ABSTRACT AND REFERENCES

INFORMATION AND CONTROLLING SYSTEM

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DESIGN OF A DEVICE FOR OPTIMAL RECEPTION OF SIGNALS AGAINST THE BACKGROUND OF A TWO-COMPONENT MARKOV INTERFERENCE (p. 4-9)

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We synthesized optimal receiver of signals observed against the background of a two-component additive Gaussian Markov interference. The inclusion of such a receiver into an automated locomotive signal system would significantly increase its noise immunity. We obtained mathematical expressions for the transformations that need to be performed over the counts of voltage of the observed mixture of signal and interference. It is shown that in a general case these transformations are nonlinear and require summing the specified counts with weight coefficients whose exact numerical values are rather difficult to calculate without specifying statistical properties and relationships of the interference components. We refined expressions that make it possible to calculate specified coefficients for the case of a Markov Gaussian interference. They proved to be variable magnitudes, expressed through the variance of interferences, their correlation coefficients and magnitudes of voltages of time-adjacent counts of the observed mixture of signal and interference. As a result, the operations, required for optimal reception, of calculating a weighted correlation sum and a weighted energy sum are nonlinear. They are based on the fulfillment of four arithmetic operations and squaring, which is easy in terms of technical implementation.

Under condition of statistical independence of counts, the solvers accumulate sums of increments of the input and reference signals, respectively. The quality of signal recognition ensured by the designed optimal receiver was estimated using computer simulation. It is shown that for actual situations the probability of error recognition of informational signals does not exceed 10-2 per one coded parcel. The practical application of results obtained in our study would make it possible to improve safety and rhythmicity in the motion of trains.

Keywords: Gaussian Markov interference, correlation sum, probability distribution density, error of recognition.

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DEVELOPMENT OF INFORMATIONALLY-PROTECTED SYSTEM OF MARINE WATER AREA MONITORING (p. 10-16)

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We report results of analysis of the systems of protection and monitoring of the situation at marine and coastal facilities, information, which is processed and transmitted via communication channels in information and telecommunication systems at facilities of marine infrastructure. The threats for information that circulates in different environments of functioning of the monitoring systems, models of pos-

sible intruders of different categories regarding possibilities of threats' realization were identified. By analyzing the signal's passing processes and the structure of the monitoring system, the types of information, which is processed in it, were determined. Taking into account the identified threats and conditions of functioning of the telecommunication network, the methods of information security of the monitoring system were selected. We proposed the generalizing index of security state and the technique for its calculation, which forms the mathematical basis for setting security goals and objectives, determining of criteria for evaluation of quality of construction and operation implementation of a complex information security system. Research results are aimed at developing, improvement of information security complexes in the networks of data transmission in systems for monitoring of marine and coastal facilities, improvement of effectiveness of measures for technical and cryptographic information security. Presented results provide baseline data for determining of directions of information leakage countermeasures, principles of organization of information security, provision of increased security levels for facilities of marine infrastructure.

Keywords: information protection, monitoring of marine water areas, data transmission network, telecommunication system.

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DEVELOPMENT OF THE METHOD FOR JOINT OPERATION OF NEURAL-NETWORK TUNERS FOR CURRENT AND SPEED CIRCUITS (p. 17-21)

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Rolling stands are complex nonlinear objects in metallurgical industry. Their parameters can change their values over time. In order to control rolling stands, direct current electric drives and P- and PI-controllers are used with constant parameters. Such systems include two control circuits. The application of algorithms of linear control leads to the deterioration of transition processes because of a change in the operational mode of the stand. This problem can be resolved by tuning the parameters of linear controllers. Neural-network tuners were previously developed for the circuit controllers of armature current and speed, working in real time without a mathematical model of the control object. The main purpose of present research is to solve a task on their joint operation in real time as well. We designed an algorithm that allows joint work of both tuners, which establishes priorities when calling the tuners. The primary one is tuning a controller of the current circuit, and only in the case that a given tuner was not called over several transitional processes, there is the possibility to call the tuner of the speed circuit. The experiments were conducted using a mathematical model of the main electrical drive of a rolling stand under conditions of change in the parameters of armature winding and mechanical part of the drive.

Control system with two neural-network tuners made it possible to improve energy efficiency of the electric drive by 1.9 % compared with the system without tuning. Such a result was achieved by compensating for a drift in the parameters of electric drive and maintaining the overshoot for speed within the required range. If the overshoot happens to exceed the permissible value, power consumption of the unit increases, which we managed to avoid.

Keywords: direct current electric drive, neural-network tuner, rolling stand.

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DEVELOPMENT OF A FUNCTIONALLY STABLE ORIENTATION SYSTEM FOR AN UNMANNED AERIAL VEHICLE (p. 22-29)

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Our approach to implementation of a functionally stable orientation system using software-hardware redundancy of measuring systems of small autonomous aerial vehicles is presented. The authors substantiated the possibility of introduction of optical systems using the algorithms of computer vision in order to provide necessary redundancy and to allow functionally stable control of small autonomous aerial vehicles. Developments in this area enjoy great demand due to the need to increase safety level of aerial vehicles in case of emergency situations. The use of camera's visual information as an additional source of geospatial information for provision of redundancy and implementation of majority calculation was proposed. As a result of the research, algorithmic dependence of signals of orientation system was established, which made it possible to perform analysis and diagnosis with subsequent restoration of the lost parameter thanks to hardware-software redundancy of devices. Dichotomous algorithms of diagnosis and the block-diagram of reconfiguration of the classical system of orientation in the real-time mode for common types of failures were presented in the paper. Practical application of the system under real conditions with the influence of artificially created obstacles was demonstrated. The functionally stable orientation system will enhance efficiency of existing unmanned aerial vehicle and reduce the risk of losing an aerial vehicle while performing a task. In comparison with currently existing correlation – optical systems, the orientation system, described in the work, makes it possible to provide functional stability through constant monitoring all measuring bodies and timely pairing of failures. In this case, a clear advantage is operation at minimal hardware redundancy of measuring bodies.

Keywords: functional stability, diagnosis, compensation, reconfiguration, orientation, fault tolerance, optical navigation system.

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A COMPARATIVE ANALYSIS OF RESULTS OF THE GROUP EXPERT ASSESSMENT OF METROLOGICAL ASSURANCE OF MEASUREMENTS (p. 30-37)

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Modern methods and means for conducting a group expert assessment are researched. The improved method of group expert assessment, which takes into account the competence of the experts involved on the basis of previously established criteria is proposed. This is important, since for the purpose of obtaining reliable estimates by a group expert assessment, it is first of all necessary to correctly approach the selection of both the method and the experts involved in the study. The improved software tools on the basis of the developed method are proposed. They are based on the integration of the element of competence assessment of the experts involved into the software tools, has no restrictions on the number of experts and the number of questions (factors) that need to be analyzed, and also allows, if necessary, adjusting the applied evaluation criteria. This contributes to the improvement of the accuracy and reliability of the results of group expert assessment, as well as the elimination of errors in calculating the results.

An estimation of the state of metrological assurance for different types of measurements (by the improved method) is carried out. The analysis of the state of metrological assurance for all types of measurements has shown that 34 % of the sub-questions are prioritized for further detailed analysis, and 66 % do not have a priority or any significance at all for their further analysis. An examination of the consistency of the expert estimates obtained using the Kendall's coefficient of concordance and the Pearson's chi-squared test is carried out.

Keywords: metrological assurance, group expert assessment, consistency coefficient, software tools.

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DEVELOPMENT OF A MATHEMATICAL MODEL FOR ESTIMATING SIGNAL STRENGTH AT THE INPUT OF THE 802.11 STANDARD RECEIVER (p. 38-43)

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A mathematical model of the spatial estimation of signal strength at the input of the receiver for the 802.11 family of standards is proposed, for a central position of the access point in a room. This model allows the assessment of signal level at any point in the room, taking into consideration the maximum possible number of factors of influ-

ence. In addition, there is a confidence interval for such a model that makes it possible to estimate the level of signal fluctuations.

It was established that the level of signal fluctuations in a room is affected by such basic independent components as the signals, reflected from surfaces in the room, interference obstacles, and noise. In the frequency range of 2.4 GHz for the 802.11 standard, there occurs a rather non-uniform distribution of signals in a room with the creation of amplifying regions, as well as signal weakening, with a difference of up to 10 dbm, and under the most complicated conditions – up to 25 dbm.

It was found that the level of signal fluctuations depends on the quantity of simultaneously existing destabilizing factors in the channel for premises where there is a wireless network. Taking these factors into consideration is possible through direct assessment, using the algorithm of monitoring, at a distance of two meters from the radiating antenna of AP. This is the basis for spatial method of signal strength control for any premises in real time.

Keywords: wireless channel of the 802.11 standard, signal strength distribution, multipath wave propagation.

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DEVELOPMENT OF THE APPROACH TO PROVING THE SECURITY OF GROSTL-LIKE HASHING ALGORITHMS TO REBOUND ATTACKS (p. 44-51)

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An approach for estimating the security of Grostl-like hashing algorithms to collision rebound attacks is proposed. The Kupyna algorithm, adopted as the new Ukrainian standard of hashing, belongs to this kind of hash functions.

The proposed approach is based on determining the boundary number of rounds for each stage of the transformation of the difference (fragment of the byte differential characteristic). The boundary number of rounds for the inbound part of the byte differential characteristic is determined based on an analysis of the results from known works. The boundary number of rounds for outbound parts of the byte differential characteristic is determined based on the known probability constraints for Rijndael-like ciphers.

The proposed approach is applied to the Kupyna algorithm, adopted as the national Ukrainian standard DSTU 7564: 2014. It is shown that the presence of 5 or more rounds in each of the P and Q transformations of this hashing algorithm makes it resistant to rebound attacks.

Keywords: hashing functions, collision rebound attack, Rijndael-like cipher, Grostl-like hash algorithms, byte differential characteristic.

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DEVELOPMENT OF A SYSTEM FOR MONITORING VIBRATION ACCELERATIONS BASED ON THE RASPBERRY PI MICROCOMPUTER AND THE ADXL345 ACCELEROMETER (p. 52-62)

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A system for monitoring and analysis of the vibration acceleration spectrum based on the Raspberry Pi 3 microcomputer and the triaxial digital ADXL345 accelerometer for a real-time operation has been developed. In the process of implementation of the system, the structure and algorithm of functioning of the system for monitoring and analysis of the vibration acceleration spectrum were constructed. The designed structure is based on the modular principle which enables fast improvement of the system.

A specialized system software has been developed. It includes a driver for adjusting, collecting and processing the accelerometer data and the corresponding software for plotting vibration acceleration signals in time and frequency domains. Moreover, the software is based on the use of free programs, it features the ability of real-time study of the vibration effect on an object, determining vibration amplitudes and frequencies, plotting graphs of vibration change in time, calculating discrete Fourier transforms and obtaining spectra.

The physical model of the system for monitoring and analysis of the vibration acceleration spectrum has been developed. It includes the Raspberry Pi 3, Model B single-board microcomputer, the ADXL345 triaxial digital accelerometer, the liquid-crystal display and is characterized by a low cost and a wide functionality.

The system makes it possible to analyze vibration parameters in order to predict and prevent possible accidents, thus reducing the costs associated with the failure of the cutting tools, expensive parts and assemblies of the CNC machine.

Keywords: vibration acceleration monitoring system, ADXL345, Raspberry Pi, spectral analysis, discrete Fourier transform.

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PROCESSING OF NOISY DIGITAL IMAGES WITH USE OF EVOLVING AUTOENCODERS (p. 63-69)

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A promising class of neural network models used recently to solve the problems of recognition of noisy images are denoising autoencoders. In particular, the evolutionary approach can be effectively used in DAE to determine the network architecture, weights and learning algorithm. The proposed neural network evolving autoencoder allows efficient processing of noisy images due to the iterative learning procedure even in the presence of local distortions. When using the EDAE for determining the network architecture, weights and learning algorithm, standard evolutionary procedures (population initialization, population assessment, selection, crossover, mutation), as well as the evolutionary algorithm for the ANN adjustment and special chromosome formats are used.

The proposed approach to filtering and recognition of noisy images based on the EDAE application is promising for environmental monitoring of landscape and industrial areas.

Keywords: digital image processing, noise filtering, evolution, population, artificial neural network, genetic algorithm, autoencoder.

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