■ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─   ABSTRACT AND REFERENCES   ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ■

INFORMATION TECHNOLOGY. INDUSTRY CONTROL SYSTEMS

DEVELOPMENT OF UNIFIED MATHEMATICAL MODEL OF PROGRAMMING MODULES OBFUSCATION PROCESS BASED ON GRAPHIC EVALUATION AND REVIEW METHOD (p. 6-16)

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A set of algorithms of programming modules obfuscation is synthesized, which differs from the known ones by taking into account the variability of data types. This made it possible to describe these processes at the upper strategic level of formalization. The possibilities of using GERT models to apply various options of the distribution laws and their parameters in the transition from state to state are investigated. A unified GERT model of the programming modules obfuscation process is developed. This model differs from the known ones by the paradigm of using the mathematical apparatus of gamma distribution as the key one at all stages of modeling the obfuscation process. This made it possible to achieve model unification in the conditions of GERT network modification. The expectation and variance of the runtime of a random value of the obfuscation and deobfuscation time of programming modules are calculated. The results of the study showed that for the developed mathematical model, the addition of another obfuscation process leads to an increase in the runtime variance by 12 %, and when removed from the system, it decreases by 13 %. The runtime expectation changes exponentially. So, when removing the node, the expectation decreases by 9 %, and when increasing by 1 node, the expectation increases by 26 %. This shows the insignificance of changes in the studied characteristics under the conditions of model modification and confirms the hypothesis of model unification in conditions of using the mathematical apparatus of gamma distribution as the main one. These results allow the developer to predict the behavior of the programming modules protection system in terms of runtime. This allows reducing the time to decide on the feasibility of the obfuscation process.

Keywords: GERT model, programming modules obfuscation, program code, gamma distribution, java.

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IMPROVING A METHOD TO ANALYZE THE REQUIREMENTS FOR AN INFORMATION SYSTEM FOR CONSISTENCY (p. 17-27)

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Modern representations of characteristics of functional requirements virtually have no formalized descriptions. That is why the application of the existing methods for the analysis of requirements faces the problems of formal confirmation or refutation of the fact that a functional requirement has an appropriate characteristic. These problems are particularly pronounced in the analysis of functional requirements for consistency.

To eliminate these problems, the task was set to develop formalized descriptions of the situations of the complete and partial inconsistency of knowledge-oriented descriptions of functional requirements and based on the resulting descriptions, to improve the existing method for analysis of functional requirements for consistency of created or modified information system. The knowledge-oriented frame-based description was used as a formal description of the analyzed functional requirement for an information system. In the course of solving this problem, the formalized descriptions of the situations of complete contradiction and partial inconsistency of descriptions of the frames of analyzed functional requirements were developed. It was shown that the situation of complete contradiction is a particular case of a situation of the partial inconsistency of descriptions of analyzed frames. This result was the basis for the improved method for analysis of separate frames of descriptions of functional requirements for consistency. The improved method makes it possible not only to identify situations of complete contradiction and partial inconsistency of analyzed frames but also to quantify the degree of the identified inconsistency.

The initial and the improved methods were tested during the analysis of the functional requirements of the problem of planning the individual activity of the academic and teaching staff of a higher education institution. Three typical situations that may arise from the analysis of functional requirements for consistency were considered. It was shown that the improved method makes it possible to find more errors in the descriptions of functional requirements.

Keywords: functional requirement, knowledge-oriented description, analysis of requirements, consistency, frame, information system.

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IMPROVING THE QUALITY OF THE TECHNOLOGICAL PROCESS OF PACKAGING SHAPE FORMATION BASED ON THE INFORMATION STRUCTURE OF AN AUTOMATED SYSTEM (p. 28–36)

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Based on the information structure of an automated quality monitoring system, we have designed a system to analyze information on the quality of forming the shape of PET-packaging, with a possibility of statistical control over the technological process using Shewhart control charts. That has been demonstrated using an example of the proposed technique of quality estimation of the finished PET bottles based on the thickness of their walls. Obtaining high-quality PET-packaging directly depends on the degree of perfection of all technological stages, thereby predetermining the necessity to build an effective system to control and manage the technological process of the shape formation of bottles made from polyethylene terephthalate.

An analysis of information about the quality of PET-packaging shape formation based on monitoring the information structure of an automated system would make it possible to ensure operative adjustment of shape forming parameters at the minimized percentage of defects by organizing selective control over the products made. The use of statistical methods based on Shewhart control charts could enable the development of authentic algorithms for monitoring the shape formation quality aimed to track violations of technological parameters and compile recommendations on improving the process quality, as well as resource-use efficiency.

The statistical estimation of cause-effect relations between the main technological parameters and product quality indicators involves the algorithm that monitors the quality of PET-packaging shape formation. This makes it possible to ensure the minimum level of defects in bottles when applying the devised Shewhart control chart.

We have proposed a fuzzy cognitive chart for defining the preventive corrective actions directed at the elimination of the main causes of a defect at bottle shape formation, taking into consideration the interrelations of factors and their consequences on the resulting process quality.

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DEVELOPMENT OF A METHOD FOR TRAINING ARTIFICIAL NEURAL NETWORKS FOR INTELLIGENT DECISION SUPPORT SYSTEMS (p. 37-47)

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A method for training artificial neural networks for intelligent decision support systems has been developed. The method provides training not only of the synaptic weights of the artificial neural network, but also the type and parameters of the membership function, architecture and parameters of an individual network node. The architecture of artificial neural networks is trained if it is not possible to ensure the specified quality of functioning of artificial neural networks due to the training of parameters of an artificial neural network. The choice of architecture, type and parameters of the membership function takes into account the computing resources of the tool and the type and amount of information received at the input of the artificial neural network. The specified method allows the training of an individual network node and the combination of network nodes. The development of the proposed method is due to the need for training artificial neural networks for intelligent decision support systems, in order to process more information, with unambiguous decisions being made. This training method provides on average 10–18 % higher learning efficiency of artificial neural networks and does not accumulate errors during training. The specified method will allow training artificial neural networks, identifying effective measures to improve the functioning of artificial neural networks, increasing the efficiency of artificial neural networks through training the parameters and architecture of artificial neural networks. The method will allow reducing the use of computing resources of decision support systems, developing measures aimed at improving the efficiency of training artificial neural networks and increasing the efficiency of information processing in artificial neural networks.

Keywords: artificial neural networks, information processing, intelligent decision support systems.

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DEVELOPMENT OF THE METHOD FOR ESTIMATING THE TECHNICAL CONDITION OF GAS PUMPING UNITS BY THEIR ACCELERATING CHARACTERISTIC (p. 48-57)

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Analysis of failures of gas pumping units (GPU) installed on the Urengoy-Pomary-Uzhhorod transcontinental gas pipeline showed that failures of automatic control systems of automatic gas pumping units occupy the second place (up to 40 %) of the total number of failures. It is shown that the well-known methods for monitoring

the technical condition of the mechanical part of a gas pumping unit can't be used to control the operability of automatic control systems and automatic gas control unit components. Among the well-known methods for monitoring the operability of automatic control systems of a gas pumping unit as a dynamic system, the most promising methods are those based on the analysis of its transient process (accelerating characteristic) with some typical input exposure.

The theoretical justification of the developed method for monitoring the performance of the automatic control system of the gas pumping unit is presented, the diagnostic feature of which is the value of the areas of accelerating characteristics. The structure of the transfer function and its parameters were determined by the area method (Simoiu method). To implement the method in MatLab, software was developed that allows one to determine the parameters of the transfer function from the experimental start-up curve of the gas pumping unit and the size of the area limited by its transient function.

The technique of experimental studies of the proposed method for monitoring the efficiency of the automatic control system of a gas pumping unit type GTK-25i example is given. Further implementation of the proposed method requires determining the conditions of its operability and parallel monitoring of the technical condition of the mechanical units of the gas pumping unit in order to exclude their influence on the result of monitoring the state of the automatic control unit of the gas pumping unit.

Keywords: gas pumping unit, automatic control system, acceleration characteristic, technical condition.

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A physical model was constructed for a pulse mechanical seal as a system for automatically controlling the end clearance.

The effect of pulse compaction parameters on static characteristics was studied. The analysis of static characteristics revealed the influence of the design parameters of pulse compaction on the size of the end clearance and the flow rate of the fluid being sealed. Conclusions were made about the influence of the load factor and the efforts of the preliminary compression of the springs on the static characteristics of pulse compaction. The static calculation helped determine the coefficient of hydrostatic stiffness, the condition of static stability, and the range of permissible sealing pressures.

The factors affecting the dynamic characteristics of the seal were determined. Dimensional values of the amplitudes of the forced axial vibrations of the ring were estimated at any rotation frequency. Expressions of the amplitude and phase frequency characteristics were obtained, which made it possible to identify dangerous regions of rotational frequencies and select the sealing parameters so that the amplitudes of the forced axial vibrations of the ring could not go beyond the limits of dynamic stability. It was revealed that the stability region expands due to a decrease in the volume of the chambers and a decrease in the coefficient of hydrostatic stiffness.

A method for the analytical calculation of pulse mechanical seals was proposed to make it possible to calculate the geometry of the seal at the design stage. The study offers an example of engineering calculations for a pulse mechanical seal as well as the design of a sealing assembly developed by the proposed method.

Keywords: pulse mechanical seal, static characteristics, amplitude and phase characteristics, dynamic stability.

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