ABSTRACT AND REFERENCES

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COMBINED METHOD FOR SCANNED DOCUMENTS IMAGES SEGMENTATION USING SEQUENTIAL EXTRACTION OF REGIONS (p. 6-15)

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We propose a combined method to segment the images of scanned documents, which, in contrast to known methods, implies a preliminary separation of the graphics and photograph regions from the text regions and a background. In this case, an analysis of the connected components is performed, which are different for graphics, photographs, and text regions. In order to classify the selected regions into the photograph and graphics regions, a block method is employed. It was established that such a technique for splitting the regions into blocks less affects the quality of segmentation when compared to applying the block method directly to the original image. To extract the text regions that are more complex in their shape from the background, the neighborhood of each pixel was processed.

To detect the boundaries of illustrations on the images of scanned documents, we applied the Bloomberg method. In order to classify into photographs and graphics, it is proposed to split an illustration into blocks of pixels. Each block of pixels is identified with a vector of two features: the mean value of the local gradient magnitude, and the mean value of the function that localizes at the images of scanned documents the linear objects (graphics and text characters). The derived feature vectors were classified using a support vector machine.

When extracting the text regions, we applied a low-frequency filtering and a thresholding.

The combined method was implemented in practice to segment the test images of scanned newspaper articles from the document database MediaTeam at Oulu University (Finland). It was established that the combined method is characterized by an increase in performance speed during image segmentation at high quality processing.

Keywords: image segmentation, scanned document, block method, graphics, photographic image, text fragment, connected component, Bloomberg method.

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DEVELOPMENT OF THE LINGUOMETRIC METHOD FOR AUTOMATIC IDENTIFICATION OF THE AUTHOR OF TEXT CONTENT BASED ON STATISTICAL ANALYSIS OF LANGUAGE DIVERSITY COEFFICIENTS (p. 16-28)

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We have developed the linguometric method for algorithmic support of content monitoring processes to solve the problem of the automatic identification of the author of the Ukrainian text content based on the technology of statistical analysis of the language diversity coefficients. The decomposition of the method for identification of the author based on the analysis of such speech factors as lexical diversity, degree (measure) of syntactic complexity, speech coherence, indexes of exclusivity and concentration of a text was performed. Such parameters of the author's style as the number of words in the specified text, the total number of words in this text, the number of sentences, the number of prepositions, the number of conjunctions, the number of words with the frequency of 1, the number of words with the frequency of 10 and more were analyzed. The features of the developed methods are the adaptation of the morphological and syntactic analysis of lexical units to the peculiarities of the structures of Ukrainian words/texts. That is, when analyzing linguistic units of the word type, their belonging to a part of speech and declension within this part of speech was taken into account. For this, the flections of these words for their classification, separation of the base for the formation of the corresponding alphabetic-frequency dictionaries were analyzed. Filling these dictionaries was subsequently taken into consideration at the following stages of the identification of the authorship of a text, such as the calculation of parameters and coefficients of the author's speech. Syntactic words (stop or anchor) words are most essential for an individual style of an author, as they are not related to the subject and content of the publication. We compared the results in a set of 200 one-author papers in the technical area of more than 100 different authors over the period of 2001–2017 to determine if and how the coefficients of diversity of a text of these authors change within different periods of time. It was found that for the selected experimental base of more than 200 papers, the best results according to the density criterion are reached by the method for analysis of an article without the initial compulsory information, such as abstracts and keywords in different languages, as well as the list of literature.

Keywords: NLP, content monitoring, stop words, content analysis, statistical linguistic analysis, quantitative linguistics.

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DEVELOPMENT OF AN APPROACH TO MATHEMATICAL DESCRIPTION OF IMBALANCE IN METHABOLIC PROCESSES FOR ITS APPLICATION IN THE MEDICAL DIAGNOSTIC INFORMATION SYSTEM (p. 29-39)

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The problem of diagnosing the metabolic syndrome associated with disturbance of carbohydrate and lipid metabolism was considered in this work. A new approach to determination of imbalance of metabolic processes was proposed. It is based on combining of the flow cultivator and the Lotka-Volterra models. Application of the model of flow cultivator provides an opportunity for objective assessment of initial conditions of behavior of the system acting as a human body and enables time matching of the model basic parameters. Initial conditions for modeling metabolic processes were determined using the Lotka-Volterra model. Use of these conditions makes it possible to determine stability of metabolic processes taking into account individual values of waist and hip circumference, weight, heart rate, age, systolic and diastolic pressure and the calculated Harris-Benedict value.

Cross-checking for a possible development of metabolic processes in people with normal and impaired metabolism has shown that the developed approach can be used in medical institutions for the early diagnosis of metabolic disorders. To establish balance of the metabolic processes that are characteristic of people without and with metabolic disorders, retrospective data of examination of 155 young people who were under observation for several years at Kharkiv municipal clinical hospital No. 11, Ukraine, have been analyzed.

The proposed approach is the basis of mathematical support of the medical diagnostic information system for detecting imbalance of metabolic processes which is developed currently. Application of such a system in the future will make it possible to study in detail the influence of various gender, territorial and age characteristics on the balance of metabolic processes in the human body.

Keywords: flow cultivator, Lotka-Volterra model, metabolic syndrome, balance, approach, energy deposition, energy consumption.

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DEVELOPMENT OF THE TENSOR MODEL OF MULTIPATH QOE-ROUTING IN AN INFOCOMMUNICATION NETWORK WITH PROVIDING THE REQUIRED QUALITY RATING (p.40-46)

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This work has solved a relevant task to ensure the required level of quality of experience in an infocommunication network, which implied the development of a mathematical model of the multipath QoE-routing while maintaining the required quality rating. In this case, quality rating calculation requires the introduction to the mathematical model of routing of additional conditions for obtaining the indicators of an end-to-end delay and a packet loss probability. To this end, it is advisable to use the tensor formalization of these conditions when implementing a multipath routing strategy. Such a technique for expanding the mathematical models (introduction of additional analytical conditions) is more flexible and would full account for the complexity of relationship between network parameters within QoE. Given this, the quality of experience of speech transmission is not defined by the absolute values of delays and loss probabilities, but rather by their relationship. The result of studying the proposed model is the calculated quantitative indicator for a quality rating, which, compared to recommended indicators according to existing recommendations, makes it possible to evaluate the execution of the predefined level of QoE. In other words, given the preset intensity of traffic in a network, we calculated indicators for the average end-to-end delay and a packet loss probability, which make it possible to assess the quality of experience in terms of a quality rating and indicate the efficiency of the proposed solution. And, on the contrary, owing to the developed model of QoE-routing, it has become possible to control the probability of losses and the average end-to-end packet delay in an infocommunication network in order to ensure meeting the specified QoE-requirements. In addition, a comparative analysis was performed of a flow model of multipath routing based on using the IGRP metric, which made it possible to assess the effectiveness of the proposed solution and demonstrated better performance in terms of a quality rating by 12 to 25 % depending on the source data.

Keywords: infocommunication network, quality of experience in an infocommunication service, average end-to-end delay, probability of packet losses, tensor, routing, quality rating.

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DEVELOPMENT OF AN APPROACH TO ENSURE STABILITY OF THE TRACTION DIRECT CURRENT SYSTEM (p. 47-56)

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The result of applying the quantitative approach to the calculation of static stability of the traction power system helped us establish that when a train runs along an actual section there emerge zones with lack of stability in terms of voltage. Exact solution to the task of evaluating the stability is extremely difficult because of the need to compute the nonlinear dependences determining the modes of operation of the traction power system and electric rolling stock.

In this work, we constructed a system of four autonomous nonlinear differential equations based on experimental data that simulate the behavior of current and voltage in the contact network. We also calculated stability regions for voltage regulators in the traction network, which stabilize voltage at pantographs of electric rolling stock.

The obtained stability regions of voltage regulators made it possible to estimate resource of stability and to find the most robust regulators out of those constructed. The study revealed that the non-linear regulator has better robust properties than the linear one. In this case, stability of the linear regulator is very narrow – $\Delta k=0.000004$, which is an order of magnitude lower than for the non-linear regulator. When applying the non-linear regulator, voltage in the contact network stabilizes 3 times faster regardless of the place of its location.

Application of the devised approach would make it possible to calculate the stability regions for various schematics of the traction network in the implementation of high-speed motion and to narrow the range of voltage fluctuations. The developed dynamic model of power consumption processes, as well as the voltage regulator, could be used when constructing an intelligent, adaptive traction power system for high-speed motion.

Keywords: traction power system, voltage regulator, stability region, nonlinear recurrent analysis.

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SYNTHESIS OF THE STRUCTURE FOR THE OPTIMAL SYSTEM OF FLOW TREATMENT OF RAW MATERIALS (p. 57-65)

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This paper demonstrates that contemporary studies into optimization of technological processes do not take into consideration in the models of systems and in the applied criteria the requirements to the overall efficiency of the process and compliance with the objectives of the owner of a privately-held industrial enterprise. This necessitates the reduction of cost and time of a technological operation, as well as maximization of the added value of the primary product.

The effectiveness of the system of a flow treatment of raw materials is estimated using a specialized model, which was synthesized in the course of this work. The proposed model is different in that it includes units to calculate the unit cost of a product depending on the quality indicator and the degree of correspondence to the proposed quantitative and qualitative constraints. There are calculation units for the dynamics of change in a qualitative indicator of the finished product depending on a flow of raw materials and the energy supplied to treatment. The units are also required to calculate the consumption of resource and energy for the transporting and treatingg parts of the system in the interval, defined as the time taken for a conditional batch to pass through the installation.

Using the developed model makes it possible to determine the value for the performance indicator for any permissible technological mode and to perform a global optimization of the process. Thus, there is a transition from the requirements to efficiency in general terms to setting the technological process parameters.

Here we propose the analytical form for a performance indicator, suitable as an optimization criterion for modes of the technological installation with a continuous supply of raw-material and energy products.

We have experimentally studied a model of the flow-through electric heater with units that calculate time and cost parameters, which has demonstrated its adequacy. The developed optimality criterion was verified and the possibility of its application was proven for determining the optimal permissible operating modes of the technological equipment with a continuous supply of raw materials and energy.

Keywords: efficiency indicator, technological installation, flow treatment, an optimal system model.

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DEVELOPMENT OF THE PID-NEUROCONTROLLER TO COMPENSATE FOR THE IMPACT OF DAMAGES AND DEGRADATION OF INDUCTION MOTOR ON OPERATION OF THE ELECTRIC DRIVE SYSTEM (p. 66-77)

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In order to synthesize adaptive control systems over asynchronous electric drive that includes a motor with defects or degradation, we proposed a structure and developed an algorithm for training a PID-neurocontroller based on a multilayer feedforward neural network. Such an approach makes it possible to operatively respond to a change in the characteristics of control object that occurs as a result of the emergence and development of damage and degradation of the motor. This, in turn, makes it possible to improve controllability of the motor, and, consequently, to prolong its operation life cycle and to enhance the energy efficiency of its operation. The proposed solutions, in contrast to the traditional, do not require the use of additional equipment for implementation. It is only needed to change a control program for the frequency converter based on the constructed algorithm. To implement the proposed solutions in practice, we synthesized an algorithm for training a neural network of the PID-neurocontroller with self-tuning. It enables the calculation of weights of the neurons that could be in the future used as the basis of software for a physical control system with the PID-neurocontroller. We mathematically modeled the operation of IM with breaks of the rotor bars and the short-circuited turns in the stator windings when using the proposed controller.

An analysis of modeling results showed that the proposed approach to control the electric drive with a damaged IM makes it possible to decrease the amplitude and the number of non-basic harmonics of current and power signals of IM while maintaining the preset parameters of the technological process. Thus, our paper demonstrates the effectiveness of applying the proposed approach to the tasks on maintaining the predefined parameters of the technological process for the case of a stochastic change in the characteristics of control object.

Keywords: PID-neurocontroller, neural network, induction motor, diagnosis, control system, frequency converter, damages.

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