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RESEARCH ON MOBILE MACHINE LEARNING PLATFORMS FOR HUMAN GESTURE RECOGNITION IN HUMAN-MACHINE INTERACTION SYSTEMS

pages 6–14

Olesia Barkovska, *PhD, Associate Professor, Department of Electronic Computers, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, e-mail: olesia.barkovska@nure.ua, ORCID: https://orcid.org/0000-0001-7496-4353*

Igor Ruban, *Doctor of Technical Sciences, First Vice-Rector, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-4738-3286*

Daria Tymoshenko, *Assistant, Department of Electronic Computers, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0001-5514-7075*

Oleksandr Holovchenko, *Department of Electronic Computers, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0009-0002-7582-1746*

Oleksandr Yankovskyi, *PhD, Associate Professor, Department of Electronic Computers, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-1268-0029*

The subject of this research is mobile machine learning platforms for human gesture recognition within human-machine interaction systems, specifically for managing smart home components.

One of the key challenges in gesture recognition is ensuring high accuracy, efficiency, and robustness of algorithms under real-world operating conditions. The problem lies in selecting optimal machine learning platforms capable of balancing local and cloud computing, processing speed, and adaptability to changing environmental conditions.

The study presents a comparative analysis of the ML platforms Create ML (Apple) and Google Cloud AI Platform, which are used for gesture detection and recognition in smart home control systems. The obtained results demonstrate that Create ML achieves an accuracy of 95.81 %, while Google Cloud AI Platform reaches 89.43 %, justifying their selection for further research. Additionally, experimental testing of sensor placement topology revealed that diagonal camera positioning increases accuracy by 0.62 % compared to parallel placement.

The increased efficiency of Create ML is due to its ability to process data locally, reducing latency and dependence on an internet connection. In contrast, Google Cloud AI Platform relies on cloud resources, enabling the processing of large volumes of data but making it dependent on data transmission speed.

The proposed gesture control algorithms can be used to enhance the accessibility of technology for people with disabilities, particularly in rehabilitation centers. Additionally, the research findings can be applied to contactless interfaces in medical facilities and public spaces, reducing the need for physical interaction with surfaces and improving hygiene levels. The use of mobile ML platforms in such scenarios allows for the optimization of computational resources and ensures the effective integration of gesture control into modern human-machine systems.

Keywords: human-machine interaction, HMI, Create ML, Google Cloud AI Platform, image processing, contactless control, ML platforms.

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DEVELOPMENT OF A STANDARDIZED APPROACH FOR EVALUATING BUSINESS INSIGHTS IN STREAM PROCESSING SYSTEMS BASED ON TECHNICAL METRICS

pages 15–20

Artem Bashtovyi, *PhD Student, Assistant, Department of Software, Lviv Polytechnic National University, Lviv, Ukraine, e-mail: artem.v.bashtovyi@lpnu.ua, ORCID: https://orcid.org/0000-0003-4304-8605*

Andrii Fechan, *Doctor of Technical Sciences, Professor, Department of Software, Lviv Polytechnic National University, Lviv, Ukraine, ORCID: https://orcid.org/0000-0001-9970-5497*

The object of research is the benchmarking process of stream processing frameworks, specifically evaluating the impact of Service Level Objectives (SLOs) in real-time data processing systems.

One of the most problematic aspects is the lack of standardization in SLO definitions, which leads to inconsistencies between technical performance indicators (latency, throughput) and business objectives. Additionally, existing benchmarking methodologies primarily assess technical metrics without considering their business relevance.

In the course of the study, experimental methods were used to analyze the relationship between latency and throughput under varying load conditions. A series of experiments were conducted with a Kafka Streams-based stream processing setup, modifying workload parameters and resource constraints.

The results obtained demonstrate the nonlinear relationship between latency and throughput. Increasing event rates can either enhance or degrade performance depending on resource constraints and Kafka Streams' commit interval settings. The findings demonstrate that under stable conditions, latency decreases from 21 s to 6.2 s while throughput increases from 0.6 ops/sec to 72 ops/sec. When computational bottlenecks are introduced, latency spikes to 349 s and throughput drops to 32 ops/sec, highlighting performance degradation. Conversely, distributed processing reduces latency to 11 s and increases throughput to 169.9 ops/sec. While higher loads generally improve throughput, excessive processing delays can unexpectedly reduce it due to resource contention.

These insights provide a foundation for dynamic SLO adjustments to optimize real-time data processing efficiency. The presented approach helps to avoid generalized and inefficient methods for measuring the performance of stream processing frameworks.

Keywords: benchmarking, distributed systems, performance measurement, SLO (service level objectives), real-time processing.

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DEVELOPMENT OF A NEURAL NETWORK MODEL FOR AN AUTOMATED HVAC SYSTEM BASED ON COLLECTED DATA

pages 21–26

Illia Velychko, *Department of Automation and Computer Technologies of Control Systems named after Prof. A. P. Ladanyuk, National University of Food Technologies, Kyiv, Ukraine, e-mail: velychkoiv@nuft.edu.ua, ORCID: https://orcid.org/0009-0001-8826-4419*

Viktor Sidletskyi, *PhD, Associate Professor, Department of Automation and Computer Technologies of Control Systems named after Prof. A. P. Ladanyuk, National University of Food Technologies, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0003-2606-3651*

The object of research is ventilation and air conditioning systems, which act as the object of data collection for the development of a neural network model based on them. The main attention is paid to the choice of algorithm, data collection for training a neural network model based on the MATLAB software package, to simplify the model development process.

The main problem that was considered in the study is the complexity of building mathematical models for ventilation and air conditioning systems. Traditional approaches require significant computing resources and in-depth analysis of physical processes, which complicates their development and practical use.

The research results show one of the approaches to creating a model of ventilation and air conditioning systems using neural networks. The proposed approach provides fast training of the model based on real data, which in further studies will allow adapting the system to changing operating conditions and increasing its efficiency.

The obtained results are explained by the fact that, unlike classical mathematical models that require precise formulation of all dependencies and parameters. Neural networks are able to approximate complex nonlinear functions without the need for a complete understanding of physical processes.

The proposed approach can be used for ventilation and air conditioning systems provided that there is a sufficient amount of data for training the neural network. Also important is the integration of such a system with controllers and SCADA systems that provide operational collection of parameters from the environment. The use of neural network models is especially effective in smart buildings, industrial facilities and energy-saving systems, where it is important to optimize energy consumption and provide comfortable conditions for users. In addition, such models can be implemented in cloud platforms for centralized management of climatic parameters in various buildings or production complexes.

Keywords: microclimate control, HVAC automation, machine learning, energy efficiency, neural networks.

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DEVELOPMENT OF A MODEL FOR COLORING RASTER ELEMENTS OF POLYNOMIAL TRANSFORMATION OF DIGITAL IMAGES

pages 27–31

Bohdan Kavyn, *PhD Student, Department of Computer Technologies in Publishing and Printing Processes, Lviv Polytechnic National University, Lviv, Ukraine, e-mail: b.kavyn2000@gmail.com, ORCID: https://orcid.org/0009-0004-6553-1061*

The object of the study is the process of pre-printing image preparation, in particular the final stage of preparing an image for printing – rasterization using polynomial transformation.

One of the problems in the process of preparing an image for printing is the lack of a program in computer graphics programs and a raster processor for constructing gradation characteristics and rasterization characteristics.

This work used scientific research methods, in particular the method of mathematical modeling, object-oriented programming and the MATLAB:Simulink software package. In the process of the study, rasterization models of polynomial transformation of digital images were built and simulators for simulation modeling were developed.

Gradation characteristics, rasterization characteristics and optical density of the raster elements were obtained, which quantitatively and qualitatively describes the raster tone reproduction of printed images. The developed model of coloring for determining the amount of paint on the surface of raster elements of polynomial transformation of images of light tones allows to correct the image based on the analysis of the properties of gradation characteristics, characteristics of screening and optical density in a wide range of tone reproduction.

Thanks to the proposed model, the informativeness of the analysis of tone reproduction is significantly expanded. This is a significant advantage over the model based on power transformation, which has limitations in terms of the reproduction of dark tones and causes the phenomenon of posterization.

Based on the obtained results of coloring raster elements of typical variants of polynomial transformation for a polynomial thickness value $H=1$ µm it was established that an increase in the thickness of the paint layer by 20 % of the nominal shifts the initial values of coloring. In particular: at $V=1.2$ the characteristics shift towards dark tones – the image darkens, and at $V=0.8$ the characteristics of coloring shift towards midtones – the image becomes lighter.

The results of the conducted studies of raster tones can be applied at the stage of preparing digital images for rasterization in computer publishing systems.

Keywords: polynomial transformation, coloring raster elements, simulator, gradation characteristics, coloring characteristics, optical density.

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DEVELOPMENT OF A MODEL OF POWER-LINEAR CONVERSION OF DIGITAL IMAGES FOR DARK TONES

pages 32–36

Sviatoslav Kavyn, *PhD Student, Department of Computer Technologies in Publishing and Printing Processes, Lviv Polytechnic National University, Lviv, Ukraine, e-mail: kavinsviatoslav@gmail.com, ORCID: https://orcid.org/0000-0002-6189-3848*

The object of research is the technological process of digital image processing using power transformation in pre-printing processes.

A significant problem in preparing an image for printing is the phenomenon of posterization, which distorts the image and limits the possibilities of power transformation for correcting dark areas of the image. This is a disadvantage of power transformation, which is that at power indicators ($r<0.45$) and ($r>1.5$) power transformation is too sensitive to changes in black levels.

The mathematical model of power-linear transformation of images for dark tones has been improved, which, unlike the known ones, involves the summation of power and linear transformation and includes a simulator of power-linear transformation of images. Taking into account the improved model, gradation characteristics, optical density dependences and contrast sensitivity were obtained, which quantitatively assess the perception of images by the human visual system.

The validity of the improved model was verified by mathematical modeling using object-oriented programming and the MATLAB:Simulink software package.

The results of mathematical modeling indicate that the development of the mathematical model allowed to further expand the possibilities of image correction. This is due to the fact that the length of the discrete gradation

characteristics is 3–4 levels, which are not noticed by the human visual system (posterization is eliminated).

The proposed model has significant advantages over image conversion methods used in printing. In particular, it expands the range of visual perception of images, eliminates the phenomenon of posterization, provides the ability to change (stretch and compress) contrast within wide limits. At the same time, it expands the functionality of power-law image conversion, and accordingly provides an increase in image quality when preparing it for printing.

The results of the conducted research are recommended to be used at the stage of preparing images for printing and in workflows by operators and technologists.

Keywords: power-linear transformation, simulator, gradation characteristics, optical density, contrast sensitivity, posterization.

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SYSTEMS AND CONTROL PROCESSES

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RISK ANALYSIS AND CYBERSECURITY ENHANCEMENT OF DIGITAL TWINS IN DAIRY PRODUCTION

pages 37–49

Tetiana Savchenko, *PhD, Associate Professor, Department of Informatics, National University of Kyiv-Mohyla Academy, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0002-8884-5360*

Nataliia Lutska, *Doctor of Technical Sciences, Professor, Department of Automation and Computer Technologies of Control Systems named after Prof. A. P. Ladanyuk, National University of Food Technology, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0001-8593-0431*

Lidiia Vlasenko, *PhD, Associate Professor, Department of Informatics, National University of Kyiv-Mohyla Academy, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0002-2003-6313*

Mariana Sashnova, *PhD, Associate Professor, Department of Software Engineering and Cybersecurity, State University of Trade and Economics, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0002-3501-0933*

Andrii Zahorulko, *PhD, Associate Professor, Department of Equipment and Engineering of Processing and Food Production, State Biotechnological University, Kharkiv, Ukraine, e-mail: zagorulko.andrey.nikolaevich@gmail.com, ORCID: https://orcid.org/0000-0001-7768-6571*

Sofiia Minenko, *PhD, Senior Lecturer, Department of Management, Business and Administration, State Biotechnological University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0003-3033-1911*

Eldar Ibaiev, *PhD Student, Department of Equipment and Engineering of Processing and Food Production, State Biotechnological University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0003-3090-3553*

Nataliia Tytarenko, *Department of Equipment and Engineering of Processing and Food Production, State Biotechnological University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-9745-883X*

The object of research is technological and technical processes that affect the effectiveness of developing a system with Digital Twins and ensuring cyber security using the example of the dairy industry.

The work is aimed at solving the problems in the sector of a comprehensive system for monitoring production processes with the possibility of early detection of deviations and potential threats. This, in turn, can lead to a decrease in product quality and an increase in cyber security risks.

During the implementation of the research, a Digital Twins of the main technological areas was developed using the example of a dairy enterprise, namely: receiving, apparatus and dietary departments. This approach provides for the collection and analysis of data on production parameters (pasteurization temperature, level in tanks, etc.), and also integrates the results of laboratory control. It was found that technological risks have the greatest impact on the effectiveness of the functioning of production processes, and security risks directly account for 35 % of the total threat structure. This is partly due to one of the main problems in the sector of insufficient data protection and possible external interference, including during cyber attacks. In addition, the analysis identified three risk groups (a total of 13 factors), which further allowed to determine their impact on the efficiency of production as a whole. This, in turn, allowed to draw a preliminary conclusion that the use of cybersecurity risk management strategies reduces the likelihood of technical failures and information threats at an industrial enterprise. The results of modeling Digital Twins of the main technological areas using the example of a dairy enterprise showed that the implementation of strategies from the security risk group increases the efficiency of the project by 4 %. The results obtained can be used to increase the level of cybersecurity and monitor production

processes in the dairy industry and other agro-industrial sectors. The developed Digital Twins can be integrated into quality and safety management systems for food production, in particular, for enterprises operating in conditions of increased risks of cyber threats.

Keywords: Digital Twins, industrial Internet of Things, monitoring, control and threat modeling, technological risks, food industry, information systems security.

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OPTIMIZATION OF AMMUNITION PREPARATION STRATEGIES FOR MODERN ARTILLERY OPERATIONS IN COMPUTER SIMULATION

pages 50–57

Oleksandr Toshev, *PhD Student, Department of Computer Technologies of Automation, Odesa Polytechnic National University, Odesa, Ukraine, e-mail: toshev.oleksandr@outlook.com, ORCID: https://orcid.org/0009-0000-4093-2556*

Kateryna Kirkopulo, *PhD, Department of Design Information Technologies and Design, Odesa Polytechnic National University, Odesa, Ukraine, ORCID: https://orcid.org/0000-0001-5570-5989*

Oleksandr Klymchuk, *Doctor of Technical Sciences, Department of Thermal Power Plants and Energy-Saving Technologies, Odesa Polytechnic National University, Odesa, Ukraine, ORCID: https://orcid.org/0000-0002-5207-7259*

Maksym Maksymov, *Senior Researcher, Scientific Research Center of the Armed Forces of Ukraine "State Oceanarium" of the Institute of the Naval Forces, Odesa, Ukraine, ORCID: https://orcid.org/0000-0002-5626-5265*

The experience of modern warfare, particularly from public reports on the Russia-Ukraine conflict, highlights significant changes in military strategies, tactics, and technology.

The heavy reliance on artillery and the high demand for shells pose major logistical, storage, and strategic challenges. Poor-quality ammunition can reduce combat effectiveness, damage equipment, jeopardize operations, and put personnel at risk, creating a cascade of additional problems.

The study was aimed at studying the effectiveness and optimization of the additional quality control strategy for ammunition. The focus was on acceptance sampling algorithms to maintain high productivity while optimizing inspection efficiency. The impracticality of 100 % inspection was taken into account.

The study develops and implements specialized acceptance sampling plans adapted to the unique quality and operational requirements of each type of artillery mission. Using iterative calculations, optimal sample sizes and acceptance criteria are established to meet predefined quality levels, minimizing resource consumption and inspection time. The developed sampling plans are structured to find balance between the allowed number of defects and inspection efficiency, ensuring that high-quality ammunition is allocated for destructive fire missions, while properly inspected but larger batches of ammunition are allocated for suppressive fire combat missions.

The new quality control step could be added to the game scenarios of ARMA 3, or to any other warfare simulations, and show that the acceptance plan strategy effectively reduces costs, increases operational safety and ensures readiness for artillery missions. The proposed statistical methods provide a reliable and adaptable approach for integrating quality control into the preparation of artillery ammunition, ensuring reliable supply in difficult combat conditions.

Keywords: computer simulations, artillery operations, stochastic models, quality control, acceptance sampling.

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DEVELOPMENT OF A DECISION SUPPORT METHODOLOGY FOR OPTIMIZING ROI IN PROJECT MANAGEMENT

pages 58–65

Alish Nazarov, *PhD, Department of Management, Azerbaijan State Oil and Industry University, Baku, Azerbaijan, e-mail: alish.nazarov.va@asoiu.edu.az, ORCID: https://orcid.org/0009-0003-6711-4731*

The object of this research is the decision-making process in project management aimed at increasing efficiency and optimizing return on investment (ROI). One of the most problematic areas identified during the audit is the limited capability of traditional multi-criteria decision-making (MCDM) methods – such as multi-objective optimization on the basis of ratio analysis (MOORA) and weighted aggregated sum product assessment (WASPAS) – to operate effectively under uncertainty, incorporate qualitative expert judgments, ensure objectivity in calculations, and maintain ranking stability when criteria weights change or when new alternatives and external factors are introduced – conditions often present in real-world management scenarios.

To address these limitations, the study employs an integrated fuzzy decision-making model that combines the fuzzy analytic hierarchy process (Fuzzy AHP) and the fuzzy technique for order preference by similarity to ideal solution (Fuzzy TOPSIS). Fuzzy AHP is used to determine the weights of criteria through expert pairwise comparisons, incorporating linguistic assessments transformed into triangular fuzzy numbers. Fuzzy TOPSIS ranks project alternatives by measuring their closeness to the ideal solution under uncertain conditions.

The proposed methodology also includes sensitivity analysis and rank reversal testing to validate the model's robustness. The results demonstrate a stable ranking of three project alternatives, with Alternative B achieving the highest closeness coefficient (0.6628), indicating its superior investment attractiveness.

This decision support model integrates expert knowledge, fuzzy logic, and mathematical modeling, and is adaptable to changes in data, incomplete information, and varying evaluation criteria. Compared to classical MCDM approaches, it offers improved accuracy, flexibility, and robustness for strategic decision-making in dynamic environments.

Keywords: Fuzzy TOPSIS, ROI optimization, Fuzzy AHP, project management, decision analysis.

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DEVELOPMENT OF A CONCEPT FOR THE TASK OF LIFE CYCLE EFFECTIVE MANAGEMENT OF AN OPERATED INFORMATION SYSTEM

pages 66–73

Viktor Levykin, *Doctor of Technical Science, Department of Information Control Systems, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-7929-515X*

Maksym Ievlanov, *Doctor of Technical Science, Department of Information Control Systems, Kharkiv National University of Radio Electronics, Kharkiv,* *Ukraine, e-mail: maksym.ievlanov@nure.ua, ORCID: https://orcid.org/0000-0002-6703-5166*

***Ihor Levykin,** Doctor of Technical Science, Department of Media Systems and Technologies, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0001-8086-237X*

***Oleksandr Petrychenko,** PhD, Department of Information Control Systems, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-1319-5041*

The object of research is the processes of functioning and maintenance, which together determine the operation stage of the information system.

The study is devoted to solving the problem of life cycle formal management of operated information systems of management of enterprises and organizations. Research in this area is mainly aimed at developing models, methods and technologies for managing material products and software applications. Issues of life cycle management of interdisciplinary IT products, such as enterprise management information systems, remain practically unexplored.

The aim and main limitations of classical (permanent) management of the life cycle of an operated information system are determined and formally described. The main disadvantage of such management is the possibility of a significant increase in the number of change requests that arise as a result of changes in business processes and IT infrastructure of enterprises and organizations. Therefore, it was proposed to move from the concept of classical (permanent) management to the concept of life cycle effective management of an operated information system. This concept allows to formally describe the task of life cycle effective management of an operated information system as a task of achieving optimal characteristics of this information system for each of its specific properties and the minimum probability of the existence of unresolved incidents and requests for changes during the operation stage of this information system. Based on the provisions of this concept, formal descriptions of the objective function and the main constraints of the task of life cycle effective management of an operated information system for its individual properties are developed. The use of this concept allows to consider classical (permanent) management as a partial case of life cycle effective management of an operated information system.

Practical application of the proposed formal description of the task of life cycle effective management of an operated information system allows to improve SLM-systems for managing the life cycle of an operated information system without global reengineering of existing systems and technologies for data storage and processing.

Keywords: information system, system life cycle management, management by properties, objective function, constraints.

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FORMATION OF A STRATEGY FOR COUNTERING AND IDENTIFYING AI TECHNOLOGIES IN THE FIGHT AGAINST DISINFORMATION UNDER MARTIAL LAW

pages 74–79

Oleksandr Cherep, *Doctor of Economic Sciences, Professor, Department of Staff and Marketing Management, Zaporizhzhia National University, Zaporizhzhia, Ukraine, e-mail: cherep2508@gmail.com, ORCID: https://orcid.org/0000-0002-3098-0105*

Yuliia Kaliuzhna, *PhD, Associate Professor, Department of Staff and Marketing Management, Zaporizhzhia National University, Zaporizhzhia, Ukraine, ORCID: https://orcid.org/0000-0002-3335-6551*

Lubomir Mykhailichenko, *PhD Student, Zaporizhzhia National University, Zaporizhzhia, Ukraine, ORCID: https://orcid.org/0000-0003-3545-0805*

Svitlana Markova, *Doctor of Economic Sciences, Professor, Department of Business Administration and Foreign Economic Activity Management, Zaporizhzhia National University, Zaporizhzhia, Ukraine, ORCID: https://orcid.org/0000-0003-0675-0235*

Yevhen Naumenko, *PhD Student, Zaporizhzhia National University, Zaporizhzhia, Ukraine, ORCID: https://orcid.org/0009-0004-9111-8617*

The methodological basis of the study is a set of techniques, principles, general theoretical, special, interdisciplinary methods of scientific research. To achieve the set goal, the dialectical method of scientific knowledge was used – to study disinformation in martial law and determine the role of artificial intelligence (AI) in its detection and neutralization. The use of a systemic approach made it possible to determine the features of the spread of disinformation through social networks, traditional media and automated bot farms, for the manipulation of public opinion. The operations research method was used to determine the advantages and disadvantages of AI tools aimed at detecting disinformation. Methods of analogies and comparison – to determine modern methods of combating fake news, including machine learning algorithms, natural language processing and image analysis. It was established that the main problem for increasing the effectiveness of combating disinformation is the implementation of European experience in using AI.

The use of systemic and critical analysis allowed to explore the international experience of using AI tools in the field of information security, their effectiveness in detecting deepfakes and other forms of false content. A comprehensive strategy for countering disinformation in Ukraine is proposed. The proposed strategy, unlike the existing strategy, takes into account the use of artificial intelligence technologies to identify fake content in social networks and news channels, the formation of a special body to analyze digital content and the development of a digital society. The comprehensive strategy, unlike the existing ones, includes the expanded use of AI to monitor the information space, combining automated analysis with human control; the implementation of state initiatives to regulate fake content and increase the level of media literacy of the population. The research results will be useful for scientists, information security experts, journalists and state bodies involved in combating disinformation. The proposed approaches will contribute to strengthening the information protection of Ukraine and reducing the impact of fake news on society.

Keywords: disinformation, artificial intelligence, fake news, social networks, deepfakes, information security.

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