INFORMATION TECHNOLOGIES

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DEVELOPMENT OF A SEMANTIC STRUCTURE FOR THE COMPOSITION OF COGNITIVE WEB SERVICES

pages 6–10

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The object of the research is the semantic structure for the composition of cognitive web services. The framework is designed to model, search, and orchestrate cognitive web services, including functionalities such as text recognition, language translation, and sentiment analysis, within dynamic environments. The problem addressed is the lack of efficient and scalable mechanisms for the automated discovery and composition of cognitive web services that can adapt to changing requirements and meet Quality of Service (QoS) constraints. Existing approaches often rely on static rules or keyword-based searches, which fail to provide adequate precision, adaptability, or scalability for complex service ecosystems.

The key result of the study is the development of a semantic framework that integrates ontology-based service modeling with logical inference using SWRL (Semantic Web Rule Language) rules. The framework supports dynamic service composition by leveraging semantic relationships between services, input/output data, and constraints such as execution time and accuracy. The results demonstrate higher semantic precision, better adaptability to changes, and improved QoS compliance compared to existing approaches. This is achieved through the use of a formalized ontology for precise service representation, SWRL rules for automated inference, and dynamic service composition based on semantic relationships, which improves query matching and reduces execution time.

The proposed framework can be practically applied in environments requiring adaptive service orchestration and composition, such as intelligent automation systems, cloud-based service ecosystems, and IoT (Internet of Things) applications. Its effectiveness is especially evident in scenarios involving complex multi-service workflows where traditional approaches are inefficient. The framework's extensibility ensures its applicability across various domains, with minimal customization required to incorporate new services or workflows.

Keywords: semantic framework, cognitive web services, service composition, ontology-based modeling, service orchestration.

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ADAPTIVE HYBRID NUMERICAL MODELING OF WAVE PROCESSES IN MULTILAYER STRUCTURES BASED ON TMM AND FEM METHODS

pages 11–19

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The object of research in this work is wave processes in multilayer thin films and methods of their numerical modeling using adaptive hybrid models. The research covers multilayer media with gradient distribution of physical parameters, including inhomogeneities.

The problem addressed in this study is the enhancement of the accuracy and efficiency of numerical modeling of wave processes in complex multilayered structures while reducing computational costs. Traditional methods, such as the transfer matrix method or the finite element method, have limitations related to computational complexity, numerical stability, and the ability to account for intricate geometric features.

The essence of the obtained results lies in the development and software implementation of an adaptive hybrid model that combines the transfer matrix method for wave propagation calculations in homogeneous regions and the finite element method for modeling complex geometries. The proposed approach optimizes computational resources by dynamically adjusting the grid resolution according to local variations in the refractive index. The use of adaptive discretization reduced the number of computational points by 40 % without compromising calculation accuracy. The relative error of the results obtained using the proposed model does not exceed 1 %, demonstrating its high precision.

The achieved results can be attributed to the implementation of efficient adaptive algorithms that automatically adjust the grid resolution based on the gradient of physical parameters, as well as the application of consistent boundary conditions between computational domains using different methods. This ensures a smooth transition between different modeling zones and minimizes numerical errors at domain boundaries.

The practical applications of these findings include optical technologies for the design and optimization of photonic devices, sensors, anti-reflective coatings, and nanostructured materials. The model can be utilized for the analysis of complex multilayered systems in nanotechnology, biomedical research, and the design of micro-optical elements. It is particularly useful in scenarios where it is

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necessary to account for structural inhomogeneities, complex geometries, and boundary conditions while maintaining minimal computational costs.

Keywords: numerical modeling, multilayered structures, wave processes, adaptive algorithms, hybrid approach, grid discretization.

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MODEL DEVELOPMENT OF DYNAMIC RECEPTIVE FIELD FOR REMOTE SENSING IMAGERIES

pages 20–25

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The object of research is the integration of a dynamic receptive field attention module (DReAM) into Swin Transformers to enhance scene localization and semantic segmentation for high-resolution remote sensing imagery. The study focuses on developing a model that dynamically adjusts its receptive field and integrates attention mechanisms to enhance multi-scale feature extraction in high-resolution remote sensing data.

Traditional approaches, particularly convolutional neural networks (CNNs), suffer from fixed receptive fields, which hinder their ability to capture both fine details and long-range dependencies in large-scale remote sensing images. This limitation reduces the effectiveness of conventional models in handling spatially complex and multi-scale objects, leading to inaccuracies in object segmentation and scene interpretation.

The DReAM-CAN model incorporates a dynamic receptive field scaling mechanism and a composite attention framework that combines CNN-based feature extraction with Swin Transformer self-attention. This approach enables the model to dynamically adjust its receptive field, efficiently process objects of various sizes, and better capture both local textures and global scene context. As a result, the model significantly improves segmentation accuracy and spatial adaptability in remote sensing imagery.

These results are explained by the model's ability to dynamically modify receptive fields based on scene complexity and object distribution. The self-attention mechanism further optimizes feature extraction by selectively enhancing relevant spatial dependencies, mitigating noise, and refining segmentation boundaries. The hybrid CNN-Transformer architecture ensures an optimal balance between computational efficiency and accuracy.

The DReAM-CAN model is particularly applicable in high-resolution satellite and aerial imagery analysis, making it useful for environmental monitoring, land-use classification, forestry assessment, precision agriculture, and disaster impact analysis. Its ability to adapt to different scales and spatial complexities makes it ideal for real-time and large-scale remote sensing tasks that require precise scene localization and segmentation.

Keywords: receptive fields, convolutional neural networks, Swin Transformers, remote sensing, scene localization, semantic segmentation.

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SYSTEMS AND CONTROL PROCESSES

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DEVELOPMENT OF METHODS OF ARTILLERY CONTROL FOR SUPPRESSION OF AN ENEMY AMPHIBIOUS OPERATION IN VIDEO GAME SIMULATIONS

pages 26–33

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The paper describes the tactical methods of using artillery guns for counter-amphibious in deep and shallow water landscapes. The study's object is to model military game scenarios, in particular, the role of artillery forces in countering an amphibious operation of one or two divisions. One of the most problematic areas is combining continuous fire support and maneuvering to maintain artillery survivability and save ammunition with limited resources.

The study used mathematical models of combat resource utilization based on Markov chains, taking into account the probabilistic aspects of target destruction. Simulation models were also developed for various scenarios of countering amphibious assault ships, which allows for optimizing the number of shells and determining the most effective moments for opening fire.

Several approaches to firing have been developed and analyzed: methods of minimizing the number of shells, rapid neutralization of enemy targets, and mixed methods that allow finding a balance between minimizing resources and speed of response. Each method has its advantages depending on the combat situation: cost minimization methods are suitable for controlled scenarios. Instead, methods of rapid destruction are effective in high-risk situations but require more resources. A new mixed tactical method has been developed. This is because the proposed methods have several features, in particular, a large discrepancy in the predicted minefield, which also made it possible to assess the ability to hold the minefield of the fairway, which is important for protection against further attacks. This ensures the possibility of obtaining a high level of minefields on the fairway (up to 67.77 %). Compared to similar indicators, which ranged from 46.42 % to 67.77 %, but without specifying the method, this provided advantages in the form of the possibility of tactical maneuvering between the proposed methods, depending on the current state of resources and the proximity of enemy targets.

Keywords: simulation modelling, Markov chains, game simulation, automated control in games, military simulation in video games.

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DEVELOPMENT OF INNOVATION PROJECTS BASED ON THE SYNERGY TRIZ PRINCIPLE AND AI TECHNOLOGY

pages 34–42

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The object of the research is a novel development methodology for innovation projects that leverages the power of the synergy principle of the Theory of Inventive Problem Solving (TRIZ). It integrates artificial intelligence (AI) technology.

The problem addressed in this research is the inefficiency and limitations of traditional methods for development innovation projects, which often fail to comprehensively evaluate their potential, risks, and alignment with future technological trends.

The research results in the synergistic application of TRIZ principles and AI technology for conducting comprehensive audits of innovation projects. By integrating the structured problem-solving framework of TRIZ with the analytical power of AI, a novel approach is proposed to enhance the evaluation and optimization of innovation initiatives. The paper explores how artificial intelligence algorithms can be used to analyze project data and identify potential obstacles and opportunities based on the principles of TEDx. As well as to create alternative solutions and predict possible outcomes, help identify synergies between different project elements and external factors. And to constantly monitor and adapt the innovation process based on real-time data and AI-driven insights.

The difference in the research is the integration of TRIZ principles into auditing innovative projects using AI systems. The presented case showed the effectiveness of the proposed conceptual, mathematical and process models of auditing innovative projects. The master's program in artificial intelligence implemented at the Kyiv National University of Construction and Architecture (Ukraine) was chosen as an example for the case study. The study demonstrates the potential of this audit-integrated approach to improve the success rate of innovation projects by providing more accurate assessments, identifying hidden opportunities, and facilitating proactive decision-making. This research contributes to more effective and successful innovation projects by providing a data-driven and intelligent approach to project development and improvement. Within the framework of the considered case, an assessment of the acceleration of analysis and decision-making processes was carried out using the example of the innovative development program for training masters in artificial intelligence. It was found that the analysis and decision-making processes are implemented 2.68 times faster without loss of decision quality.

Keywords: innovation project development, TRIZ, artificial intelligence, project management, predictive analytics, decision making.

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EVALUATION OF THE PERFORMANCE OF DATA CLASSIFICATION MODELS FOR AERIAL IMAGERY UNDER RESOURCE CONSTRAINTS

pages 43–48

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The object of the study is the process of aerial imagery data processing under limited computational resources, particularly onboard unmanned aerial vehicles (UAVs) using classification models.

One of the most challenging issues is the adaptation of classification models to scale variations and perspective distortions that occur during UAV maneuvers. Additionally, the high computational complexity of traditional methods, such as sliding window approaches, significantly limits their applicability on resource-constrained devices.

The study utilized state-of-the-art neural network classifiers, including ResNet50v2, DenseNet121, and MobileNetV2, which were fine-tuned on a specialized aerial imagery dataset**.**

An experimental evaluation of the proposed neural network classifiers was conducted on Raspberry Pi 4 Model B and OrangePi 5 Pro platforms with limited computational power, simulating the constrained resources of UAV systems. To optimize performance, a stripe-based processing approach was proposed for streaming video, ensuring a balance between processing speed and the amount of analyzed data for surveillance applications. Specific execution time evaluations were obtained for different types of classifiers running on single-board computers suitable for UAV deployment.

This approach enables real-time aerial imagery processing, significantly enhancing UAV system autonomy. Compared to traditional methods, the proposed solutions offer advantages such as reduced power consumption, accelerated computations, and improved classification accuracy. These results demonstrate high potential for implementation in various fields, including military operations, reconnaissance, search-and-rescue missions, and agricultural technology applications.

Keywords: neural networks, machine learning, image processing, classification, convolutional neural networks, unmanned aerial vehicles.

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CORRELATION AND REGRESSION ANALYSIS IN ASSESSING THE RELATIONSHIP BETWEEN WATER INDICATORS: A BRIEF DESCRIPTION OF LONG-TERM MEASUREMENT DATA FROM BIOSENSORS

pages 49–53

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The object of the study is the method for assessing the relationship between the results of long-term observations of water parameters obtained by the method of combined measurements by a biosensor system. The biosensor system is designed for the combined measurement of five water parameters based on physical value sensors. In the paper, the problem under consideration quite fully levels out a significant limitation of the known solutions designed for the simultaneous measurement of three or four water parameters. Existing approaches in their structure combine less than five biosensors-sensors, which significantly limits the simultaneous measurement of five water parameters.

One of the main and principal results of the paper is the development of a statistical model for assessing the relationship between the combined measurements of five water parameters. It was revealed that among the five measured parameters, the most influential predictor for acidity, conductivity, turbidity and oxidation-reduction potential is water temperature. The established significant and non-random relationship between the parameters is mainly associated with the effect of temperature on the physical processes occurring with an increase and decrease in water temperature depending on the observation time. These estimates demonstrate a higher, statistically significant relationship between the measurement information data. This is achieved by implementing the method of aggregate measurement of water parameters: temperature, acidity, turbidity, conductivity, oxidation-reduction potential.

The efficiency of the statistical model is confirmed by calculating the correlation coefficient based on the Pearson method and the coefficients of determination and reliability of the model. The regression model can be used in practice in developing new or improving known measuring systems and control devices to increase the reliability and effectiveness of water quality control.

Keywords: water indicator, measurement system, multi-sensors system, correlation analysis, testing, internet of things, biosensors.

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INTEGRATION AND COORDINATION OF ELECTRONIC WARFARE ASSETS THROUGH LARGE-SCALE LANGUAGE MODELS

pages 54–61

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As an object of research, the work considers the process of functioning of electronic warfare (EW) means using artificial intelligence (AI) technologies

based on large language models (LLM). One of the most problematic issues in increasing the efficiency of their functioning is ensuring the adaptability function in EW means, as well as timely detection of threats and formation of appropriate countermeasures. This problem is solved by implementing a multi-agent architecture, the task of which is to ensure continuous exchange of information, both between agents in the EW means themselves and in the system as a whole.

The considered method of increasing the adaptability of the system due to LLM with self-learning mechanisms provides the system with the opportunity to improve its data processing algorithms, promptly detect new types of signals and respond to changes in the parameters of the enemy's REM. Using the Retrieval-Augmented Generation (RAG) approach allows to detect and enter new types of signals into the database and quickly form appropriate recommendations for countermeasures.

An equally important component is the use of combining several EW tools into a single information network. This approach will ensure the consistency of the actions of all EW tools (agents) and the rapid exchange of information between them.

Taking into account the above, there is a possibility of significantly increasing the adaptability and efficiency of EW systems by integrating multi-agent structures using LLM, which allow optimizing resource allocation and making decisions in real time. This will ensure a high level of adaptation of EW tools, which is an important feature for working in conditions of dynamically changing electromagnetic environments.

Thanks to the proposed architecture and the use of appropriate algorithms, it is possible to obtain high indicators of classification accuracy and signal processing speed, which positively affects the adaptability of the system and the overall effectiveness of countering threats.

Keywords: electronic warfare, large language models, artificial intelligence, multi-agent structures, knowledge base, executive modules.

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DEVELOPMENT OF A DECISION SUPPORT SYSTEM USING ADVANCED MULTI-CRITERIA DECISION-MAKING TECHNIQUES

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The object of research is decision-making processes in conditions of uncertainty, with an emphasis on improving the accuracy and reliability of multi-criteria decision-making methods. The problem to be solved is the difficulty of making reliable and optimal decisions in dynamic environments where data variability, incomplete information, and subjective judgments pose significant challenges. Traditional methods often fail to adequately address these complexities, leading to suboptimal or unreliable outcomes.

The essence of the results lies in the creation of a DSS (Decision Support System) that leverages Z-number TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) to combine performance metrics with confidence levels, providing a more comprehensive framework for decision-making. The system is uniquely suited to prioritize alternatives effectively, even when faced with high levels of uncertainty and variability in input data. Due to its features and characteristics, the DSS allows for greater adaptability and precision in decision-making, ensuring results that are not only accurate but also reliable. The explanation for these results lies in Z-number TOPSIS's ability to integrate quantitative analysis with the evaluation of data reliability, making it far more effective than traditional MCDM (Multi Criteria Decision Making) techniques. A systematic comparison with other methods, such as traditional TOPSIS and Fuzzy TOPSIS, demonstrates that Z-number TOPSIS consistently outperforms these approaches, particularly in scenarios involving dynamic and uncertain conditions. The study contributes to the advancement of decision-making methodologies by providing insights into how uncertainty can be systematically incorporated into ranking models. A comparative analysis with traditional TOPSIS and Fuzzy TOPSIS shows that Z-number TOPSIS outperforms these methods, providing a 10 % improvement in consistency under noisy data conditions and a 15 % better adaptability under conflicting criteria scenarios.

The results are applicable in fields such as supply chain management, where decision-makers must optimize inventory distribution and supplier selection under fluctuating demand, healthcare, where prioritization of patient treatment is required under resource constraints, and financial risk assessment, where investment decisions depend on uncertain economic conditions. The findings highlight the potential of Z-number TOPSIS in supporting more reliable and adaptable decision-making processes in complex and uncertain environments.

Keywords: TOPSIS, fuzzy TOPSIS, Z-number TOPSIS, decision-making methods, DSS.

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