buildings

MDPI

Editorial

The Role of Artificial Intelligence in Architecture and Interior Design

Ewa Janina Grabska [1] and Baohua Wen [2,*]

[1] Department of Design and Computer Graphics, Jagiellonian University, 31-007 Kraków, Poland; ewa.grabska@uj.edu.pl
[2] School of Architecture and Planning, Hunan University, Changsha 410082, China
* Correspondence: wenbaohua@hnu.edu.cn

1. Introduction

Design is one of the most creative aspects of human endeavor. Thinking in the design process is, on the one hand, logical and rational, and on the other, intuitive and imaginative. Analysis of design problems reveals that the nature of design is divergent; it assumes multiple perspectives and encompasses numerous possibilities for the design task. However, convergent tasks clearly exist in every design process, in which logical reasoning and the search for more or less optimal solutions are required [1]. Design is characterized by two distinct worlds and the actions that define them. The first internal world is constructed in the designer's mind through perceptual, functional, and conceptual actions. The second external world is created through physical actions, such as drawing, copying, and deleting elements. A physical action in design is a change in the external world that aligns with a goal envisioned in the internal world [2].

Recent research is exploring hybrid artificial intelligence (AI) frameworks that are replacing earlier versions of isolated design tools. We are currently moving from viewing AI as a technical aid to understanding it as an integrated element in the design process. AI supports the designer's internal world, increasing design efficiency and enriching the creative process of finding solutions, while retaining the designer's key decision-making authority.

The past decade has witnessed a paradigm shift in computational design driven by advances in deep learning and neural network architectures. Unlike rule-based parametric systems, modern deep learning models learn implicit patterns from extensive architectural datasets, generating solutions that balance creativity with functional requirements [3]. Generative adversarial networks (GANs) [4], Variational Autoencoders (VAEs) [5], and diffusion models [6] have transformed early-stage design by enabling high-fidelity image synthesis and exploration of latent design spaces. Text-to-image diffusion models, such as Stable Diffusion and DALL-E, have been widely adopted for rapid concept visualization and ideation [7].

Parallel advances in computer vision and 3D reconstruction, including Neural Radiance Fields (NeRF), convolutional neural networks (CNNs) [8], and Vision Transformers (ViTs) [9], are redefining how architects capture, analyze, and model built environments. Large language models (LLMs) now facilitate natural language interaction with design tools, enabling designers to express intentions conversationally rather than through complex coding [10]. Collectively, these technologies expand the boundaries of architectural design and foster interdisciplinary collaboration between computer science and architecture.

Although the research focus of this Special Issue is limited to architecture and interior design in the context of artificial intelligence, its aim is more general: to highlight the

Check for updates

Received: 21 May 2026
Accepted: 22 May 2026
Published: 25 May 2026

Copyright: © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

ongoing enrichment of the framework for the interdisciplinary integration of diverse aspects of design and artificial intelligence technologies.

2. An Overview of the Published Articles

The ten articles published in this Special Issue collectively demonstrate the diverse applications of AI across the entire architectural design lifecycle.

Hong and Choo (contribution 1) address a critical limitation of current text-to-image diffusion models in architectural design: the lack of precise control over architectural parameters. They propose fine-tuning the Stable Diffusion XL (SDXL) model using Low-Rank Adaptation (LoRA) in a dataset of 1000 architectural massing images. Systematic evaluation of training parameters—epoch, batch size, and network rank—demonstrates that LoRA fine-tuning significantly improves the model's ability to generate accurate architectural masses from text prompts, offering practical guidance for domain-specific AI adaptation.

Wang et al. (contribution 2) develop a hybrid multi-criteria decision-making framework to analyze the influence mechanisms of AI-based Architectural Design (AIAD). Integrating Analytic Hierarchy Process (AHP), Decision-Making Trial and Evaluation Laboratory (DEMATEL), Interpretive Structural Modeling (ISM), and Cross Impact Matrix Multiplication Applied to Classification (MICMAC) methods, they identify 18 key factors across technology, organization, environment, project, education, and economy. Technological factors and project execution processes emerge as primary drivers of AI adoption, while learning and time costs act as barriers, offering structured insights for design firms undergoing digital transformation.

The article by Nam and Park (contribution 3) deals with the use of artificial intelligence in assessing the effectiveness of screen façades that are designed with geometric patterns and play a key role in shading. In this study, generative adversarial networks (GANs) and machine learning classification based on convolutional neural networks (CNNs) were applied to the generative method of designing screen facade features and integrating them with daylight simulation analyses. Using StyleGAN3 trained on 664 black-and-white patterns, these models generated 5000 unique façades, classified using CNN-based hierarchical clustering. The proposed daylight simulations revealed that frame ratios of 50-65% optimize daylight and glare reduction. This workflow integrates generative AI with performance simulation, enabling rapid exploration of thousands of alternatives.

Mehraban et al. (contribution 4) proposes an innovative process that enables the generation of semantically and geometrically useful BIM-based models from RGB images captured by standard cameras or unmanned aerial vehicles (UAVs). The proposed solution is based on Neural Radiation Fields (NeRF), artificial intelligence models known for their use in reconstructing detailed 3D scenes from 2D images. In the case considered by the authors, a precision of up to 0.994 and 0.992 Intersection over Union (IoU) were achieved for window and door detection, offering a cost-effective and scalable approach to BIM generation, supporting practical applications such as renovation and facility management.

The article by Zhong et al. (contribution 5) addresses the problem of automatically completing a floor plan from an unfinished design. A self-supervised framework for floorplan (FP) completion was developed using a Masked Autoencoder (MAE) strategy with Vision Transformer (ViT). Training on the FloorplanNet dataset of 8000 layouts yielded consistent examples of residential layouts. FP-MAE reconstructs missing regions by capturing global structural patterns, accelerating early-stage design and reducing repetitive revisions.

The article by Lim and Yoon (contribution 6) demonstrates how image-based deep learning and expert evaluation can help identify trends in residential building design in the post-pandemic era, using over 10,000 interior images. Features extracted by a pre-trained

convolutional neural network (ResNet50) reveal transformations in openness, flexibility, and integration with nature, highlighting the evolution of living spaces toward resilience and human-centered design. Although expert assessments largely confirmed the deep learning results, there were also discrepancies. Combining AI-based computational analysis with expert assessment is valuable because it allows for the identification of gaps between design intent, professional expectations, and implemented AI-enabled spatial configurations.

The article by Zhang et al. (contribution 7) explores the challenges of architectural heritage management using a Heritage Building Information Model (HBIM) with intelligent, data-driven decision-making. This workflow integrates 3D laser scanning, UAV photogrammetry, and archival data, with a parametric component library and value-risk model to enable the automated evaluation and real-time visualization of conservation priorities. This framework has been validated in its application to the Suopo Ancient Watchtower Complex in Danba, Sichuan.

The article by Liang et al. (contribution 8) proposes an integrated methodology for automating the identification and analysis of large-scale morphological features in typical residential courtyards. This approach utilizes both deep machine learning based on computer vision and GIS spatial statistics for large-scale morphological analysis of vernacular courtyards in Wu'an, Hebei. Using high-resolution network architectures pre-loaded with weights (HRNetV2) for semantic segmentation on satellite imagery for 134,280 courtyards, spatial statistics revealed regional patterns influenced by climate and topography, offering scalable methods for heritage preservation.

The article by Alana et al. (contribution 9) describes the transformation of architectural education toward human–AI collaboration, examining the impact of AI on six stages of architectural design via mixed-methods research. Evaluating AI across efficiency, creativity, accuracy, integration, adoptability, and environmental impact, student participants reported that AI is most effective in the early stages of design, where it supports idea generation, visualization, and iterative exploration. However, human expertise and critical reasoning remain crucial in later technical phases, as emphasized by the field, which prioritizes AI's analytical and evaluative capabilities, enabling informed decision-making. The contemporary educational task is to convince students that AI works most effectively as a complementary partner, not as a replacement for humans.

The article by Han and Jeong (contribution 10) validates generative AI-generated 360° images for indoor environmental research. Using a three-stage framework, base panorama generation, AI-based greenery integration, and validation, the stimuli exhibited minimal distortions and high visual fidelity, surpassing conventional 3D modeling for research applications. The model offers an alternative to expensive physical photography or complex 3D simulations, particularly for studies requiring precise control of environmental variables. It can be considered an extremely efficient and inexpensive spatial perception research paradigm for future indoor environment research, utilizing AI-generated virtual reality stimuli, enabling more diverse and scalable experimental designs.

3. Conclusions

The articles published in the Special Issue devoted to artificial intelligence in architecture and interior design are characterized by a wide spectrum of research topics and the resulting variety of methodologies. The following main thematic categories are presented:

1. General—searching for a methodology integrated with artificial intelligence, reflecting the contemporary role of artificial intelligence in architectural design.
2. Applied—searching for a methodology integrating artificial intelligence methods to solve specific design problems.
3. Educational—transforming architectural education towards human–AI collaboration.

4. Collaborative—identifying gaps in combining AI-based computational analysis with expert assessment.

In other words, this collection of articles provides a comprehensive overview of the current state of AI research in architecture and interior design, highlighting both the significant progress achieved and the important challenges that remain to be addressed. From a more detailed perspective, it presents the transformative impact of AI on the entire lifecycle of an architectural project, from early concept generation through heritage conservation to post-occupancy evaluation.

Looking forward, several key directions emerge for future research in AI and architectural design. First, there is a critical need to develop more controllable and interpretable generative AI models that can better respect architectural constraints and design intent. While current models excel at generating esthetically pleasing images, they often struggle with precise control over functional parameters such as spatial relationships, structural integrity, and building code compliance [11]. Second, further research is needed to develop seamless integration between AI tools and existing BIM and CAD workflows, enabling bidirectional data exchange and preserving design intent throughout the design process [12]. Third, there is an urgent need to address the ethical implications of AI in architecture, including issues of authorship, intellectual property, algorithmic bias, and the potential impact on employment in the design professions [13]. Fourth, future research should explore the potential of AI to address global challenges such as climate change, urbanization, and social inequality by enabling more sustainable, equitable, and resilient design solutions [14]. Finally, there is a need for continued interdisciplinary collaboration between architects, computer scientists, engineers, and social scientists to ensure that AI technologies are developed and deployed in ways that serve human needs and enhance the quality of the built environment [15].

In conclusion, this Special Issue demonstrates that artificial intelligence is no longer a futuristic concept but a rapidly evolving reality that is fundamentally reshaping architectural practice. While significant challenges remain, the potential benefits of AI in terms of increased efficiency, enhanced creativity, and improved design quality are undeniable. As the articles in this Special Issue illustrate, the most promising path forward is not one of AI replacing human designers, but rather one of human–AI collaboration, where each partner contributes their unique strengths to create better, more sustainable, and more human-centered buildings and cities. We hope that this collection of research will inspire further innovation and dialog in this exciting and rapidly evolving field.

Funding: This research was funded by the National Natural Science Foundation of China, grant number 52578016; Natural Science Foundation of Hunan Province, grant number 2025JJ50234; Science and Technology Program Project of Hunan Province, grant number 2025RC3096.

Acknowledgments: We sincerely thank the authors for their valuable contributions and high-quality submissions to this Special Issue. We are equally grateful to the reviewers for their diligent and constructive feedback, which greatly improved every paper. Finally, we extend our appreciation to the editorial team of *Buildings* for their professional support, which was key to the success of this Special Issue.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions

1. Hong, S.M.; Choo, S. Systematic Parameter Optimization for LoRA-Based Architectural Massing Generation Using Diffusion Models. *Buildings* **2025**, *15*, 3477. https://doi.org/10.3390/buildings15193477.

2. Wang, X.; Zhao, Y.; Zhang, W.; Li, Y.; Shi, X.; Xia, R.; Su, Y.; Li, X.; Xu, X. Artificial Intelligence-Based Architectural Design (AIAD): An Influence Mechanism Analysis for the NewTechnology Using the Hybrid Multi-Criteria Decision-Making Framework. *Buildings* **2025**, *15*, 3898. https://doi.org/10.3390/buildings15213898.
3. Nam, H.; Park, D.Y. Screen Façade Pattern Design Driven by Generative Adversarial Networks and Machine Learning Classification for the Evaluation of a Daylight Environment. *Buildings* **2025**, *15*, 4056. https://doi.org/10.3390/buildings15224056.
4. Mehraban, M.H.; Mirzabeigi, S.; Wang, M.; Liu, R.; Sepasgozar, S.M.E. Automated Image to-BIM Using Neural Radiance Fields and Vision-Language Semantic Modeling. *Buildings* **2025**, *15*, 4549. https://doi.org/10.3390/buildings15244549.
5. Zhong, J.; Luo, R.; Li, P.; Li T, Zeng, P.; Lei, Z.; Feng, T.; Yin, J. FP-MAE: A Self-Supervised Model for Floorplan Generation with Incomplete Inputs. *Buildings* **2026**, *16*, 558. https://doi.org/10.3390/buildings16030558.
6. Lim, H.; Yoon, H.J. Post-Pandemic Trends in Residential Space Design: An Analysis Using Deep Learning and Expert Evaluation. *Buildings* **2026**, *16*, 589. https://doi.org/10.3390/buildings16030589.
7. Zhang, L.; Tang, C.; Ye, Y.; Yang, J.; Xu, F. Intelligent HBIM Framework for Group-Oriented Preventive Protection: A Case Study of the Suopo Ancient Watchtower Complex in Danba. *Buildings* **2026**, *16*, 995. https://doi.org/10.3390/buildings16050995.
8. Liang, L.; Li, X.; Liu, S.; Guo, Z.; Tang, S.; Wen, B. Integrating Computer Vision and GIS for Large-Scale Morphological Mapping and Driving Force Analysis of Vernacular Courtyard Dwellings. *Buildings* **2026**, *16*, 1118. https://doi.org/10.3390/buildings16061118.
9. Alana, H.; Fikry, M.; Hasan, A. Human–AI Collaborative Design in Architectural Studios: Evaluating Paradigm Shifts Across the Six Stages of the Design Process. *Buildings* **2026**, *16*, 1445. https://doi.org/10.3390/buildings16071445.
10. Han, Y.; Jeong, J. Leveraging Generative AI for High-Fidelity 360° Spatial Images: Methodological Validation for Use as Experimental Stimuli. *Buildings* **2026**, *16*, 1679. https://doi.org/10.3390/buildings16091679.

References

1. Lawson, B. *How Designers Think*; Butterworth Architecture: Oxford, UK, 2001.
2. Suwa, M.; Gero, J.; Purcell, T. Unexpected discoveries and S-invention of design requirements: Important vehicles for a design process. *Des. Stud.* **2000**, *21*, 536–567. [CrossRef]
3. Zhuang, X.; Zhu, P.; Yang, A.; Caldas, L. Machine learning for generative architectural design: Advancements, opportunities, and challenges. *Autom. Constr.* **2025**, *174*, 106129. [CrossRef]
4. Goodfellow, I.; Pouget-Abadie, J.; Mirza, M.; Xu, B.; Warde-Farley, D.; Ozair, S.; Courville, A.; Bengio, Y. Generative adversarial networks. *Commun. ACM* **2020**, *63*, 139–144. [CrossRef]
5. Girin, L.; Leglaive, S.; Bie, X.; Diard, J.; Hueber, T.; Alameda-Pineda, X. Dynamical variational autoencoders: A comprehensive review. *Found. Trends Mach. Learn.* **2022**, *15*, 1–175. [CrossRef]
6. Ho, J.; Jain, A.; Abbeel, P. Denoising diffusion probabilistic models. *Adv. Neural Inf. Process. Syst.* **2020**, *33*, 6840–6851.
7. Yiannoudes, S. Shaping architecture with generative artificial intelligence: Deep learning models in architectural design workflow. *Architecture* **2025**, *5*, 94. [CrossRef]
8. Almaz, A.F.; El-Agouz, E.A.E.-A.; Abdelfatah, M.T.; Mohamed, I.R. The future role of artificial intelligence (AI) design's integration into architectural and interior design education is to improve efficiency, sustainability, and creativity. *Civ. Eng. Archit.* **2024**, *12*, 1749–1772. [CrossRef]
9. Maurício, J.; Domingues, I.; Bernardino, J. Comparing vision transformers and convolutional neural networks for image classification: A literature review. *Appl. Sci.* **2023**, *13*, 5521. [CrossRef]
10. Fernandes, D.; Garg, S.; Nikkel, M.; Guven, G. A GPT-powered assistant for real-time interaction with building information models. *Buildings* **2024**, *14*, 2499. [CrossRef]
11. Bagasi, O.; Nawari, N.O.; Alsaffar, A. BIM and AI in Early Design Stage: Advancing Architect–Client Communication. *Buildings* **2025**, *15*, 1977. [CrossRef]
12. Kutá, D.; Faltejsek, M. The role of artificial intelligence in the transformation of the BIM environment: Current state and future trends. *Appl. Sci.* **2025**, *15*, 9956. [CrossRef]
13. Oluwagbemiga, A. The role of artificial intelligence in enhancing design innovation and sustainability. *Smart Des. Policies* **2024**, *1*, 6–14.

14. Suleimany, M.; Gonbad, M.R.S.; Naghibizadeh, S.; Niri, S.D. Artificial intelligence as a tool for building more resilient cities in the climate change era: A systematic literature review. In *Artificial Intelligence and Machine Learning Applications for Sustainable Development*; CRC Press: Boca Raton, FL, USA, 2025; pp. 60–81.
15. Onatayo, D.; Onososen, A.; Oyediran, A.O.; Oyediran, H.; Arowoiya, V.; Onatayo, E. Generative AI applications in architecture, engineering, and construction: Trends, implications for practice, education & imperatives for upskilling—A review. *Architecture* **2024**, *4*, 877–902. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.