CSIT'2019

CSIT'2019

Program of Workshop

Computer Science and Information Technologies

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Welcome

Dear Participants,

These programs contain abstracts selected for presentation at the 21st international seminar on Informatics and information technology (CSIT'2019). The previous 20 Workshops on Computer Science and Information Technologies (CSIT) were organized in Moscow (1999), Ufa (2000, 2001, 2003, 2005, 2007), Patras, Greece (2002), Budapest, Hungary (2004), Karlsruhe, Germany (2006), Antalya, Turkey (2008), Crete, Greece (2009), Moscow – Saint-Petersburg, Russia (2010), Garmisch – Partenkirchen, Germany (2011), Ufa – Hamburg – Norwegian Fjords (2012), Vienna – Budapest-Bratislava (2013), Sheffield, England (2014), Rome, Italy (2015), Czech Republic (2016), Germany, Baden-Baden (2017), Bulgaria, Varna (2018). The Workshop's aim is bringing together researchers from different areas, including Distributed Information Systems, Data&Knowledge Management, Computer Control, IT Applications. These areas are heavily related nowadays.

The Workshop attracted more than two hundred submitted technical papers from different countries including both conceptual and experience papers. Both types of submissions were evaluated similarly, in accordance with standards of international forums. The careful reviewing procedure by the program committee resulted in 56 papers being chosen for the presentation in the international track (Volume 1). The next sections - Information Systems; Information Technology; Artificial Intelligence Tools, IT Applications, Robotics; Digital Transformation; Mathematical Models, Algorithms and Simulation. Researches of young scientists - appear to be gaining attention. Some of the experience papers, especially at the industrial sessions, reflect the results in development/application of real systems, and were considered by the program committee to be of interest to a wider community.

The Program Committee would like to extend appreciation to all those who submitted the preliminary versions of the papers or extended abstracts for international peer reviewing.

Our thanks go to all the attendees of the Workshop here in Vienna that boosted the research activity in the Computer Science and Information Technologies areas.

Organising committee of CSIT'2019 is grateful to the Thilo Sauter (Technische Universitaet Wien, Vienna, Austria), mag. Andreas Zemann (TU Wien, International Office), dr. Komendantova Nadejda (IIASA), dr. Albert van Jaarsveld (Director General of IIASA), Acting Rector of Ufa State Aviation Technical University dr. Sergey V. Novikov, prof. representative of the Republic of Bashkortostan in

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Nafisa Yusupova

Scientific Program

Main workshop activity will take place in the new "Electrotechnishes Institut" building, Technische Universitaet Wien (TU EI). Address: Gusshausstr, 27-29.

Monday, 30 September	
16:00 – 17:00	Welcome Reception (hotel Asperner Loewe)
17:00 – 21:00	Vizit to Therme Wien
Tuesday, 01 October	
09:00	Bus from hotel Asperner Loewe to Laxenburg
10:00 – 13:00	Round table discussion (IIASA, Laxenburg)
13:00 – 14:00	Lunch (Laxenburg)
from 14:00	Excursion … (AIT? Seestadt?)
Wednesday, 02 October	
09:00	Departure from hotel (subway)
09:30-10:00	Registration (TU EI Kontaktraum, 6th floor)
10:00-10:30	Opening Ceremony of Workshop (TU EI Kontaktraum, 6th floor) Chairwomen Prof. N. I. Yusupova
	Prof. N. I. Yusupova (Ufa State Aviation Technical University, Ufa, Russia) — Welcome word
	Prof. T. Sauter (Technische Universitaet Wien, Vienna, Austria) — Welcome word
	Representative of the Republic of Bashkortostan in Austria Markus Scheiblhofer — Welcome word
	Dr. Sergey V. Novikov (Acting Rector of Ufa State Aviation Technical University) — Welcome word
	Prof. Andrei V. Melnikov (Ugra Research Institute of Information Technologies, Khanty-Mansiisk Autonomous Okrug, Russia) — Welcome word
10:30 – 11:30	1st Plenary session (TU EI Kontaktraum, 6th floor) Co-chairs: Prof. N. Yusupova
	Prof. Hannes Wertner
	Prof. Thilo Sauter
11:30 – 12:00	Coffee break (TU EI 6th floor)
12:00 – 14:00	2nd Plenary session (TU EI Kontaktraum, 6th floor)
	1-2 more professors from Austrian side
	Andrey V. Melnikov — Use of Topic Modelling for Improvement of Quality in the Task of Semantic Search of Educational Courses
	Valeria V. Gribova — Cloud Infrastructure for Creation of Interpretable Diagnostic Knowledge Bases of Diseases Regardless Their Etiology
	Tatiana I. Mikheeva — The Standard of Location and Visualization of Geo-Objects on Thematic Layers of the Geographic Information System
	Lyudmila V. Massel — Intelligent Decision Support for Assessing of the Energy Sector Impact on Geo-Ecology, Taking into Account the Quality of Life

14:00 – 15:00	Lunch (TU EI Mensa Buffet, grounfloor)	
15:00 – 17:00	Research session «IT Applications» (TU EI Kontaktraum, , 6th floor)	
	Vadim M. Kartak	Balancing Electricity Consumption and User Comfort in Load Management of Electric Tank Water Heaters
	Stefan Wilker	Towards an Evaluation Framework for Indoor Localization using Directional Antennas
	Nafisa I. Yusupova	Models and Methods for Solving Face Recognition Problem by Photos
	Nafisa I. Yusupova	Intellectual Decision Support in Complex Socio-Economic Systems
	Tatyana I. Mikheeva, Nikita A. Ostroglazov	Method of Construction of Routes of the Unmanned Aerial Vehicle on the Interactive Electronic Map
	Tatyana V. Sazonova	Cognitive Maps in the Development of the Multi-Dimensional System of Objects' Management for the Manufacturing of Products from Composites
17:00 – 17:30	Coffee Break (TU EI 6th floor)	
17:30 – 19:50	Research session «Digital Transformation» (TU EI Kontaktraum, 6th floor)	
	Alexander S. Geyda	Models and Methods to Estimate Digitalization Success Predictively
	Tatiana I. Mikheeva, Sergey V. Mikheev	Problem-Oriented Stratification of Transport Infrastructure Management
	Alexey Massel	Risk Assessment of Energy Security Threats based on Semantic Modeling
	Lyudmila E. Rodionova	Method of Designing a Software Analytical Complex based on a Cartesian Closed Category Using Virtual Objects
	Research session «Information Technology» (TU EI Kontaktraum, 6th floor)	
	Alex N. Kopaygorodsky	Technology of Application of Software Tools for Energy Technology Forecasting
	Anatoly P. Beltiukov	Identifying the Strength of Emotions in Relation with the Topic of Text Using Word Space
	Oksana Ya. Bezhaeva	The Method for Linear Regression Models Constructing Based on the Sharing of Measured Data and Expert Assessments
Thursday, 03 October		
10:00 – 11:30	Special session «Alumni» (TU EI Kontaktraum, 6th floor) Co-chairs:	
	Lada E. Gonchar	Implementation of Secure Software Development Lifecycle in a Large Software Development Organization
	Khazankin	
	Kulmukhametov	
11:30 – 12:00	Coffee break (TU EI 6th floor)	
12:00 – 14:00	Research session «Artificial Intelligence Tools» (TU EI Kontaktraum, 6th floor)	
	Irina P. Bolodurina	Comparative Analysis of the Convergence of the Population-Based Algorithm and the Gradient Algorithm for Optimizing the Neural Network Solution of the Optimal Control Problems
	Karina I. Shakhgeldyan	Artificial Intelligence Methods in Assessing the Severity and Differential Diagnosis of Bronchoobstructive Syndrome
	Marat R. Bogdanov, Irina N. Dumchikova	Processing of Biomedical Data with Machine Learning
	Olga I. Khristodulo	Methodical Fundamentals for Choosing the Location of Waste Treatment Enterprises based on the Indicators of the Territorial System Status
	Dmitrij V. Pesterev	Technology of Conversion From Dynamic Cognitive Maps to the Production Rules of the Expert System
	Vladimir R. Kuzmin	Typal Intelligent DSS for Making Strategic Decisions in the Energy Sector and Examples of Application based on Agent-Service Approach
14:00 – 15:00	Lunch (TU EI Mensa Buffet, grounfloor)	
15:00 – 17:00	Research session «Information systems» (TU EI Kontaktraum, 6th floor)	
	Boris E. Fedunov	On-Board Intellectual Tactical Level Systems: Composition, Purpose, Use in the Flights of the Passenger Aircrafts with

		Landing on Water
	Yuri I. Rogozov, Alexander N. Belikov	The Approach to Basic Abstraction Construction for the Architectural Schemes Design
	Anatoly P. Beltiukov	Constructive Ontologies
	Rashit V. Nasyrov	The Concept of Decision Support in Evaluating the Functional State of Complex System of the Biological Type
	Rashit V. Nasyrov	Construction of Mathematical Relationships and Software Implementation of a Simulation Model of the Behavior of Components of the Musculoskeletal System of a Person
	Alia S. Davlieva	Ensuring Functional Safety Hardware and Software Components as a Prerequisite for the Formation of a Digital Ecological Environment in Implementing Innovative Projects
17:00 – 17:30	Closing Ceremony, than walk to Siebensternbrau Chairwoman Prof. Yusupova N. I.	
18:30	Conference Dinner (Siebenstern Bräu, SIEBENSTERNGASSE 19)	
Friday, 04 October		
10:00 – 12:00	Round table discussion on Disrtibuted Ledger Technologies (ICT Besprechungsraum, TU EI 2nd floor)	

Abstract

Section «Artificial Intelligence Tools»

Section «Robotics»

Section «Digital Transformation»

Without Section

Section «Information Systems»

On-Board Intellectual Tactical Level Systems: Composition, Purpose, Use in the Flights of the Passenger Aircrafts with Landing on Water

Boris E. Fedunov, Federal Science Center. State Scientific Research Institute of Aviation Systems (GosNIIAS), Moscow, Russia

Abstract. The on-board intellectual systems of the tactical level (BIS-TU) promptly solve (in the course of the flight mission performance by the crew) the task of operational goal-setting and the task of constructing a method for achieving the operatively assigned current flight target. The examples of passenger aircraft flights show how the crew faces these tasks and what intellectual support of the crew can be provided such intelligent systems.

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The Standard of Location and Visualization of Geo-Objects on Thematic Layers of the Geographic Information System

Tatiana I. Mikheeva, Sergey V. Mikheev, Samara State Technical University, Samara, Russia
V.V. Elizarov, Samara University, Samara, Russia

Abstract. Currently, the standardization of the thematic layers of the intelligent transport geographic information system is considered to work in a market economy in accordance with the rules of work and the norms of international standardization. Standardization is regarded as an information management tool that provides visualization and location of geo-objects with access to a database. Today it is not enough to strictly follow the requirements of progressive standards - it is necessary to back up the issue of the standard and the provision of services with a safety or quality certificate. The standard of thematic layers in the geographic information system is necessary in terms of streamlining the exchange of data. Developed uniform requirements for the classification and coding of geo-objects on thematic layers and are dictated by the objectives of ensuring the comparability of cartographic information, the unification of forms of its presentation and processing. Conditions have been created for the organization and replenishment of the information database of geo-objects on thematic layers of the intellectual transport geographic information system "ITSGIS".

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The Approach to Basic Abstraction Construction for the Architectural Schemes Design

Yuri I. Rogozov, Alexander N. Belikov, O.V. Shevchenko, Institute of Computer Technologies and Information Security Southern Federal University, Taganrog, Russia

Abstract. According to statistical studies, a large number of IT projects end in failure. One of the reasons is the complexity of transferring the originally inherent meaning into the system. According to researchers, the cause of such current situation is the inconsistency of the image (meaning) of the target system, which arises due to misunderstanding between persons involved in the development at different life cycle stages. This problem arises due to the inconsistency of the forms used by persons to represent the image (meaning) of the system. Existing decisions on the development of the system image or meaning relate to the field of architectural (conceptual) design. Analysis of existing approaches to architectural design shows that the basis of the approaches is the notion of "final result", in the form of an artifact (ready-made forms). On the one hand, representation forms of systems are used, that contain meaning (knowledge forms), on the other, meaning is fixed in forms (meaning forms). However, when converting the meaning represented by a particular form into forms that contain meaning (functions), the meaning is most often distorted, and sometimes lost.

The main results presented in the paper are based on the proposed distinction between the concepts of knowledge and cognition as well as the forms of their presentation. Knowledge is currently represented as a form of action (function) or a form containing knowledge in itself. According to H. Maturana, "cognition as knowledge is action, but the form of knowledge is the result of cognition". Therefore, cognition is proposed to represent by structure, mechanism of action, which is the process of knowledge forms design (functions). To test the results, by analogy of the Zakhman model, it was proposed to present the structure of actions of artifacts creation in the form of a table. With this approach, the architecture model is at the same time the meaning of the represented form of the table and the process of specific forms designing of actions containing the meaning (functions, forms of systems). Based on the results obtained, an effectiveness assessment is made using the obtained model to eliminate the semantic gap in the systems design.

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Constructive Ontologies

Anatoly P. Beltiukov, Department of Computer Science, Udmurt State University, Izhevsk, Russia

Abstract. An approach to the description of subject areas is proposed to solve constructive tasks in the form of constructive ontologies at the abstraction level of Cartesian closed categories. Constructiveness of ontology makes it possible correct automatic or automated (man-machine) construction of problem solving. In theory the ontology is constructed in such a way that it decides by itself tasks.

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Providing Functional Safety of Hardware-Software Complexes as Mandatory Condition of Forming Digital Eco-Environment at Innovative Project Implementation

Vladimir E. Gvozdev, Daria. V. Blinova, Nikolay. I. Rovneyko, Alia. S. Davlieva, Department of Computer Science and Robotics, Ufa State Aviation Technical University, Ufa, Russia

Abstract. A key part digital eco-environment plays at the implementation of innovative projects brings about qualitative changes of requirements towards the functional safety of hardware-software complexes. The paper dwells upon the issues of increasing the functional safety of hardware-software complexes by means of reasonable resource allocation for locating and eliminating defects. The purpose of the research is the development of the information support of planning resources for defect elimination in software modules. The scientific idea is the development of the method of building linear regression dependencies on the basis of common use of expert assessments and measuring data. The approach novelty consists in the transformation of expert assessments and measuring data towards a single form of the random value distribution law.

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RESTful Web Services Development in Situation-Oriented Databases

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Abstract. New features RESTful web services development, envisaged in the situation-oriented databases (SODB), are considered. SODB is a heterogeneous data integrator driven by an

embedded hierarchical situational model (HSM), in which virtual documents are mapped onto heterogeneous physical data. Microservices and microservice architecture are discussed in terms of the benefits of scaling and modifying web applications. Elements of the situational model that define HTTP-request processing are considered in terms of access to request properties and attached data based on the concept of virtual documents. An HTTP-request processing design pattern developed to work with relational database tables for which data sources are external web services is discussed. The structure of the HSM-model, which performs selective processing depending on the type of request, is discussed in detail for HTTP-request methods GET and POST. An example of the practical implementation of microservices based on SODB for the problem of monitoring student views of educational videos on YouTube is given.

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Implementation of Secure Software Development Lifecycle in a Large Software Development Organization

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Abstract. Secure Software Development Lifecycle is an important part of developing secure software. On the one hand, such process requires a significant effort, on the other hand, generates a large amount of data on the process level (e.g. assets, dependencies, risks and mitigations) as well as on the technical level (e.g. results of static and dynamic code analysis tools). We demonstrate how to handle this effectively in the large software development organization.

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Section «Information Technology»

Use of Topic Modelling for Improvement of Quality in the Task of Semantic Search of Educational Courses

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Abstract. This paper proposes an approach, improving the quality of the original educational course programmes semantic search algorithm, based on vector representations, produced by distributional semantic. Proposed approach works by providing an expert with interpretable topic filtering of courses in search results. Application of probabilistic topic modeling based on additive regularization ensures the interpretability of vector components in representations of texts, allowing the expert, in the process of exploratory search, to narrow down the set of relevant documents found previously by using the vector model. In our experiments, we study the applied task of educational course search, using current requirements of the labor market (requirements described in professional standards serve as search queries). Implementation of topic filtering is based on the open source library BigARTM. We investigate the influence of hyperparameters and the choice of regularizers in construction of a topic model on the improvement of quality of educational course semantic search using various vector models: word2vec, fasttext, TF-IDF are investigated.

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Technology of Application of Software Tools for Energy Technology Forecasting

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Abstract.

References.

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Identifying the Strength of Emotions in Relation with the Topic of Text Using Word Space

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Abstract. Emotion analysis from text is a topic of growing interest over recent years. It is because of the growth and availability of internet. The emotion analysis from text and the strength of the emotions in text plays an important role in understanding and predicting the future events. In this paper, we are identifying the relationship between the strength of emotions and the topic of the text. In our methodology, we extend the concept of Word space that we proposed in our previous works for analyzing emotions. In Word space distances between the words and their occurrences are measures. The emotion carry words with relatively high frequency and less distance between their occurrences are strong emotions. Whereas less frequent emotions that occurs far from, each other are considered less intense emotions in the text. We also made a comparison between the changes in intensity of emotions on same topics over period. The paper is divided into different section. In the methodology and conclusion section, the results of our research mentioned in detail.

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The Method for Linear Regression Models Constructing Based on the Sharing of Measured Data and Expert Assessments

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Abstract. The paper discusses the classical approaches to the construction of regression models on the basis of independent and dependent random variables distribution laws. The analysis allows to conclude that the known methods for constructing of regression models focused on the processing of jointly observed measured data. The authors of the paper propose the method for constructing linear regression dependencies based on the sharing of measured data and expert assessments. Methodological basis for ensuring the comparability of measured data and expert analysis is to convert it to a form of random variables distribution laws.

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Validation of Origin-Destination Matrix by Open Data

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Abstract. Many global factors can influence the socio-economic situation in the country. One such factor is the transport systems of cities. It depends on the state of the transport infrastructure of the city: business development, investment, quality of life, employment growth. However, in larger cities observed the deterioration of the situation with the transport systematic in connection with the increasing number of cars and other factors. To solve these problems resort to modelling. The dynamic modelling allows to determine the characteristics of the future project (capacity, number of road lanes, traffic light cycle, etc.) without high capital investments. But the main difficulty in modelling is the validation that the constructed model is conforms with real transport situation. Authors propose the method of validation of origin-destination matrix by open data provided by Uber company.

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Flow-Based Upscaling for Voronoi Grid near a Hydraulic Fracture

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Abstract. An important task in reservoir simulation is to take into account the hydraulic fracture effect on well performances. A numerical near-well upscaling pro-cedure for finite conductivity hydraulic fractures is presented. Simulation results obtained by the upscaling procedure are shown to be significantly more accurate than the ones obtained by the classical EDFM method.

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The Principles of Forming of the Mathematical Model of Nanoelectronic Components of Quantum Computer Systems with Memresistance Branches

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Abstract. In article features of forming of mathematical models of components of quantum computer systems with introduction to structure of the electric multiterminal network of the branches containing a new element of a nanoelectronics - the memristor are considered.

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Risk Assessment of Energy Security Threats based on Semantic Modeling

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Abstract.

References.

Method of Designing a Software Analytical Complex based on a Cartesian Closed Category Using Virtual Objects

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Abstract. The article examines the problem of formalization and identification of information objects (real and virtual) and traceability of their relations in the studied subject area according to the rules of monomorphism and polymorphism of the mathematical theory of categories of sets. Based on these conditions, a formal model of interaction processes of the components of a software analytical complex with a Cartesian closed category and a set-theoretic method for mapping the functional interaction of software systems in accordance with the principles of ISO 15288 are developed. It is shown that the structure of such software analysis complex satisfies the conditions of Cartesian closed logic, which significantly increases the range of tasks. This is achieved by possibly conducting effective software reengineering without changing its base code in real time. A formalized description of the relationship between virtual and real objects in symbolic form according to the rules of the data warehouse is proposed. The method of constructing hierarchies by N. Chomsky and the method of semantic differentials by C. Osgood are applied. As an example, the structure of a distributed software analytical complex for managing the personnel reserve of an industrial enterprise, which is being developed jointly with educational institutions of higher education, has been modified.

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Section «Artificial Intelligence Tools»

Cloud Infrastructure for Creation of Interpretable Diagnostic Knowledge Bases of Diseases Regardless Their Etiology

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Abstract. The paper presents a cloud infrastructure for creation of interpretable diagnostic knowledge bases for intelligent decision support systems in medicine. An ontology of diagnosis allows us to form diseases regardless their etiology as a multivariate developing internal process. The article is useful for developers of medical diagnostics systems.

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Comparative Analysis of the Convergence of the Population-Based Algorithm and the Gradient Algorithm for Optimizing the Neural Network Solution of the Optimal Control Problems

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Abstract. In this paper, we consider the functional representation of the solution of the optimal control problem without restrictions using the neural network approach. Based on the necessary first-order optimality conditions, the original problem is reduced to a nonlinear optimization problem where the weights and displacements associated with all neurons are unknown. The minimization of the error function of the neural network solution is carried out by the gradient descent method, as well as by the population gravity search algorithm. Several examples demonstrating the effectiveness of the considered methods are considered. A comparative analysis of the convergence of the algorithms used is carried out.

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Artificial Intelligence Methods in Assessing the Severity and Differential Diagnosis of Bronchoobstructive Syndrome

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Abstract. Respiratory muscles strength is the main indicator of their functional state. The study of respiratory muscles strength is becoming increasingly prevalent in clinical pulmonology, especially in case of chronic obstructive pulmonary disease (COPD) and asthma. However, respiratory muscles strength is used neither for COPD stratification nor for differential diagnosis of COPD and asthma related to the broncho-obstructive syndrome. The aim of the study was to develop models that support medical decision making in broncho-obstructive syndrome diagnostics. Material and methods. 214 patients who were hospitalized with COPD exacerbation (115 people), severe uncontrolled asthma (56 people), and their combination (43 people). Respiratory muscles strength indicators (MEP, MIP and SNIP), 9 anthropometric parameters, spirometry and blood gas parameters, modified medical research council dyspnea scale, COPD assessment test data were recorded. Data processing was carried out by means of Mann-Whitney, Fisher and Tukey tests and correlation analysis. Respiratory muscles strength models were performed by linear and nonlinear regression methods. COPD stratification and differential diagnosis of COPD and asthma models were performed by artificial neural networks. Results. Respiratory muscles strength models of healthy individuals and COPD patients allowed to estimate the effects of various factors on the respiratory muscles functional status. Comparative analysis of COPD severity verification showed that models accuracy increased when we had added a respiratory muscles strength indicator. The most informative indicators were MIP, total body mass, partial pressure of carbon dioxide and fibrinogen. Moreover, MIP increased the accuracy of all the models. Conclusion. Practical application of artificial neural networks models in telemedicine projects allows developing information services to support real-time assessment of the patient's condition.

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Processing of Biomedical Data with Machine Learning

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Abstract. The paper is about processing of biomedical data. It were used 13 methods of machine learning (Naive Bayes classifier for multivariate Bernoulli models, A decision tree classifier, An extremely randomized tree classifier, Classifier implementing the k nearest neighbors vote, Linear Discriminant Analysis, Linear Support Vector Classification, Logistic Regression, 9 - Nearest centroid classifier, A random forest classifier, Classifier using Ridge regression, Ridge classifier with built in cross validation, Gaussian Mixture Models, Support Vector Machines) and one method of deep learning (Multiplayer Perception). A discrete wavelet transform was used to extract of biometric features. Haar wavelets, Daubechi wavelets, Symlets, Coiflets, Biorthogonal, Reverse biorthogonal, Discrete Meyer (FIR Approximation) were used. The influence of ECG recording time on the accuracy of biometric identification and diagnosis of cardiovascular diseases was studied. It was found that the best methods of classification are: Multiplayer Perception, An extremely randomized tree classifier, Classifier implementing the k nearest neighbors vote and Logistic Regression aka logit MaxEnt classifier. Wavelet family doesn't affect significantly on accuracy of recognition. With increasing registration time, accuracy increases .

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Methodical Fundamentals for Choosing the Location of Waste Treatment Enterprises based on the Indicators of the Territorial System Status

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Abstract. In recent years, effective environmental protection activities of the environment related to anthropogenic pollution, which has become widespread, influenced by increasing industrial production and population growth, have gained particular importance.

Waste can be viewed in two different ways: as a powerful trigger of pollution that can lead to an environmental catastrophe and as secondary raw materials for waste recycling enterprises and, as a result, the source of necessary resources for industry and the economy.

But at the same time, the established practice of waste management in Russia is characterized by an ever-increasing negative impact on the environment and human health and an inefficient use of material and energy resources. At the same time, the need to resolve the issues related to recycling has become more acute in recent years as a result of the deterioration in the quality of natural raw materials and the depletion of its number and the accumulation of volumes and types of waste.

This article outlines the main components of municipal solid waste management problems from the perspective of considering the waste management system as an open complex system with ambiguous goals. The system-forming factors of the formation of a geographically-distributed waste management system are emphasized. The method of selecting the location of industrial waste processing enterprises is proposed depends on various indicators of the state of the territorial system based on mathematical and geographic information modeling. An example of resolving the issues of zoning the territory of the Republic of Bashkortostan by a set of indicators characterizing the impact of waste on the environment and human health.

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Principles of the Knowledge Base Formation as a Part of Intellectual Decision Making Support System in Innovative Projects Management

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Abstract. According to methodology of decision making support in innovative projects management, developed on the previous stages of the research, a method of expert's knowledge formalization based on the decision making support ontology, was developed. The method allows to integrate the means of ontological analysis and knowledge representation in the knowledge base creation for decision making support in problem situations. Knowledge base is structured according to the set of classes selected by the results of ontological analysis. Knowledge, which logical system is ordered, is presented in the module of rules. Decomposition of the rule base is performed in accordance with the hierarchy of objects established as a result of modelling. Empirical knowledge for solving the problems of innovative projects management is presented in the form of cases for providing recommendations that can be adapted to a concrete problem situation.

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Technology of Conversion From Dynamic Cognitive Maps to the Production Rules of the Expert System

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Abstract.

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Typal Intelligent DSS for Making Strategic Decisions in the Energy Sector and Examples of Application based on Agent-Service Approach

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Abstract.

References.

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Section «IT Applications»

Information Support in Working-Out the Innovation Development Strategy at the Regional Level

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Abstract. The article deals with the development of strategies for the innovative development of Russian regions. The formalized description of the methodology for assessing the effectiveness of the regional innovation subsystems development is presented. The database structure has been developed for a system of information support for decision making in the construction of the region innovative development strategy.

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Balancing Electricity Consumption and User Comfort in Load Management of Electric Tank Water Heaters

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Abstract. Today electrical utility company programs engage residential consumers in transition towards the future sustainable power system. In particular in load management programs, electricity providers can reward their customers financially in return for the gained flexibility to reduce their loads at certain times on demand. By participating in such programs, householders may, on the other hand, fulfill their goals of money/energy savings and/or reduce their environmental footprints. Utility companies can account for and utilize consumer flexibility to modify their loads in the grid balancing processes, hence increase the reliability of the energy supply. Despite the above benefits of load management programs, there is a risk of a consumer comfort deterioration. In case the load reduction significantly changes the usual operation of household electrical devices, occupants might experience discomfort and finally sign out from the program. The question of whether or not to modify the energy consumption profile and how is highly challenging due to difficulties in estimating the impacts on comfort of occupants. Therefore, it is essential for consumers to have means for estimation of the potential impact of load reduction on their comfort before the load reduction.

We previously proposed an energy-comfort balancing model for electric tank water heaters (WHs) that can be used by residents upfront load reduction to estimate and fairly align their energy consumption for water heating to the desired level of thermal comfort. Unfortunately, that model provided solutions that were only nearly optimal. The model operated on a discrete temperature scale and thus suffered from rounding errors that accumulated with time.

This paper presents a new model for energy-comfort balancing of WHs. Unlike the old model, the proposed model works on the temperature scale represented by an infinite set of real numbers. Thus, the model lacks errors resulting from the temperature discretization. The simulation results show that the refined model allows for higher energy savings due to the reduced stand-by heat losses of the WH as compared to the old model.

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Cognitive Maps in the Development of the Multi-Dimensional System of Objects' Management for the Manufacturing of Products from Composites

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Abstract. The article discusses the problem of automation of technological processes for the manufacturing of products from polymer composite materials used in mechanical engineering. The methodology of cognitive maps modeling in the development of the multidimensional system of objects' management for the manufacturing of products from composites is considered.

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Towards an Evaluation Framework for Indoor Localization using Directional Antennas

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Abstract. Using Received Signal Strength(RSS) for indoor localization is presently an area of vibrant research activities, and the use of directional antennas seems to hold the promise of improving the performance as well as reduce the effect of disturbances during the localization process. In order to reduce the complexity of the endeavor using directional antennas, several approaches have been adopted so far, out of which, those involving "clustering" are perhaps the most prominent ones. In this paper, we propose an evaluation framework for such clustering algorithms, which can be used to tune the parameters for the clustering process, as well as compare the performance of different clustering algorithms. Using the said framework, we demonstrate the effect of selected clustering algorithms, as well as the hyperparameters within each algorithm, on the overall localization performance.

The localization procedure we have implemented has two phases- the offline phase and the online phase. In the offline phase, an RSS map is created by measuring the RSS at predetermined points, followed by classification of the RSS map into regions of different ranges of signal strength. Points at each of these regions are then clustered based on their spatial coordinates as well as RSS value, in order to reduce the search space. In the online phase, the target point is first assigned a class based on its RSS fingerprint. A position estimation algorithm runs on the reduced search space defined by the cluster centers of the required class. The evaluation framework is developed in order to make the overall process more efficient and increase position estimation accuracy. The hyperparameters of the clustering algorithms are tuned to improve the quality of the clustering algorithm using internal metrics, as well as to minimize the average position estimation error obtained from a random sampling of known target points, by optimizing external metrics. Comparison of the selected clustering algorithms being used during the procedure is another aspect of the evaluation framework. We improved the process of RSS based indoor localization using directional antennas and the observations obtained from the proposed evaluation model.

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Acknowledgments.

Models and Methods for Solving Face Recognition Problem by Photos

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Abstract. Automatic detection and detection technologies are widely used in different areas. This article contains an analysis of the face recognition problem, a description of the problem, the mathematical formulation of the problem, the results of analysis of the methods for solving it, a description of the proposed approach, the results of the experiment. The proposed approach to solving the problem in the form of a set of methods (histogram equalization; color image segmentation in RGB color space based on color saliency; measure distances between markers attached to facial landmarks; nearest neighbor algorithm), implemented at different steps gives a positive result. The results obtained in the course of experimental studies allow us to conclude that the developed software, which is based on the above methods, gives also positive result.

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Intellectual Decision Support in Complex Socio-Economic Systems

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Abstract.

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Risk Analysis System in Geriatrics

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Abstract.

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Section «Robotics»

Method of Construction of Routes of the Unmanned Aerial Vehicle on the Interactive Electronic Map

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Abstract. Unmanned aerial vehicles are increasingly used to perform complex transport processes and operations, such as monitoring transport processes, photogrammetry of transport infrastructure, inspection of geoobjects and tracking of mobile agents. The construction of rational routes in

solving the problems of management of the functioning of the transport infrastructure, taking into account various criteria, is a complex procedure that requires reducing the time, improving the trajectory. The use of heuristic algorithms, for example, the ant colony algorithm, which has high accuracy and speed of solving problems, is relevant. To perform complex technological processes and operations, unmanned aerial vehicles (UAVs) are increasingly used that can replace a human operator in dangerous living conditions. To implement these processes, it is necessary to control the flight. As a result, it is revealed that the advantage of the ant algorithm method is the possibility of finding a rational route, which is achieved by repeated repetition of the procedure of passing agents along the route.

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Energy-Efficient Path Planning: Designed Software Implementation

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Abstract. This article is a continuation of the developed method of the quasioptimal per energy efficiency design of the motion path for the anthropomorphic manipulator in a real time operation mode. The aim of the work is to implement the previously developed methods and algorithms for the quasi-optimal motion path for the anthropomorphic manipulator. The General structure and interrelation of the developed methods and algorithms are described, as well as their importance for obtaining the final result. The structure of software components of the system and the composition of each software component is given. The illustration of the developed software implementation is given.

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Quadrotor Angle Stabilization Using Full State Feedback by Partial Robust Pole Assignment Method: Pole Retention

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Abstract. Quadrotor also referred to as quadcopter has an increasing reputation nowadays as a practical rotorcraft and an unmanned aerial vehicle (UAV). The high number of degrees of freedom makes stability a serious issue as well as a performance criterion. Although, many different methods and strategies of control are applied to different models of quadrotors, an important issue that has not been covered widely is the robustness of the control and parametric uncertainty notions. Robust control seeks to design systems which work despite changing operating conditions, measurement errors and unknown affects. This paper presents a deep analysis of the robust pole assignment method for full state feedback-controlled quadrotor. A new numerical method for a multi-linear coefficient uncertain polynomial is introduced using quasi-gamma stability. Pole retention method is used as a robust pole assignment method for designing the feedback controller to guarantee the stability of the system for an interval of state feedback coefficients. The initial state response of the uncertain quadrotor system is shown to verify the system's performance.

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Development of an Encryption Method based on Cyclic Codes

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Abstract. This article (report) proposes a research on the de-velopment of an encryption method based on cy-clic codes. An example of the work of the program module developed on the basis of

the proposed method is given. The developed software encryp-tion module will solve the problem of protecting in-formation for small companies and private users, and also saves a large amount of resources, since one module solves the problem of ensuring the con-fidentiality and noise stability of transmitted mes-sages.

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Section «Digital Transformation»

Models and Methods to Estimate Digitalization Success Predictively

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Abstract. The article outlines models of the formation of digitalization effects on the example of modern information (digital) operations use in technological systems and methods to estimate indicators of digitalization success predictively. Such models and methods can be used, for example, to estimate the digitalization performance, efficiency, and effectiveness indicators based on predictive mathematical models of information technology usage. Such models could be used for the estimation of dynamic capability and indicators of system potential as a result of technological systems digitalization. The estimation of mentioned operational properties of digitalization is obtained by plotting the dependences of predicted values of operational properties of the use of information technology as a result of digitalization against the variables and options of the problems to be solved.

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Improving the Efficiency of MCVD Process by Taking into Account the Specifics of Applied Equipment and Prefabrications based on the Use of Classification Task and Machine Learning Methods

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Abstract. The article considers the task of choosing the optimal set of silica tubes for the operation of jacketing in the production of optical fiber, taking into account the available types of silica tubes, the features of the used equipment and the quality of products in previous cycles of production. The model which allows considering the previous experience at a performance of the operation of a jacketing during the industrial process based on the decision of a problem of classification results. The model takes into account the physical features of the process and uses the results of technological operations for further refinement and correction. For primary education, the models used already available statistical data. Practical application of the model allows getting many possible solutions to the problem of selection of jacket tubes, which helps to reduce scrap in the jacketing.

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Simulation Model of an Autoclave Operation Using iThink Software

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Abstract. This study focused on a simulation model of an autoclave operation and temperature control in the autoclave, which -depending on a number of input parameters- allows to simulate the operation process of an autoclave, analyze its operation dynamics hour by hour based on graphic data and simulate the mutual influence of control loops on each other.

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Problem-Oriented Stratification of Transport Infrastructure Management

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Abstract. The paper analyzes basic mathematical models on the basis of the fundamental laws of intellectual control. The models take into account of the sensitivity of the global systemic objective functional to the components of the set of states of the models in accordance with the systemic objectives definition principle. Decomposition of the underlying model is based on the information, methodological and functional principles of stratification. Based on stratification, the strata of the problem-oriented mathematical models are set up in the form of sets of private models and sequences of its mappings – morphisms. The morphisms meet the system quality criteria and are suitable for transport management. Stratified design based on patterned *P*-model, represented by the set of embedded spherical strata, mapping the strata of the domain space and relationship types

between the space strata. Taxonomy allows you to design new types of objects based on old ones, inheriting their properties and methods.

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Intelligent Decision Support for Assessing of the Energy Sector Impact on Geo-Ecology, Taking into Account the Quality of Life

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Abstract.

References.

Acknowledgments.

Without Section

The Concept of Decision Support in Evaluating the Functional State of Complex System of the Biological Type

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Abstract. The aim of the work is to develop a conceptual approach to decision support in assessing the functional state of a complex system of biological type. The definition of the functional state and the basic principles of its evaluation for complex systems of biological type on the basis of system representations are formulated. A situational model of the problem environment as a set-theoretic composition of the main components and evaluation functions was developed, which allowed to formulate the definition of the problem situation. The structure of the application of data mining to assess the functional state of a complex system using as feedback models of three levels - strategic, tactical and operational. A system of coordinated models for decision-making in assessing the functional state of a complex system based on causal representations in the form of Markov chains and Petri nets is proposed.

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Construction of Mathematical Relationships and Software Implementation of a Simulation Model of the Behavior of Components of the Musculoskeletal System of a Person

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Abstract. The article is devoted to the creation of a software tool for modeling the behavior of the components of the musculoskeletal system using the example of segments of the spine using the Orne-Liu formalism. A system of differential equations is written that describes the movement of the components of the spine in the sagittal plane (up-down, forward-backward, rotation).A tool has been obtained that allows one to study the evolution of the centers of three vertebrae interconnected when applying standard exposure. The data obtained during the calculations can then be applied to the already developed three-dimensional model of the thoracic spine. In the future, a similar mathematical model can be applied to the entire spine, since the initial data for the cervical, thoracic and lumbar spine are calculated and can be used.

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Big Data Analysis and Machine Learning in Loyalty Assessment Tasks

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Abstract.

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Issues of Improving the Accuracy of Demand and Sales Forecasting Using Decomposition of Components and Fuzzy Error Estimation

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Abstract. The efficiency of production and sales systems focused on public markets and the enlargement of variable parts of the orders depends on the accuracy of demand and forecasting and planning of production volumes. To tackle the problem of improving the forecasting accuracy of time series in this paper we have tested the hypothesis that the parameters associated with the flow of orders contain several components that can be described separately using existing approaches. Hence, the forecasting error can be represented as a set of fuzzy numbers. Hence, the forecasting error can be represented as a set of time series' fuzzy numbers. As a result of the hypothesis investigation, we obtained forecasting data in its fuzzy form, which already contains results of possible deviations and their probability. Moreover, this method of using fuzzy numbers may improve the accuracy of forecasting. The use of fuzzy forecasts allows us to solve planning and management problems in its fuzzy formulation and thereby to obtain results containing assessments of the range of possible deviations, risks and possible strategies of behaviour without additional research.

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Risk Analysis System in Geriatric Care

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Abstract. This paper describes the geriatric analysis system which accounts for group as well as individual risks of patients. A review of studies related to various aspects in geriatrics is provided. The purpose of the study, along with tasks to be solved, main modules and users of the geriatric risk analysis system are discussed.

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Information Security Risk Assessment Methodology and Software «Rubikon»

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Abstract. Risk assessment is an important part of the process of ensuring the required levels of information security of an organization. An urgent task is to develop a methodology for assessing information security risks, allowing not only to assess risks at the asset level, but also to trace their impact on the organization's activities. This article describes the methodology of information security risk assessment "Rubikon", including the algorithm of the acceptable risk assessment, fuzzy cognitive model and the algorithm of the current risks assessment. To determine the level of acceptable risk, we proposed to construct an acceptable risk curve. The developed model and the algorithm of the current risks assessment allow determining the set of values characterizing the current level of information security risks based on establishing of relationships between negative events, potential threats, protective measures, implemented attacks, information assets, sub-processes and main business processes of the organization. Results visualization is a set of points on the "damage-probability" coordinate plane. The conclusion about the acceptability of risks is made based on an analysis of the location of these points relative to the acceptable risk curve. In order to reduce the complexity of the risk assessment procedure using the «Rubikon» methodology manually, we developed a software. In addition, the article provides an example of risk assessment using this software and a comparison of the results with the proven method. This proves the adequacy and reliability of the proposed approach to information security risk assessment.

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The Simulation Model of the Asynchronous Transformation of Self-Similar Traffic in Switching Nodes using a Queue

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Abstract. The simulation model of the asynchronous trans-formation of self-similar packets flow in the switch-ing nodes has been developed. The producer-consumer pattern with a limited-sizes queue was used for the model; the asynchronous programming method was used to transform the self-similar traffic in the switching nodes. Unlike the well-known queu-ing models, the developed simulation model allow to take into account a limited amount of buffer memory when servicing a self-similar packets flow. The simulation model allows to investigate: the de-pendency between the size of the buffer and the network performance in terms of the quality of ser-vice; the amount of lost packets depending on the queue size; the effect of the queue size on the num-ber of processed packets; the dependence of the number of lost packets on time with different Hurst exponent values.

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Improved Method of Formation of an Increased Number of Binary Quasi-Orthogonal Code Sequence Systems with the Required Statistical and Correlation Characteristics

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Abstract. The article offers the use of a class of special signals for information security in telecommunication systems with code division of channels. By varying the parameters of the random number generator, the type of initial distribution laws and the law of transformation, it is possible to form an unlimited number of ensembles of pseudo-random sequences with specified properties. This approach is an improved method of forming an increased number of binary quasi-orthogonal systems of code sequences with the required statistical and correlation characteristics. The proposed method of formation of an increased number of binary quasi-orthogonal code sequence systems with the required statistical and correlation characteristics can be used to obtain expanding codes in satellite communication systems.

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Computer Modeling of Orthogonal in the Amplified Sense Signal

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Abstract. The article solved the problem of finding analytic dependency showing the influence coefficients of the second diagonal Hermitian matrix by correlation and spectral properties defined by it in the strong sense of orthogonal signals. The analytical dependences between the coefficients of the second diagonal of the Hermitian matrix and the correlation and spectral characteristics of ensembles of discrete orthogonal signals in the amplified sense are determined. The use of formulas allows for specific selection of ensembles orthogonal in the strong sense signals, which reduces the time of synthesis.

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Method for Reduction the Errors of Likelihood in the Authentication by the Iris

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Abstract. The article contains recommendations on reducing the probability of errors in authentication in iris access control systems. To obtain a high quality iris image at the stage of its registration, it is necessary to take into account the eye color of the user of the system. To solve this problem, it is recommended to use a biometric threshold authentication system with the functionality of visible and IR scan ranges.

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Efficient Algorithms for the Numerical Solution of the Coupled Sediment and Suspended Matter Transport Problems in Coastal Systems

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Abstract. This work is devoted to the development and numerical study of coupled models of sediment transport and suspended matter, taking into account coastal currents and stress near the bottom caused by wind waves, turbulent spatially 3D movement of the aquatic environment, the complex shape of the coastline, bottom topography, and other factors. Conservative stable difference schemes are constructed and investigated. A comparative analysis of the efficiencies of using explicit difference schemes with implicit schemes, as well as with schemes of a special form, explicitly implicit schemes, is given. The main idea is to use an additive difference scheme, consisting of a chain of spatially one-dimensional implicit and spatially two-dimensional explicit difference problems, approximating the original problem in the total sense. The explicit two-dimensional diffusion-convection-reaction problems, as well as the spatially two-dimensional sediment transport problems are approximated by regularized explicit schemes that involve the introduction of second-order difference derivatives with respect to the time variable with a relatively small time step - the regularizer as an additional term in the left-hand sides of the equations. This allows us to repeatedly increase the admissible time step in comparison with the unregularized explicit difference equations of the parabolic type. It is this method that has shown its advantage over explicit and implicit schemes.

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Use of Potentials in Linear Programming Models

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Abstract. The article describes a modified Kantorovich model based on the use of accumulated potentials. Accumulated and predicted potentials are described in detail in previous works by the authors. A real-life example illustrates the benefits of modeling using potentials. It is shown, in particular, that the use of accumulated potentials significantly reduces the uncertainty of the model. This broadens the horizons for using linear optimization models. This allowed us to formulate a modified linear optimization Kantorovich's model. The model is the basis of a well-known resource planning scheme. In order to be able to use this scheme, additional research was conducted. A model of the effectiveness of the resources based on accumulated potentials was formulated in particular. The formula for calculating the normative time of production operations was obtained also. In addition, a model for the formation of a production program based on accumulated potentials is described. Corresponding indicators and their dimensions are given.

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Pliability Identification of Elastic Support for Elastic Cantilevered Rod Based on Eigenfrequencies of its Oscillations

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Abstract. Currently, modern turbomachines, for example, aircraft gas turbine engines are equipped with highly intelligent automated monitoring and control systems, including a large number of sensors that control various parameters of the product being operated. In particular, there are sensors that monitor the oscillation frequencies of the most critical structural elements. This paper estimates the ability to determine the support stiffness of a cantilever rod under the two first eigenfrequencies of its oscillations. A similar problem arises in the non-destructive testing of the axial compressor blade root of a gas turbine engine when a certain decision of its further operation possibility or changing its operation mode is can be made on the basis of the blade oscillation eigenfrequencies spectrum. As a result of the implementation of the paper proposed method it was obtained that the identification error does not go beyond 28%, which is quite acceptable for assessing the technical condition of the support in the engine corresponding to the range of existing engines.

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Investigation of Nonlinear Multi-connected Systems of Automatic Control with Delay

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Abstract. The problem of controlling objects with time delay is quite complicated. The presence of a delay in the control loop leads to an increase in the phase shift, which can provoke instability of the system. The paper proposes a study of a nonlinear multi-connected system of automatic control (MSAC) of an object with a delay by frequency methods, based on the method of harmonic linearization and a system description of the characteristics of a multi-connected automatic control system. A nonlinear multi-connected automatic control system with delay in direct channels and cross-channels is considered. The nonlinear multi-connected automatic control system with delay consists of a set of identical separate subsystems and mutual connections between subsystems are single. With the help of frequency methods, the parameters of periodic motions (PM) in nonlinear homogeneous multi-connected automatic control systems with delay (amplitude and frequency of self-oscillations) are determined and their stability is estimated according to the proposed criteria. The paper presents examples that demonstrate the use of the proposed techniques to assess the stability of a nonlinear multi-connected system of automatic control of the object with delay both in direct communication channels and cross and finding the parameters (amplitude and frequency) of periodic movements. The results of the study were confirmed by simulation using MATLAB SIMULINK package.

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Analysis of the Correctness of the Model of Biomedical Experiment Based on the Transition Graph by Means of a Matrix Algebra

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Abstract. The article deals with the problems of formal description of methods of organization of biomedical experiment. The need for a formal description of the experimental scheme is postulated. One of the ways of formal representation of the biomedical experiment based on the transition graph, which is one of the variants of the description of the finite state machine, is considered. The description revealed that the main characteristics of this representation are the correctness and adequacy of the representation in the form of a graph of transitions. The problem of description of nested sequences of actions corresponding to the beginning and end of the use of different components of the experiment is considered. An example of such use is the serial and parallel activation of experimental equipment. In this case, the correct sequences correspond to the implemented experiments, and the wrong ones correspond to the unrealizable ones. In this regard,

there is a need to verify such feasibility. The necessity of checking the correctness of the graph as the main condition for the feasibility of the experiment is substantiated. One of the approaches to the analysis of the correctness of such a graph on the basis of matrix calculations is presented. The method of constructing the transition graph matrix is considered. The basic transformations necessary for checking the correctness of the transition graph of the biomedical experiment are given.

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Covering an Arbitrary Shaped Domain by Identical Circles

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Abstract. The problem of covering a bounded disconnected arbitrary shaped area (domain) by identical circles is considered. To describe analytically the coverage conditions we use special continuous and everywhere defined functions for modelling relations between circles and the border of the area. A new function for modelling the relations between three circles when covering the

interior part of the domain is defined. An integrated mathematical model of the coverage problem is provided in the form of a nonlinear programming problem. A new strategy for solving the problem is proposed. To demonstrate the efficiency of the developed algorithm an example of solving the problem for optimizing the length of the network connecting centers of the circles is presented.

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Fuzzy Controllers for Position Control Electro-Hydraulic Actuators

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Abstract. This paper describes fuzzy controllers of an electro-hydraulic actuator in the control loop. The aim of research is to reduce steady-state error and a time response as short as possible. The electro-hydraulic actuator mathematical model is design taking into account the functional jet pipe servo-valve. This model is used to numerically simulate the functioning of the system. The model uses mass flow ratios to provide a more stable and realistic numerical simulation. Dynamic modeling provides to study the behavior of a servo with various controllers in the control loop. Through simulation, the proportional controller and the types of fuzzy controllers are tested. The controllers are implemented in MATLAB/SIMULINK. The fuzzy controllers are an intelligent technique to reduce steady-state error and time response.

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Abstract.

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