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INTELLIGENT LAYOUT AND ILLUSTRATION SYSTEMS FOR PUBLICATIONS AS PART OF AN AUTOMATED PUBLISHING ECOSYSTEM

The concept of intelligent layout and illustration systems for publications as part of an automated publishing and editing ecosystem is considered. The need to integrate the processes of technical editing, layout and illustration creation into a single digital environment is justified. It has been established that traditional methods of preparing various types of publications are labour-intensive and cannot fully ensure consistency between text and graphic components. Modern studies demonstrating the effectiveness of AI technologies in layout have been analysed, but they do not fully take into account the semantics of the text and the accuracy of graphic placement. An approach to determining the effectiveness of the system based on technical, visual, and readability criteria is proposed. The use of such systems reduces the time of the publishing and editing cycle, reduces the number of errors, increases the uniformity of design, and ensures compatibility with international standards. The developed concept contributes to the formation of a new paradigm of digital publishing, where artificial intelligence, computer science and automation ensure high quality and efficiency in the preparation of scientific publications.

Based on the analysis, a concept of 'smart publishing' has been developed, within which intelligent layout and illustration systems provide an automated cycle of scientific material preparation – from manuscript processing to the creation of adaptive publications in PDF, HTML or EPUB formats. The expected results of implementing such systems are a reduction in the publishing cycle time, a decrease in the number of technical errors, increased uniformity of design, and ensuring data openness and compatibility with international publication standards. The article emphasises the importance of developing standards for data exchange between system modules, developing explainable AI to control the layout generation process, and expanding metrics for evaluating the quality of illustrations and text readability.

Key words: *intelligent layout systems, automated publishing ecosystem, technical editing, generative models, illustration, artificial intelligence.*

Formulation of the problem. A modern publication (printed or electronic) is a synthesis of three logically and technologically related components: the author's text, technical editing (structural and stylistic corrections, metadata standardisation, verification of references and formulas) and illustrations (drawings, diagrams, charts and infographics). Existing workflows are often divided: editors work in text environments, designers work in graphic tools, and illustrators work in separate software packages. This creates a number of problems: labour intensity, long approval cycles, human errors in the integration of text and graphics, complexity of scaling (large number of publications/languages/formats) and high preparation costs.

The scientific and practical value of implementing a 'smart publishing' system: acceleration of the publishing cycle, improvement of publication quality, reduction of costs, the possibility of mass personalisation of publications, standardisation of metadata (important for scientific journals, repositories, Open Access) and improvement of the accessibility and readability (UX) of materials.

Analysis of recent research and publications. The current stage of development in publishing is characterised by the active introduction of artificial intelligence, machine learning and automation technologies, which is leading to the emergence of new approaches to the organisation of layout, technical editing and illustration processes. Recent research has focused on creating systems capable of automatically generating document structure, optimising the placement of text and graphic elements, and ensuring stylistic consistency across publications. The development of generative neural networks, in particular the LayoutGAN and LayoutTransformer models, has opened up opportunities for automated layout generation in compliance with compositional principles and user restrictions. At the same time, a number of

works are devoted to the application of transformer architectures for modelling contextual relationships between structural components of a document and creating designs that take into account the semantics of the text.

Despite significant progress in this area, the comprehensive integration of automated layout, technical editing and illustration processes into a single intelligent publishing system remains under-researched. Most existing solutions focus on individual stages of the publishing cycle, while coordination between semantic, typographical and graphic aspects of design requires further scientific justification. That is why a systematic analysis of current research in this area is necessary to identify pressing issues, develop approaches to solving them, and create an integrated model of an intelligent publishing ecosystem.

The paper [3] presents LayoutGAN, a new GAN that directly synthesises a set of graphic elements in a design. In a given design task, a fixed set of element classes (e.g., 'heading,' 'image') is determined in advance.

Each element is represented by the probabilities of its class and geometric parameters, i.e., the key points of the bounding rectangle. The generator takes graphic elements with randomly selected class probabilities and geometric parameters as input and places them in the design; the result is refined class probabilities and geometric parameters of design elements. The generator has the desirable property of being invariant to permutation: it will generate the same layout if we change the order of the input elements [3].

The generation of 2D or 3D scenes based on syntax, scene graphs, layouts, or existing images has attracted considerable interest among the image processing community. Depending on the input data, some works generate fixed layouts and diverse scenes, while others generate diverse layouts and scenes. These methods involve the use of pipelines, which are often trained and evaluated end-to-end [1].

In [3], the generation of an original layout based on requirements and constraints is investigated.

A layout is often used as an intermediate representation in the task of generating images based on text or scene graphs. Instead of directly learning the mapping from the input domain (e.g., text and scene graphs) to the image domain, these methods model the operation as a two-stage structure. First, they predict layouts based on input sources, and then generate images based on the predicted layouts. However, graphic design layouts have several fundamental differences from natural scene layouts. The requirements for relationships and alignment between components in graphic design are strict. A few pixels of component offset can cause a difference in visual perception or even ruin the entire design. A graphic design layout must not only look realistic, but also take into account the aesthetic perspective [2].

The aim of this study is to justify the architecture of an intelligent system that combines: semantic text analysis, original layout generation, automatic or semi-automatic creation or integration of illustrations, and a module for technical editing and validation of compliance with editorial requirements.

Task statement. The development of an intelligent layout, editing and illustration system involves the creation of a methodological framework that combines AI, natural language processing, generative modelling and technical editing technologies. This study proposes a developed system architecture that performs an automated publishing preparation cycle – from initial analysis of text material to the formation of an adaptive layout and the creation of visual elements. The methodology is based on the principles of modularity, semantic consistency and parametric flexibility, which allows achieving high quality and stability of results with minimal editor intervention.

Methodological foundations of system development. The system is based on a multi-level model that combines semantic text analysis, automatic content placement, and illustration generation in a shared working environment. The methodology is based on the concept of 'smart publishing,' in which publishing and editorial processes are viewed as the interaction of data, algorithms, and publication design standards. Each individual component of the system performs specialised functions, but interaction is carried out through a common metadata base, which allows the results obtained to be harmonised and reused.

Architecture of an intelligent publishing and editing system. The proposed architecture of the publishing and editing model consists of four main modules:

Semantic text analysis module – performs structural and semantic markup of a document using NLP (Natural Language Processing) technologies. The module can identify logical parts of the text, analyse key concepts and determine hierarchy.

It performs:

detection of structural elements such as headings, paragraphs, formulas, captions, tables, and others. It classifies the meaning and purpose of each fragment (purpose, methods, results), extracts key terms and entities;

interface to metadata (DOI, ORCID, list of authors).

Layout Generation Module – performs automatic placement of text and graphic elements using mod-

els such as LayoutGAN and LayoutTransformer. The algorithm forms a visually balanced page structure, taking into account the type, format and target audience of the publication, the volume of material, image proportions, etc.

Includes:

hybrid approach: a combination of rules and templates (for compliance with standards) and a generative model for creating multiple layout options;

a generative sublayer (based on LayoutGAN / LayoutTransformer / Neural Design Network) is responsible for the placement of blocks such as headings, main text, illustrations, tables, captions, etc., taking into account semantics and the restrictions imposed;

post-processing for precise alignment, formatting, typography, and overflow optimisation (float placement, widows/orphans control).

Illustration Generation Module – automatically generates graphics and diagrams based on text descriptions or other metadata. This is done using various generative models (diffusion-based AI) and templates based on infographic parameters. The module ensures visual consistency with the layout, style, and appearance of the publication.

It is used for:

diagrams and graphs: automatic conversion of structured data into high-quality graphics (algorithmic libraries);

for scientific illustrations: the application of special AI tools with control capabilities (prompt engineering + constraint enforcement) or the use of domain-oriented generative models (e.g., models trained on scientific figures);

containers for vector graphics (SVG/PDF) to preserve scalability and the ability to edit later.

Work [2] presents examples of using the illustration generation model. Given the components and partial constraints specified by the user, the model can generate layouts that meet these constraints. Figure 1 shows examples of designs created based on the generated layouts.

Modern generative approaches have greatly simplified the creation of visualisations, but require control to ensure scientific accuracy [6].

The Technical Editing Module checks the correctness of alignment, formatting, typographical parameters, style compliance, and compliance with standards. This module evaluates the quality of automatically generated layouts. The check is performed according to the following criteria: readability, structural consistency, visual integrity, and data accuracy.

It performs:

style checks (citations, references), LaTeX and/or MathML validation, duplication checks, verification of compliance with journal requirements;

validation of illustration placement: presence of captions, correspondence of references in the text, no overlapping of key text sections, readability of fonts and sizes.

integration with CI/CD publishing pipeline (automatic PDF/HTML preview, multi-format export);

Practical relevance: commercial automation systems already implement some of these functions (Typefi as an example of robotic typesetting and export), but without a flexible generative part [2].

The structural diagram of the architecture of the intelligent publishing and editing system is shown in fig. 2.

The architecture of the publishing and editing system supports integration with content management systems (CMS) and various platforms for scientific publications, ensuring a continuous workflow – from the initial stage, i.e. manuscript preparation, to the final creation of the final electronic or printed format (PDF, HTML, EPUB).

Research results and effectiveness assessment. Analytical assessment of the effectiveness of the intellectual publishing and editing system and illustration was based on the construction of formal models describing the expected performance indicators of its key modules.

To predict the quality of the semantic analysis module, a generalised accuracy model for trans-

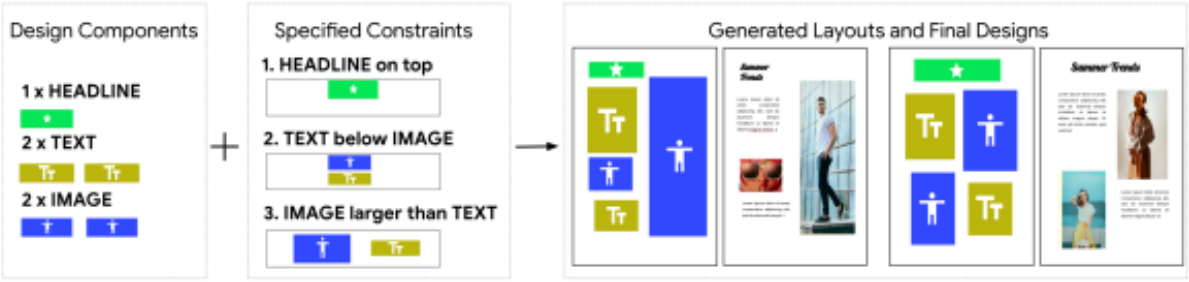

Fig. 1. Creating a graphic layout taking into account user restrictions [2]

Fig. 2 Architecture diagram of an intelligent publishing and editing system

former architectures was used. Based on the average results presented in recent publications, the accuracy of the classification of structural components of text is determined by formula (1):

$$P_{av} = \frac{\sum_{i=1}^{n} w_i x\, p_i}{\sum_{i=1}^{n} w_i},$$

where – p_i – average accuracy for the element type (heading, paragraph, table, etc.);
w_i – its weight in the document structure.

The time required to generate a page layout was determined using the model represented by formula (2):

$$T = T_p + T_l + T_o,$$

where – T_p – time spent on preliminary text processing;
T_l – time spent on forming a logical structure;
T_o – time spent on optimising the placement of elements.

The compliance of layouts with reader-friendliness standards was assessed using a compositional balance metric based on the following formula:

$$C = 1 - \frac{E_d + E_a + E_s}{3}$$

where – Ed – deviation from the rules of dominance (visual support);
Ea – deviation from the alignment rule;
Es – deviation from the structure rule (grid).

Generalisation of the results of modern generative models allows us to apply the model according to the formula:

$$S = \alpha S_{sem} + \beta S_{st} + \gamma S_{ac}$$

where – S_{sem} – semantic correspondence;
S_{st} – stylistic consistency;
S_ac – accuracy of reproduction of structural elements.

In the study, the effectiveness of technical editing is assessed using a complex formula:

$$R = 0.35R_{orth} + 0.35R_{punct} + 0.30R_{str}$$

where – R_{orth} – indicator of spelling accuracy;
R_{punct} – indicator of punctuation accuracy;
R_{srt} – indicator of structural compliance.

The weights in the formula are distributed as follows:

0.35 – spelling (the most common type of error; easily automated).

0.35 – punctuation (important for understanding the meaning; more complex than spelling).

0.30 – structure (determines the quality of layout and readability; requires a complex review of the document).

This ratio reflects the actual priorities in publishing practice.

The comprehensive integral indicator is determined by the formula:

$$E = \frac{P_{av} + C + S + R}{4}$$

Practical significance. The implementation of intelligent publishing and editing systems and illustration allows the creation of flexible automated publishing environments that minimise human involvement in routine operations, leaving quality control and content editing functions. This contributes to the efficiency of publishing processes, reduces costs, and provides the ability to scale the system for different types of publications – from scientific journals to educational and multimedia materials.

Conclusions. The study showed that intelligent systems for layout, technical editing, and automated illustration are becoming a key element of the modern publishing ecosystem. The use of machine learning, generative models, and optimisation algorithms increases the accuracy, speed, and consistency of publishing processes.

The proposed model of an automated ecosystem demonstrates the potential to combine editorial analysis, compositional structuring, and illustration generation in a single working environment. Analytical evaluation confirmed that the predicted level of technical editing efficiency can reach about 93%, which meets modern professional standards.

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Андрющенко Т.Ю. ІНТЕЛЕКТУАЛЬНІ СИСТЕМИ ВЕРСТКИ ТА ІЛЮСТРУВАННЯ ВИДАННЯ ЯК СКЛАДОВА АВТОМАТИЗОВАНОЇ ВИДАВНИЧОЇ ЕКОСИСТЕМИ

Розглянуто концепцію інтелектуальних систем верстки та ілюстрування видання як складової автоматизованої видавничо-редакційної екосистеми. Обґрунтовано потребу інтеграції процесів технічного редагування, верстки й створення ілюстрацій у єдиному цифровому середовищі. З'ясовано, що традиційні методи підготовки різних видів видань є трудомісткими та не можуть повною мірою забезпечити узгодженість між текстовими і графічними компонентами. Проаналізовано сучасні дослідження, які демонструють ефективність AI-технологій у верстці, але не враховують повністю семантику тексту й точність розміщення графіки. Запропоновано підхід до визначення оцінювання ефективності системи за такими критеріями, як технічні, візуальні та читабельні. Використання таких систем дозволяє скоротити час видавничо-редакційного циклу, зменшити кількість помилок, підвищити уніфікацію оформлення та забезпечити сумісність з міжнародними стандартами. Розроблена концепція сприяє формуванню нової парадигми цифрової видавничої справи, де штучний інтелект, інформатика й автоматизація забезпечують високу якість і ефективність підготовки наукових публікацій.

На основі проведеного аналізу розроблено концепцію «розумного видавництва», у межах якої інтелектуальні системи верстки та ілюстрування забезпечують автоматизований цикл підготовки наукових матеріалів – від обробки рукопису до створення адаптивних публікацій у форматах PDF, HTML або EPUB. Очікуваними результатами впровадження таких систем є скорочення часу видавничого циклу, зменшення кількості технічних помилок, підвищення уніфікації оформлення, забезпечення відкритості даних і сумісності з міжнародними стандартами публікацій. У статті наголошено на важливості розроблення стандартів обміну даними між модулями системи, розвитку explainable AI для контролю процесу генерації макетів, а також розширення метрик оцінювання якості ілюстрацій і читабельності тексту.

Ключові слова: *інтелектуальні системи верстки, автоматизована видавнича екосистема, технічне редагування, генеративні моделі, ілюстрування, штучний інтелект.*

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