SIMULATION OF DESIGN COMPONENTS OF POWER SUPPLY SYSTEMS FOR PERSONAL COMPUTERS

A.N. Yurov, D.V. Tsymbal

Abstract: we propose the development of a digital model of the product, which is a computer component - a pulsed power supply. We carried out the analysis of the expected components of the personal computer that will be installed in the system. If necessary, there is a choice with the addition of new components to the system unit of the computer. After determining the specified PC components, the power is calculated, which is needed to obtain stable operation of the system as a whole. According to the calculations made, 3D-modeling of the power supply unit with connectors for connecting the motherboard, video card, as well as other devices, including information storage devices, is performed. The paper investigates the issues of using linear programming methods for solving the assigned tasks in accordance with the initial data, as well as approaches to obtaining a 3D model of a power supply with constructed routes to the connectors for connecting devices and components of a personal computer. In addition, we prepared the software, in which the process of building an assembly model of a power supply unit is visually presented according to the calculations

Key words: design modules, imported 3D models, construction of routes, geometric core of Open Cascade

ORGANIZATION OF INTERACTION WITH VIRTUAL REALITY BASED ON A RUNNING PLATFORM FOR COMPREHENSIVE TRAINING OF SPECIALISTS

A.D. Obukhov, D.L. Dedov, V.V. Vostrikova, D.V. Teselkin, E.O. Surkova

Abstract: one of the modern tools for organizing the training process for specialists is the use of virtual training complexes, which make it possible to simulate regular and emergency scenarios of professional activity and develop the necessary competencies for students. Existing approaches to interacting with virtual reality within the framework of training complexes are based on the use of various kinds of controllers, which negatively affects the immersiveness of the learning process. The controllers also do not allow simulating the physical activity that occurs when walking or running, which is necessary when training specialists in a number of areas (Ministry of Emergency Situations, the military industry, the mining industry, and others). To solve this problem, it is necessary to use different running platforms. The study identified certain problems of existing approaches to interacting with virtual reality through a running platform. To solve them, we propose to develop new methods of platform management. The paper considers several algorithms for platform control: linear, nonlinear and nonlinear modified. We present a mathematical description of the algorithms, we carried out experimental studies, which make it possible to choose the optimal control algorithm in accordance with a set of certain metrics. The use of the developed control algorithm will improve the quality of the teacher's interaction when interacting with virtual reality on the running platform. The results obtained can be used in organizing the process of training specialists using virtual reality systems

Key words: virtual reality, running platform, running platform control algorithm

Acknowledgments: the study was supported with the financial support of the RFBR grant in the framework of the scientific project No. 19-07-00660 and the laboratory of medical VR simulation systems for training, diagnostics and rehabilitation

RANDOM MULTI-MODAL DEEP LEARNING IN THE PROBLEM OF IMAGE RECOGNITION

A.I. Parshin, M.N. Aralov, V.F. Barabanov, N.I. Grebennikova

Abstract: the image recognition task is one of the most difficult in machine learning, requiring both deep knowledge and large time and computational resources from the researcher. In the case of using nonlinear and complex data, various architectures of deep neural networks are used but the problem of choosing a neural network remains a difficult issue. The main architectures used everywhere are convolutional neural networks (CNN), recurrent neural networks (RNN), deep neural networks (DNN). Based on recurrent neural networks (RNNs), Long Short Term Memory Networks (LSTMs) and Controlled Recurrent Unit Networks (GRUs) were developed. Each neural network architecture has its own structure, customizable and trainable parameters, and advantages and disadvantages. By combining different types of neural networks, you can significantly improve the quality of prediction in various machine learning problems. Considering that the choice of the optimal network architecture and its parameters is an extremely difficult task, one of the methods for constructing the architecture of neural networks based on a combination of convolutional, recurrent and deep neural networks is considered. We showed that such architectures are superior to classical machine learning algorithms

Key words: random multimodal deep learning, machine learning, deep learning, artificial neural network, convolutional neural network

METHOD OF COMPREHENSIVE DATA ANALYSIS IN DIAGNOSTICS OF COMPLEX POWER EQUIPMENT

E.A. Abidova, A.D. Danilov, A.E. Dembitskiy, A.V. Chernov

Abstract: the article suggests an approach to the diagnosis of complex and oversized equipment by the example of determining the technical condition of a diesel engine. A distinctive feature of the diesel engine is the complexity of the design, which requires the use of a set of methods to ensure complete control and sensitivity when detecting defects at early stages of development. We describe the data processing scheme, which allows you to increase the sensitivity in diagnostics due to the complex analysis of data of various physical nature using the principal component method. The increase in sensitivity is justified by numerical modeling and processing the results of measuring diagnostic parameters in real production conditions. Distances between coordinates of centers of clusters of parameters of serviceable and faulty state in initial space and in space of principal components are considered as indicators of sensitivity. We demonstrated that the proposed approach provides increased sensitivity in conditions where the effect of a defect on diagnostic parameters is comparable to measurement errors. The indicated improvement in the quality of diagnostics is achieved due to the correlation between the parameters due to their representation in the form of trajectory matrices. In addition to increasing sensitivity when detecting defects, significant compression of information that is used to determine the state is also achieved. The advantage of the proposed approach is also the vivid visualization of the results

Key words: diagnostics of diesel-generators, vibration diagnostics, indicator pressure, complex analysis, method of principal components

SOLVING THE PROBLEM OF DETERMINING THE LOCATION OF AN UNMANNED AERIAL VEHICLE IN THE COORDINATE COUNTING MODE USING A TECHNICAL VISION SYSTEM

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

Abstract: we present the rationale for the use of an optoelectronic system as a navigation-measuring complex. We carried out a brief analysis of existing navigation systems applicable to an unmanned aerial vehicle and propose an algorithm for providing a video surveillance system in the reckoning mode using a vision system. The problem of reckoning UAV coordinates using video sequences of images of the earth's surface can be solved with high accuracy using a binocular TVS. However, in case of failure of one of the cameras, the determination of the coordinates of the location will continue with sufficient accuracy to solve the task. And the lack of measuring instruments is ensured through the use of 6 special points of the earth's surface. Therefore, we propose an algorithm for determining the location using a monocular vision system. To solve the problem of determining the location, we selected and determined the coordinates of the singular points on the surface image. To find the special points, we processed the digitized image using the FAST-9 method. Since the image is obtained in color, the procedure for finding special points is reliable by applying the FAST-9 method for two or even three color components. This procedure allows you to achieve high accuracy in determining the reckoning coordinates of the UAV. To solve problems of reckoning coordinates, it is preferable to use the methods of simple iterations, Brown or Newton

Key words: coordinate counting, monocular vision system, location detection, unmanned aerial vehicle

IMPROVEMENT OF INFORMATIVITY OF COMBINED DIFFERENT-RANGE IMAGES IN MEDICAL DIAGNOSTICS

A.N. Vetrov, A.Yu. Potlov

Abstract: in the medical diagnostics of diseases, it is necessary to obtain the most reliable information in order to obtain the correct diagnosis and, as a result, the correct treatment for the patient. One of the methods of diagnostic studies of oncological diseases of a near-surface nature is to obtain infrared images. It is possible to increase the reliability of information by combining images obtained from thermal imagers, as well as from television video cameras. In this paper, we propose a technique in which two images of a particular object obtained from sensors operating in different frequency ranges, having the same spatial parameters, and formed from the same angle, are interlaced into a common image. The novelty of the proposed method lies in the fact that after combining the images, the specified parts of each pixel are mutually transmitted to the neighboring pixels vertically. In the resulting image, each pixel contains information of optical and infrared images in appropriate proportions. It is shown that the proposed method provides an increase in information content in the resulting image six times relative to the original image. The proposed technique for combining multi-range images can be applied in various areas

Key words: medical imaging, medical diagnostics, image, pixel, information content

FEATURES OF ORGANIZATION OF ACCESS IN AUTOMATED INFORMATION SYSTEMS BASED ON THE PRINCIPLES OF NONLINEAR DYNAMICS

Yu.S. Shevnina, L.G. Gagarina, A.V. Chirkov, N.S. Mironov

Abstract: we investigate three solutions to the problem of the nonlinear process of organizing access to the AIS of the educational spectrum. We identified the key reasons for the emergence of difficulties with the use of automated information systems and carried out the analysis of existing tools and techniques that are used in organizing interaction between users and AIS. We explained in what way we can simplify the access to AIS by using the principles of decomposition and hierarchy. The implementation indicates what the structure of the AIS of a typical educational institution can be. We carried out comparison of the advantages and disadvantages of different systems of accounting, managerial economic and economic accounting from the point of view of integration into the work of higher educational institutions. Special attention is paid to the analysis of the mechanisms and features of the interaction between the AIS subsystems and the database on the example of carrying out certification activities. On the basis of the studied aspects of the functioning of the AIS, we made a conclusion about the insufficient use of local systems by universities and the need for the development and subsequent integration of personalized high-tech solutions that will increase the efficiency of educational activities. The perspectives show what tasks you can set in order to implement additional aspects of decomposition and hierarchy in similar systems

Key words: AIS, IR, IS, decomposition, hierarchy, essence, system, subsystem, database, structure

APPLICATION OF MATHEMATICAL MODELS AND ALGORYTHMS FOR THE WATER SOURCES CONSUMPTION PLANNING AND FORECASTING

V.V. Mokshin, A.V. Spiridonova, G.V. Spiridonov

Abstract: this article discusses mathematical and informational methods for effective forecasting of water consumption. We calculated the water consumption for a typical administrative building. The materials proposed in the article are of interest to a wide range of specialists working on the development of economic and mathematical models and increasing the efficiency of housing and communal companies. We carried out the prediction using regression methods - Forward Regression and Backward Elimination, which include both linear and multiple nonlinear approaches to data analysis. We paid special attention to the comparison of actual and predicted readings. In the course of the work, we identified the most relevant algorithms, which allowed us to make a fairly accurate assessment of water consumption, which is an extremely important aspect in the field of water supply and management of water supply networks. In the course of the study, we found that the correctness of the predicted results equally depends both on the amount of initial data, on the basis of which the models are built, and on the number of days for which the forecast is made. In the case of a sample of data of 255 baseline and 116 forecast days, we obtained the most probable values by regression methods of direct and inverse selection of variables. The analysis made it possible to indicate the reasons for the appearance of errors when using these methods. Based on the reliability of the calculated readings, we can talk about the relevance and suitability of the studied methods among information systems at industrial and housing and communal facilities. An integrated approach optimizes the planning process and increases the accuracy of the predicted values of daily water consumption within residential areas, which today is an extremely important aspect in the field of water supply and management of water supply networks

Key words: regression, forecasting, water sources consumption calculations, correlation

ZIGBEE SIGNALS ANALYZER

I.S. Faustov, V.B. Manelis, A.B. Tokarev, V.A. Koz'min, V.A. Sladkikh

Abstract: the widespread adoption of wireless technologies requires the development of controls over devices and data networks and in particular over ZigBee wireless personal networks. Known methods of searching for and receiving ZigBee signals, which require a preliminary assessment of frequency offset, have a high computational complexity. The non-coherent method of receiving ZigBee signals does not require large computing resources but does not provide satisfactory noise immunity. The purpose of the work was to develop a combined algorithm for detecting and receiving ZigBee signals. Based on the developed algorithm, we built an analyzer that allows you to identify personal networks, their transmitting and receiving devices. Novelty: to receive signals with an unknown frequency offset, we used a combination of coherent processing at short time intervals with their subsequent non coherent accumulation. The proposed algorithm is able to work effectively in unfavorable reception conditions and has a relatively low computational complexity. Result: the use of the presented solution allows you to detect and receive ZigBee signals from radio-accessible sources, identify a personal network, a transmitting and receiving device in this network Practical relevance: the proposed method can be used to build a ZigBee signal analyzer on an SDR with a band of simultaneous signal processing from 2 MHz. The ZigBee network analyzer, implemented on the basis of a digital radio receiver of the ARGAMAK family, serves as the basis for the device for searching and localizing unauthorized radio sources in controlled objects

Key words: IEEE 802.15.4, ZigBee, WPAN, passive radio monitoring, signal detection, service parameters of signals

HALF-WAVE DIPOLE WITH AN ACTIVE REFLECTOR BASED ON OPTO-CONTROLLED METAMATERIAL

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

Abstract: to ensure radio communication, various antenna designs are used, which can have omnidirectional or narrowly directional radiation patterns, while directional antennas have the greatest protection of the communication channel from interference and interception. However, their disadvantage is that to ensure communication in all directions, either the installation of a group of antennas or the use of turntables are required, which degrade the reliability of the system, as well as complicate it. Therefore, as a rule, to provide communication, omnidirectional antennas are used, which have a radiation pattern in the form of a toroid. The disadvantage of such antennas is, as a rule, a small directional coefficient, as well as the reception of a large number of noises, which complicates the subsequent signal processing. In this work, we propose a design of a dipole antenna placed in an active metamaterial with the possibility of forming a beam by switching the layers of the structure, which forms dynamically tunable reflectors. Directional patterns obtained in the course of system operation have high directivity values, as well as high noise immunity and protection against interception due to directional properties. As a result of the study, we obtained an antenna design, placed in a cubic structure of an active metamaterial with the possibility of switching conductors using pin diodes or MEMS switches, which allows for fast switching of device operating modes, formation of a directed beam and providing noise-immune and interception-proof communication

Key words: active metamaterial, active reflector, radio communication

Acknowledgments: this research was funded by the grant of the President of the Russian Federation for Young Scientists, the grant number MK-57.2020.9

RESULTS OF MATHEMATICAL SIMULATION OF RELIABILITY OF PROJECTED SATELLITE COMMUNICATION STATIONS ON MOBILE OBJECTS

D.G. Pantenkov, V.P. Litvinenko

Abstract: modern complex radio communication and systems are part of rocket-space, aviation, dry-track, marine products that provide the solution of tasks both to increase the defense and safety of the Russian Federation and meet the interests of civilian consumers. At the same time, at the stage of design of radio engineering complexes and systems, the required design parameters for reliability, safety, durability, technological and technical support are laid in order to ensure the required period of their effective functioning to solve the set target tasks. This article considers the results of mathematical modeling of reliability of projected satellite communication stations on mobile objects (spacecraft, unmanned aerial vehicles, cars, railway trains), which reflect the methodological approach to determine the reliability of the complex or upper-level system. A fundamental point is the possibility of determining the numerical values of this indicator even at the stage of compiling tactical and technical (technical) tasks for R&D, conducting an advance project, i.e. those stages of work at which the error price is not significant and there is a fundamental possibility to make changes to the design and schematic parameters of the developed radio systems and systems

Key words: station satellite communication, reliability, quality, time between failures, average recovery time, spare parts, tools and accessories, mathematical modeling, dynamic process model, calculations

MATHEMATICAL MODEL OF A CORRELATION RECEIVER WITH A PIECEWISE LINEAR APPROXIMATION OF THE DECISION FUNCTION OF THE THRESHOLD DEVICE

M.F. Volobuev, V.S. Kostennikov, A.O. Shmoylov

Abstract: we developed a mathematical model of a two-channel correlation receiver of radio signals with piecewise linear approximation of the decision function of the threshold device. The receiver is designed to receive the most commonly encountered signals in practice with a random initial phase in a white Gaussian noise environment. In the synthesized mathematical model, a piecewise linear approximation of the decision function of the threshold device is used. We carried out a comparative analysis of the characteristics of detecting radio signals with a random initial phase from the signal-to-noise ratio, calculated using the developed mathematical model of a correlation receiver with a piecewise linear decision function of the threshold device and known. The paper presents the dependences of the probability of correct detection on the signal-to-noise ratio obtained as a result of mathematical modeling of the process of functioning of the correlation receiver when detecting signals with a random initial phase under noise conditions. We show that the results of simulation are consistent with theoretical calculations. We found that the representation of the decision functions of threshold devices in the classical theory of signal detection in the form of idealized (optimal) ones, which do not take into account their nonlinearity, lead either to an increase in the probability of a false alarm, or to a decrease in the probability of correct detection, which leads to errors of the first kind

Key words: mathematical model, signal detection, decision function, threshold device, simulation

DESIGNING A MIMO ANTENNA ARRAY FOR 5G NETWORKS

K.A. Berdnikov, E.A. Ishchenko, V.V. Kuznetsova, S.M. Fyedorov

Abstract: the article discusses an antenna system for networks of the fifth generation of 37 GHz frequencies (millimeter-wave radio waves). We propose to install the antenna on the rear wall of the device, radio waves are emitted through the glass rear panel of the device. For functioning in networks of the fifth generation, a MIMO antenna array was developed, which consists of four elements and is capable of functioning in a "smart" mode. This makes it possible to form a beam in the antenna system (beamforming). To analyze the characteristics of the antenna system, we obtained the correlation coefficients of the envelope, directional patterns, patterns of electric fields, the dependences of the effective isotropically radiated power (EIRP), and we plotted the graphs of the cumulative distribution functions of EIRP on a linear and logarithmic scale. To determine the effect of radiation on a person, we built pictures of the specific absorption rate (SAR) in accordance with European standards for 10 grams of tissue. All the results obtained show the high efficiency of the developed design of the antenna array for fifth generation networks. Antenna elements have low cross-correlation, allow for beam formation, cumulative distribution functions show a high level of coverage of the sphere of effective isotropically radiated power by radio waves. We also show that the developed antenna system has a low level of specific absorption coefficient, which proves the safety of fifth-generation networks of millimeter-wave radio waves. The development of modern communication systems makes it possible to achieve high security and efficiency in obtaining information

Key words: fifth generation (5G) networks, MIMO antenna array, effective isotropic radiated power (EIRP), cumulative distribution function (CDF), specific absorption rate (SAR)

ESTIMATION METHODS OF A CHANNEL WITH SPATIAL MODULATION BASED ON CORRELATION

O.N. Chirkov

Abstract: the article considers methods for estimating a communication channel with spatial modulation. This type of modulation is a single-stream multiple-input multiple-output (MIMO) technique in which only one transmit antenna is activated at a time. Spatial modulation allows for complete elimination of inter-channel interference, and also demonstrates great energy savings in the RF circuit. However, unlike multi-stream MIMO systems, channel estimation for spatial modulation becomes a problem because a MIMO channel cannot be estimated in a single transmission step on a single stream. Based on this fact, I proposed a new channel estimation scheme that uses channel correlation and jointly estimates channels for different transmit antennas. The proposed method provides the same evaluation period as multithreaded MIMO schemes. The change in the number of transmitted pilot-signals with spatial modulation is investigated for both traditional and new methods of estimation of the communication channel. By balancing accuracy and data volume, an optimal pilot signal ratio can be achieved for maximum channel throughput. Simulation results show that the new scoring approach outperforms the traditional method with a much lower optimal pilot count ratio

Key words: channel estimation, pilot signal, spatial modulation, correlation, MIMO system

ALGORITHMS FOR THE FORMATION OF NARROW-BAND SPECTRAL-EFFICIENT RADIO SIGNALS OUTSIDE THE RING OF PULSE-PHASE AUTOMATIC FREQUENCY TUNING OF THE FREQUENCY SYNTHESIZER

S.S. Pechnikov, S.A. Sherstyukov

Abstract: the paper considers the process of data transmission over a radio channel by modulating the parameters of the carrier wave with an information signal. When transmitting an information signal, the carrier frequency values must take discrete values in one-to-one correspondence with the information sequence, thus the formation of an undistorted radio signal is one of the main requirements for the operation of a quadrature modulator. The article analyzes the operation of a quadrature modulator and a quadrature phase modulator based on the shapers of the functional components of the modulating signal. We propose a distortion compensation method using synthesized compensation signals, which makes it possible to effectively compensate, firstly, rapidly changing noise inside balanced modulators and phase shifters, and secondly, noise coming along with an input high-frequency signal, for example, from the output of a power amplifier through circuits feedback and, third, slow deviations of amplitudes and phases. We carried out the modeling of the distortion compensation method using synthesized compensation signals

Key words: modulation, quadrature modulator, quadrature phase modulator, distortion compensation, parasitic amplitude modulation, parasitic modulation, nonlinear amplifier

ACCOUNTING THE DIRECTIONAL DIAGRAM OF THE ON-BOARD ANTENNA IN ANALYSIS OF THE COMMUNICATION CHANNEL WITH THE AIRCRAFT

S.V. Kuz'min, K.O. Korovin, A.V. Andropov

Abstract: the synthesis of the optimal, in terms of range, directional pattern is one of the main tasks of building a communication channel. For many applications, such as a 2D secondary locator, a communication channel with a UAV, the cosecant radiation pattern is optimal. As a first approximation, the on-board antenna has an almost constant gain towards the stationary antenna. The characteristics of the onboard antenna are obtained by solving the problem in free space. Taking into account the scattering properties of objects of complex geometric shapes with dimensions of tens of wavelengths is an urgent but difficult task. When moving over the surface of the carrier, the radiation pattern of the onboard antenna can change significantly. Modern computer-aided design systems based on approximate numerical methods of electrodynamics make it possible to obtain the characteristics of antennas placed on real objects. Due to the increase in the number of payloads on board, it is not always possible to place the onboard antenna in such a place that makes it possible to neglect the influence of the carrier geometry. As a result, interference dips or minima will appear in the directional pattern of the onboard antenna. The operating range will depend on the movement of the media. We considered a method for taking into account the characteristics of the antenna pattern of an airborne antenna, which allows minimizing the margin for fading

Key words: antenna array, airborne antenna, cosecant radiation pattern, synthesis of radiation patterns

HYBRID MODELUNG FOR ELECTRODYNAMIC ANALYSIS OF LARGE-SIZED OBJECTS

S.M. Fyedorov, E.A. Ishchenko, K.A. Berdnikov, B.A. Shiyanov, A.A. Kozlova

Abstract: the article discusses methods for modeling complex electrodynamic structures, which consist of an antenna and a carrier object whose dimensions exceed 100 wavelengths. When performing the simulation, we propose to calculate the characteristics of the antenna using the finite integration method and installed on the carrier platform using the method of geometric diffraction and physical optics. The development of modern computing environments has made it possible to implement a hybrid simulation system, which allows achieving high performance, automation, and accuracy of the results of the simulation. When performing the study, we studied the situation with the installation of a satellite positioning antenna on a submarine, and the dimensions of the antenna carrier exceeded 800 wavelengths, which made it impossible to use the finite integration method to solve the problem. The paper considers three ways to solve the problem posed: using the radiation pattern and its manual transfer to the site of the planned antenna installation, unidirectional hybrid modeling method using a near-field source, hybrid modeling with feedback between projects. We found that the highest accuracy is provided by the method of hybrid simulation with feedback, but its application requires a high speed of the data accumulator, and also takes a long time. The fastest method is the method of hybrid modeling with unidirectional communication, as it provides an automated calculation and solution of the problem

Key words: asymptotic modeling methods, finite integration method

RESEARCH OF ENERGY EFFICIENCY OF TWO-CHAMBER PULSE DEVICES FOR STAMPING

A.Yu. Botashev, A.A. Musaev

Abstract: one of the types of devices that carry out pulse methods of pressure treatment are two-chamber devices for sheet stamping, using gas-air fuel mixtures as an energy carrier. The supply of compressed air to the combustion chamber in the considered two-chamber device for sheet stamping is carried out by a compressor. We carried out the analysis of thermodynamic processes taking place in the combustion chamber and the working cylinder of a two-chamber device for sheet stamping. We found that the energy spent on the operation of the compressor is about 45% of the energy released in the combustion chamber. We obtained the dependence for determining the thermodynamic efficiency of two-chamber devices for sheet stamping; its value is about 0.25. We established that the energy efficiency of two-chamber devices is not inferior to the energy efficiency of traditional stamping equipment, while the energy costs of two-chamber devices are lower due to the use of a cheap energy carrier. In a two-chamber die-forging device for sheet metal stamping, the electrical energy used to operate the compressor is less than 1/3 of the total energy consumption of the device. Therefore, all other things being equal, the cost of energy carriers will be significantly less than in stamping equipment operating on electric current

Key words: two-chamber stamping device, stamping equipment energy efficiency

DESIGN FEATURES OF CARBIDE ASSEMBLY WORKING ELEMENTS OF DEFORMING BROACHES

Ya.B. Nemirovskiy, I.V. Shepelenko, S.E. Sheykin, Yu.A. Tsekhanov, F.Y. Zlatopolskiy, O.I. Popova, M.I. Popova

Abstract: we developed an algorithm and assessed the strength of prefabricated carbide elements with solid and discrete working surfaces. We obtained dependencies that make it possible to establish a relationship between the design parameters of prefabricated deforming tools and their strength. We performed strength calculations of the deforming tool for machining holes of significant diameter with solid and discrete working surfaces. We obtained the distributions of equivalent stresses in the elements of the tool and contact stresses over the contact surface of the hard-alloy insert - body by numerical modeling, by the finite element method, which made it possible to analyze the strength of the tool under load. We determined the design parameters of the tool and here we give algorithms for the sequence of calculation of prefabricated deforming elements (DE). We developed an algorithm for the sequence of calculating the prefabricated DE for discrete broaching. The proposed design of the prefabricated working element allows not only to improve the machinability of the cutting product but also to reduce the consumption of an acutely deficient hard alloy in comparison with a hard alloy DE of similar dimensions by 6 kg. The results obtained can be used in engineering calculations when designing a prefabricated tool for discrete deformation, as well as for assessing the strength of prefabricated tools, for example, cutters, countersinks, reamers when specifying external loads
.

Key words: broach, deforming element, discrete broaching, carbide, element strength

INFLUENCE OF TECHNOLOGICAL FACTORS ON THE EFFICIENCY OF REMOVAL OF SCALE FROM FLATS FOR HOLLOW BALLS

A.V. Panfilova, A.V. Korolev, O.P. Reshetnikova, B.M. Iznairov, A.N. Vasin

Abstract: here we consider the results of experimental studies of the method of removing scale from the surface of steel sheet products. We propose a new method and device for cleaning the surface of rolled sheets from scale by cutting plates rotating around an axis moving translationally along the treated surface. The plates are tilted in the direction of the rotation vector at an angle of up to 10 degrees and are elastically pressed to the treated surface. This makes it possible to reproduce the macro-dimensions of sheet metal during the surface cleaning process. We present the results of experimental studies. We constructed mathematical and graphical dependences describing the influence of process factors on the efficiency of cleaning the rolled surface. We show that the most significant influence on the optimization parameter is exerted by the force of the tool's impact on the surface of the workpiece. Moreover, this influence is realized in a directly proportional relationship. Other factors studied, namely the angle of inclination of the plate, its rotation speed and feed, have a much smaller impact on the degree of cleaning of rolled products. These studies were necessary from the point of view of determining the design parameters of the power elements of both the technological equipment implementing this method and the technological installation as a whole. We adopted the experimental plan based on the real production capabilities of the industrial partner and corresponded to the classical concepts of the cutting theory. The described results make it possible to plan further experiments to study the directions of using the method

Key words: hollow balls, experimental studies, scale, processing modes, technological factors, regression dependence, moment of resistance, degree of influence

Acknowledgements: the study was carried out with the financial support of the grant of the President of the Russian Federation for governmental support of young Russian scientists (PhD) Grant No. MK-2395.2020.8

CALCULATION OF NON-STANDARD SINGLE CARGO HOOK

V.I. Seroshtan, P.V. Vitchuk, V.Yu. Antsev, N.A. Vitchuk

Abstract: load single-hooks for cranes are made by hot stamping and free forging. The current standard provides for 26 standard sizes of cargo hook blanks. Obviously, the range of standard single-horned cargo hooks is limited and cannot satisfy the whole variety of requirements when creating special lifting machines for specific conditions. In the case of using non-standard hooks or with non-standard crane lifting capacity, a verification calculation of the hook is carried out. In the existing simplified method for calculating one-horned load hooks, the cross-sections of the hook are replaced with a regular trapezoid without taking into account the fillets. Therefore, we propose a refined method for calculating non-standard single-horned hooks of hoisting cranes. We tested the method using SolidWorks and proved its accuracy. We carried out a comparative analysis of the results of calculations by the proposed and existing simplified methods. Comparison of the calculated cross-sectional areas of cargo hooks obtained by the proposed and simplified methods shows that the difference between them for standard hooks ranges from 6-10%. On average, the cross-sectional area ofthe hook, obtained according to the proposed refined calculation, is less than the simplified one by 8%. The results of calculating the exact cross-sectional area of the load hook and the values of stresses in dangerous sections obtained on their basis allow one at the design stage to achieve the optimal shape of the load hook. This will allow one in the production process to obtain the smallest value of the metal consumption of the cargo hook, which will have a positive effect on its cost

Key words: crane, cargo hook, billet, design, optimization

STUDYING THE PROCESS OF HEATING OF A PIPE BILLET DURING GAS FORMING

A.Yu. Botashev, R.A. Bayramukov, N.U. Bisilov, R.S. Malsugenov

Abstract: we developed a diagram of a new device for stamping parts by heating a pipe billet by the action of combustion products of a gaseous fuel mixture. A combustible gas can be used as a fuel mixture - a mixture of air with methane or with propane-butane. We present the results of a study of the process of heating a pipe billet by the action of combustion products. We carried out the study on the basis of the equations of convective heat transfer, heat balance and thermodynamics. We obtained the dependence for determining the heating temperature of the pipe billet. We found that the temperature of the workpiece depends on the material and geometric dimensions of the workpiece, as well as the pressure of the fuel mixture. This device provides heating to the hot working interval of steel pipe billets with a diameter of more than 150 mm with a wall thickness of up to 1.2 ... 1.5 mm, and with a diameter of more than 300 mm - with a thickness of up to 2.0 ... 2.5 mm. To heat tubular billets made of non-ferrous metals and alloys (for example, aluminum and copper), a lower pressure of the fuel mixture is required than for steel, due to this, billets of a much greater thickness are heated, in particular, billets made of aluminum with a thickness of up to 6 mm

Key words: stamping of parts from a pipe billet, fuel mixture gas stamping