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Key words: robotics complexes, positioning, navigation, video positioning, technical vision, compression and processing of video data, video shaking, structurally-protected radio link, universal radio signal generator, universal noise-proof encoder.

The development and implementation issues of the intellectual life support system of the mobile ground robotics complex are considered. The aim of the work is to summarize the scientific results of the scientific school team in the form of new technical solutions within navigation system development, technical vision system, video and telemetry transfer channel from the mobile robotics complex to operator console for provide movement and orientation, as well as performing a variety of specific functions. The system of video positioning and dynamic radio positioning, recommended for use in open and slightly intersected areas, where satellite navigation signals can be suppressed or strongly distorted, are presented. A technical vision system based on a structurally-protected algorithm for compressing and enhancing the visual quality of video data, adapted for use in mobile ground robotics complexes, is proposed. For information exchange with the operator's console, a program-controlled shaper of spectral-effective radio signals and a universal device for anti-interference coding have been developed.

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**Yu. N. Parshin, S. I. Gusev, I. I. Frolov, S. V. Kolesnikov, P. V. Zharikov. EFFICIENCY OF SPATIAL SIGNAL PROCESSING UNDER THE INFLUENCE OF ELEMENT MUTUAL IMPEDANCES IN ANTENNA ARRAY**

Key words: antenna array, mutual impedance, spatial structure, interference suppression, amplitude-phase distribution, intermodulation interference.

The influence of antenna elements mutual coupling on the efficiency of spatial signal processing in antenna array is researched. **The aim of the work** is to improve the efficiency of spatial processing with mutual influence of antenna array elements. The optimal spatial structure of signal amplitude-phase distribution measurements is calculated. The spatial structure of antenna array is optimized to increase the noise immunity to spatially concentrated interferences and intermodulation interferences. The efficiency of active interference spatial suppression using spatial structure optimization is researched. This process significantly reduces the dispersion of spatial correlation matrix eigenvalues and increases the algorithm convergence rate.

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**V. I. Koshelev. ANALYSIS OF FILTER AND PROCESS PARAMETRIC MODELS CHARACTERISTICS IN FREQUENCY DOMAIN**

Key words: dynamic frequency characteristics of filters, transient process length reduction.

The problem of analyzing the frequency characteristics of filters in unfinished transient processes (dynamic frequency characteristics) is considered. Such problems are typical both for IIR-filters including the ones based on auto regression models and for FIR-filters, viz. moving average filters. The application of a given approach is especially important for concatenated filters. The methods to reduce the length of transient processes improving dynamic frequency characteristics of filters are analyzed. **The aim of the work** is to analyze the degree of static and dynamic frequency filter characteristics correspondence depending on the length of the sample and techniques to accelerate transient processes in IIR filters.

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**B. A. Alpatov, P. V. Babayan. IMAGE PROCESSING AND RECOGNITION TECHNOLOGIES IN ON-BOARD  
TECHNICAL VISION SYSTEMS**

Key words: image, object, detection, tracking, multispectral, fusion.

Since 1980 the Department of Automation and Information Technologies in control (previously – automation and telemechanics) of the Ryazan State Radio Engineering University has been working on the development of algorithms and devices for detection, tracking and recognition of objects during video surveillance. By now, the scientific school, which was formed at the department, received universal acceptance. This scientific school includes professors, researchers, postgraduate students and students who apply their competencies in the direction of development new technologies for image processing and analyzing in various technical applications. Firmware and software developed by the members of the team who enter the leading scientific school has been put into industrial production and used in serial equipment and video analytics systems. **The aim of this paper** is to review the main achievements of the scientific school and the prospects of its main scientific direction evolution.

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**Y. S. Bekhtin. PRACTICAL ISSUES OF THE THEORY FOR WAVELET-BASED ENCODING OF NOISY SIGNALS AND IMAGES**

Key words: wavelet transform, wavelet-based encoding of noisy signals, SPIHT, wavelet codec.

There are three examples on how to put the developed theory of wavelet-based noisy signal and image encoding in practice. The first example demonstrates possibilities of the theory to fuse multispectral images. The residual ones are devoted to description of the specialized software which is implemented for the secure TV systems and noisy image processing along with the program code for FPGA-based on-board systems.

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**SCIENTIFIC SCHOOL: Space technologies and earth remote sensing systems .....53**

**V. V. Ereemeev, N. A. Egoshkin, A. A. Makarenkov, A. E. Moskvitin, V. A. Ushenkin. THE PROBLEMS IN PROCESSING OF DATA FROM SPACEBORNE HYPERSPECTRAL AND SAR SYSTEMS OF EARTH SURVEY**

Key words: Earth remote sensing, hyperspectral image processing of, SAR data processing, imaging models, imagery fusion, synthetic aperture radars, equalization of spatial resolutions, object selection.

The field of data processing from spaceborne hyperspectral and SAR surveying systems, the development of which is defined in the Russian Federal Space Program as priority direction of modern Earth remote sensing systems evolution, is considered. **The aim of the paper** is to present the results of researches performed by the scientific research institute of aerospace imagery processing to solve some problems in the field specified above. They are to identify the generality and difference of hyperspectral and SAR data geometric and radiometric models, to equalize spatial resolutions and to select objects in hyperspectral data, to fuse hyperspectral and high-resolution data, to perform interferometric processing of SAR data. The examples of the processing results are presented.

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**A. I. Taganov, S. I. Gusev, A. N. Kolesenkov, M. V. Akinin, N. V. Akinina, O. V. Spirkina, V. G. Psoyants. INTELLECTUAL METHODS AND TECHNOLOGIES OF INFORMATION TRANSMISSION AND PROCESSING IN AEROSPACE SYSTEMS**

Key words: space technologies, intellectual methods, space data transmission, aerospace images processing, analysis and environmental risks monitoring methods, geoinformation systems, ecological monitoring.

The problem of scientific direction formation and development of Space Technologies Department of Ryazan State Radio Engineering University in the field of intellectual methods and information technologies for the transmission, interference-immunity information reception and processing in radio electronic systems, computer vision and ecological geoinformation monitoring are considered.

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**B. V. Kostrov, V. N. Ruchkin, A. I. Taganov, A. N. Kolesenkov. THREE-LEVEL EARTH REMOTE SENSING ON THE BASIS OF CYBER-PHYSICAL SYSTEMS**

**Key words:** ground, air and remote sensing of the Earth, cyber-physics system, cloud computing, super-computer, fire monitoring, sensors, decision-making risks, clusters, microprocessor module, intelligent telecommunications structure.

The issues of cyber-physical systems (CPS) application to organize three-level monitoring of objects and territories for forecasting, warning and early detection of emergencies are considered. The aim of the work is to develop software for basic CPS management of the complex of information, operational and algorithmic support for terrestrial, airborne and remote sensing of the Earth. Computer systems and sensors that provide monitoring of various indicators and automatic transmission of collected data to the next level are the basis for such CPS. On the basis of the received data, special devices of the CPS make changes in the external environment, reducing the risks of emergencies. The operational component, including supercomputers, the cloud computing environment SaaS, PaaS or IaaS provides the implementation of the tasks set. As a result of using artificial neural networks, the complex is intelligent, capable of learning and self-learning. The structure and prototype of the CPS interface is proposed, the principles and algorithms of the main procedures are described. The hierarchical intellectual telecommunication structures of the components of the CPS based on the neuroprocessor MB 7707 and the modern NM 6407 are studied to reduce the risk of decision making due to specialized processing of data in conditions of uncertainty.

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**A. I. Efimov, L. N. Kostyashkin, A. A. Loginov, E. R. Muratov, M. B. Nikiforov, A. I. Novikov. IMAGE PROCESSING IN MULTI-SPECTRAL TECHNICAL VISION SYSTEMS**

**Key words:** Image processing, image superimposition, low-level sensors system, software stand.

An anthology of the work on the creation of specialized computing devices on the department of electronic computers, the main stages of the development and scientific research, since 1970, is considered. The main scientific and technical results obtained by the collective of SEC «SpecEVM» in the framework of joint work with the SCC VCT JSC «RSIE» in the period since 2003 are described in detail. In particular, algorithms and software for improved and combined vision systems, image pre-mapping, image quality estimation of image superimposition results, control and automation of parking areas, automation of testing and comparative analysis of video processing algorithms are discussed. A brief review of the main results of the research carried out on the topic of multispectral systems of technical vision is given.

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**SCIENTIFIC SCHOOL: Design automation and software for high-performance systems and computer nets ..... 93****V. P. Koryachko, S. V. Skvortsov, A. P. Shibanov, D. A. Perepelkin. METHODS AND TECHNOLOGIES OF DESIGN AUTOMATION OF HIGH PERFORMANCE SYSTEMS AND COMPUTER NETWORKS**

**Key words:** GERT-networks, equivalent transformations, analytical functions, software defined networks, adaptive routing, multipath routing, load balancing, multi-threaded programs, multi-core processors, graphics accelerator.

The main results obtained by the staff of the CAD department of RSREU in the field of design automation high performance systems and computer networks are considered.

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**V. P. Koryachko, A. P. Shibanov, V. A. Shibanov, A. N. Saprykin, X. L. Fam. DESIGNING THE DATA NETWORK OF OPTOELECTRONIC DEVICES DURING FLYING APPARATUSES TESTING**

**Key words:** aircraft testing, measuring information, data transmission network, optoelectronic facilities, traffic balancing, theory of deductions, time distribution of frame transmission, bandwidth, genetic algorithms, traffic visualization.

**The aim of the research** is to review the work done at the CAD RSREU department on methods for creating a promising network for transmitting information from measuring systems while testing the aircraft. Increase of reliability and speed of local networks of measuring points on the flight path is achieved on the basis of VLB-networks with a randomized load distribution and routing through the intermediate node. The distribution of the transmission time of optical-electronic information frames using the theory of analytic functions of a complex variable is found. Using the theory of GERT-networks, the total bandwidth of chan-

nels and paths of a specialized data transmission network is determined. The optimal solution is found using genetic algorithms. Limits on the average time of information transfer from measuring devices to test control center, as well as restrictions on the amount of the reserve of channel bandwidth are introduced. The description of traffic visualization in the network of a polygon measuring complex is given.

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**V. V. Zolotarev, G. V. Ovechkin, P. V. Ovechkin. EFFECTIVE MULTITHRESHOLD DECODERS FOR SELF-ORTHOGONAL CODES**

**Key words:** communication system, error-correction coding, self-orthogonal codes, multithreshold decoder, concatenated codes, decoder complexity, binary Gaussian channel, q-ary symmetric channel, erasure channel.

Results of long-term researches in the field of multithreshold decoding (MTDs) of self-orthogonal codes development are presented. Bases of multithreshold decoding are stated, possibilities of MTDs implementation on modern element base are shown. The performance comparison of MTDs and concatenated methods of error correction based on them with decoders of the best error-correction codes over the binary Gaussian channel, the q-ary symmetric channel and the erasure channel is fulfilled. It is shown the MTDs provide efficiency comparable to other error-correction methods at significantly smaller implementation complexity.

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**A. N. Pylkin, A. V. Kroshilin, S. V. Kroshilina, D. H. Doan. THE CONSTRUCTION OF MEDICAL EXPERT SYSTEMS FOR MEDICAL-TECHNOLOGICAL PROCESS SUPPORT**

**Key words:** the decision support system for medical decision making, medical knowledge base, medical expert systems, medical information systems.

The approach for solving the problem of constructing medical expert systems for support of medical-technological process on the basis of indistinct-plural approach is proposed.

**The aim of this work** – development of principles of medical information systems construction which include the support functionality making medical decisions based on fuzzy logic with the use of the accumulated statistical information and the data obtained during survey under patients. The formation of the structure of medical expert system to generate the recommendation database in questions of medical technological process support with the use of mining techniques; construction of semantic networks and mathematical models; application of the developed method is fuzzy clustering.

The article gives the peculiarities of medical database design, the example to construct the rules and implement logic conclusion in such systems. General scheme to design medical expert systems of mixed type in medical institutions is offered. The stages to building medical knowledge base and examples of writing logical rules are represented.

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**SCIENTIFIC SCHOOL: Methods and equipment to research the composition and structure of materials, devices of power and plasma electronics ..... 131**

**E. V. Mamontov, V. S. Gurov, E. Ju. Grachev, A. A. Djagilev, V. N. Dvojnin, V. V. Zhuravlev, D V. Kirjushin, A. A. Salikov. PRODUCTION ENGINEERING OF PLANAR DISCRETE ELECTRODES FOR IONIC-OPTICAL SYSTEMS OF CHARGED PARTICLES MASS-ANALYSERS**

**Key words:** mass-spectrometry, quadrupole fields, planar discrete electrodes, time-of-flight mass-separation of ions, Fourier transform of the induced currents.

**The aim of the work:** development of methods and tools for analytical research on the basis of technologies for the formation of electric fields of ion-optical systems with planar discrete electrodes. Distribution of potentials to boundary surfaces of ionic-optical system is formed by system of the distributed resistor-capacitor voltage dividers formed between metallized coverings of dielectric emulsion carriers. Using the technique offered the methods of ion mass division in electric fields on time of flight and with Fourier transform of induced currents are developed. The analytical theory of methods is confirmed by the results of computer modeling and experiments.

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**V. S. Gurov, M. V. Dubkov, M. A. Burobin, V. V. Ivanov, A. V. Nikolaev, I. A. Kharlanov. QUADRUPOLE MASS ANALYZERS BASED ON THIN-WALLED HYPERBOLOID ELECTRODE SYSTEMS**

**Key words:** quadrupole mass filter, monopole mass analyzer, thin-walled hyperbolic electrode, electrolytic coating, sectional electrode system.

The principles of designing the flight quadrupole mass spectrometers based on thin-wall hyperbolic electrode systems are considered. The aim of the work is to develop the principles of designing thin-walled electrode systems of quadrupole mass analyzers.

The design of a quadrupole electrode system is developed, all four electrodes of which have a hyperbolic profile, limited on X and Y axes at a certain level. The technology to manufacture thin-walled electrode systems in the form of monoblock was created. By numerical simulation of monoblock electrode system, the quality of the electric field in it is estimated. Mechanical and thermal tests of monoblock electrode system were carried out.

The constructions of flight hyperboloid mass-spectrometers (quadrupole mass filter and monopole mass analyzer) are proposed in which an extended electrode system is assembled from short identical monoblock sections. The sectional design of electrode system makes it possible to improve the quality of electric field in the working volume of mass analyzer.

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**N. M. Vereschagin, S. A. Kruglov, A. A. Seryozhin, S. G. Shatilov, K. D. Agaltsov. RESEARCHES OF THE GENERATOR OF HIGH-VOLTAGE PULSES WITH INDUCTIVE ENERGY STORAGE AND GAS DISCHARGE CURRENT INTERRUPTOR**

**Key words:** thyatron, gas-discharge current interrupter, inductive energy accumulator, critical charge, break current; break time, turn-off time, electron-ion collisions.

The main results obtained by employees of «Industrial electronics» department in the field of high-voltage pulse technology are presented.

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**A. N. Vlasov, Yu. V. Cherkasova, M. A. Burobin. GENERATION OF POWERFUL PULSES OF MAGNETIC FIELD AT INGIR-MEGA-15 INSTALLATION**

**Key words:** generator, high-voltage vacuum solenoid contact, reed switch, capacitor bank, field-generating system, solenoid, pulsed magnetic field, circuit time.

The problem of generating powerful pulses of magnetic field with amplitude stabilization at the INGIR-Mega-15 facility is considered.

**The aim of the work** is to develop a technique for calculating the parameters of an induction sensor for high-power magnetic field pulses based on reed switch and experimental verification of the theoretical estimates obtained. The value of the induction of the magnetic field at a point remote from the solenoid by a given distance is found. The time of contact closure of reed contact is determined. In the process of experiments, oscillograms of solenoid current signals, the voltage on it and trigger signal of reed switch are taken. The feature of the method studied is the possibility of obtaining a stable amplitude of the magnetic field pulse due to feedback through reed switch, which contributes to the improvement of technological cycles frequency, for example, in the detonation sputtering of metal.

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**SCIENTIFIC SCHOOL: Physics of semiconductors, micro- and nanoelectronics ..... 163****N. V. Vishnyakov, Yu. V. Vorobyov, V. V. Gudzev, A. V. Ermachikhin, D. S. Kusakin, V. G. Litvinov, A. D. Maslov, V. G. Mishustin, N. M. Tolkach, T. A. Kholomina. THE DEVELOPMENT OF METHODS FOR STUDIES OF SEMICONDUCTOR MATERIALS AND DEVICE STRUCTURES FOR MICRO- AND NANO-ELECTRONICS**

**Key words:** micro- and nanostructures, experimental investigating methods.

In this paper several diagnostic methods to investigate semiconductor micro- and nanostructures, developed by scientific school of department of micro- and nanoelectronics, are considered. The aim of this work is modification of existing and development of new methods to study and control electronic micro- and nanostructures, in particular, methods of scanning probe microscopy and spectroscopy, noise spectroscopy of electronic states, compensating the current of non-stationary photoconductivity. The features of these methods application are investigating objects such as structures based on non-crystalline semiconductors with low mobility of charge carriers, semiconductor structures with quantum wells and dots, other nanoobjects and micro- and nanostructured materials. These materials and structures

are used in semiconductor solar cells, optical sensors and light emitting devices, non-volatile phase-change memory devices, memristors and other devices of electronics.

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**SCIENTIFIC SCHOOL: Adaptive and intellectual methods  
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**A. M. Abramov, V. V. Bondartsev, S. G. Gurzhin, V. I. Zhulev, M. B. Kaplan, S. V. Nikitin, E. M. Proshin, G. A. Sadovskii, A. V. Shulyakov.** AUTOMATION METHODS AND MEANS TO MEASURE AND TEST COMPLEX OBJECTS

Key words: statistical analyzers of distribution functions, impulse tensometry, small radiotelemetry, digital oscillography, metrological tests automation.

Original methods and means of measuring and studying complex dynamic signals of random, single, repetitive and periodic nature developed at the Department of Information-Measuring and Biomedical Engineering for fifty years are considered. The aim of the work is to present significant developments, results and achievements of the scientific school «Adaptive and intelligent methods and means of measurement and testing in complex objects». Unique equipment for small radiotelemetry has been created to measure static and dynamic deformations in caterpillar tracks and to test moving parts of vehicles. A new class of digital multifunctional analyzers of random processes of wide application has been developed. A new scientific direction in the field of recording and temporal analysis of dynamic signals is opened - digital oscillography. The first computer-based automated reference complex was created on the basis of a configurable modular data acquisition system for carrying out complex certification tests and attestation of measurement modules for on-board information and measurement systems. The directions of further development and increase of efficiency of methods and means of measurements and tests of complex objects are shown.

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**SCIENTIFIC SCHOOL: Biotechnical systems of chronodiagnostics  
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**E. M. Grigoriev, S. G. Gurzhin, V. I. Zhulev, M. B. Kaplan, V. G. Kryakov, S. V. Nikitin, E. M. Proshin, A. V. Shulyakov.** STAGES OF INTEGRATED CHROMOMAGNETIC THERAPY SYSTEMS DEVELOPMENT

Key words: complex chronomagnetotherapy, magnetic field configuration, biotropic parameters, therapeutic exposure, bioengineering feedback.

The systems of complex chronomagnetotherapy of different generations developed at the department of information-measuring and biomedical engineering during the last forty years are considered. The aim of the work is to perform a system analysis and present important developments and results of the scientific school «Bioengineering systems of chronodiagnostics and bioadaptive chronomagnetic therapy». As a reproducible physical factor in all magnetotherapeutic systems designed having positive influence on human body we use electromagnetic field possessing several advantages such as considerable amount of biotropic parameters, fast speed of distribution, high penetration, etc. The formation of therapeutic magnetic explosion is based on information approach which creates, on the one hand, great variety of configurations of magnetic fields with given set of regulated biotropic parameters, and on the other hand, the possibility of their correspondence with the characteristics of patient diagnostic signals. The directions to increase the efficiency of magnetotherapy devices by means of creating bioengineering feedback of different levels, to organize and doze magnetic field parameters as well as to give the possibility of simultaneous dynamic combination of general, distributed and local exposure are shown.

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