in the vertical direction. The maximum error values are determined at the level of 0.85 mm, 1.2 mm, 1.5 mm for the corresponding surfacing methods implemented in the experiment. Thus, the spatial orientation of the layers, as well as the overlap coefficient of the layers, are significant, affect the numerical value of the shape error of the resulting surface, should be taken into account when designing algorithms for dividing into layers, filling them with additive shaping by an electric arc in a protective gas medium

Key words: additive technologies, layer-by-layer synthesis, shaping, error