IMPROVING THE RELIABILITY OF INFORMATION-CONTROL SYSTEMS AT POWER GENERATION FACILITIES BASED ON THE FRACTALCLUSTER THEORY (p. 4-12)

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We have developed a cluster model for the structure of an informational space as a combination of informational signals that carry information about emergency signs at a deviation of a technological process parameters at electric power facilities, based on the application of an apparatus of the fractal-cluster theory. A dynamic fractal cluster model is derived to describe processes in the informational space of information control systems in software technical complex of the automated control system for a technological process at a power plant. We have established functional dependences of the dynamics of change in the electro-physical magnitudes of technological parameters, such as current and voltage, on the informational fractal dimensionalities. Based on the application of a dynamic fractal cluster model, we detected random informational signals that make it possible to identify false triggering and failures of technological equipment. To estimate the reliability criterion in the functioning of information control systems in software technical complex of the automated control system of a technological process at power plants, we derived analytical dependences that connect a gain in the amount of information, fractal time and the informational fractal dimensionality. By determining the amplitude, phase, and frequency of random informational signals in real time, we established conditions for the signs of emergency and pre-emergency. The obtained theoretical and practical results have been demonstrated to improve the reliability of operation of information control systems in a software technical complex for automated control systems.

Keywords: information processing, fractal cluster model, emergency signs, reliability criteria.

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TESTING OF MEASUREMENT INSTRUMENT SOFTWARE ON THE NATIONAL LEVEL (p. 13-20)

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Features of software for measuring instruments are considered. A comparative analysis of the general requirements in the documents and guidelines of the international and regional organizations of legislative metrology OIML and WELMEC concerning the testing of software for measuring instruments was carried out. The main factors that are monitored during quality testing of software for measuring instruments were identified by constructing Ishikawa cause-effect diagrams based on the requirements of the OIML document and the WELMEC guide.

The possibility of joint use of the requirements of the OIML document and the WELMEC guide for testing the MI SW was analyzed. The general Ishikawa cause-effect diagram was developed, its main factors can be used for the development of special checklists for testing the MI SW taking into account different risk classes. The algorithms for testing the SW for MI in accordance with the requirements of documents of international and regional organizations of legislative metrology OIML and WELMEC were defined. A universal MI SW testing algorithm was proposed.

It was proposed to apply approaches based on the requirements of documents and guidelines of international and regional metrology organizations for the preparation of special universal checklists for testing the software of virtually all categories of measuring equipment at the national level. This will confirm the authenticity and quality of the MI SW appraisals.

Keywords: software, measuring instruments, testing, legal metrology, normative base.

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FORMALIZATION OF THE CONCEPT OF ADAPTIVE TASKS MAPPING IN THE RECONFIGURABLE COMPUTERS ON FPGA (p. 20-28)

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The effectiveness of data processing in the reconfigurable computer systems depends significantly on the unproductive time costs of the reconfiguration of the FPGA computational space. It is an important modern problem that hinders the intensive progress of reconfigurable computations. The aim of the research is to improve the efficiency of the process of tasks mapping into the reconfigurable computing structure of the dynamically RCs by reducing the communication delays when the reconfiguring FPGA space in the Run Time mode.

Mathematical models for determining the main efficiency criteria of the dynamically RCs and estimating the execution time of the main stages of adaptive tasks mapping that take into consideration the influence of delays of the configuration data transfer at all organization levels of the system are proposed. The concept of adaptive tasks mapping into the dynamically reconfigurable FPGA space based on the new approach to the transformation of algorithms' MDG and the multilevel configuration data caching is proposed and formalized. That allows the realization of various strategies of adaptive tasks mapping based on the criteria of overhead time minimization considering FPGA hardware limitations and parameters of the changing computing environment during the tasks mapping. The experiments showed that the use of adaptive tasks mapping allows to reduce the overhead time and increase the effectiveness of reconfigurable computations for executing the algorithms with frequent repetition of similar tasks.

Keywords: reconfigurable computer systems, partial dynamic reconfiguration, reconfiguration overheads, tasks mapping.

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DETERMINING ELECTRICAL LOSSES OF THE TRACTION DRIVE OF ELECTRIC TRAIN BASED ON A SYNCHRONOUS MOTOR WITH EXCITATION FROM PERMANENT MAGNETS (p. 29-39)

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We have studied a traction drive based on the synchronous motor with excitation from permanent magnets for its electrical losses. A simulation model of the traction drive is synthesized, which employs the algorithm of a space-vector PWM. A special feature of the model is the application of parameters of actual IGBT-transistors and the possibility for obtaining instantaneous values of electric losses in transistors and snubbers of the inverter under different modes of operation. We have devised a procedure for calculating electric losses in the traction engine based on the shape of phase currents, geometrical and electrical parameters of the engine. Simulation of the traction drive and calculation of losses in the traction engine is integrated, which makes it possible to account for the impact of the inverter and engine on each other.

We have simulated work of the reducer-free traction drive based on a synchronous motor with excitation from permanent magnets with a capacity of 80 kW. The dependences were constructed for losses in the traction inverter and engine on the clock frequency of a space-vector PWM and motion speed.

The proposed procedure makes it possible to quantify the magnitude of electric losses in the traction drive elements depending on the types of transistors applied, clock frequency of the inverter, and parameters of the engine. This enables the optimization of the traction drive for the criterion of maximum performance efficiency, as well as thermal calculation of the elements of the drive.

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DEVELOPMENT OF COMMUNICATION MODELS OF WIRELESS ENVIRONMENT IN EMERGENCY SITUATIONS (p. 40-47)

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Two-point communication model of the wireless environment with one-beam and multi-beam propagation of radio waves were developed. The specified models make it possible to create various particular two-point communication models of wireless environment, taking into account the assigned geometry of location of shadowing and scattering structures in the environment. The practical use of the proposed models is limited to arbitrary points of radiation and reception in the environment, taking into account location of directional aerials in them. To study known multipoint technologies under conditions of emergency situations, we developed the multipoint communication models with one-beam and multibeam propagation of radio waves from each radiation point to each reception point, predetermined by the presence of shadowing and scattering structures in the environment. The developed multipoint models make it possible to create specific models at the physical level for various multi-aerial technologies, taking into consideration the use of aerial arrays of arbitrary configuration at the transmitting and receiving sides. Verification of the developed communication models of the wireless environment was performed. It was found that the use of directional aerials at the transmitting and receiving sides of the wireless environment in the presence of considerable shadowing and scattering structures makes it possible to significantly improve noise immunity. It is noted that with the use of the developed communication models, it is possible to carry out in-depth examination of the physical level with a view to developing a reliable and stable architecture of communications under conditions of emergency situations.

Keywords: wireless environment, communication model, emergency situation, MANET, VANET, FANET.

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DEVELOPMENT OF THE METHOD FOR DECOMPOSITION OF SUPERPOSITIONS OF UNKNOWN PULSED SIGNALS USING THE SECOND-ORDER ADAPTIVE SPECTRAL ANALYSIS (p. 48-54)

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We considered the issue of "intuitive" analysis, processing, and synthesis of unknown pulse sequences in a detailed form. We studied both classical methods of analysis with all pluses and minuses and the developed prospective method created on their basis. The developed method is adaptive, it is based on the consistent use of various methods of spectral analysis, which increases reliability, sensitivity, and resolution capability of visual analysis of echo-pulse images. Thus, we solved the problem on processing pulse signals. The proposed method makes it possible to increase resolution capability in the processing of signals and images without using a priori information on the form of elementary pulses. It is resistant to the influence of measuring noise. We presented the results of numerical simulation and actual verification on the example of a seismic image. The considered method has a significant development potential, both in theoretical and application aspects (first of all, in areas of ultrasonic medical diagnosis, seismic imaging, and non-destructive testing).

Keywords: pulse, model, signal, superposition, spectrum, echo-pulse image, measurement noise.

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RECURRENT NETWORK AS A TOOL FOR CALIBRATION IN AUTOMATED SYSTEMS AND INTERACTIVE SIMULATORS (p. 54-60)

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We have constructed a method for the auto-calibration and correction of values of the vector of magnetic induction, which is suitable for use under conditions of limited computational resources in microcontrollers and SoC System-on-a-Chip. The efficiency of the system in general was investigated experimentally by using an additional board, which holds six pairwise connected primary Hall

sensors. Correctness of work of the algorithm was checked at the designed and fabricated microprocessor test module, the prototype of which was the most simplified variant of the popular microcontroller board Arduino. We have implemented the structure of a recurrent network that is built based on vectors-indicators and recurrent decomposition; and examined the efficiency of algorithms for the calibration and processing of peripheral information. The microprocessor module was designed and manufactured, using which we studied dependence of the magnitude of measurement error on the properties of the sensor and hardware features for the automated systems and interactive simulators. A principle of the modular structure of software was employed, which increases the percentage of reuse of software parts by the organization of requests, as well as makes it possible to create new functions without making significant changes to the existing code. To ensure the independence of software from the hardware platform of sensor realization and the system of data processing and transfer, it is equipped with a module that adapts the level of hardware abstraction. The result of its implementation is the simplified procedure for software deployment in other hardware means. All platform-dependent system functions are implemented at this level. Independence from the hardware features of platforms is provided by engaging the computational tools, techniques, tools and modules of SPI, UART interfaces, and Modbus-RTU protocol. They help configure and exchange data with peripheral devices for its further processing by a personal computer.

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We proposed the introduction of an additional mode of dispersed reception and the combination of one-position and multiple reception of signals to the existing one-position observation radar. We improved the algorithm for detection of an air object at its irradiation by several transmitters. We provided compensation of a delay time and Doppler frequency in each receiving channel to a separate volume of an observation radar upgrading the algorithm. The improved algorithm for detection of an air object at its irradiation by several transmitters is reduced to: coherent processing of received signals in each processing channel in each element corresponding to the relevant separate volume and the relevant separate Doppler frequency; quadratic detection in each processing channel in each element corresponding to the relevant separate volume and the relevant separate Doppler frequency; weight summation of detector outputs for each processing channel in each element corresponding to the relevant separate volume and the relevant separate Doppler frequency.

We constructed a structural diagram of the detector of an air object at its illumination by several transmitters. Each receiving channel of a signal is a multichannel for distance and speed. The diagram provides reception, coherent processing of echo signals from third-party sources, compensation of delay and Doppler frequency differences relative to a separate volume of the observation radar and incoherent weight summation.

We carried out estimation of the efficiency of detection of an air object at its irradiation by several transmitters. We established that the transition from a single-channel detection of an air object to the detection of an air object at the incoherent combination of two channels results in a significant shift of detection characteristics to the left.

We selected the number of receiving channels to be combined. We established that it is most effective to combine two, at most three, reception channels.

We constructed a structural diagram of channels that process echo signals of an observation radar by combining the methods of one-position and differential signal reception. For combining of one-position and dispersed location modes of observation radars, we provided complexing of corresponding digital reception devices and digital signal processing systems. The main principle underlying the combination of the mentioned receiving devices is the informational supplement without violating the standard modes of operation of observation radar.

Keywords: small-sized air object, detection, signal reception, one-position system, multiposition system, processing channel.

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EXPERIMENTAL STUDY OF THE METHOD OF LOCOMOTIVE WHEEL-RAIL ANGLE OF ATTACK CONTROL USING ACOUSTIC EMISSION (p. 69-75)

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The methods for determining the locomotive wheel-rail angle of attack are considered. To reduce the power impact of the wheel flange with the rail head when the locomotive moves on curved sections of the track, it is advisable to change the locomotive wheel-rail angle of attack by turning the wheel pairs. Controlling the locomotive wheel pair position is possible by means of an operational measurement of the actual wheel-rail angle of attack. Measurement of the wheel-rail angle of attack is not performed because it is impossible to determine the value directly.

It is proposed to measure the locomotive wheel-rail angle of attack when the wheel pair moves in the rail track on the basis of the method of acoustic emission resulting from the wheel-rail contact interaction. An information measuring system has been developed for the determination and analysis of acoustic emission from the wheel-rail contact consisting of: a stand roller magnet, a speed sensor, a directional microphone, an analog-digital card, a sound level meter. The obtained experimental data of acoustic emission from the contact of the roller stand wheel with the roller during motion are analyzed. The dependence of the acoustic emission of the locomotive wheel-rail contact interaction on the values of the maximum deviation of the sound pressure level from the equivalent level in the frequency range 200...300 Hz is revealed.

The obtained analytical dependence of the maximum deviation of the sound pressure level from the equivalent at different values of wheel-rail angles of attack can be used to create an automatic control system of the wheel pair position in the rail track.

Keywords: angle of attack, acoustic emission, wheel pair, control, stand, spectral analysis, information measuring system.

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