ABSTRACT AND REFERENCES

CONTROL PROCESSES

RATIONALE FOR THE TYPE OF THE MEMBERSHIP FUNCTION OF FUZZY PARAMETERS OF LOCOMOTIVE INTELLIGENT CONTROL SYSTEMS (p. 4-8)

Tatiana Butko, Aleksandr Babanin, Aleksandr Gorobchenko

Presentation of the train speed as a fuzzy number is justified by the impossibility to accurately predict this value. This is caused by deviation of many train and locomotive parameters in operating conditions. According to statistics, the actual train speed is different from the design speed by up to 5 km/h. According to the distribution of the speed deviation from the design value, a hypothesis about using t- and π-class membership functions was proposed. It was found that with the fuzziness coefficient values less than 2, it is necessary to use the triangular activation function to present the fuzzy variables. If the fuzziness coefficients are greater than 2, it is reasonable to use both classes of membership functions. This will allow to apply artificial intelligence theory methods in modeling the decision support system for locomotive crews.

Keywords: train control, fuzzy number, locomotive crew, membership function.

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DEVELOPMENT OF AN AUTOMATED OPTIMIZATION SYSTEM OF THE TRANSSHIPMENT COMPLEX (p. 8-14)

Stanislav Zabara, Mykola Dekhtyaruk

Based on optimality criteria, an automated optimization system of the port industrial-transshipment complex was developed. The automated system is implemented as a software computer complex, which is developed using visual design environment EmbarcaderoC++Builder XE5. Software complex consists of a main form Form1, with the component TabControl, consisting of a set of bookmarks bars.

Each bookmark represents a separate subroutine, which allows to perform optimal cargo distribution among the berths according to two options of cargo operations (direct and through the warehouse) using existing groups of berths (bulk, general, grain) and available cargo handling mechanisms and human resources by the optimality criteria – maximum cargo turnover, minimum cargo handling time and minimum cargo handling cost.

As a result of the optimal redistribution of the cargo and resources of the port industrial-transshipment complex, according to groups of berths and options of loading operations, the calculation of cost savings when performing reloading operations was carried out.

Keywords: automated system, transport logistics, transshipment complex, optimization, software complex.

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AN INTERVAL METHOD FOR IDENTIFYING EQUIVALENT ENGINE LOAD PARAMETERS (p. 15-20)

Mykola Kosterev, Volodymyr Litvinov

We have devised a method for identifying parameters of an equivalent circuit for an equivalent asynchronous engine in the load node of the energy system. The suggested method uses available for measurement load node parameters as input information. An advantage of the method consists in identifying intervals for each parameter of the equivalent circuit. This allows considering the change of engines' composition in the load node as well as the change of their wear-out characteristics.

The obtained optimization task has a complex structure since there are many restrictions in the form of inequalities; that is why it is solved by means of a genetic algorithm. The latter applies genetic operators for "hybridization" and "mutation". Determined parameter values of an engine equivalent circuit can be identified within the obtained intervals at any moment with the help of the formed reverse optimization task that is also solved by means of the genetic algorithm.

The devised method should be used for solving the tasks of risk-oriented electrical power systems management, for calculating their regimes on-line, and for predictive calculations.

Keywords: asynchronous engine, equivalent circuit, load node, interval estimation, genetic algorithm.

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METHODS OF CONSIDERING THE SUBJECTIVE CHARACTER OF INPUT DATA IN VOTING (p. 20-25)

Oksana Mulesa

The problems of decision theory include voting tasks. Contemporary science knows a lot of methods to determine the collective order, each of them having its advantages and disadvantages. Practical voting tasks often suggest cases that consider voters' individual rankings as well as their subjective characteristics such as nihilism, extreme optimism or inability to clearly determine the best candidate for themselves. There is also an interesting case when the winner of the voting task is a candidate rejected by the majority of voters. To analyze such cases, we should consider a fuzzy voting problem in which voters indicate both individual rankings and the degree of each candidate's affiliation to the fuzzy set characterizing the degree of the candidate's proximity to the victory.

The study focuses on a fuzzy voting problem. We suggest heuristics for preliminary processing of input data. At the first stages of solving the problem, the data allow weeding out the worst candidates for a specified number of voters and excluding the rankings of voters characterized by extreme nihilism or extreme optimism, etc. We have worked out rules for establishing the collective order in a fuzzy voting problem. The rules are similar to some of the rules in a clear case.

We have devised examples that demonstrate usefulness of the suggested heuristics and rules to solve voting problems.

Keywords: fuzzy voting problem, heuristics, collective order, subjective voters' characteristics.

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FUZZY CLASSIFICATION KNOWLEDGE BASE CONSTRUCTION BASED ON TREND RULES AND INVERSE INFERENCE (p. 25-32)

Hanna Rakytyanska

In this paper, an approach to fuzzy classification rules construction within the framework of fuzzy relation equations is proposed. At the same time, the system of fuzzy trend rules serves as a carrier of expert information and generator of rules – solutions of fuzzy relation equations. The system of fuzzy classification rules can be rearranged as a set of linguistic solutions of fuzzy relation equations using the composite system of fuzzy terms, e. g. "significant rise", "essential drop" etc., where causes and effects significance measures are described by fuzzy quantifiers. The problem of inverse logical

inference, which lies in restoring the coordinates of the maximum of the fuzzy input terms membership functions for each output class is reduced to solving the system of fuzzy relation equations using a genetic algorithm.

The proposed approach allows to avoid the alternative rule selection. The aim of the rule selection methods is to reduce the system complexity by removing inefficient and redundant rules and improve the system accuracy by introducing alternative rules into the final rule base. Using expert knowledge cannot guarantee the optimal cooperation activity among rules. The rule selection problem is still relevant since there is currently no single methodical standard for the optimal structural adjustment of fuzzy classification knowledge bases.

Solving fuzzy relation equations using the genetic algorithm ensures the optimal number of fuzzy rules for each output term and optimal form of the membership functions of the fuzzy input terms for each linguistic solution.

Consecutive solution of the optimization problems provides complexity reduction of the problem of fuzzy classification knowledge bases generation.

Keywords: fuzzy relations, inverse logical inference, solving systems of fuzzy logical equations.

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MATHEMATICAL MODELING OF BASIC PHYSICAL AND CHEMICAL PROCESSES IN THE PRODUCTION OF GLASS (p. 32-36)

Vitalii Tsapar, Oleksii Zhuchenko

The main stages of the glass manufacturing process in terms of mathematical modeling were considered. Based on the formulated assumptions, describing the glass manufacturing process physics, equations of continuity, momentum, energy, turbulent kinetic energy, turbulent kinetic energy dissipation in the form of Reynolds-averaged Navier-Stokes equations were described. Initial and boundary conditions needed to solve the mathematical modeling problem were determined. The bi-directional emissivity indicator on the translucent border between the flue gases and molten glass was defined from Fresnel formulas. Temperature distribution simulation was performed by the computational fluid dynamics (CFD) methods. Simulation of turbulent flows was carried out using the κ-ε turbulence model. Solution of the radiation energy transfer equation is based on the P1 approximation of the spherical harmonics method for gray two-temperature medium. As a result, the temperature distribution in the glass furnace was obtained. The temperature distribution is an important tool for investigating glass furnace control systems.

Keywords: mathematical model of glass furnace, Navier-Stokes equations, temperature fields.

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RELIABILITY MODEL DEVELOPING FOR PROTECTIVE FITTINGS TAKING INTO ACCOUNT LOAD-SHARING EFFECT (p. 37-44)

Serhiy Shcherbovskykh, Tetyana Stefanovych

The mathematical reliability model of protective fittings for the pressure vessel was developed in the paper. The model is intended for the quantitative analysis of the system failure causes. System reliability was formalized by a dynamic fault tree with the set logical conditions of load sharing. Reliability characteristics were calculated based on the split homogeneous Markov model. The split Markov model implies that the operating time of the protective fitting components is distributed according to the Weibull law. The scientific value of the model lies in the fact that it takes into account the load-sharing effect in the three-way tap, safety valves and overpressure valve on the system failure probability. The result of the simulation is a family of probabilistic curves, obtained for different values of load-sharing ratios. The dependence of the change in the main cause of the system failure on the change in these ratios was shown.

Keywords: protective fittings, reliability model, fault tree, Markov model, failure cause.

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ANALYSIS OF THE NEED TO IMPLEMENT DSTU ISO/IEC 80079-34 (p. 45-49)

Valentin Tikhenko, Konstantin Mezhenkov, Tetiana Antonenko

Taking into account the adaptation of Ukrainian technical regulations to European Directives, there is the need for timely implementation of harmonized international and European standards, participation of technical committees and specialized organizations in budget programs for standardization.

The paper considers the actual problem of the lack of the state standard for quality management system of explosion-proof equipment manufacturer. As a result of the study, the scope of international standard was presented, the main differences in ISO/IEC 80079-34 and DSTU ISO 9001:2009 were highlighted, the use of the standard as an evidence base in assessing conformity with the Technical regulation was justified.

The results have practical value and can be used for further adaptation of the Ukrainian technical regulation system to European requirements. The findings presented in the paper are of interest to government agencies, technical committees and organizations that deal with the above problem.

Keywords: standard, explosion-proof equipment, quality management system, conformity assessment, certificate.

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ANALYSIS OF ADMISSIBILITY OF CENTRAL TENDENCY MEASURES TO ESTIMATE AVIATION OPERATOR PROGRESS (p. 49-52)

Sergii Borsuk

Human role in ensuring flight safety in the system " flight crew – aircraft – medium – air traffic service unit" is considered. The pos-

sibility of the training process modeling using stochastic models is shown. The components of the stationary stochastic model of the aviation operator training process were determined. Eleven central tendency measures: arithmetic mean, geometric mean, harmonic mean, three previous measures using weight coefficients, median, mode, Tukey's test, trimmed mean, Winsorized mean and implementation of so-called "bottleneck planning" as potential indicators of aviation operator's permanent personal characteristics were examined.

For each of the potential indicators of permanent personal characteristics, their mathematical properties were analyzed and compared with the requirements arising from the application features. The necessity to synthesize a single parameter, which will be based on the requirements of the real process was substantiated.

Keywords: flight safety, aviation operators, training models, operator's permanent personal characteristics.

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ASYSTEM DESIGN OF THE INFORMATION MODEL OF PROJECT MANAGEMENT IN THEMANUFACTURING PROCESS (p. 53-56)

Viktoriia Zakharchenko, Viktor Nenia

For a purposeful management of designing technical engineering objects, we suggest that design should be considered as a manufacturing process. Its model is built according to a hierarchicalblock-principle and a "top-down" approach.

The data sets on the componentsof the design process are grouped in blocks according to the accepted division of the design process into stages, steps, design operations, and design procedures. Due to the diversity and collective performance of design operations, we suggest dividing them into industrial procedures as the smallest structural units of the industrial process and information description that are carried out by one performer. Respectively, industrial procedures description occupies the lowest level in the description of each design procedure. Industrial design procedures are singled out according to the obligatory requirement that only one specialist should make the finished product that is subject to evaluation and external control.

The suggested structurally homogeneous model provides an easy and reliable program implementation with the use of a relational data model due to the third normal form. The model comprises practically available properties of the industrial process and underlies design monitoring and managerial decisions making as to supervision of performers involved in the designprocess.

Keywords: automated design system, design process, industrial process, information model.

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DEVELOPMENT OF INTELLIGENT SYSTEM OF AUTOMATIC DIAGNOSTICS OF GAS-TURBINE ENGINE MODES (p. 57-64)

Nikolay Kravchuk

Efficiency of GTE in any field depends on the technical condition (TC) and operating economy. At present, one of the promising development areas of the maintenance and repair systems of GTE is the transition to the exploitation by the technical condition. The issue of increasing the efficiency of defining the current condition of the engine and forecasting trends in its vibration parameters that characterize this condition, e.i., diagnosing and predicting the future condition of the GTE plays an important role in solving this problem. Among the numerous methods of technical diagnostics of GTE, vibration diagnostics methods that are focused on using diagnostic information about oscillatory processes of machines and structures hold a special place. The basic problems of gas-turbine engine (GTE) diagnostics by the technical condition (TC) were described. The structural and functional description of intelligent system of automatic diagnostics and reconfiguration of control (ISADRC) over the GTE operating modes based on the integration of fuzzy logic and neural networks was proposed. The operating principle, training algorithm and software complex of the hybrid ISADRC were given. The feasibility of the hybrid ISADRC based on the radial-basis networks and fuzzy logic theory, integration of fuzzy logic and neural networks was substantiated. Theoretical and experimental capabilities of the developed ISADRC were investigated in order to assess its effectiveness for classifying the TC of the GTE and reconfiguring its operating modes.

Keywords: gas turbine engine, intelligent system, control reconfiguration, diagnostic system, technical condition.

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