Informatics, computer engineering and control

USING ANT COLONY OPTIMIZATION ALGORITHM IN THE INTELLECTUAL SCHEDULING SYSTEM OF DISCRETE PRODUCTION

A.D. Danilov, V.A. Lomakin

Abstract: problems and bottlenecks in the creation of calendar plans for metalworking production are considered, as well as the complexity of synthesizing an intelligent control system for flexible automated production facilities, which makes it possible to optimally distribute the load among technological units. To solve the problems arising in the process of drawing up schedules of discrete production, it is proposed to interpret the task of distributing tasks between machines and other technological equipment in the form of a weighted graph whose vertices will be operations on details. In this situation, as an effective method for optimizing the start-up schedule of parts for processing on the equipment, an algorithm of ant colonies was used, which copes well with large-dimensional problems. To apply this meta-heuristic approach in the intelligent dispatching system of flexible automated production, the algorithm of the ant colonies was adapted to the features of the scheduling task. This intellectual system, for testing purposes, was implemented in MATLAB, the result of its work is a structured graph illustrating the distribution of equipment between operations on parts, the sequence of tasks by machines with numerical control, the execution time of the operation block

Key words: flexible manufacturing system, scheduling, ant algorithm

NUMERICAL CHARACTERISTICS ESTIMATION FEATURES OF THE DURATION

OF COMPLEX OF SEQUENCE-PARALLEL WORKS

S.A. Oleynikova

Abstract: the object of the research in this paper is stochastic multi-stage systems, in which the process of servicing is the execution of a set of sequentially parallel works with a random execution time. In this case, the service time of the entire application is a random variable. The estimation of the numerical characteristics of a random variable describing a given duration is of undoubted interest. At present, there is an approach PERT that allows one to obtain the required estimates. However, the assumptions on the basis of which these estimates were obtained are not available for all systems. Moreover, in some cases, these assumptions are unjustified. In this connection, the question about accuracy of the proposed estimates of the PERT method is arises. The aim of the paper is to evaluate the analytical capabilities that allow one to estimate the characteristics of the investigated quantity as accurately as possible. The analysis of the specifics of the systems under study made it possible to analytically describe the unknown random quantity as a maximum of a set of quantities representing the duration of the sequence of works on the given path. In the article, the possibility of analytical obtaining of characteristics of a random variable was investigated. As a result, it was concluded that the apparatus of numerical methods should be connected. Thus, the features of an estimation of numerical characteristics of the random variable describing duration of performance of a complex of consecutive-parallel works are analyzed

Key words: stochastic multi-stage systems, service time, PERT, expected value, variance

RESEARCH OF INDUSTRIAL PRODUCTS PROCESSING IN THE ROTARY KILNS IN ZINC PRODUCTION

A.L. Rutkovskiy, M.A. Kovaleva, V.M. Alkatsev, A.K. Makoeva

Abstract: the main object of the analysis is to search for the optimum temperature of the exhaust gases in a rotary-kiln, at which the maximum process productivity is reached. Changing the consumption of cake affects the temperature of the kiln, as well as the process quality. The increase in cake consumption leads to an increase in the total volume of raw materials entering the kiln, more of them is required for heating and evaporation of moisture. The results of the study of the influence of batch and breeze coke loading are presented, the average daily data for a long period of operation of the rotary kiln, which correspond to the normal operation of the kiln, are collected, and the influence of the cake consumption on the temperature of the exhaust gases was analyzed using the software product MathCad. Models of interrelation are considered: linear, cubic, quadratic, and residual dispersion is calculated for each type of model. It was found that the smallest residual variance occurs with a cubic regression model. The obtained results are the basis for constructing an automated system for

controlling the temperature of the waste gases. When automating the control of the waelz process, in addition to the tasks of monitoring and stabilizing the regime parameters, it is expedient to solve the operational problem of optimizing the regimes. With this mode, the maximum capacity of the furnace is ensured, therefore, the environmental load is reduced

USE OF SIMULATION IN THE MATLAB+SIMULINK FOR THE PARAMETRIC SYNTHESIS OF CONTROL SYSTEMS

A.M. Litvinenko, L.B. Afanas'evskiy, A.N. Gorin, M.A. Chursin

Abstract: one of the possible ways to reduce the time for determining the optimal parameters of control devices is the use of the MATLAB computer system and the Simulink block modeling system integrated in MATLAB. Transient processes in the control system are formed in the simulation model of the control system. The control system model is built in the Simulink environment. When implementing the simulation model as a result, one point in the parameter space of the control device is obtained. Therefore, the next step is the construction of a plan of computational experiments on the model in the domain of parameter determination. The input data of the model is formed in MATLAB. Further processing of simulation results is carried out, i.e., processing of the transient process in MATLAB. The transient process is formed as a result of integrating the system of differential equations of the simulation model with variable steps, therefore the number of transition points for each point from the space of values of the input parameters of the model will be different. The graphs of the transient processes in the control system are given at the optimum parameters of the control device and a single change in the driving force. The proposed organization of interaction between MATLAB and Simulink can be applied in the simulation of both continuous and discrete systems

METHOD OF OPTIMAL CONTROL OF AIRCRAFT MOVEMENT ON THE ALGORITHM OF OPTIMAL ESTIMATION OF NAVIGATION INFORMATION

S.V. Ivanov, N.Ya. Polovinchuk, E.V. Markin, V.I. Timofeev

Abstract: one of the directions for improving control systems for highly maneuverable unmanned aerial vehicles (UAVs) is the formation of control on the final section of the trajectory. However, the accuracy of such algorithms in traditionally used control systems is reduced due to the action of large-level perturbations, which are a priori uncertain. To increase the accuracy of the work, the algorithm for processing navigation measurements is used on the basis of the algorithm of the generalized Kalman filter. There are iterative procedures in the terminal control algorithms associated with the prediction of the future motion, which, with limited capabilities of the computer, makes it impossible to significantly increase the frequency of the loop closure. The algorithms of the terminal control of the UAV's movement allow to take into account the final conditions of the aircraft's delivery to the final area of space, but in order to calculate the trajectories of motion along the program optimal trajectory, in the conditions of uncertainties associated with opposing the means of the opposing side, control algorithms that are able to form control actions for making maneuvers of evasion at all stages of motion are needed. Using an approach that takes into account the formation of identification algorithms in the forecasting loop makes it possible to compensate for the limited computing capabilities of on-board computers and to improve the accuracy of landing of UAVs in a given terminal area. The numerical simulation of the presented algorithm is carried out

PARTIALLY AUTONOMOUS ROBOT-TELEPRESENCE AS AN ELEMENT OF MULTIAGENT INTERACTION

A.Yu. Solov'ev, M.A. Tsukanov

Abstract: the article deals with the task of endowing a robot-telepresence with functions of partial autonomy. The sphere of application of robots-telepresence is considered, the analysis of current decisions in the market of similar robots is done. The classical scheme of control of robots-telepresence is presented and on the basis of the resulted scheme the basic lacks of similar decisions are allocated, namely the big loading on the operator in the course of management of the robot, and also complexity of process of training of the operator. Based on the identified shortcomings, a solution is proposed that can provide robots-telepresence with a partial autonomy. As autonomous functions, recognition of a person, following a person, bending obstacles are considered. These autonomy functions were identified as priority, which will help to avoid the identified problems in the management of robots-telepresence. Also, the market for such solutions was analyzed, during the analysis it was revealed that most of the solutions do not even have a partial autonomy. To implement the solution of endowing robots-telepresence with autonomy functions, the authors suggest using a robotic platform that was developed at the Department of Automated Information Control Systems of the Stary Oskol Institute of Technology. A block diagram of the proposed solution is given. The authors also suggest the structure of a multi-agent system for solving tasks for carrying out activities requiring the participation of several robots-telepresence

STUDY OF TRACKING SYSTEMS IN MATLAB WHEN EXPOSED TO DISTURBANCES

IN THE CONTROL CIRCUIT

A.P. Kharchenko, Yu.S. Slepokurov, Yu.N. Karevskaya

Abstract: remote control of the transport robot requires the transfer of the control and reception of the controlled signals in the conditions of external disturbances. The use of an automatic system with a modal regulator and an observer as a servo drive assumes the implementation of a modal controller and an observer in a master device remote from the transport robot. Remote transmission of control and controllable information signals requires taking measures for interference immunity of communication channels. For the mathematical description of a servo system with a modal controller and an observer, a vector-matrix equation is used which can be conveniently obtained from a structural scheme with access to the state variable of the controlled state vector X. Vector-matrix equations of tracking systems with the modal regulator, observer and Kalman filter taking into account perturbations are presented. When investigating the influence of disturbances in the negative feedback circuit, one- and multi-loop structural circuits of the servo system with the same motor, control system and position feedback sensor are used. Filtering of the disturbance in the channels of information transfer in the state space is carried out by the Kalman filter. The Kalman filter performs a recursive estimation procedure when the signal to be evaluated is the input signal of a non-stationary dynamic system. The obtained coefficients of the modal regulator of the structure circuits of the servo system, the type of the obtained transition characteristics, the transfer functions of the Kalman filter and the Kalman filter, and the degree of restoration of the information signal by the Kalman filter are compared. Conclusions on the research of systems are given

ESTIMATION OF THE STABILITY OF THE SYSTEM "DRIVER - VEHICLE - ENVIRONMENT"

V.L. Burkovskiy, D.A. Andrikov, Yu.A. Khalin, E.A. Titenko, A.G. Kurochkin

Abstract: the solution of the problem of driving a vehicle under the conditions of braking is considered. The classical approach is based on the understanding of a driver as a subject of management, and a vehicle as an object of control. This is a well-known mechanistic-deterministic approach with an unambiguous prediction of the vehicle's motion and the target reaction of the driver. The management system is a tool that gives deterministic estimates and forms a forecast. Intellectualization of information-computational processes in the vehicle is associated with an analysis of the state of the metasystem "Driver-Vehicle-Environment". It is shown that in this metasystem the interaction of elements can be formalized using the theory of conflict. This means that the objects of consideration are open systems. Unlike closed systems that tend to conserve rest energy, open systems with several active objects (players) form different coalitions. The coalition seeks to subordinate the "losers" of the metasystem and to ensure further extremum of the coalition function. The coalition "Driver - Vehicle" is being considered. To provide such an approach, the estimation of the stability of oscillatory processes is chosen as the mathematical basis of motion control. The form of the algebraic criterion in the form of the Hurwitz criterion is chosen. This criterion can be applied to determine the stability of both open and closed systems. The matrix and the Hurwitz criterion use the idea of stratifying the coefficients to reduce the degree of the solved equations. Stratification is performed on even and odd positions with a variable length of a series of coefficients. This two-dimensional combination of coefficients allows to maintain the correctness of the result and simplify the decision process. Consequently, the calculations of the Hurwitz criterion are hardware-oriented and provide a reduction in time. The Hurwitz stability conditions necessary for controlling the metasystem "Driver-Vehicle-Environment" are shown

DEVELOPMENT OF SPECIALIZED LIBRARIES FOR IMPLEMENTING SERVER APPLICATIONS IN JAVA

V.F. Barabanov, N.I. Grebennikova, D.S. Galamaga, S.L. Kenin

Abstract: the article gives a general description of the technology for the development of large projects, shows the importance of prototyping in order to minimize losses when using libraries. Reducing the development time of the prototype and reducing the cost of the development process occurs with the preservation of the possibility of finalizing and replacing any component without interfering with the rest of the product without limiting the available functionality. The developed library is intended for writing a server application with any requirements in the shortest possible time. The

composition of the library, which is a set of services and utilities, allows organizing distributed load, working with files and databases, organizing interaction of various parts of the application, monitoring and logging of the application, serialization and deserialization of objects. An example of working with this library is given, for this purpose a server application was created, an algorithm for its operation is given. The structure of the developed server application allows to use the logging and server metrics functions at all stages by all the functional parts. The working conditions of the program, the order of installation and configuration of the program product are given, the configuration file containing the necessary settings is offered. The sequence and order of tuning described allows to make full use of the proposed features of the class library

CONSTRUCTION OF FUZZY INTELLIGENT SYSTEM OF CRYOGENIC LIQUIDS STORAGE

M.V. Bogdanova

Abstract: the construction of an intelligent information system for the propagation of heat in a cylindrical vessel partially filled with a cryogenic liquid is considered. The vessel is exposed to external heat. As a result of convective processes and heat transfer processes, significant temperature and pressure gradients arise which can lead to a violation of the storage conditions of cryogenic liquids. The growth of pressure is investigated with the aid of a fuzzy component, which in turn makes it possible to reduce the external thermal effect. The Navier-Stokes equations are considered. The transition is made from the three-dimensional problem to a sequence of two-dimensional problems. After determining the thermal field and flow field with the help of fuzzy mathematics, the pressure that arises inside the vessel is determined. In the work there is a combination of computational physics and fuzzy logic. With the support of the symbiosis of these sciences, the task of managing an individual intellectual system is carried out. The main method of solution is the method of finite differences, which allows to determine the state of both fluid and gaseous medium at each fixed point at each fixed time. The solution of such problems will be useful in many fields of science and technology. Technical areas of safe storage of cryogenic liquids are among them

Energetics

DETERMINATION OF THE OPTIMUM PARAMETERS OF THE HEAT-TRANSFER AGENT IN THE TECHNOLOGY OF QUALITY MANAGEMENT OF WHEAT GERMS

O.A. Orlovtseva, V.V. Portnov, L.I. Nazina, N.L. Kleimenova

Abstract: the work is devoted to the determination of the optimum heat-transfer agent regimes for stabilizing the quality of wheat germs during storage. The choice of the investigated product is due to the valuable biochemical composition and the variety of its application. The source of the hot and cold flows is a vortex tube, the work of which is based on the Rank-Hilsch effect. To determine the parameters of wheat germs, which will ensure the invariability of the quality of the product during storage, orthogonal compositional planning was used. As a result of the processing of experimental data, regression equations were obtained adequately describing the process of stabilization of wheat germs under the influence of heating, inhibitor introduction, and cooling. As a result of the solution of the optimization problem, the values of the optimal regimes of the investigated factors were obtained: the temperature of the heated wheat germs was 57 °C, the concentration of ascorbic acid was 9.5%, and the temperature of the cooled product was 4 °C. Based on the received data, the values of the hot and cold flows were established necessary for controlling the quality of the product. The methods for calculating the parameters of the vortex tube were analyzed

Radio engineering and communication

OFDM FREE SPACE OPTICAL SYSTEM BASED ON LDPC CODE WITH INTERLEAVING IN TURBULENT ATMOSPHERIC CHANNEL

R.P. Krasnov

Abstract: a model of an atmospheric optical communication system is presented in which the input data is encoded by an interlaced LDPC encoder and converted to an output digital stream. It is proposed to use OFDM As a modulation method. In the receiver for optoelectrical transformation, an array of photodetectors is used, the signals at the output of which are combined according to the maximum likelihood method, successively passing through the operations of inverse frequency conversion, OFDM demodulation, LDPC decoding and deinterleaving. For this model, the dependence of the bit error value on the signal-to-noise ratio in the atmospheric optical communication system with OFDM modulation on 64 subcarriers in the case of small and strong turbulence in the communication channel was obtained, as well as the dependence of the average fading duration on the threshold current value. It is shown that if there is a backup radio channel, it is possible to organize a feedback. The method for determining the size of an interleaving block based on the calculation of the average fading time in a channel is given

RESULTS OF APPLICATION OF EVOLUTIONARY ALGORITHM FOR PARAMETRIC SYNTHESIS OF NOT-EQUIDISTANT ANTENNA ARRAYS

I.A. Kirpicheva, A.V. Ostankov

Abstract: development of antenna arrays with adjusted or special characteristics of directivity involves algorithms of parametrical synthesis. In spite of critics, individual types of evolution algorithms (in particular, genetic algorithms) can be successfully used for solution tasks of optimization and synthesis of antenna technics. Analysis of sources shows that domestic practice of using genetic algorithms for synthesis of antennas appears mainly occasional. The article shows expediency and potency of using genetic algorithm for synthesis of aperture linear antenna arrays. The authors represent examples of such synthesis which are based on using well-known modification of the genetic algorithm. In particular, optimization of the directional properties of nonequidistant rarefied uniform antenna arrays is performed. The search of the optimal dimensions between elements by criterion of the maximum directivity of antenna (in normal direction of radiation) results in symmetric geometry relative to the center. The feature of such array is the fact that the center part is free of elements. The central elements are appeared displaced at periphery of the array and are located there nearly periodicly with the step from 0.8 to 0.9 of wavelength. Further, the article contains the statement of problem of synthesis of a linear uniform nonequidistant antenna array. Criterion of the synthesis is concluded in minimization of side lobe level of antenna pattern in broadside mode. The authors adduce the basic mathematic relations, describe the goal function and constraints imposed on dimensions between elements of the array. The article includes particular results of synthesis of the arrays with various numbers of elements (from 4 to 20) and set point of rarefaction factor. It is equal to the ratio of period the array to wavelength at equidistant arrangement of elements. The analysis of the results showed that scoring by side lobe level of an optimal array with respect to periodic array amount 6.74 dB for 10 elements and 10.5 dB for 20 elements. The results described in the article can be used for design corresponding antenna systems and also for potential estimation of directional properties of uniform antenna arrays

TECHNIQUE OF OPTIMUM DESIGNING OF AN ELECTRONIC MODULE COOLING SYSTEM

N.V. Tsipina, S.S. Potapov, I.V. Cheprasov

Abstract: when designing modern radioelectronic devices, there is a need for observing the temperature regime for the functioning of the power elements of the apparatus. Most often, the problem can be solved by installing a radiator. The difficulty lies in the choice of its size, shape and material, from which it will be made. In order to determine all these characteristics, the constructor resorts to analytical calculation methods that suffer from their accuracy and the time required to design. This article deals with the design of a bimetallic (copper-aluminum) brazed radiator, effectively cooling the elements of the electronic module with high heat flow unevenness. The characteristics of the radiator and the method of constructing the initial (non-optimized) model with allowance for the required constraints are given. With the help of modern computer-aided design tools, the study was carried out, based on the results of which further optimization of the design was carried out. The optimization was carried out in two stages. The first stage consisted in the search for the optimal geometry of the radiaor structure, where the thicknesses and heights of the ribs and slats acted as variables. The second stage consisted in the gradual replacement of the material of elements from copper to an aluminum alloy. The influence of a change in a design parameter is described. Graphs and tables of results are given, on the basis of which it is possible to draw conclusions about the significance of a particular parameter on the distribution of heat fluxes. We describe all the difficulties that the authors encountered during the optimization of the design of the radiator in the modeling environment, and the ways to solve them. The main tasks solved with the help of the developed optimization algorithm are the increase in accuracy, the reduction in labor intensity and the duration of the search for the optimal design, the exclusion of the influence of the "human" factor

Key words: bimetallic radiator, thermal research, optimization, system Solidworks Simulation, cooling system

DEVELOPMENT OF MODELS AND DESIGN ALGORITHMS FOR DIGITAL DEVICES WITH THE USE OF PROGRAMMABLE LOGICAL INTEGRAL SCHEMES

A.A. Pirogov, A.B. Buslaev, A.S. Kostyukov

Abstract: in recent years, new technologies for the design of electronic equipment have emerged, based on integrated CAD systems and programmable logic integrated circuits. This paper deals with the transfer of the structures of integrated circuits with fixed functional to the base of integrated circuits with variable functioning. These circuits, which include programmable logic integrated circuits with variable (programmable) structures, are the most promising at the moment, they have a high degree of universality, low cost of development and short design time. Programmable logic integrated circuits are used to build reconfigurable systems, in logical emulation tasks. The effectiveness of schemes with a programmable structure stimulates the rapid growth of the relevant industry and the volume of their production, as well as scientific research on the development of their architectures, circuitry and algorithms for solving practical problems. Modeling and analysis of the received structure of the arithmetic logic unit was performed. Arithmetic logic devices are specialized microcircuits that perform arithmetic or logical transformations of binary information in accordance with the program on the service inputs. In microprocessor technology, arithmetic logic devices are basic elements, they are used in combination with memory and shift registers, random access memory and other digital nodes

Key words: arithmetic logic unit, programmable logic integrated circuit, design, verification, simulation

FRONT ACOUSTIC SYSTEMS FOR HOME CINEMA

A.S. Badaev

Abstract: in this paper, the methods for calculating the acoustic design of the type "acoustic transmission line (acoustic labyrinth)" and "bandpass resonator" are presented. It is shown that the optimal length of the labyrinth in terms of sound pressure level, efficiency, radiated acoustic power and minimal distortion is a quarter of the sound wave emitted by the loudspeaker head (LH) at the frequency of its main resonance, and its cross-sectional area is equal to the effective area of the diffuser LH. At the same time, the input resistance of the labyrinth is maximal and has a purely active character, its behavior is similar to a parallel electric circuit tuned to resonance. At the frequency of this resonance, the labyrinth tube intensively emits sound energy into the surrounding space, and the amplitude of the oscillations of the diffuser LH is minimal, as a result, distortions sharply decrease. The proposed method for calculating the fourth-order bandpass resonator (BR) used as the acoustic design of the speaker subwoofer is based on the representation of the BR as a LH, installed in a closed case (rear camera) and loaded on a case with a bass reflex (front camera). Taking into account the effect of air spring elasticity in the back chamber on the parameters of the LH and their choice, it was possible to calculate the BR with high sound pressure and efficiency, without compromising the transient characteristics. On the basis of the proposed methodologies, speakers were developed for a home theater, the feature of which is the use of two units that are structurally connected in one block, the speaker itself and an active subwoofer, implemented on the basis of different design of the labyrinth and band resonator. The technical parameters and characteristics of the developed systems are presented. Analysis of the measurement results shows the correct calculation of the speakers, marked by a high level of sound pressure and good sound quality developed by the acoustic systems

Key words: home theater systems, acoustic systems, acoustic transmission line, acoustic labyrinth, bandpass filter, loudpeaker heads

OPTIMIZATION OF RADIOELECTRONIC COMPONENTS ACCORDING

TO CRITERIA FOR INTRA-APPARATUS-ELECTROMAGNETIC COMPATIBILITY

V.V. Glotov, M.A. Romashchenko

Abstract: the provision of electromagnetic compatibility in various electronic media is one of the most topical issues for today due to the increase in the total number of electronic media and their miniaturization. In radio engineering, the type of optimization problems for rational redistribution is widespread. For such tasks, three elements are necessary:a goal, constraints and variable parameters. Tasks of optimization, as a rule, are solved at two hierarchical levels. As the optimization tasks spread in various scientific directions, appropriate mathematical methods were developed. The simplest and the earliest is the method of differentiating the objective function obtained with allowance for constraints, and equating the derivative to zero. This method of optimization is most common in radio engineering and, in particular, in optimization problems using EMC criteria. In more complex problems, the methods of Lagrange multipliers, the methods of dynamic, linear, quadratic, convex, geometric programming, the maximum method are used. However, the choice is most often made subjectively and not always in the best way. The analysis of the provision of electromagnetic compatibility in various electronic devices has shown that the development of any electronic instrument should pay the greatest attention to the design of printed circuit boards. Therefore, the developer can determine in advance the problem areas of the printed circuit board in the early stages. This will allow the engineer to reduce the time of production of electronic equipment and reduce the cost of creating this product

Key words: design of radioelectronic facilities, noise immunity, noise srability, electromagnetic compatibility, design methods, optimization

FAST DIGITAL SIGNAL DEMODULATION ALGORITHM WITH QUADRATURE AMPLITUDE MANIPULATION

V.P. Litvinenko, E.A. Bokova, A.O. Apalikhin, S.V. Shkil'naya

Abstract: the hardware implementation and application of the fast digital signal demodulation algorithm with quadrature amplitude manipulation (QAM) based on programmable logic integrated circuits (FPGAs) is considered. Based on the fast digital algorithm for coherent processing of narrowband signals, a simple digital signal demodulator with quadrature amplitude manipulation is proposed, which allows efficient implementation on modern programmable logic integrated circuits. The RF patent was obtained for the demodulator under study. For its implementation, a description of the demodulation algorithm is developed on the VHDL FPGA, the synthesis of HDL-code and modeling in the application package with fixed signal parameters is carried out. A comparison is made between different series of modern FPGAs by ALTERA for various parameters of the processed signal. An expression is given for calculating the probability of a demodulation error. Using the methods of statistical simulation in the MATLAB / Simulink system, the operability of the FPGA demodulator is checked, its noise immunity at various signal parameters is investigated. The results of the studies indicate the possibility of hardware implementation of the proposed demodulator

Key words: quadrature-amplitude manipulation, digital demodulation, FPGA, VHDL, Verilog, MATLAB

DEVELOPMENT AND ANALYSIS OF THE MODEL IMITATING INTERFERENCE OF RECEPTION OF PHASE-ANIMATED SIGNALS TO PROVIDE ELECTROMAGNETIC COMPATIBILITY OF RADIO ELECTRONIC DEVICES

A.L. Neklyudov, A.A. Pirogov, N.V. Tsipina, I.S. Bobylkin

Abstract: in the modern world, when receiving signals that carry useful information, in conjunction with the main signal simultaneously, interference of the most diverse origin is recorded. These include distortions of useful signals under the influence of various disturbing influences. The allocation of a useful information component from the general spectrum of detected signals, as well as the most effective suppression of noise and interference in the signal under consideration while maintaining its integrity, is one of the primary tasks of primary processing of received signals. The article presents the development and analysis of the simulation of the imitation interference of receiving phase-manipulated signals (PMS) necessary for calculating the EMC of REM and allowing one to estimate the probability of a failure in the transmission path of the information transfer, when simple and complex interference affects it, two and four-position phase-manipulated

signals with various elementary forms sending, as well as other signals, taking into account the distorting effect. The structural scheme of the communication system model with imitation of interference of the PMS reception is considered, in addition, the graphs of the signals with binary frequency and linear frequency manipulation are presented. In the developed model of the manipulator of interferences it is possible to generate pulses with a predetermined duty cycle and intrapulse manipulation by any of the available kinds of signals, and also a different pulse front or a smoothed sinusoidal signal can be set

MONITORING SYSTEM OF MOBILE RADIO COMMUNICATION OF 2G-4G NETWORKS

O.V. Boyko, D.V. Zhuravlev, I.A. Safonov

Abstract: in the modern world, mobile cellular radiocommunication systems are developing fast and for their 20 years of progress have densely entered the life of mankind, covering all areas of our activities. The GSM public communication system allows solving the widest range of tasks, having long ago left the limits of normal voice communication. An example of this can be remote control of various devices, or, for example, a mobile surveillance system behind the object, GSM "bugs" to determine its location. Due to the constant expansion of the GSM cellular communication system, the problem of rational use of the radio-frequency spectrum arises. The peculiarities of the 2G-4G standards used in the transmission of data in this system of cellular mobile radio make it necessary to continuously assess the quality of communication in cells. To solve these problems, a monitoring system specially designed for the required tasks is needed. Such systems are quite complex technical devices, while at the same time differing in their high cost. However, the relatively young SDR technology can successfully solve the required tasks and organize an affordable monitoring system for 2G - 4G networks. In this article, the application of the proposed solution is briefly considered using the GSM-900 mobile cellular radio range analysis as an example, the most technically accurate method for estimating important parameters is shown

Mechanical engineering and science of machines

CONTROL OF SPATIAL ORIENTATION OF ROBOT'S NODES IN THE PROCESS OF ADDITIVE PRODUCT FORMING

A.N. Grechukhin, V.V. Kuts, M.S. Razumov

Abstract: the article is devoted to the study of the accuracy of the formation of the surface layer of engineering products by additive methods. The analysis of advantages and disadvantages of layered products synthesis technologies is carried out. It is revealed that, in additive shaping, the exact characteristics of the surface layer differ significantly from the accuracy characteristics of the surface layer of products obtained by traditional methods. Shaping the surfaces of details of a complex profile by additive methods is characterized by high values of the static component of the processing error-the error in shaping (approximations). The analysis of domestic and foreign works on the topic of research is carried out. It is proposed to carry out the dynamic spatial orientation of the final element of the forming system of additive equipment to improve the accuracy characteristics of complex product surfaces obtained by additive methods. To control the spatial orientation of the final element of the forming system, the use of mechatronic 6-coordinate devices is proposed. A technique for calculating the controlled parameters of a 6-coordinate robot is developed, under which the spatial orientation of the final element of the forming system will be provided along the normal at the point of the nominal surface of the part to be formed. The multivariance of the values of the controlled parameters of the 6-coordinate robot under the transition of the final element of the forming system from the previous point to the next one is considered. A condition is proposed for choosing a rational variant of the transition. The controllable parameters of the 6-coordinate robot are calculated for the shaping of a spherical surface by additive methods. The proposed technique will allow the dynamic spatial orientation of the final element of the forming system of additive equipment, which will reduce the roughness of the complex profile surfaces of parts when they are formed by additive methods

DIFFUSION WELDING OF TITANIUM THIN-WALLED STRUCTURES WITH T-JOINTS

V.V. Peshkov, A.B. Bulkov, I.B. Korchagin, S.M. Larsov

Abstract: the use of thin-walled layered structures with a honeycomb core is an effective way to reduce the weight of aircraft products. The purpose of this work is to determine the influence of the ratio of the thicknesses in the T-joint of the filler elements and the shells on the development of the diffusion welding process. Experimental studies were carried out on tubular samples with the wall thickness of 0.5 mm from an OT4 alloy with a coarse-grained structure simulating one cell of a honeycomb core, to the end of which plates with the thickness of 0.5 to 2 mm of sheet alloy OT4-1 were welded by diffusion welding, having globular microstructure in the initial state. After welding, the diffusion bond was mechanically tested for strength, and the profilograms were taken from the surface to determine the depth of indentation of the tubular sample. It was established that the formation of the diffusion bond and its strength are specified by the development of the process of deformation of welded blanks in the contact zone. When the thickness of the shells is less than 1.5 mm, the process of its deformation is difficult because of the contact hardening that occurs as a result of friction against the steel sheet. The value of hardening depends on the thickness ratio and is numerically characterized by the hardening coefficient

Key words: diffusion welding, T-joint, deformation, contact hardening

WAYS OF INCREASING THE RESISTANCE OF HOB CUTTER

O.I. Popova, M.I. Popova, L.S. Pechenkina

Abstract: the ways of increasing the durability of hob cutters are considered in the article. The main ways to improve the wear resistance of gear cutting tools are the creation of new designs of high-performance hob cutters, as well as using the tool design of improved self-hardening complex alloys. Two ways of increasing the durability of hob cutters are proposed. The first way is the creation of new designs of high-performance hob cutters; the second is the optimal choice of the alloy brand for the tool. In the proposed hob cutter design, by reducing the working height of the tooth for the first, second and third passes, the length of the base of each tooth is shortened, which makes it possible, without decreasing the strength of the tooth, to reduce the angular pitch of the teeth in the end section and form on the same outer diameter a hob cutter racks. An increase in the number of racks gives a greater number of profiling cuts, which reduces the irregularity of cutting and dynamic loads. The new design of the hob cutter significantly reduces the wear rate of the tool teeth, which leads to an increase in tool life. The requirements to the second path can be satisfied by self-hardening complex iron-based alloys that combine high hardenability with the principle of composite hardening

Key words: new hob cutter, durability, complex alloys

TECHNO-ECONOMIC SUBSTANTIATION OF THE USE OF NEW METHODS OF PROCESSING AND RESULTS OF SCIENTIFIC RESEARCH IN MACHINE-BUILDING

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Abstract: the feasibility of selecting technological options for manufacturing products and introducing research results that require minimum costs for obtaining high-quality products is justified. For an objective assessment of the legality of the choice of the process, criteria are proposed that take into account the costs at the stages of the product life cycle, taking into account the individual capabilities of the manufacturing enterprises, the requests of customers and developers of promising products. The first group of criteria is aimed at the design of the technological process that provides the operational requirements for the part, the second one characterizes the economic efficiency of the application, for example, of electrical processing methods, which should take into account such indicators as tool wear during electroerosion processing and mass outbursts in the electrochemical process, taking into account the capabilities of the equipment used. When developing the control program and technological modes of electrical processing methods, these criteria constitute a general structure and meet economic criteria. The goal of implementing the projected technologies and control programs for electrical processing methods is manufacturing products that meet specified performance characteristics of quality while minimizing the resulted costs. Examples are given of developing effective control programs for electrical processing methods, technical and economic results obtained by replacing machining with a combined electroerosion-chemical process in the manufacture of a central hole in details

Key words: project feasibility, processing methods, effectiveness, limitations, examples of use

Physics

STAGES OF DEVELOPMENT OF SCIENTIFIC RESEARCH WORK AT THE DEPARTMENT OF GENERAL CHEMISTRY OF THE VSTU. OVERVIEW

B.A. Spiridonov

Abstract: the information on the formation of the Department of Chemistry in the VSTU and the development of research work for the period from 1968 to 2017 are given. The most notable contribution to the establishment of the Department of Chemistry was made by Professor A.I. Falicheva. Fourteen candidate dissertations were successfully defended under her leadership. The main scientific areas were electrochemistry, electroplating, corrosion and metal protection. The establishment of interrelation between the electrochemical parameters of the reduction of chromium (111), chromium (V1), and aluminum (111) ions with the spectral characteristics of solutions became a modern trend in science, which allowed us to formulate the theoretical foundations for the development of new electrolytes. Other topical problems related to the development of electrolytes and technologies in the production of galvanic coatings - zinc, aluminum, chromium-cobalt, chromium-nickel, nickel-boron, nickel-indium, tin-nickel, etc. also were successfully solved. Based on the studies, the article presents data on the solution of various practically important problems, for example, refining gold by electrolysis using reverse pulsed current, anodizing aluminum to produce nanoporous alumina. In 2010, the Department of Chemistry was headed by Dr. Tech. Sci., Professor V.A. Nebol'sin. Under his leadership, research was continued on the anodizing of aluminum and titanium to produce nanoporous oxide films, which were used as matrices in the pores of which carbon nanotubes (CNTs) and filamentary nanocrystals (FNCs) of silicon and Si_xGe_{1-x} were grown. It was found that CNTs on a matrix of porous alumina can be used as sorbents of various gases (hydrogen, ammonia, etc.). The principal possibility was found of growing the ordered FNC systems of silicon and Si_xGe_{1-x} using a masking matrix of nanoporous titanium dioxide and nickel particles as a catalyst for the growth process

Key words: electrolyte, electrolysis, electroplating, anodizing, aluminum, titanium

CYCLIC TESTS OF CARBON FIBER REINFORCED PLASTICS BASED ON HOT-MELT EPOXY BINDER T-107

A.M. Kudrin, **K.S. Gabriels**

Abstract: within the framework of complex research tests of technological material adapted for automated layout – based on carbon fiber Formosa 12K and hot-melt epoxy binder T-107, modeling of long-term mechanical stress (fatigue tests) was carried out. The studies showed that qualitative prediction of residual properties of CFRP was determined by strength tests after impact and cyclic loading schemes. Performed cyclic physical and mechanical tests in accordance with ASTM D 5766 and D 7615 allowed to determine the value of the maximum load (mechanical resistance of the material with the stress concentrator) at the level of 50.62 kN, and also to simulate the real operating conditions. The article shows the nature of the material destruction – LGM (lateral-gage-middle) – the destruction of the CFRP along the entire thickness of the sample directly in the region of the notch with the presence of insignificant delamination in the working zone in the directions ± 45 ° from the center of the notch. A similar type of failure, but with much more destruction, was observed with cyclic loading of CFRP samples with an amplitude range from 10 % to 70 % of the fracture load. Samples with loading ranges of 20-60 % and 15-65 % withstood 10^6 cycles of fatigue tests without visible deformation, showing a residual strength of 90 % from the original value

Key words: polymeric composite material, CFRP, carbon fiber reinforced plastics, fatigue test, notch tension strength, cyclic tests

STRUCTURE OF THIN FILMS OF WIDE-ZONE SEMICONDUCTORS In_2O_3, ZnO, MODIFIED BY CARBON

O.V. Zhilova, V.A. Makagonov, S.Yu. Pankov

Abstract: the thin-film nanostructures ZnO-C and In_2O_3-C and thin films ZnO, In_2O_3 and C were synthesized by ion-beam sputtering. The X-ray diffraction analysis of the obtained samples showed that thin films of ZnO and In_2O_3 obtained by ion-beam sputtering of oxide targets are characterized by nanocrystalline structure with hexagonal crystal lattice for ZnO (space group P63mc) and cubic for In_2O_3 (space group Ia-3). Thin films of pure carbon in the initial state are amorphous. Thin films of ZnO-C and In_2O_3-C are characterized by a heterogeneous structure in which the nanocrystals of the oxide semiconductor are located in the matrix of amorphous carbon. The thermal treatment of ZnO, In_2O_3, ZnO-C, and In_2O_3-C films at temperatures up to 873 K leads to an increase in the size of the oxide semiconductor crystals, however, in ZnO-C and In_2O_3-C films, the growth of the crystals is markedly weaker, which indicates a higher stability of the nanostructured state of In_2O_3, ZnO films modified by carbon. In ZnO-C and In_2O_3-C films, a certain excess diffraction background was detected, which can be related to the average distance between the crystals of the oxide semiconductor

Key words: wide-bandgap semiconductors, thin films, indium oxide, zinc oxide, ion-beam sputtering, thermal treatment, X-ray analysis

THE INFLUENCE OF ELECTROLYSIS MODES ON THE PHASE COMPOSITION

AND STRUCTURE OF TITANIUM OXIDE FILMS

V.A. Nebol'sin, B.A. Spiridonov, V.A. Yur'ev, N. Swaikat, A.V. Makarova

Abstract: electrochemical modification of the metal surface was used to obtain functional materials with different properties. Thin oxide films were obtained by the potentiodynamic method. The kinetics of electrochemical anodizing of titanium grade W6 was studied. It was found that the anodic oxidation of titanium in the ethylene glycol electrolyte in the presence of NH_4F formed a nanoporous structure of titanium oxide with a pore diameter of 50-70 nm. In an acidic electrolyte containing HF, nanopores with a diameter of 100-110 nm were formed, which is associated with a higher rate of dissolution of titanium oxide in comparison with the rate of its formation. Thicker films (>5 μm) were obtained from electrolytes with controlled pH. It was shown that at the initial stages of anodizing at the duration of electrolysis 1-2 min the appearance of the surface of anodized titanium differed markedly from the oxide formed at the duration of electrolysis more than 4 min. According to X-ray and electron diffraction data, a crystalline phase of Ti_6O oxide was formed on the surface of titanium at the early stages of electrolysis, and a diffuse halo was observed with an increase in the anodizing time, which means a transition to the amorphous phase of TiO_2

Key words: titanium anodizing, electrolysis, titanium oxide, nanopores