

ABSTRACT AND REFERENCES

INFORMATION TECHNOLOGY. INDUSTRY CONTROL SYSTEMS

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DEVELOPMENT OF METHODS FOR THE ANALYSIS OF FUNCTIONAL REQUIREMENTS TO AN INFORMATION SYSTEM FOR CONSISTENCY AND ILLOGICALITY (p. 4-11)**Maksym Ievlanov**Kharkiv National University of
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The order of work aimed at analyzing the requirements is considered, taking into account application of the service approach to development of IS, models and methods of development of representations of functional requirements to IS at the knowledge level. It was proposed to perform work on IS requirements analysis in parallel to the work on the requirements development. Such an organization of work makes it possible to reduce the time required to perform work on the IS macro design.

Methods of analysis of separate frames and relations between frames and between frames and interfaces of representations of functional requirements to IS at the knowledge level were developed. The essence of the methods lies in comparison of frames and relations, used for description of concepts and terms in a subject area. These methods make it possible to detect inconsistencies, caused by attempts to describe the same object in a subject area in different ways.

The indicator of illogicality of the stated functional requirement and the method of detection of illogical functional requirements was developed. The essence of this method lies in identification of separate branches of the frame hierarchy (ontological points) that are present in representation of only one functional requirement to IS. Such requirement is not related to other functional requirements to IS and is considered to be illogical. This method makes it possible to assess a degree of illogicality of each functional requirement, based on which it is possible to make a decision about the feasibility of IS development.

The research contains an example of testing the developed methods in the analysis of functional requirements to the project related to the functional labor safety module.

Keywords: requirements analysis, functional requirements, frame, inconsistency, illogicality, ontological point.

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UNCERTAINTY REDUCTION IN BIG DATA CATALOGUE FOR INFORMATION PRODUCT QUALITY EVALUATION (p. 12-20)

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The method of vitality of the information product evaluation is built. This method, as opposed to others, takes into account components of the information product, which gave an opportunity to forecast (predict) the sequence of changes in its states. The operations over the relation with indeterminacy for the purpose of their application in the data warehouse with the consolidated data are improved that allowed realizing unary operations of Big data catalogue.

The method for reducing the indeterminacy of data available in the repository of consolidated data as a basis for further evaluation of the quality of consolidated data was created. The considered methods are useful also for decision making, because they provide a search for hidden relationships between the characteristics of the consolidated data repository. Such dependence should be considered when making decisions based on consolidated data.

The result of this work is to reduce the uncertainty for assessing the viability of the information product. This allows us to increase the quality of the information product for Big data analysis.

Keywords: Big data, uncertainty reduction, risk factor, F-dependence, usefulness of information product.

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IDENTIFICATION OF HEAT EXCHANGE PROCESS IN THE EVAPORATORS OF ABSORPTION REFRIGERATING UNITS UNDER CONDITIONS OF UNCERTAINTY (p. 21-29)

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Analysis of the evaporator of the absorption refrigerating secondary condensation unit of ammonia production was performed. The need to minimize the temperature mode of operation of the evaporator, which provides for energy efficiency in ammonia production by decreasing natural gas consumption was substantiated. Statistical processing of experimental data with assessment of the quality of obtained information was performed. Identification of the heat exchange process of the evaporator was performed and the equation for numerical evaluation of uncertainty of coefficients of thermal efficiency, heat transfer and condensation thermal resistance was obtained. According to the results of statistical modeling of the primary condensation unit, the equation for numerical evaluation of uncertainty of ammonia concentration in circulating gas at the evaporator inlet. The authors proved the possibility of its application for identification and mathematical modeling of heat exchange process at existing relationship of ammonia concentration in the circulating gas at the evaporator inlet and condensation thermal resistance. Algorithmic support of numerical evaluation of uncertainties and calculation of target indicators of the evaporator's efficiency

was created. The technical structure of the automated system for identification and timely obtaining of the mathematical model of the evaporator, which is adapted to the existing information system of the industrial ammonia synthesis unit, was developed.

Keywords: ammonia production, secondary condensation, mathematical modeling of heat exchange processes, automated system.

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DEVELOPMENT OF ADAPTIVE FUZZY-LOGIC DEVICE FOR CONTROL UNDER CONDITIONS OF PARAMETRIC NON-STATIONARITY (p. 30-37)

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We studied an automatic control system with the fuzzy adaptive device for setting parameters of the PI-controller under conditions of non-stationarity of parameters of the control object's model. The relevance of present research is in the application of more complex control structures, when it is necessary to achieve small deviations in quality control parameters under conditions of change in the parameters of control model. In contrast to the common circuit when the fuzzy controller is directly included into the main control channel, in the present article we consider a circuit with the fuzzy controller as a unit of adaptation of PI-controller's parameters. Coefficients of the standard controller are adjusted to the changes of object in real time on the basis of rule base for the fuzzy adaptive device and two input signals: an inconsistency signal and derivative from the inconsistency signal. Mathematical modeling of the designed system was performed.

We compared a single-circuit system at constant settings of the controller and the adaptive system for different states of an object that are determined by variable parameters of its model. Parameters of operation quality of both systems were calculated. Application of the fuzzy adaptive device warrants the required stability factor. In this case, high quality of operation of an automatic control system under conditions of parametric non-stationarity of the studied object was preserved.

Keywords: fuzzy logic, non-stationarity, adaptive system, stability factor, control system, robustness.

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SYNTHESIS OF ROBUST CONTROLLERS FOR THE CONTROL SYSTEMS OF TECHNOLOGICAL UNITS AT IRON ORE PROCESSING PLANTS (p. 37-47)

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In order to synthesize a robust system of control over technological units, an analysis of appropriate mathematical models was performed. The uncertainty of models of technological iron ore processing units was accounted for by connecting a diagonal block at the top using a fractional linear transformation.

To study robust control systems of technological units, we applied the following types of robust controllers: suboptimal H_∞ -controller, a controller that was synthesized using the method of circuit formation, and μ -controller. We performed an analysis of results of the study into indicators of robust quality and stability of control, created on the basis of these types of controllers.

The best results were obtained using μ -controller, which ensures a minimal overshoot value of 2 %. Reducing the order of the selected μ -controller to the fourth order was performed by approximation using the Hankel norm. Under such a condition, a root-mean-square error relative to the base controller is 0.027.

Results of present research could be used in the synthesis of control over technological iron ore processing units under conditions of uncertainty in parameters.

Keywords: robust controller, automated control, ore enrichment, suboptimal controller, frequency characteristics.

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ANALYSIS OF AMPLITUDE-PHASE FUNCTIONS OF THE DRILL STRING AS A COMPONENT OF AUTOMATION SYSTEM (p. 48-58)

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We determined amplitude-phase frequency functions of the drill string for translational motion while drilling with immersed engines. It was established that amplitude-phase characteristic of the drill string changes with increasing depth of the well. When drilling in hard rocks, it is advisable to use cushion subs in order to reduce the level of reflected wave of mechanical stresses. To eliminate the impact of the reflected wave, it is necessary to apply a bit feed drive with absolutely soft mechanical characteristics.

We performed analysis of dynamic modes of the process of drilling wells as a control object based on provisions of the synergetic theory of information. It is proposed to employ energoinformational approach to analyze processes in the system of control over well drilling. This is due to the fact that the drilling process evolves over time and functions under conditions of a priori and current uncertainty in terms of parameters and structure of the object. Since such a system develops over time, it undergoes changes in the structure of design of the drill string. Therefore, in order to resolve tasks on control over the process of drilling, it is necessary to know how dynamic properties of the column change depending on depth.

We identified five modes of operation in the process of drilling as a complex dynamic system: equilibrium, ordered, sorted-chaotic, randomly-ordered, and chaotic. This makes it possible to solve an important applied problem of determining amplitude-phase characteristics of the drill string depending on depth of the well, and to use them for mathematical substantiation of automated control system over drilling.

Keywords: drilling process, amplitude-phase characteristics, drill string, energoinformational approach, automated system.

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DEVELOPMENT OF THE IMITATION MODEL OF THE TWO-STAGE SEPARATION PROCESS OF OIL (p. 59-67)

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In accordance with the law of preservation of the amount of substance, an imitation model for the process of two-stage oil separation has been developed. The creation of this model took into account the features of the operating mode of the horizontally placed separators B-1 and B-2 of the first and second stages of separation.

The simulation mathematical model after the identification of parameters was investigated by a numerical method that takes into account the effect of perturbations on the separation process, which is a consequence of the action of a number of physical quantities from the environment on the object. Automated control systems that operate on the principle of negative feedback were used to stabilize the main technological parameters of oil separation. But since the deviation of the regulated quantities from their given values is small, this allowed linearizing the nonlinear model of the two-stage separation process.

After studying the simulation model by a numerical method, it is established that the mathematical model of the installation of two-stage separation can be used for the synthesis of effective control systems of the two-stage separation process and the creation of mathematical models in terms of “input-output”. The obtained numerical and graphical result in the form of functional dependencies allows us to establish the relationship of technological parameters, in other words, the change of the value of the parameters at the second stage of separation will depend on the first one and vice versa. Thus, the applied aspect of using the obtained scientific result is the possibility of improving the typical technological process of oil separation.

Keywords: system synthesis, two-stage separation, numerical method, parameter identification, simulation model.

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QUALITY ASSESSMENT OF CONTROL OVER THE TRACTION VALVE-INDUCTOR DRIVE OF A HYBRID DIESEL LOCOMOTIVE (p. 68-75)

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We have studied the valve-inductor drive for its application as a traction motor in a hybrid locomotive. We identifying parameters of the valve-inductor engine and built its simulation model based on a Lagrange equation. The model constructed makes it possible to take into consideration non-linearity of the engine. We have synthesized a modal speed controller and a controller based on fuzzy logic for the valve-inductor drive of a hybrid locomotive. The operation of two types of controllers was analyzed in terms of their influence on the basic quality indicators of control; it was found that the fuzzy controller was better at processing the set value of input magnitude. We have designed a simulation model of the traction valve-inductor drive of a hybrid locomotive with a fuzzy speed controller, and studied its work along a railroad section with actual profile and limitations.

Control systems based on a modal controller and fuzzy logic were synthesized. It is established that the modal controller has the following quality indicators: maximal overshoot – 12.27 %, re-adjustment time – 5.08 s, number of oscillations – 2. For the FPID-controller, the quality indicators are: 3.75 %, 3.01 s, and 1, respectively. Thus, on analyzing the quality of their operation, it was found that the best indicators were demonstrated by the FPID-controller.

The built physical model of the valve-inductor drive, specifically the system wheelset-engine with a control system that employs the fuzzy algorithm of speed regulation, confirms the feasibility of a fuzzy controller.

Keywords: traction valve-inductor engine, modal controller, fuzzy controller, hybrid shunting locomotive.

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