SOLVING THE MATRIX OF SINGULAR PERTURBED LINEAR PROBLEMS OF OPTIMUM CONTROL WITH THE MINIMUM STRENGTH AND DIMENSIONAL CONTROLS

Yu.V. Korypaeva, V.V. Peshkov

Abstract: this paper suggests asymptotic approach to solution of optimal control problems with lowest possible power. Dynamic system belongs to the class of matrix of linear singularly perturbed systems. Executive functions are considered to be multidimensional, and the Euclidean norm of their values is limited. For a matrix of singularly perturbed systems for the analysis of this problem is still not implemented. Earlier, the task in the same setting, but for a singularly perturbed linear dynamical system was solved by A. Kalinin. This paper presents the study of the conditions under which the initial equation of state can be reduced to a system in which fast and slow variables are singled out are listed. Further, the algorithm for finding the asymptotic solution of the problem under consideration is constructed and justified. It is based on splitting the initial perturbed optimal control problem into two problems – first, the problem of smaller dimension and second - not containing perturbations, which is the corresponding singular problem. After solving these problems structure of optimal control is fully specified and can be obtained in an explicit form the expression for the asymptotically suboptimal control for the desired order of accuracy

Key words: singular perturbations, asymptotic methods, optimal control, multidimensional control actions

ALGORITHMIC SUPPORT FOR CONSTRUCTING THE TRAJECTORY DEVIATIONS OF THE AIRCRAFT PROVIDED BY THE GUIDED WEAPONS

M.A. Gorchakov, A.V. Lushchik, V.I. Rubinov

Abstract: analyzing the current status and prospects of the aid system for crew decision-making in critical situations allows us to conclude that existing system remains under development and is not able to correctly map all the incoming information on air situation processes, assess it, work out various options and, thus, assist pilot in taking the correct decision. Promising technique of increasing safety for various military tasks is the modernization of the above systems through the introduction of algorithmic support, in which the path of maneuvering aircraft from guided weapons in unattended or automated mode is applied. Path computation in flight-navigation complex has to be performed hierarchically: both at the navigation and trajectory levels. The first level is intended to determine the point in three-dimensional space, the motion which is achieved by minimizing the probability of injury or failure of the guidance. On the second level it has to build the trajectory of maneuvering, or otherwise, the polynomial time for each axis individually, in pursuit of which the probability decreases from 0.89 to 0.18. The interaction of levels is performed under the condition that the output signals of the navigation level (the coordinates of the computed points) are set up for the specifying trajectory

Key words: flight safety, maneuvering trajectory, flight-navigation complex

MANAGEMENT STRATEGY THE PLAYER-ALLY IN THE TASK NONLINEAR DIFFERENTIAL GAMES WITH TERMINAL CONSTRAINTS

I.V. Shcherban, S.V. Ivanov, O.G. Shcherban

Abstract: the method of the strategy formation for the control of the player-ally in the task of nonlinear differential games of pursuit is reviewed in the article. Considering that the adversary generates the most probable control for the purpose of interception of the object ally, and that in each moment of time ally known initial conditions and dynamic capabilities both as a player ally and an enemy. Management aircraft ally is formed by the autonomous means of the control system in real time. It is possible to reduce gaming to the problem the unilateral management of ally that do not require performance conditions to achieve a saddle point. The control is implemented in the form of a synthesis and further ensures the implementation of the requirements about bringing the object of allies in a given area of space with the terminal improvements phase variables. The aim of this work is to build effective computational method for the solution of the problem of synthesis of terminal optimal control of the movement of the player-ally in the above-mentioned conditions. This formulation differs from the classical conflict task on the prosecution, which applies the theory of differential games. Article reviews practical example, which allows to evaluate the computational efficiency of the presented approach. it also introduces the numerical modeling with the practical example

Key words: nonlinear differential game of pursuit, one-way control of an ally player, terminal optimization

MODEL INFORMATION PROCESSING SYSTEMS ON RELIABILITY TESTING EQUIPMENT

A.Yu. Rusin, G.A. Dmitriev, M.A. Abdulhameed

Abstract: at present, one of the main tasks in testing of equipment is the development of accelerated methods for determining the quantitative values of reliability indicators. Indicators of reliability of mechanical systems can be determined only after the accumulation of a sufficient amount of statistical data. The average operating time to failure of modern machines and equipment, their individual parts and assemblies can be calculated for years, therefore, existing methods of testing prototypes are not effective because of their duration. To reduce the duration of testing the laws of mathematical statistics, the general theory of experiment planning and applying a computer can be used. Increasing the cost-effectiveness of the equipment reliability test system can be achieved by reducing the test time or reducing the number of test samples. When the test time is shortened, the degree of censoring of the sample increases, and when the number of samples decreases, the sample size of the equipment development decreases as well. The article a presents regression models, thus establishing the relationship between the deviation of the maximum likelihood estimate from the true value and the parameters characterizing the sample structure. They allow us to calculate and introduce corrections to the maximum likelihood estimates. Experimental studies of the results of their use were carried out. The accuracy of the maximum likelihood estimates after application of the developed models and the introduction of an amendment to the maximum likelihood estimates is significantly increased

Key words: computer simulation, information handling, equipment test, reliability, censored samples, maximum likelihood method, software

DEVELOPMENT OF ALGORITHMS OF THE TESTING PROCESS FOR A SOFTWARE-HARDWARE COMPLEX CLIMATIC TESTS POWER SUPPLY MODULES

A.D. Danilov, V.A. Mineev

Abstract: this article is devoted to the process of developing algorithms for the testing process for the hardware and software climate test complex of power supply modules. It considers the stage of manufacturing of power supply modules, the stage of conducting the thermal cycling test was chosen. Existing hardware and software complexes that allow to make the stage of climate testing completely automated. The shortcomings of existing hardware-software systems are revealed. The specifics of monitoring the parameters of power supply modules are specified. The structure of the developed software and hardware complex is described, taking into account the specifics of the tests. The method of data organization for the hardware and software complex is chosen. The choice of software architecture for working with devices at the lower level is explained. The selection of the programming environment for the development of the human-machine interface and options for its main purpose are considered. The basis for the implementation of the script system has been selected. The technological process of checking the power supply modules for the effect of low and high ambient temperature is presented. An example of implementation of a technological process on the basis of a software and hardware complex using a script system is given. Algorithms of tests are described. The database interaction process and the scenario description method for testing are shown. The listing of the test script is presented. Possible options of using the developed software and hardware complex are considered. The advantages and disadvantages of creating scenarios for users at this stage of development are reviewed

Key words: software, computer systems, algorithms, databases

COMPARATIVE ANALYSIS OF GRADIENT DISTRIBUTION METHODS FOR ALLOCATION OF THE OBJECT CONTOUR ONTHE IMAGE

O.A. Pakhomova, O.Ya. Kravets

Abstract: basic definitions of basic concepts in the theory of selection of object boundaries, such as detection, gradient, contour point and brightness are given in the paper. The way of converting an image from RGB to a grayscale format is introduced. The mathematical model of formation and the method of calculating the gradient, as well as its role in object identification, are considered. The ways of discretization of the gradient for each pixel of the image are shown, based on the concept of finite difference and on the convolution of the original image with the mask of operators Sobel, Roberts, Pruitt and Scharra. The results of a computational experiment on the application of masks by the operators Sobel, Roberts, Pruitt and Scharr are presented for calculating the values of the gradients and their directions to a specific image. The method of finite differences consists in replacing the domain of continuous variation of the argument by a finite set of points. Convolution can be called an operation that redefines the value of the pixel under consideration taking into account its environment. A mask is a definite matrix - the core of the convolution, which is predetermined in view of the use of this or that boundary detection operator. In this article, a comparative analysis was carried out and the best methods were selected based on the visual perception of the resulting contours in the image and the calculated gradients

ALGORIHM FOR DETERMINING THE COORDINATES AND PARAMETERS OF THE MOTION OF GROUND OBJECTS

V.V. Shipko, V.I. Rubinov, I.E. Sharonov, A.S. Hanov

Abstract: the article presents the model and algorithm of setting out coordinates and movement parameters of the ground objects using optoelectronic system with unit of digital images processing, carried on board of an unmanned aerial vehicle. After detection and seizure of the ground object by optoelectronic system setting out coordinates and movement parameters of the object are set by solving geometric task. This method ensures passive remote setting out coordinates of ground objects and their movement parameters. Particularly, the proposed algorithm does not need require Doppler velocity meter or any other additional equipment. As a result, there is a great reduction of coast and weight of equipment carried on board of an unmanned aerial vehicle. The consumption of energy of an on-board energy source by this equipment is greatly reduced as well. The algorithm allows setting out coordinates, speed and direction of ground objects' movement which move in any direction in relation to flight path of an unmanned aerial vehicle

Energetics

DECISION MAKING ALGORITHMS FOR MANAGING THE DURATION OF NUCLEAR ENERGY FACILITIES

V.P. Povarov, M.B. Bakirov, A.D. Danilov

Abstract: the article reviews operational damageability of critical units of nuclear power stations power plants. It estimates the scales of influence of heat-hydraulic and physical characteristics of the stratification flow damaging metal parts. The mechanism of plastic deformation and accumulation of operational damageability as a cause of delayed destruction of critical elements under temperature stress is shown. To monitor such damage, the concept of multi-parameter monitoring was used, which allowed the development of the special procedure for calculation and experimental prediction of the residual life of nuclear power plant equipment. A scheme for the analysis of the safe residual life of critical elements is presented using multi-parameter calculation and experimental monitoring. An algorithm for determining the intensity of failures and the transition to the limit state in the control of the service life is developed. Based on the analysis done in the article, an algorithm for implementing the concept of safe operation of nuclear power facilities was proposed. Based on these studies, the period of industrial operation of "Novovoronezh NPP" Unit 5 has been prolonged for 30 years and work is underway to re-extend the validity period for another four units of the nuclear plant

FEASIBILITY OF DECENTRALIZING THE COMPENSATION OF REACTIVE POWER WITHIN THE ENERGY SUPPLY SYSTEM OF THE REPUBLIC OF TAJIKISTAN

S.Sh. Tavarov

Abstract: article reviews the problem of active power and voltage loss in a 220 kV electric network of the Northern part of the Republic of Tajikistan energy supply system. This particular problem is caused by the lack of reactive power compensation in the 10 kV distribution network units and the transfer of the necessary reactive power over 220 kV and below to consumers within the energy supply network itself. Maximum active and reactive power values for the distribution network units with a voltage of 10 kV are, therefore, calculated and introduced in the article. Power supply method, which presumes the centralized compensation of reactive power with subsequent transfer of the necessary reactive power from the "Sughd-500" power system substations to consumers, does not solve the above problem. High losses of active power and voltage in electrical networks of 220 kV voltage themselves and in the subsequent stages of the voltage types are being observed. Thus, in order to reduce the losses of active power and voltage it is necessary to decentralize the reactive power compensation with the facilities for compensating reactive power for 10 kV

DATA PROCESSING WITHIN THE SYSTEM OF CONTINUOUS OPERATIONAL MONITORING OF CRITICAL ELEMENTS DAMAGES OF BASIC INSTALLATION UNITS OF POWER PLANTS

V.P. Povarov, M.B. Bakirov, A.D. Danilov

Abstract: ultrasonic monitoring procedure for the collection and analysis of information about the studied process of formation of mechanical damages of critical elements of the nuclear plant is reviewed in the article. The composition of the ultrasonic monitoring system and the technology for collecting and analyzing information about the process of formation of mechanical damage are presented. The main informative growth parameter of the defect is the increase in the amplitude of the echo signal (equivalent area), which varies with time during defect growth. During the monitoring all collected data are recorded to the so called A-scans of echoes in each of the 3 measuring gates installed on the UMD-8 flaw detector, and the maximum amplitude values of the registered echo values are determined. A-scan is an image of echoes reflected from defects in welded joints or structural elements of the controlled zone. In this case, the time interval between the probing pulse and the echo pulse reflected from the defect, taking into account the velocity of ultrasonic vibrations, determines the distance from the ULTRASONIC transducer to the defect, and the amplitude of the echo signal is proportional to the size of the defect. The studies performed have shown that the ultrasonic method of control is currently the most effective and reliable way to identify and measure the characteristics of defects in equipment and pipelines of nuclear power plants

Key words: ultrasonic monitoring, A-scans, echo-signals, measuring gates, digital processing, data analysis, area of defect

Radio engineering and communication

THE MULTIBEAM ANTENNA WITH COMB REFLECTOR

A.V. Ostankov

Abstract: modern telecommunication systems are in dire need of antennas with multi-beam directional diagrams (DD). Mirror multi-beam antennas are preferred in many cases and for a number of reasons. If for the traditional version of a mirror antenna the task of realizing a multi-beam DD is successfully solved, for antennas with flat mirrors it is still relevant. An antenna with a reflector in the form of a comb lattice is considered in the article. The shortened slits of the comb have different depths and thereby correct the phase shift of the reflected partial waves, focusing them at the location of the irradiator. To investigate the feasibility and efficiency of realizing the multi-beam DD of such an antenna with a multi-position irradiator, an original computational algorithm was used. The algorithm is based on a relatively strict solution of the problem of the irradiation wave diffraction on the finite comb lattice. The article presents the main relationships that are the basis of the algorithm. For the indicated parameters of the mouth and the irradiator, the influence of the irradiator displacement on the antenna directional properties was investigated. It is established that the displacement is accompanied by a deviation of the main lobe of the DD from the original direction and an increase in the level of the lateral radiation. The magnitude of the displacement which leads to a deflection of the beam by 1° is estimated. The search for the spatial position of the irradiators of the multibeam antenna is reduced to finding the extremum of the objective function, taking into account both the misalignment of the expected and actual angular directions of the beam, and the maximum level of the side lobes of DD, and is realized on the basis of the genetic algorithm. The results of the parametric synthesis of the antenna are presented in the form of the DD of each of the six realized channels of a multi-beam antenna with an angular spread of 5°. The analysis, performed by mathematical modeling methods, confirms the possibility of effective implementation of the multi-beam DD based on the antenna with the comb reflector. The computational algorithm used can find the optimal position of the irradiators. The simulation results state that the directional properties of the antenna in the transition from the central beam to the peripheral beams slightly deteriorate

Key words: antenna, irradiator, comb reflector, simulation, multibeam directional diagram

SOLUTION TO PROBLEMS OF DECIMATION WITH THE CIC-FILTER IN A DIGITAL RECEIVER

D.V. Zhuravlyev, S.V. Polyakov

Abstract: in this article, we give a brief description and calculation part of a receiver built using CIC filters in decimation problems. By decimation is meant a decrease in the

sampling frequency of a discrete signal in time by thinning its readings. The use of these filters is necessary due to the absence of multiplication operations in them, which simplifies and speeds up the work of the processor. The calculation of filters was carried out in the program "Softcell Filter Designer" from the company Analog Devices, also the structural diagrams and methods for calculating are given for such parameters of the receiver as sensitivity, selectivity for the adjacent channel, dynamic range. The sensitivity was measured in the frequency range from 2.5 MHz to 22.5 MHz with a signal-to-noise ratio of 12 dB. The sensitivity value was 35 μV. The selectivity for the adjacent channel was measured at the frequencies of 7.8 MHz and 14.2 MHz, since rejection filters (RF) were used in the measurement at the corresponding frequencies, because of interference from other reception channels into the spectrum of the useful signal. The measured dynamic range (89.5 dB) was less than the calculated (91 dB), since the formulas given in the calculation refer to the ideal receiver, in which there are no ADC noise, noises of other reception channels and noises of the ether

EXPERIMENTAL DETERMINATION OF THE E-FIELD RADIATION ATTENUATION
COEFFICIENT IN THE RANGE OF DECIMETRIC WAVES

D.V. Asotov, B.V. Matveev, A.V. Ostankov, A.A. Makarov

Abstract: the article proposes the procedure for determining the attenuation coefficient of E-field radiations (AC EFR) when calculating the size of the zone of possible reception of EFR (zone 2). Two methods for its determination are considered, theoretical and experimental. The peculiarity of this problem is that the determination of the AC EFR must be carried out for individual frequencies in the ultra-wide range from ten megahertz to one gigahertz. It is shown on the two-beam model of radio wave propagation above the earth's surface that it is impossible to reliably determine the EFR attenuation at an arbitrary point in space under multipath conditions due to the formation of interference dips and hits in it. The results of an experimental study of propagation of radio waves obtained for three typical traces are presented: open (above the ground), closed (room-wall-street) and inside the room. The possibility of calculating the EFR attenuation is shown on the basis of experimental data obtained for three channels of its propagation. The influence of multipath on the error in calculating the size of zone 2 is revealed. An approach is proposed to reduce the influence of multipath based on smoothing the frequency dependence of the electric field intensity (EFI). The technique for the experimental determination of the attenuation value of EFR is established

ARCHITECTURE FOR STOCHASTIC LDPC-DECODERS C USING THE EFFECTIVE CHIP AREA BASED ON EPLD

M.V. Khoroshaylova

Abstract: this article explores the complexity and performance of stochastic low density parity check (LDPC) decoders based on EPLD. A new and powerful decoding algorithm using the low density parity check (LDPC) method based on erasable programmable logic device (EPLD) for implementing fully parallel LDPC decoders is presented. The proposed method is designed to optimize the use of EPLD logic and reduce decoding delay time. To

reduce complexity, the output counter of the variable nodes (VN) is deleted, and each internal VN memory is displayed in only one distributed RAM. In addition, in order to increase the convergence of the decoder, effective initialization of the variable nodes (VN) is performed using the probability of the input channel, without the need for additional resources. The implementation of Xilinx EPLD shows that the proposed approach to decoding achieves high performance along with a reduction in the use of logic even for short codes. To test the advantages of the proposed approach, the EPLD is implemented using Xilinx Virtex-6 VLX240T. As a result, for (200, 100) correct codes 57% of reduction in average decoding cycles is achieved with an improvement in bit error rate, with an $Eb / N0 = 5.5$ dB ratio. In addition, a significant reduction in hardware is achieved

Key words: completely parallel architecture, LDPC decoder bandwidth, message transfer algorithm

METHODOLOGY OF DEFECTOSCOPY AND CALIBRATION OF OPTICAL PHASED ANTENNA ARRAYS, BASED ON APPROXIMATION OF THE SPACE STRUCTURE OF THE FIELD BY THE METHOD OF AUXILIARY SOURCES

D.K. Proskurin, Yu.G. Pasternak, K.S. Safonov, F.S. Safonov

Abstract: considering the fact that the dimensions of the elements of the optical antenna arrays, as a rule, do not exceed half the minimum wavelength of the working wave band, the actual problem is the detection of defects in the structure of an antenna array and the calibration of the optical wave receiving and emission channels during the operation of the optical system. When the optical phased array is functioning, it is necessary to control the geometry of its elements, as well as their material properties. The geometry of the elements of the optical phased array can change, either as a result of mechanical influences, or as a result of the temperature dependence of the linear dimensions of the device parts. In addition, in semiconductor optical modulators based on the Erley effect (variations in the thickness of the p-n junction on the magnitude of the applied bias voltage), there is also a temperature dependence, both the thickness of the p-n junction and the electron and hole concentrations, and hence the complex dielectric constant of the inhomogeneous material. Therefore, the detection of defects in the structure of the optical phased array antenna should be performed to correct the control voltages applied to the optical phase modulators, both in semiconductor phase shifters and in reflective optical phased arrays, built on MEMS mirrors, moving in the direction of the normal to the array. In the present work, an attempt is made to create a methodology for flaw detection and calibration of optical phased array antennas based on the approximation of the spatial field structure using the auxiliary sources method based on measuring the complex amplitudes of the optical field at points corresponding to the phase centers of the elements of the optical antenna array

Key words: optical antenna array, calibration, phased array, flaw detection, field approximation, auxiliary sources, complex amplitude and phase, virtual antenna array, real antenna array

INFLUENCE OF THERMOSTABILIZATION OF THE REFERENCE GENERATOR ON THE ACCURACY OF MEASURING FREQUENCY OF RADIOSIGNALS AND RECOMMENDATIONS ON THE MINIMIZATION OF ITS NEGATIVE SIDE EFFECTS

A.O. Ryzhov, I.B. Kryzhko, A.A. Makarov, A.B. Tokarev

Abstract: thermostabilization of the reference generator of the measuring radio receiver helps to reduce the deviation of the actual frequency of its oscillations from the nominal value, but in practice it is not ideal. During exploitation of the measuring equipment in a wide temperature range, the real temperature regime of the generator is characterized by slow quasiperiodic temperature fluctuations, which are accompanied by quasiperiodic fluctuations in the frequency of the reference generator. If it is required to improve the stability of the reference frequency further, it is necessary to use measures based on a different stabilization mechanism. A possible option to increase the accuracy of the measuring receiver is to control the mismatch of its local time scale (LTS) with the high-precision external scale of the universal coordinated time UTC. The gating-pulses (PPS), produced by the timing navigation receiver at the beginning of every second on the UTC scale, serve as the base for tracking and tuning the LTS. To obtain more precise estimates of the frequency of the received oscillations, it is recommended to limit to only mathematical account of the corrections corresponding to the current mismatch of the scales, but not to use the physical correction of the reference generator, which may give rise to certain side effects. The article specifies the algorithm for tracking the mismatch of LTS and UTC scales, proposes a rule for calculating the correction to the estimated frequency, and gives the formula for calculating the relative error of the measurements, taking into account the correction. It was found that under typical operating conditions of the thermostabilization system, the use of corrections based on the control of the discrepancy of LTS in relation to UTC makes it possible to reduce the relative error of the estimation by 3-4 times or more

Key words: frequency measurement, reference generator, radio signal parameters estimation, temperature stabilization

EVCLIDOVO-ORTHOGONAL LDPC-ARCHITECTURE WITH LOW DEGREE OF COMPLEXITY FOR LOW POWER APPLICATIONS

A.V. Bashkirov, **M.V. Khoroshaylova**

Abstract: this article proposes a highly efficient low-density parity-check (LDPC) decoding architecture for low power applications. Low-density codes (LDPCs) were implemented in digital video broadcasting, broadband wireless access (WiMax) and the fourth generation of wireless standards. This study also deals with the design and analysis of the blocks of the control node and the variable node and the Euclidean orthogonal generator in the LDPC architecture of a decoder. The Euclidean orthogonal generator is used to reduce the error rate of the proposed LDPC architecture, which can be included between the architecture of the test node and the variable node. This proposed decoder design is synthesized on a Xilinx 9.2i platform and modeled using Modelsim, designed for 45nm devices. This article shows that the proposed architecture significantly reduces energy consumption and hardware when compared with other traditional architectures. The model demonstrates better results than other traditional decoder architectures with less equipment usage and energy consumption of about 27 mW, which is more suitable for most applications with low power consumption

Key words: euclidean orthogonal generator, LDPC decoder, low power consumption, message transmission algorithm

INVESTIGATION OF THE APPROXIMATION METHOD OF ELECTROMAGNETIC FIELD IN THE LOCATION OF AN OPTICAL ANTENNA ARRAY BASED ON THE USE OF AUXILIARY SOURCES OF FIELD

D.K. Proskurin, Yu.G. Pasternak, K.S. Safonov, F.S. Safonov

Abstract: In this paper, we consider a model of an optical antenna array operating in the mode of receiving electromagnetic waves in the frequency range 30-300 THz (the wavelength varies from 10 μm to 1 μm). In the course of numerical experiments (to solve the system of Maxwell equations in the integral formulation we used Weiland's method [1]), the accuracy of the approximation of the spatial structure of the optical field at the locations of the elements of the "virtual" antenna array was studied using the method of auxiliary field sources. Also, a study was made of the possibility of using a virtual antenna array formed on the plane of the arrangement of the elements of a real array to enhance the resolution of a multichannel optical system. At the upper frequency of the analyzed range of 300 THz, the wavelength is 1 μm. The array period was chosen to be equal to half the minimum wavelength of 0.5 μm, so that the spatial distribution of the field in the space between the elements of the antenna array could be approximated, in accordance with the requirement of the Kotel'nikov-Shannon theorem

Key words: optical antenna array, virtual antenna array, real antenna array, approximation of the optical field, auxiliary sources of field

JOINT MULTIPLEXING AND THE DATA STREAM SPACE SWITCHING IN INFORMATION TRANSFER WIRELESS LINKS

B.V. Matveev, D.V. Asotov, V.I. Maslov, L.Sh. Goloskokova

Abstract: the article developed proposals to improve the reception of information transmitted in data transmission wireless channels (DTWC) of regional networks, based on the analysis of results of DTWC functioning features. The possibility of using DTWC of IEEE 802.16 (WiMAX) standard for accessing a particular receiver using MIMO technology ("multiple input multiple output") in combination with spatial switching of the transmitted data stream is shown. In MIMO mode, the data stream in DTWC at the transmission side is divided by demultiplexing into N independent channels in the form of bit sequences. This division of the data stream allows to carry out spatial channel switching before the emission into the air, during which each of the N bit sequences is divided into time intervals of a certain length $\varDelta t$, and at the same time, a part of the bit sequence is transferred from a certain time slot of one channel to the same time slot of another channel. On the receiving side, the reverse operation of spatial switching of N channels is first performed for each time interval $\varDelta t$, and then the data stream is multiplexed from N independent spatial channels. The receiver, to which information is not intended, by receiving it on the main wireless channel, after spatial switching receives a signal in the form of a bit sequence consisting of fragmented packets of length $\varDelta t$, the alternation of which is carried out randomly. The content of such a bit sequence greatly complicates the restoration of the semantic content of the transmitted messages

Key words: wireless links, WiMAX, MIMO, space multiplexing

DIFFUSION-WELDED TITANIUM THIN-WALLED LAYERED CONSTRUCTIONS

V.V. Peshkov, **A.B. Bulkov**, **V.I. Maksimenkov**, **A.B. Kolomenskij**

Abstract: one of the ways to reduce the weight of aircraft is to use large-sized thin-walled shell structures made of titanium alloys in design of the aircraft. An extremely important part of production of such constructions is binding of their elements with each other. The main requirement for the process of joining bars is to provide high strength and reliability without losing the stability of the bars to be connected with each other. The article analyzes the traditional manufacturing techniques for the patterns of this type of constructions. In particular, brazing with solder is used for the production of nozzles for liquid jet engines and impellers of turbo-pump aggregates, contact welding for connecting elements of sound-absorbing structures of aviation equipment and motor-vehicle components, mechanical fastening methods are used in the exit windows of electron accelerators with the output of a beam of accelerated particles into the atmosphere or into a gas of increased pressure. Drawbacks of these technologies and possible design defects associated with the type of binding, welding materials or process parameters are reviewed in the article. Possibilities for manufacturing of the above units by means of diffusion welding are proposed by the aythors. To substantiate the possibility of using diffusion welding in the preparation of permanent joints, the results of mechanical tests and fractographic article provides the studies of the surfaces of damaged assemblies and structures

Key words: diffusion welding, titanium alloys, thin-walled structures

INFLUENCE OF TURNING PROCESS PARAMETERS ON SELF-OSCILLATIONS OCCURRENCE

V.S. Bykador, E.S. Shalamov, O.S. Tetenko

Abstract: the article provides a research of self-oscillations development in the turning system depending on the values of the parameters controlling cutting, namely, cutting speed and depth. It demonstrates that certain combinations of cutting speed and depth in a process of turning system can cause self-oscillations. It is established that at a certain cutting depth exceeding some limit value the cutting speed variations can have a significant influence on the development of sustainable vibrations in the processing system. The latter fact has a particular significance if such system is located on the border dividing decaying and self-oscillations. The research was conducted with the as a simulation experiment based on a computer-aided simulation of the mathematical model for turning dynamics. Its dynamic characteristic considered the coordinates and speed connection of cutting. Such connection occurs as a result of various motions of the process system elements due to a final nature of the stiffness properties of a cutting tool subsystem and cutting forces affecting the tool. The conducted computer simulation resulted in the determination of the areas of decaying. It also proved the existence of certain self-oscillations' characteristics for the subsystem of the turning system tool. Such areas are formed in the plane of cutting modes – cutting depth and speed, which in its turn allows for choosing the values of cutting depth and speed depending on the motion type to be provided in the turning system

Key words: self-oscillation, dynamics, turning

Physics

LOW-FREQUENCY INTERNAL FRICTION IN SUPERCONDUCTORS

I.M. Shushlebin, O.V. Kalyadin, A.V. Sergeev

Abstract: the review considers the main works that form the methodological basis for superconductors research that have been conducted for almost half a century of the history of the cryogenic laboratory of Voronezh State Technical University (Voronezh Polytechnical Institute) with the direct participation of its head Vladimir Evdokimovich Miloshenko. In presenting the material, the authors tried to preserve as much as possible the unique scientific style inherent in the works of V.E. Miloshenko. The review includes the results obtained by the method of internal friction in the sound frequency range. The studies of the influence of the superconducting state on the damping of bending vibrations of superconductor plates are considered first. Here, in the region of the superconducting transition, a peak of internal friction was observed, the effect of an external magnetic field on its magnitude, the frequency of the vibrations, and the state of the crystal structure of the superconductor were studied. Special attention is paid to studies of anomalous attenuation of oscillations of second class superconductors in an external magnetic field. In the mixed-state region, peaks of the variation of internal friction and the oscillation frequency near the second critical field were observed. This electrodynamic contribution to internal friction has a certain peculiarity. In experimental situations with systems including superconducting and normal components, the elastic energy of a nonsuperconducting body, on which a superconductor is fixed, can dissipate, which is caused by processes inside the superconductor

Key words: superconductor, liquid helium, internal friction, oscillations, magnetic field, energy dissipation