Andriushchenko T.Yu.
Simon Kuznets Kharkiv National University of Economics

COMBINING ARTIFICIAL INTELLIGENCE AND DIGITAL TECHNOLOGIES METHODOLOGY FOR EFFICIENT GRAPHIC INFORMATION PROCESSING

Contemporary innovative approaches to graphic information processing represent a significant research direction, considering the rapid development of technologies and the expanding applications of graphic data in various fields. This article explores the technological challenges associated with the need for efficient processing of large volumes of graphic information and the further development of computational methods in the publishing and printing industry in Ukraine.

The paper emphasizes the importance of improving algorithms for graphic data processing. Methods for enhancing graphic information are discussed, aiming at optimizing computational processes and ensuring processing accuracy. Attention is devoted to technical challenges related to the real-time processing of large volumes of graphic data, considering the needs of modern applications such as virtual reality and augmented reality.

In particular, the article examines the application of artificial intelligence in graphic information processing and its impact on improving image automation and analysis. The author explores the prospects for the development of these technologies in the publishing and printing industry in Ukraine, drawing conclusions about their potential in the future development of graphic information processing.

In the modern publishing and printing industry, the use of artificial intelligence combined with digital technologies can significantly enhance the efficiency and quality of processes involved in creating, editing, and printing graphic content. The presented methodology focuses on optimizing workflow processes and ensuring high-quality publishing products. Innovative approaches to graphic information processing in the context of the contemporary publishing and printing environment are discussed. In summary, the article aims to understand and address technological challenges in the field of graphic information processing, taking into account the prospects for its development and impact on various application domains.

Key words: *graphic information processing, technological challenges in the publishing and printing industry, artificial intelligence, development prospects of the publishing industry.*

Formulation of the problem. In the context of innovative approaches to graphic information processing, a range of technological challenges emerges, limiting the potential of this direction and complicating its development. One of the key issues is the need to enhance algorithms for processing graphic data to ensure efficiency and accuracy in diverse applications. This becomes particularly relevant due to the increasing volume of graphic information that needs real-time processing.

Another problem is addressing technical challenges associated with real-time processing of large volumes of graphic data. These challenges arise from the growing demands for interactivity and the speed of processing graphic elements in modern applications and systems.

Additionally, it is crucial to address the application of artificial intelligence and deep learning in graphic information processing. Defining effective methods and their successful implementation can be a complex task due to the high complexity of graphic data and the necessity to develop adaptive models.

These technological challenges require careful scientific analysis and the development of new approaches for effectively solving graphic information processing problems. Understanding and overcoming these challenges may open new perspectives for the development of innovative graphic data processing systems and expand their applications in various fields.

Analysis of Recent Research and Publications. Recent research in this field indicates a growing interest in using artificial intelligence and deep learning to improve algorithms for processing graphic data. There is a tendency to address efficiency and accuracy issues using intelligent methods such as neural networks.

Some studies also emphasize the resolution of technical challenges related to real-time processing of large volumes of graphic data. This may involve developing optimized algorithms and utilizing distributed computing to ensure speed and efficiency in processing.

Overall, research in this area aims to discover new, more efficient, and intelligent methods of graphic information processing for the development of novel applications in various domains, including computer games, virtual reality, medicine, and multimedia.

Both Ukrainian and foreign researchers are engaged in the issues of image processing, preparation, optimization, and encryption. Scholars such as Yu.M. Rashkevych, A.M. Kovalchuk, D.D. Peleshko [2], N.O. Kustra, N.D. Lotoshynska, V.G. Krasilenko, S.K. Hrabovlyak [1], K.S. Popaдунець, I.A. Khizhnyak, Yunak O. M. [4], and others have conducted research on the encryption and decryption of images. The studies of researchers M.M. Botvin, O.A. Hertsyi [3] are dedicated to improving the visual quality of digital images. V. Vanin, O. Zalevska, O. Vorobiov, and Yu. Lazarchuk-Vorobiova [6] have addressed the issues of existing software applications for graphic image processing.

Task statement. The aim of the article is to analyze innovative approaches to graphic information processing, focusing on identifying technological challenges that complicate the development of this field and highlighting development prospects in the context of these issues.

Outline of the main material of the study. Presentation of the main material. Graphic information processing in contemporary information society is becoming an increasingly vital component for numerous domains, including computer games, virtual reality, medicine, and multimedia. However, this progress inevitably presents us with a set of technological challenges that require careful analysis and systematization.

Improvement of Graphic Data Processing Algorithms. The first key challenge is the ongoing need to enhance algorithms for graphic information processing. With the growth in volume and complexity of graphic data, there is a necessity to develop more efficient, optimized algorithms capable of ensuring not only high speed but also precision in processing. It is essential to consider the diversity of applications for graphic information, ranging from the gaming industry to medical research.

Spatial Methods for Enhancing Graphic Data Processing. Spatial methods for enhancing graphic data processing are techniques based on direct manipulation of image pixels. In general, spatial image processing can be described by the equation [3]:

$$g(x, y) = T[f(x, y)] \qquad (1)$$

The group of image enhancement methods includes linear transformations, for example, image to negative transformation, logarithmic transformation, etc.

Image enhancement using the Laplace operator, this type of enhancement refers to linear spatial filtering methods and allows you to visually improve the image by increasing the sharpness according to formula 2:

$$g(x, y) = f(x, y) + c\nabla^2 f(x, y) \qquad (2)$$

Analysis of spatial methods for improving the visual quality of digital images. Analyzing spatial methods for enhancing the visual quality of digital images, it can be concluded that the optimal choice in this case is the use of the Laplace operator for image improvement. This method contributes to making the image sharper, with clearer contours of elements, thereby emphasizing the details of the image. However, it is important to consider other methods that may prove more effective in different usage conditions.

Increasing the efficiency of computational processes. Another crucial aspect is the need to increase the efficiency of computational processes related to graphic information processing. Modern applications, such as virtual reality and computer games, demand significant computational power to ensure continuous interactivity and realistic graphical rendering.

Modern technological developments in graphic processing for the publishing and printing industry. The modern development of graphic processing technologies within the context of the publishing and printing industry offers unique opportunities for improving and expanding content creation and presentation processes. This research aims to explore contemporary and prospective methods of graphic information processing, including the application of artificial intelligence, and their impact on addressing technological challenges faced by the publishing industry.

Utilization of digital technologies in graphic design for publishing. contemporary publishing processes increasingly utilize digital technologies for processing and displaying graphic information. Graphic design, using editing and composition software, ensures high-quality graphic content.

Impact of artificial intelligence on graphic information processing. Research on the impact of artificial intelligence on graphic information processing reveals the potential for automating and optimizing content creation and editing processes. Machine learning algorithms can enhance pattern recognition, automate the resolution of technical challenges, and improve the quality of graphic products.

Integration of technologies in the publishing-polygraphic environment. In the modern publishing-

polygraphic environment, the combination of artificial intelligence (AI) and digital technologies can significantly enhance the efficiency and quality of processes involved in creating, editing, and printing graphic content. The methodology for this combination is presented below, with a focus on optimizing workflows and ensuring high-quality publishing products.

A methodology for combining AI and digital technologies with a focus on optimising workflows and ensuring high quality publishing:

Step 1: Assessment of needs and objectives:

1.1. Identification of requirements: analysis of the needs of the publishing and printing process and identification of key tasks where AI and digital technologies can be applied.

Step 2: Integration of artificial intelligence:

2.1. Use of machine learning algorithms: Implementation of machine learning algorithms for recognising and classifying graphic elements, which will facilitate the automation of content editing and categorisation processes.

2.2. Automated image generation: development of a system that uses AI to automatically generate images for covers and illustrations, taking into account style and preferences.

Step 3: Implementation of digital technologies:

3.1. Effective content management: use of digital technologies to create content management systems that allow easy tracking, editing and storage of graphic content.

3.2. Virtualised print proofing: using virtual reality (VR) to preview the look of print and correct any errors before physical printing.

Step 4: Optimisation and monitoring:

4.1. AI-assisted quality control: Developing a quality control system that uses AI to detect and correct errors in graphic content.

4.2. Data analytics for process improvement: applying data analytics to identify weaknesses and optimise.

Step 5: Implementation Preparation:

5.1. Training and Staff Support: Providing training for personnel on the use of new technologies and establishing a support system for effective implementation. With the growing volume of graphic information and the challenges associated with its processing, the development and implementation of new methodologies and approaches become necessary. This research aims to identify and propose new methods to effectively address technological challenges in the field of graphic information processing.

1. Application of Contextual Analytics:

– deep content analysis. Using deep learning algorithms to analyze the context of graphic information, facilitating more accurate recognition and understanding of content;

– contextual modification. Developing a system that considers the context of graphic information for automated modification and adaptation of content to various requirements and platforms.

2. Integration of content management systems:

– unified content management platform. Creating a unified content management system that integrates editing, analysis, and publication of graphic content;

– distributed editing system. Implementing a distributed editing system for collaborative work among editors and authors, considering geographical distances.

3. Development of virtual reality (VR) technologies:

– virtual editing tools. Developing virtual tools for editing graphic content, allowing editors to interact with objects in a 3D space.

For example, the use of Emu Video enables the creation of not only short videos based on textual input but also images. The user enters text, and the tool generates an image based on it. The second stage involves generating a video based on the text and previously generated images. With Emu Edit, images or their parts can be edited, following textual prompts for AI. Users can modify individual elements, geometry, background, colors, etc. [9];

– virtual print preview: Creating the capability for a virtual preview of graphic content before printing to prevent potential defects.

4. Expansion of multimedia processing functions:

– interactive multimedia elements. Implementing interactive features into graphic content to enhance user interaction and attractiveness.

Multimedia interactive publications (formats such as ARK, EXE, EPUB3, FLASH, HTML5, IBOOKS, specialized formats of individual manufacturers). In the layout and formatting of multimedia books and magazines, various types of software are used, including 1) desktop programs (software editors and compiler programs); 2) online cloud platforms; 3) content management systems (CMS) [8];

– automated file size optimization. Developing a system for the automatic optimization of file sizes to ensure fast loading and efficient device utilization.

Methods of lossless information compression are universal and cover all types of images but have a relatively small compression ratio. Using one of the lossless compression methods can provide

approximately a two-fold compression of the image, although this largely depends on the characteristics of the image. Lossy compression methods are the most effective but also require evaluation based on the criteria mentioned above, as a crucial aspect in reproduction methods is ensuring the rational reproduction of the original (analog or digital) with a full set of color and tonal characteristics [7].

The development and implementation of new methodologies in the field of graphic information processing will contribute to the improvement of productivity, accuracy, and quality of work in this segment. The proposed approaches take into account current technological challenges and create new opportunities for the industry's development.

Conclusions. In the context of graphic information processing, the key challenges lie in ensuring the efficiency and accuracy of graphic data processing. Improving algorithms and enhancing the efficiency of computational processes will be decisive steps in overcoming these challenges. Research in this direction has the potential not only to improve the technical aspects of graphic information processing but also to expand the applications of these technologies in various fields from entertainment to science.

The combination of artificial intelligence and digital technologies in the publishing and printing industry can significantly improve the productivity and quality of the publishing process. Thoroughly studying requirements, integrating new technologies, and systematically analyzing potential enhancements are key stages in this process. The applications of new graphic data processing technologies in the publishing industry are outlined below:

1. Efficient editing and design:

– automated editing of images and graphics. Using graphic data processing technologies for automated editing and optimization of images, allowing more efficient adaptation of graphic content to various publishing formats;

– creation of interactive graphic content. Developing interactive graphic elements to enrich publishing content and engage readers.

2. Enhancing visual appeal:

– use of 3D Models in publications. Integrating three-dimensional models and graphics to enhance the visual appeal of covers and illustrations.

– adaptive design for different platforms. Applying adaptive design technologies to automatically adjust graphic content to different devices and screen sizes.

3. Improvement of production processes:

– automation of verification and correction processes. Using machine learning algorithms to automate the verification and correction processes of text and graphic elements in publications;

– efficient print preparation. Implementing graphic data processing technologies to optimize files before printing, reducing time and production costs.

4. Personalized graphic content:

– analysis of reader preferences. Utilizing data analysis to understand reader preferences and create personalized graphic content;

– interactive graphic elements in electronic publications. Embedding interactive graphic elements, such as animations or videos, in electronic publications to enhance the reading experience.

5. Virtual reality in publishing:

– creation of virtual covers and promo materials. Using virtual reality technologies to create impressive virtual covers and promotional materials;

– virtual book presentations. Organizing virtual book presentations and events for interaction with authors and readers in a virtual environment.

Overall Benefits: The use of new graphic data processing technologies in the publishing industry can improve not only the quality and attractiveness of products but also make publishing processes more efficient and adaptable to modern reader demands.

Bibliography:

1. Красиленко, В.Г., Грабовляк, С.К. Моделювання матричного афінноперестановочного алгоритму для криптоперетворень зображень. *Наука і навчальний процес: науково-методичний збірник матеріалів науково-практичної конференції Університету «Україна».* Вінниця, 2012. С. 171–172.

2. Рашкевич Ю., Ковальчук А., Пелешко Д., Купчак М. Застосування тернарних афінних перетворень в шифруванні та дешифруванні трьох зображень. *Науковий вісник НЛТУ України.* 2011. Вип. 21.5. С. 336–340.

3. Ботвін М. М., Герцій О. А. Аналіз просторових методів покращення візуальної якості цифрових зображень. *Збірник наукових праць Державного економіко-технологічного університету транспорту. Серія: Транспортні системи і технології.* 2017. Вип. 30. С. 191–196.

4. Герцій О. А., Бутрик Н. О. Порівняльний аналіз методів компактного представлення графічної інформації. *Збірник наукових праць Державного університету інфраструктури та технологій. Серія : Транспортні системи і технології.* 2021. Вип. 37. С. 130–143. URL: http://nbuv.gov.ua/UJRN/ Znpdetut_tsit_2021_37_15 (дата звернення: 12.01.2024).

5. Юнак О. М., Стрихалюк Б. М., Юнак О. П. Шифрування графічної інформації за допомогою матриць перетворень, для захисту від дешифрування нейронними алгоритмами. Artificial intelligence. 2020. № 2. С. 15–20. URL: http://nbuv.gov.ua/UJRN/II_2020_2_4. (дата звернення: 10.01.2024).

6. Ванін, В., Залевська, О., Воробйов, О., Лазарчук-Воробйова, Ю. Переваги та недоліки існуючих програмних застосунків для обробки графічних зображень. *Сучасні проблеми моделювання*. № 23, 2022. С. 38–44. https://doi.org/10.33842/2313-125X-2023-23-38-44.

7. Афанасьєв Д. Систематизація методів стиснення цифрових зображень. *Сучасне репродукування: інжиніринг, моделювання, мульти- та кросмедійні технології*. 2018. С. 24–29.

8. Женченко М. І. Технології макетування і верстання інтерактивних електронних видань. *Обрії друкарства*. Київ. № 1 (8). 2020. С. 62–75.

9. Meta презентувала інструменти для редагування фото та відео на основі ШІ. URL: https://ain. ua/2023/11/17/emu-meta (дата звернення 27.12.2023).

Андрющенко Т.Ю. МЕТОДИКА ПОЄДНАННЯ ШТУЧНОГО ІНТЕЛЕКТУ ТА ЦИФРОВИХ ТЕХНОЛОГІЙ ДЛЯ ЕФЕКТИВНОЇ ОБРОБКИ ГРАФІЧНОЇ ІНФОРМАЦІЇ

Сучасні інноваційні підходи до обробки графічної інформації представляють значущий напрямок досліджень, враховуючи стрімкий розвиток технологій та розширення застосувань графічних даних у різних галузях. У цій статті розглядаються технологічні виклики, пов'язані з необхідністю ефективної обробки великих обсягів графічної інформації та подальшого розвитку обчислювальних методів у видавничій та друкарській промисловості в Україні.

У статті акцентується увага на важливості удосконалення алгоритмів обробки графічних даних. Розглядаються методи покращення графічної інформації, спрямовані на оптимізацію обчислювальних процесів та забезпечення точності обробки. Увага приділяється технічним викликам, пов'язаним із обробкою графічних даних в реальному часі, з урахуванням потреб сучасних застосувань, таких як віртуальна реальність та розширена реальність.

Зокрема, у статті розглядається застосування штучного інтелекту в обробці графічної інформації та його вплив на удосконалення автоматизації та аналізу зображень. Автор досліджує перспективи розвитку цих технологій в видавничій та друкарській галузі в Україні роблячи висновки про їхній потенціал у майбутньому розвитку обробки графічної інформації.

У сучасній видавничій та друкарській галузі використання штучного інтелекту разом із цифровими технологіями може значно підвищити ефективність та якість процесів, пов'язаних із створенням, редагуванням та друкуванням графічного контенту. Представлена методологія фокусується на оптимізації робочих процесів та забезпеченні високої якості видавничої продукції. У статті обговорюються інноваційні підходи до обробки графічної інформації в контексті сучасного видавничого та друкарського середовища. Узагальнюючи, стаття спрямована на розуміння та вирішення технологічних викликів у галузі обробки графічної інформації, враховуючи перспективи її розвитку та вплив на різні сфери використання. Результати досліджень можуть виявити суттєвий вплив на подальший прогрес цієї важливої галузі технологій.

Ключові слова: обробка графічної інформації, технологічні виклики видавничо-поліграфічної галузі, штучний інтелект, перспективи розвитку видавничої галузі.