## ABSTRACT AND REFERENCES
## INFORMATION AND CONTROLLING SYSTEM

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**A STUDY TO DETERMINE THE ONSET OF CATASTROPHIC WEAR OF A PROCESSING TOOL BY STATISTICAL PARAMETERS OF ACOUSTIC EMISSION (p. 6-11)**

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In the present study, experimental research was carried out to determine the effect of the processing tool wear on the mutual change in the average statistical amplitude parameters of acoustic emission signals. Acoustic emission signals were recorded when turning silumin. The research was aimed at finding parameters to determine the occurrence of critical wear of the processing tool. It is shown that the recorded signals are continuous. The statistical amplitude parameters of the acoustic emission signals were processed under normal and catastrophic wear of the processing tool. It has been determined that the development of normal and catastrophic wear of the tool leads to a decrease in the values of the statistical amplitude parameters of the recorded signals. However, no peculiarities were found in their change to determine the developing type of wear. Meanwhile, at different time intervals, there was an anticipating increase or decrease in one of the statistical amplitude parameters of the acoustic emission signals.

The processed parameter was a coefficient characterising a mutual change in the statistical amplitude values of the recorded signals. It has been determined that absence of the tool wear is characterised by stable values of the calculated coefficient in time. The occurrence and development of catastrophic wear leads to an outburst of the value of the calculated coefficient with its subsequent accelerated decrease to the destruction of the tool. The emergence and development of normal wear leads to an increase in the value of the calculated coefficient with a subsequent transition to a sawtooth change and a gradual decrease of its size. The obtained regularities can be used when devising methods for controlling and monitoring the condition of the tool during the mechanical processing of materials, including monitoring the state of the processing tool in robotic industries.

**Keywords**: acoustic emission, composite material, statistical amplitude parameters, mechanical processing of materials, wear of a processing tool.

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**MODEL OF DYNAMICS OF THE GROUPING STATES OF RADIO ELECTRONIC MEANS IN THE PROBLEMS OF ENSURING ELECTROMAGNETIC COMPATIBILITY (p. 12-20)**

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A dynamic model of multiple interactions of n-elements of a complex mobile communication system is developed, which takes into account the nature of inter-element communications and phase states of the grouping of electronic devices. The model describes the electromagnetic environment of the grouping of electronic equipment in the state space during group use of a frequency resource.

The simulation of the dynamics of interaction and phase states of the grouping of electronic equipment is done with the group use of the frequency resource.

It is shown that at sufficiently large values of the growth coefficient of the number of electronic devices, both a sharp increase in the level of interaction intensity and a sharp decrease characteristic of those situations that occur in mobile communication systems during the busy hours in places of high density of mobile users can occur.

The analysis of the dynamics of the grouping of radio-electronic means of a mobile communication system at different intensities of linear and non-linear multiple interactions, the combined nature of which is displayed by the normalized value of the signal/(jam+noise) ratio, is carried out. The dynamics of non-equilibrium states of the groups of 2 mobile networks at various values of the intensity of interactions is considered.

It is established that the non-equilibrium state of the mobile communication system occurs when the total level of the group influence of the emitting devices on the receiving devices increases with a normalized value of the interaction intensity of more than 1.4.

The conditions are identified under which the grouping of radio-electronic means of a mobile communication system can function without deterioration of quality indicators, characterized by the total level of group influence of radiating devices on receiving devices, under conditions of optimal frequency resource distribution.

It is shown how, using the non-linear Volterra system, which simulates the dynamics of the interactions of a grouping of electronic equipment, it is possible to analyze its state in the future. This model allows to analyze the grouping of electronic equipment with various specific parameters of individual types of electronic equipment, the nature and intensity of their interaction in the group with the current distribution of resources.

**Keywords**: dynamic model, multiple interactions, electromagnetic environment, resource allocation, frequency distribution.

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**DEVELOPMENT OF A METHOD OF PROCESSING IMAGES OF LASER BEAM BANDS WITH THE USE OF PARALLELHIERARCHIC NETWORKS (p. 21-27)**

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A method for processing images of spots of laser beams is presented for systems using a modern and promising form of communication using atmospheric-optical communication lines (AOCL). The method allows to significantly expand the use of laser technology in information transfer systems by increasing speed, their efficiency and the characteristics of the positioning subsystem in them. This is important because under the influence of the atmosphere (rain, fog, dust, snow) the laser beam is deformed, and this, in turn, affects the quality of the results obtained from such systems. The necessity of filtering images received from the transmitter by using adaptive methods of processing information in parallel hierarchical networks is substantiated. In order to accelerate the processing of images of spots of laser beams, a specialized random access memory (RAM) is developed, which is used in modeling the developed method for processing images of spots of laser beams.

Based on the obtained simulation data, the results of predicting the location of the receiver and the system performance obtained with the presented method are 15–20 % better than the results obtained using known methods. As a result of the development of the presented method, it is possible to reduce the number of accesses to RAM by 2 times, and therefore reduce the load on the memory. The operation of reading 2-port memory has been improved, it allows to create a displacement vector of parallel-hierarchical transformation in one cycle, dividing the width of the record and reading the data bus, which in turn increases the RAM efficiency.

**Keywords**: parallel-hierarchical networks, atmospheric-optical communication systems, programmable logic circuits, laser beams, classification of images of spots of laser beams.

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**IMPROVEMENT OF THE METHOD FOR ASSESSING THE LEVEL OF SPEECH INFORMATION SECURITY (p. 28-38)**

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Assessment of the level of speech information protection from leakage through acoustic and vibration channels is carried out according to international and national standards and in compliance with regulatory documents. To assess its security level, regulatory documents in many countries imply the use of signal/noise ratio. However, the method has a series of significant shortcomings, which do not make it possible to determine the real state of security level.

The improved objective evaluation method, which is based on determining the coefficient of residual intelligibility for a test-signal after its recovery by the methods of mathematical analysis (adaptive filtration, correlation and spectral analyses, wavelet transformation, etc.) was proposed. The coefficient of residual intelligibility is determined for each word included in a short phrase, a test signal.

The analysis of frequency of using the phonemes in the Ukrainian speech was performed. It was shown that given the definition of the term "allophone" and the number of native speakers, it is possible to assume that the total number of allophones tends to infinity. To reduce the calculation complexity, we proposed the formalized approach based on the simplified linguistic model – a phoneme (a letter), a diphone (two letters), and a triphone (three letters). As a source of information, it is possible to use text documents.

We proposed analytical dependences for calculating the coefficient of residual speech intelligibility and its components – coefficients of frequency of using allophones in the words of the Ukrainian language and the importance of allophone recognition for the word recognition.

The interrelations of the SPC (speech privacy class) and word intelligibility W were shown. On their base, the scale of objective estimation of the degree of speech information privacy on the boundary of the controlled zone by the criterion of residual speech intelligibility was proposed.

**Keywords**: digital phonogram, speech intelligibility index, destructive changes of phonemic structure, wavelet transformation.

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**PARAMETRIC SYNTHESIS OF THE ELECTRONIC CONTROL UNIT OF THE COURSE STABILITY SYSTEM OF THE CAR (p. 39-45)**

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The problem of parametric synthesis of an electronic control unit for a brake system of a car is considered, which consists in the process of choice of values of the varied parameters of electronic CU. The selected parameters should provide the maximum margin of stability and maximum velocity of the closed-loop system of automatic control of a given direction of car movement in braking mode. This is important because modern high-velocity cars, operating in conditions of low-quality road surfaces of highways, often become objects of road traffic accidents, despite the fact that they are equipped with anti-lock braking and traction control systems. In this regard, the design development of the latest models of automotive equipment is aimed at creating directional stability systems, increased vehicle dirigibility in case of loss of wheel adhesion with the road surface. The problem is solved using the method of "frozen coefficients", which is based on the iterative process of sequential selection of numerical values of the varied parameters of the electronic unit. In particular, it is found that the characteristic equation of a closed-loop stability control system contains three variable parameters, and the system itself is a two-channel one.

The first control channel for the inclination angle of the car body contains variable parameters $k_{\psi}$ and $k_{\dot{\psi}}$, and the second control channel for side skid contains a variable parameter $k_y$. It is shown that 5–6 steps of the iterative process are sufficient to obtain optimal values of the varied parameters that provide the maximum safety margin and maximum performance of the closed-loop vehicle stability program. The work proves the effectiveness of the developed algorithms for parametric synthesis of the electronic control unit for a car, the simplicity of their imple-

mentation, as well as the high quality of stabilization processes of the car body. The optimal values of the varied parameters are $k^*_{\psi} = 399\ V; k^*_{\dot{\psi}} = 13,8\ V \cdot s; k^*_y = 143\ V \cdot m^{-1}$. In this case, the margin of stability of the system is $\alpha^* = -8,8\ s^{-1}$.

**Keywords**: car dirigibility, directional stability system, channel of the body angular deflection, channel of lateral displacement of the center of mass.

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**THERMAL MICROELECTROMECHANICAL SENSOR CONSTRUCTION (p. 46-52)**

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The problem of constructing a thermal sensor based on the technology of microelectromechanical systems is solved by structural and circuit integration of capacitance-dependent and thermomechanical parts. For this, the use of a MOS transistor (capacitance-dependent part) with a gate in the form of a bimorph membrane (thermomechanical part), which performs cyclic oscillations under the influence of heating from a sensitive element and subsequent cooling, is proposed. The novelty of the proposed sensor is the provision of a frequency-dependent output signal without the use of additional generator circuits. This makes it easier to combine the sensor with digital signal processing systems and reduce the influence of transmission lines on measurement accuracy. Also, the advantages of the sensor include reduced overall dimensions, which is achieved due to the vertical integration of its elements.

Model studies of the sensor are carried out and on their basis circuit and software-hardware solutions for determining the temperature of the sensitive element are proposed. It is shown that the use of logarithmic dependence to approximate the influence of the temperature of the sensitive element on the output pulse frequency of the sensor minimizes the measurement error to 3.08 %. The composition of the information and measurement system, which contains a thermal sensor, a sensor signal pre-processing circuit and measurement processing unit using the Atmega328 microcontroller on the platform of the unified ArduinoUno module, is determined. It is shown that the total error of temperature determination in the developed system does not exceed 4.18 % in the temperature range of the sensor element from 20 °C to 47 °C.

The program code for the microcontroller part of the information and measurement system is developed, which occupies 12 % of the program memory and 4.9 % of the dynamic memory of the unified module.

The proposed thermal microelectromechanical sensor can be used for contact measurement of the temperature of gaseous and liquid media, recording of optical radiation and microwave signals.

**Keywords**: MOS transistor, bimorph membrane, sensitive element, pulse frequency, microcontroller.

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**DEVELOPMENT OF SCENARIO MODELING OF CONFLICT TOOLS IN A SECURITY SYSTEM BASED ON FORMAL GRAMMARS (p. 53-64)**

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The results of the development of tools for scenario modeling based on formal grammars are presented. The works related to various ways of scenario description in their development systems are analyzed. For the natural language description of scenarios, it is indicated that this approach is sufficiently transparent and understandable for users. However, this approach has several disadvantages for formalizing and unifying scenario description. In particular, the presence of a number of ambiguities in the language makes it impossible for the description to be uniquely interpreted, and as a result, unsuitable for performing formal transformations on the description. The graphical representation of the script is a visual representation of the script.

Moreover, the visual representation of the scenario in the form of some automaton model can be estimated as extremely attractive for subsequent multi-agent modeling of its execution. The disadvantage of such scenario description is still the difficulty of performing formal manipulations and the need to switch to a more convenient representation for manipulations. Using formal grammars to describe scenarios is a compromise approach that allows scripts to be described in an unambiguously interpreted form. The formal grammar description is also more familiar to computer language specialists. In addition, there are programs focused on working with formal grammars. The transition from the natural linguistic description of scenarios to its formal representation as a standard description in the Backus-Naura form is shown. The change in the presentation form was made using the example of description of the scenario of behavior of cyber-conflict participants in the security system. The resulting script description was used in the context-free grammar analyzer. The results showed the applicability of the proposed approach and the tools used to describe and verify the description correctness of scenarios related to any subject area.

**Keywords**: scenario modeling, security system, formal grammar, context-free grammar, Backus-Naura form.

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