ABSTRACT AND REFERENCES

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DEVELOPMENT OF THE MODEL OF THE PROACTIVE APPROACH IN CREATION OF DISTRIBUTED INFORMATION SYSTEMS (p. 6-15)

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We discuss an integrated approach to complex projects management, creating distributed information systems, which is based on the analysis of the relationship of project management processes, product creation, management of interested parties and external environment. We analyzed the features of project implementation on the development of distributed information systems that are subject to the significant number of complex effects from the turbulent external environment and project response to these effects. To solve the resulting problems, a proactive approach was proposed.

The work has identified and formalized basic structural elements of models of complex projects of creation of distributed information systems. A conceptual model was built, which facilitated research of the effect of the turbulent environment of the project on all elements of the model. The key branches of knowledge of this effect are identified. We developed the structural model of components in distributed information systems using cloud technologies and design approach, which takes into account the response to dynamic changes and turbulence of the external environment.

The mathematical model of the process of creating a complex IT product is constructed, taking into account the influence of the turbulent external environment of the project, the main characteristics and parameters are determined. We performed the modeling of objective functions of the mathematical model of the process of creating a complex IT product.

The algorithm of change management based on the proactive approach in the projects of creating distributed information systems is proposed, taking into account monitoring of the project implementation environment and identification of three types of possible events.

The studies confirmed the effectiveness of using a proactive approach in projects of creation of distributed information systems, which will allow using the proposed model for managing complex IT projects.

Keywords: cloud technologies, distributed information systems, IT projects, proactive management.

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ENHANCING THE PERFORMANCE OF DISTRIBUTED BIG DATA PROCESSING SYSTEMS USING HADOOP AND POLYBASE (p. 16-28)

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The approach to improvement of performance of distributed information systems based on sharing technologies of the Hadoop cluster and component of SQL Server PolyBase was considered. It was shown that the relevance of the problem, solved in the research, relates to the need for processing Big Data with different way of representation, in accordance with solving diverse problems of business projects. An analysis of methods and technologies of creation of hybrid data warehouses based on different data of SQL and NoSQL types was performed. It was shown that at present, the most common is the technology of Big Data processing with the use of Hadoop distributed computation environment. The existing technologies of organization and access to the data in the Hadoop cluster with SQL-like DBMS by using connectors were analyzed. The comparative quantitative estimates of using Hive and Sqoop connectors during exporting data to the Hadoop warehouse were presented. An analysis of special features of Big Data processing in the architecture of Hadoop-based distributed cluster computations was carried out. The features of Polybase technology as a component of SQL Server for organizing a bridge between SQL Server and Hadoop data of the SQL and NoSQL types were presented and described. The composition of the model computer plant based on the virtual machine for implementation of joint setting of PolyBase and Hadoop for solving test tasks was described. A methodological toolset for the installation and configuration of Hadoop and PolyBase SQL Server software was developed with consideration of constraints on computing capacities. Queries for using PolyBase and data warehouse Hadoop when processing Big Data were considered. To assess the performance of the system, absolute and relative metrics were proposed. For large volume of test data, the results of the experiments were presented and analyzed, which illustrated an increase in productivity of the distributed information system – query execution time and magnitude of memory capacity of temporary tables, created in this case. A comparative analysis of the studied technology with existing connectors with Hadoop cluster, which showed the advantage of PolyBase over connectors of Sqoop and Hive was performed. The results of the research could be used in the course of scientific and training experiments of organization when implementing the most modern IT-technologies.

Keywords: Hadoop, MapReduce, HDFS, PolyBase SQL Server, T-SQL, distributed computing, scaling, PolyBase scalable group, external objects, Hortonworks Data Platform.

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ALGORITHMIC TOOLS FOR OPTIMIZING THE TEMPERATURE REGIME OF EVAPORATOR AT ABSORPTION-REFRIGERATION UNITS OF AMMONIA PRODUCTION (p. 29-35)

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We analyzed evaporators at absorption-refrigeration plants in a secondary condensation unit of ammonia production as control objects. Coordinates of the vectors of state, control and external perturbations were determined. The necessity of solving the problem on minimizing the cooling temperature of a circulating gas at evaporators in order to improve the energy efficiency of production was substantiated. Based on the analysis of industrial hardware-technological implementation of units for primary and secondary condensation, we elucidated features of operating conditions of evaporators, which predetermine the parametric uncertainty in the functioning of control objects. The main one among these uncertainties is associated with the control action related to the consumption of reflux. By using the method of mathematical modeling, based on the developed algorithm, we defined patterns of control action related to the consumption of reflux on the efficiency of heat exchange processes at evaporators in the absorption refrigeration units. We have established the extreme character of dependence of the heat flow (cooling capacity) and the temperature of cooling a circulating gas on the consumption of reflux. Maximum cooling capacity, and therefore the minimum temperature of cooling a circulating gas at a certain temperature head, are predetermined by the achievement of a critical regime of the bubbling boiling of a refrigerant. A further increase in the temperature head with an increase in the consumption of reflux contributes to the establishment of the transitional regime and reduces effectiveness of the heat exchange surface. We determined indicators of energy efficiency for ammonia production, namely, natural gas consumption under conditions of change in the control action related to the consumption of reflux and values of coordinates for the perturbation vector. The developed algorithmic tools make it possible to carry out the task on minimizing the cooling temperature of a circulating gas using a gradient-free technique of the step type applying the methods for a one-dimensional search for an extremum. It is shown that minimizing the cooling temperature of a circulating gas could reduce annual natural gas consumption by 500 thousand nm^3 on average.

Keywords: ammonia production, absorption-refrigeration unit, evaporator, consumption of reflux, temperature optimization algorithm.

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EXPERIMENTAL STUDY INTO OPTIMAL INTERDEPENDENCE OF ENERGY-TIME COSTS FOR EMPTYING A DRY DOCK (p. 35-55)

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The influence of discrete properties of the microprocessor control systems based on Arduino Due on the accuracy of the physical model of the dock pumping station by modeling in MATLAB was assessed. In this case, such factors were taken into account as the PWC switching period, the quantization pitch by level and by time of ADC and DAC of the microprocessor, the time of the program cycle execution, noise of the least significant discharges of ADC, noise and inertia of the current sensor, as well as deviation of parameters of capacitive filters, included in the feedback channels by voltage, from the nominal values, load the converter and voltage drop at the terminals of the battery.

The results of calculations revealed that this influence can be neglected and the data, collected using a physical model of the dock pumping station, are reliable. Through physical simulation, the experimental correlation between energy-time costs of emptying the chamber of a dry dock was obtained, which proves the possibility of significant energy saving when the process is optimized by the appropriate criterion. It became possible thanks to multiple numerical solution of the edge problem directly on a physical model. The obtained characteristic suggests that at a short time of the process of chamber emptying, energy saving, which is achieved through optimal control of an electric drive of the pump, is relatively small compared with the option of an unregulated electric drive. However, at dragging out the process, it can reach the values at the level of 13 %. It is also noteworthy that beginning from some value of time of dry dock chamber emptying, the energy practically does not change, which makes it rational to introduce an idle pause in the law of optimal control of the object.

Thus, the possibility and feasibility of optimizing the process of dry (bulk – liquid) dock chamber emptying by the energy consumption criterion was proved experimentally.

Keywords: Arduino Due, U4814, liquid, dry dock, pump, electric drive, optimal control.

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DEVELOPMENT OF STRUCTURAL-PARAMETRIC OPTIMIZATION METHOD IN SYSTEMS WITH CONTINUOUS FEEDING OF TECHNOLOGICAL PRODUCTS (p. 55-62)

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Increasing the efficiency of continuous technological processes, in practice, involves certain difficulties. The presence of these difficulties is due to the fact that the technological product quality is functionally related to energy consumption. In turn, the lack of necessary degrees of freedom, within the framework of the system under investigation, limits the optimization capabilities of control processes.

To increase the degrees of freedom of control, the technological mechanism was divided into technological sections. The sections allow collecting independent modules, each of which has its own subsystem of stabilization of the technological product qualitative parameter.

This approach allowed us to set different trajectories of changes in the technological product qualitative parameters within one production stage.

As a result of the research, it was found that the change in the technological mechanism structure (the modules number) and the trajectory of the change in the technological product qualitative parameter made it possible to change the total energy consumption and wear of the working mechanisms of equipment.

The proposed approach made possible to obtain two degrees of freedom of control: the possibility of changing the sectional structure into self-stabilizing modular systems and changing the trajectory of the technological product qualitative parameter within the production stage.

The obtaining of degrees of freedom of control, in turn, allowed to change the resource efficiency of the continuous technological process and to develop the method of structural-parametric optimization. As an optimization criterion, an evaluation indicator was used, which was verified for the possibility to use it as an efficiency criterion.

As a result, the optimization control capabilities are significantly increased.

The principles of the approach are considered in the work with the example of one-, two- and three-step process of continuous liquid heating.

Keywords: structural-parametric optimization, continuous process efficiency, continuous technological process.

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SYNTHESIS AND TECHNICAL REALIZATION OF CONTROL SYSTEMS WITH DISCRETE FRACTIONAL INTEGRAL-DIFFERENTIATING CONTROLLERS (p. 63-71)

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Control systems with a fractional order which provide better dynamic and static indicators for many technical objects in comparison with systems with integer order of astaticism were studied. Based on the analysis of frequency characteristics, transient processes and a modified criterion for quality assessment, optimal relationships between parameters of the desired transfer function were obtained. Normalized transition functions of closed systems with the order of astaticism from 1 to 2 were presented with overregulation less than 2...5 % on the basis of which parameters can be chosen and the controller structure determined.

The process of stabilizing cutting power was analyzed for a milling machine as an example of the systems with nonlinear parametric and structural dependences in control and perturbation channels. It was shown that fractional integral-differentiating controllers make it possible to provide the order of astaticism from 1.3 to 1.7 and permissible level of overregulation in a wide range of external perturbing influences.

A method for approximate calculation of fractional integrals based on the approximation of the highest coefficients of expansion in a series of geometric progressions was developed. It provides reduction of the memory capacity required to store the coefficient arrays and the history of the input signal and requires significantly less CPU time to calculate the controller signal. For example, for controllers based on the Intel® Quark ™ SoC X1000 or FPGA Altera Cyclone V, the quantization period is 6...15 μs and several milliseconds for Atmega328. This makes it possible to implement fractional integral-differentiating controllers based on widely used modern processors and apply fractional-integral calculus methods for synthesis of high-speed automatic control systems. The proposed methods can be used in the control of the objects both with fractional and integer orders of differential equations.

Keywords: astatic system, fractional integration, fractional differentiation, algorithm of fast fractional integral calculation.

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THE CONCEPT OF A MODULAR CYBERPHYSICAL SYSTEM FOR THE EARLY DIAGNOSIS OF ENERGY EQUIPMENT (p. 71-79)

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We have proposed a concept of the modular cyberphysical system for the early diagnosis of industrial and household power equipment based on the application of approaches and standards of Industry 4.0, in particular the concept of the Internet of Things. The main task of the concept and approaches proposed in this paper is the indirect diagnosis and identification of any power equipment whose basic element is the asynchronous motor, in particular the identification of failures and excessive power consumption. In order to resolve the set tasks, it is proposed to use a modular structure of Smart Box diagnosed devices. Specifically, we demonstrate a model of the modular cyberphysical system using a Smart Box device for the early diagnosis of electric equipment, as well as its information flows. This makes it possible to divide all the technological objects at an enterprise into separate structural units, which could form a part of the information cluster. That reduces the reaction time in a cluster system by 30–35 % compared to a standard one. In addition, the use of a given type of the system makes it possible to reduce the quantity of specialized equipment to the application of similar power equipment.

It is proposed to use as a computational core of a Smart Box device the structure a neuro-fuzzy network, which consists of 5 layers. A special feature of this system is the capability to change the number of terms for input variables in order to improve the quality of identification of induction motors. We have chosen, as informative attributes, the characteristic frequencies, which identify an electric motor in the power grid. Specifically, for the systems with small generating capacity, in order to increase the diagnosed induction motors within a cluster, it is advisable to reduce the input set, for example, to 3–4 CF.

The results of our study, in the form of a model of the modular cyberphysical system could be used to build hardware and software modules for the diagnosis of technological and household electrical equipment. In turn, these modules could be combined into an overall global network of IoT.

Keywords: Smart Box, Industry 4.0, early diagnosis, cyberphysical system, induction motor.

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