ABSTRACT AND REFERENCES

INFORMATION AND CONTROLLING SYSTEMS

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IMPROVING THE MODEL OF DECISION MAKING ABOUT ABNORMAL NETWORK STATE USING A POSITIONING SYSTEM (p. 6-11)

Ivan Antipov
Kharkiv National University of Radio Electronics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9754-4412

Tetyana Vasilenko
Kharkiv National University of Radio Electronics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-1291-8065

We have proposed to supplement the model of decision making about abnormal states of a wireless network under conditions of uncertainty by another attribute – the location of wireless mobile and stationary devices in a controlled network.

The method of trilateration, based on the measurement of signal strength at three points, is considered. This method has a high accuracy of determining the location of a wireless device, provided that the most accurate model of radio waves propagation is constructed. However, given the specificity of radio waves propagation inside the premise, it is rather difficult to build such a model for them. Therefore, it is proposed to use the method of radio fingerprints. This method is based on the construction of radio maps for each of the three access points, which indicates the signal level from a typical wireless device located at a certain number of reference points. We have also considered the possibility of the combined application of two methods, which will make it possible to determine the location of a wireless device even when it is outside the radio map.

Experimental studies were carried out, including the creation of radio maps for a room of area 70 m^2 with 26 reference points. We employed three identical routers and a smartphone. During the experiment, it turned out that, depending on the orientation of the mobile device (in fact, its antenna), the measured power changes, so the radio maps were constructed based on average power for six different positions of the mobile device. It is shown that the level of the signal is almost independent of the door and window position in the room.

This analysis of the principles of organizing various types of attacks on wireless networks has revealed that accounting for the position makes it possible to detect attacks of the types "man in the middle" and "false access point" that were not identified by the base model. In addition, the improved model allows determining the source of interference at the "muting" attack.

Keywords: signal strength, trilateration, radio fingerprints method, radio map, location of wireless subscriber.

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DEVELOPMENT OF PROCEDURES FOR DETERMINING THE PARAMETERS OF AN AIRCRAFT SERVO ACTUATOR (p. 11-18)

Eugene Kononykhin
PrJSC FED, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-2140-519X

Main trends in the use of electro-hydraulic actuators and requirements to parameters were discussed. Necessity of using automatic methods for testing an electro-hydraulic actuator together with the standard hardware of the electronic control unit was substantiated. The procedures for testing the control loop of an electro-hydraulic actuator set forth in this study make it possible to eliminate effects of mutual influence of dynamic and static characteristics of the actuator and hardware of the electronic control unit. Procedures for automatic identification of the actuator model and procedures for automatic determination of main parameters and characteristics of the actuator such as zero shift, dead space, amplitude-frequency, phase-frequency and speed characteristics have been proposed. When introducing the proposed procedures, the problem of processing high-speed characteristics of the actuator having high noisiness associated with the pulse nature of the derivative of the discrete signal of the actuator position (12 bits) was solved. In order to avoid introduction of errors in the waveform, in addition to standard digital filtering methods, it was proposed to approximate the noisy actuator characteristic by means of the Bezier curve. A procedure was proposed to record hysteresis of the speed characteristic by means of a cycle of continuous change of speed of movement of the output link of the actuator during the working stroke. The method for automatic identification of a simplified actuator model can significantly reduce labor costs in processing of experimental data. The parameters of the actuator model obtained for various deviations in parameters and various actuator operating conditions (external factors) can improve quality of synthesis of control algorithms.

Keywords: electro-hydraulic actuator, speed characteristic, dead space, amplitude-frequency characteristic, phase-frequency characteristic.

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TESTING OF MEASUREMENT INSTRUMENT SOFTWARE WITH THE PURPOSE OF CONFORMITY ASSESSMENT (p. 19-26)

Oleh Velychko
Scientific and Production Institute of Electromagnetic Measurements
State Enterprise "All-Ukrainian State Scientific and Production Centre for Standardization, Metrology, Certification and Protection of Consumer", (SE "Ukrmetrteststandard"), Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-6564-4144

Valentyn Gaman
Scientific and Production Institute of Electromagnetic Measurements
State Enterprise "All-Ukrainian State Scientific and Production Centre for Standardization, Metrology, Certification and Protection of Consumer", (SE "Ukrmetrteststandard"), Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-6656-9887

Tetyana Gordiyenko
Odessa State Academy of Technical Regulation and Quality, Odessa, Ukraine
ORCID: http://orcid.org/0000-0003-0324-9672

Oleh Hrabovskyi
Odessa State Academy of Technical Regulation and Quality, Odessa, Ukraine
ORCID: http://orcid.org/0000-0001-7134-3682

The analysis of the regulatory framework for testing measuring instruments (MI) software at the national level to determine its suitability for carrying out conformity assessment was conducted. Comparison of the general requirements of national normative documents and documents of international and regional organizations of legal metrology OIML and WELMEC was conducted. In particular, regarding the suitability of software for application and protection against unauthorized interference. It is found that the current national standard contains only general requirements for software protection and does not determine the methodology of software testing. This is important because the MIs, which are intended for use in the field of regulated metrology, must undergo a procedure for conformity assessment with the requirements of the technical regulations.

The main differences were identified and the necessary elements were established to achieve the presumption of conformity of the software with essential requirements of the technical regulations during conformity assessment of the MI. Requirements of normative documents concerning suitability for application and protection against unauthorized interference are identified. In order to specify requirements for software and to ensure compliance with the requirements of the software test method, the need for additional use of the requirements of the OIML D 31 and WELMEC 7.2 documents was established. The need to revise the current national standard for MI software testing was proved. The algorithm of testing of the MI software for conformity assessment was established and studied. The algorithm takes into account the requirements of international standards for the software life cycle and the quality system when developing the software. This will take into account all the elements necessary to achieve the presumption of conformity of software with the essential requirements of technical regulations.

Keywords: software, measuring instruments, testing, conformity assessment, technical regulations.

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DEVELOPMENT OF NIEDERREITER HYBRID CRYPTOCODE STRUCTURE ON FLAWED CODES (p. 27-38)

Serhii Yevseiev
Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-1647-6444

Oleksii Tsyhanenko
Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-5784-8438

Alla Gavrilova
Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-2015-8927

Viktor Guzhva
National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-6832-4480

Oleksandr Milov
Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-6135-2120

Valentina Moskalenko
National Technical University "Kharkiv Polytechnic Institute" , Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9994-5404

Ivan Opirskyy
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-8461-8996

Oleksandr Roma
Institute of Special Communication and Information Security National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-9074-6137

Bogdan Tomashevsky
Ternopil Ivan Puluj National Technical University, Ternopil, Ukraine
ORCID: http://orcid.org/0000-0002-1934-4773

Olexander Shmatko
National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-2426-900X

The use of the Niederreiter modified crypto-code structure (MCCS) with additional initialization vectors (with many invalid positional vectors of the error vector and multiple positions of shortening the error vector) requires an increase in the speed of cryptographic transformation of the system as a whole. For this purpose, it is proposed to use flawed codes. Flawed codes allow you to increase the speed of code transformations by reducing the power of the field while damaging the plaintext and reducing the amount of data transferred by damaging the ciphertext. This approach allows the construction of hybrid crypto-code structures based on the synthesis of Niederreiter modified crypto-code structures on modified (shortened or extended) codes on elliptic curves with damaging procedures. A significant difference from classical hybrid (complex) cryptosystems is the use of asymmetric cryptosystems to ensure data security with fast crypto-transformation procedures (generation and decoding of a codogram). The paper discusses methods for constructing flawed codes and approaches for using the Niederreiter hybrid crypto-code structure on modified elliptic codes. Practical algorithms are proposed for using the MV2 damage mechanism in the Niederreiter crypto-code structure on modified elliptic codes, which makes it possible to implement a hybrid crypto-code structure. The results of a comparative assessment of energy consumption for the formation of an information package with various methods of damage, which determined the choice of damage method in practical algorithms. The conducted studies confirm the competitive efficiency of the proposed cryptosystem in Internet technologies and mobile networks, ensuring practical implementation on modern platforms and the necessary cryptographic strength under post-quantum cryptography.

Keywords: flawed codes, Niederreiter hybrid crypto-code structure, modified elliptic codes, multichannel cryptography.

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THE DEVELOPMENT OF METHODS FOR DETERMINING VIBRATION STOCHASTIC FIELDS OF TECHNOLOGICAL COMPLEXES (p. 38-47)

Nadiia Marchenko
National Aviation University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-5008-4116

Olena Monchenko
National Aviation University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-8248-5704

Ganna Martyniuk
National Aviation University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-4234-025X

The force effects occurring in technological complexes have been studied on the basis of the analysis of technical diagnostics system.

Due to the distinction between deterministic and random force effects, there have been proposed various methods to distinguish the vibration of informational diagnostic characteristics in order to ensure prompt and reliable detection of the rapidly developing defects. Reliable diagnostics will make it possible to switch from a system of scheduled preventive repairs to the organization of repairs for the current state, with a decrease in the cost of repairing and rebuilding the units of technological complexes by early detection of the defects emerging in the assembly components.

On the basis of analyzing the process of propagation of vibroacoustic waves caused by the power action, there has been developed a mathematical model for the emergence and propagation of elastic waves in sophisticated technological complexes from the places of their origin to the point of observation. There have been suggested kinematic schemes for propagation of low-frequency vibrations, vibrosignals from the brush-collector unit, as well as waves from the inner ring of the bearing. This makes possible to substantiate a mathematical model of the occurrence and propagation of vibroacoustic waves in the parts and units of technological complexes from various sources of vibration.

The comparative analysis of the research findings on the real vibration fields and the results of numerical modeling confirms the adequacy of the model to the real process. The article presents the graphs of the temporal realization of signals in the model, the spectra of the realized signals, as well as their autocorrelation functions reflecting the main characteristics of the signals at the measurement point. The findings can be used to diagnose and reduce the cost of repair and restoration of the units in sophisticated technological complexes by early detection of the defects emerging in the assembly parts.

Keywords: vibration signal, stochastic, rolling bearings, vibration fields, vibroacoustic waves, shock pulse.

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COMPREHENSIVE APPROACH TO MODELING DYNAMIC PROCESSES IN THE SYSTEM OF UNDERGROUND RAIL ELECTRIC TRACTION
(p. 48-57)

Sergiy Yatsko
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-5977-8613

Borys Sytnik
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9664-5617

Yaroslav Vashchenko
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-5030-4107

Anatoliy Sidorenko
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-5550-6103

Borys Liubarskyi
National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-2985-7345

Ievgenii Veretennikov
National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-6773-0388

Marina Glebova
O. M. Beketov National University of Urban Economy in Kharkiv, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-0973-150X

An analysis of tasks on improving energy efficiency of electric traction systems reveals the need for the introduction of new technologies, namely modern rolling stock with a traction asynchronous electric drive, as well as traction substations, based on new technolo-

gies. To solve this class of problems, we have defined the need for an integrated simulation model of the electric traction system that would ensure a sufficient level of its reliability.

This work reports details of algorithms for calculating the parameters in order to develop a simulation model of the integrated electric traction system of an underground rail system, which consists of electricity supply subsystems, electric drive of rolling stock, and mechanical part of the traction transmission.

In the programming environment Matlab/Simulink, based on the known, actual and refined, estimation parameters, we developed a simulation model of the system of traction electric supply to an underground rail with a two-way power to two tracks. We have constructed a simulation model of the modern traction electric drive of the underground rail cars with a vector system to control an asynchronous electric drive and a uni-mass mechanical part, capable of taking into consideration the impact of the coefficient of adhesion.

We have compared results from the imitational simulation of dynamic processes with oscillograms for the actual operation modes of an underground rail system, which confirmed the adequacy of the model to the examined object. The correspondence between results obtained from simulation is confirmed by the oscillograms from analysis of voltage and current of the contact network, as well as by characteristics of the traction and braking modes of rolling stock.

We have simulated processes of work of the power supply system, a nonstationary regime at deterioration of adhesion conditions, and a recuperative braking mode with energy transferred to other trains.

Using the developed model of the integrated system of electric traction would contribute to a more detailed study into the mutual influence of elements in the electric traction system. That would make it possible to improve the efficiency of making technical decisions related to meeting safety requirements, preventing the disruptions of normal operation, and bringing down operating costs.

Keywords: imitation simulation, underground rail system, traction power supply, electric train, traction induction electric drive.

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DEVELOPMENT OF THE ALGORITHM OF VIDEO IMAGE ADAPTATION TO SPECTRAL POWER DISTRIBUTION OF ILLUMINANTS (p. 58-67)

Volodymyr Pyliavskyi
O. S. Popov Odessa National Academy of Telecommunications, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-4468-2192

Proposals for further progress of video technologies, issues that need to be resolved to implement this progress and possible ways to implement them in real devices of special and general application are made. It is proposed to supplement the conventional model of the video path with a color perception model and an adaptive model of the spectral power distribution of the illuminant. Attention is paid to the end devices of the video path, which may introduce unacceptable changes in the transmitted video information, namely color. The schemes of the algorithm of adaptation to the spectral power distribution of the illuminant are presented. The possibility of universal use of the proposed algorithm in video transmission systems is considered. The algorithm of video image adaptation to the spectral power distribution of illuminants based on the selection of reference spectral power distributions with the given color coordinates is proposed. The algorithm of allocation of the spectral power distribution of the illuminant from the overall image scene is presented. Metrological support to assess the influence of the illuminant on the quality of color rendering is proposed. It is proposed to use spectral color distributions, the set of which is presented in the paper, as optical test images for testing the color rendering quality. Comparative characteristics with existing sets of spectral power distributions are presented and it is shown that they are not enough to implement the proposed algorithm. The simulation results prove the necessity and advantages of using the proposed algorithm. The image after the application of the algorithm is such if it was observed in sunlight, regardless of what type of lighting was used during shooting or observation. In addition, the presented algorithm allows adaptation to the spectral power distribution of various illuminants, such as incandescent lamps, fluorescent, LED, signal flares, and the like.

Keywords: spectrum, adaptation, color rendering, color perception, assessment, metrology, video applications, video communication, CAM16.

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DESIGNING ADAPTIVE PID CONTROLLER NON-SENSITIVE TO CHANGES IN AERODYNAMIC CHARACTERISTICS OF AN UNMANNED AERIAL VEHICLE (p. 68-75)

Ouissam Boudiba
National Aerospace University Kharkiv Aviation Institute, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-3565-789X

Sergei Firsov
National Aerospace University Kharkiv Aviation Institute, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-6316-5035

The method of implementing an adaptive PID controller using a reference model of an unmanned aerial vehicle is presented. The unmanned aerial vehicle has a nonlinear characteristic and high sensitivity to external influences. The operation of a standard controller in a nonlinear model in the event of disturbing influences does not meet the specified quality criteria. Problems that affect the flight time of the unmanned aerial vehicle are represented by variations in aerodynamic coefficients in the known ranges. Herewith, aerodynamic parameters change, and the system becomes unstable. To eliminate unwanted deviations, an adaptive PID controller loop is introduced into the aerial vehicle control system. Using the reference model of the control object, the adaptation comparator provides the necessary PID controller settings. The introduction of such a correction control signal allows countering various failures and disturbances that lead to uncontrolled control. It was found that this method of control of the unmanned aerial vehicle is very effective, since the obtained result is closer to the experimental one. The study of failures was carried out through the observation of changes in aerodynamic coefficients. The study of changes in aerodynamic coefficients allows failure-free determination of the nominal values of the object coefficients. Such an approach to modeling the unmanned aerial vehicle also makes it possible to solve the economic side of the problem – to conduct experiments in the ANSYS-CFX aerodynamic application without costs for restoring vehicles and structures lost as a result of experimental testing.

Keywords: adaptive PID, reference adaptive control model (RACM), aerodynamic coefficients, uncertain model.

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