

Redefining Architectural Montage: The Synergistic Role of Artificial Intelligence in Contemporary Architectural Practice

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ABSTRACT: This study explores the application of Artificial Intelligence (AI) in contemporary architectural design, particularly in reshaping the architectural montage concept. The primary objective is to understand how AI, as a design tool, influences and transforms the methods and styles of architectural design. The research explores different applications of AI in architectural design that include assisting in conceptual design, generation and imitation of architectural styles, architectural model rendering and creation of effect images through literature review and case study analysis. The study summarises new perspectives and tools AI provides in architectural design, such as its data processing and pattern recognition capabilities, enabling designers to explore more complex and dynamic designs. The study demonstrates how AI creates and presents new architectural design concepts by analysing AI tools (such as Midjourney, Stable Diffusion, and DALL-E). Additionally, the research explores AI's ability to rapidly generate architectural content from "low information" to "high information" and to transform non-architectural information into architectural design inspiration, as well as its potential to enhance the efficiency of design communication. The findings indicate that AI impacts architectural design at a technical level and reshapes the concept of architectural montage in artistic and cultural significance. Despite specific challenges, such as ethical and aesthetic issues of AI in architectural design, the introduction of AI undoubtedly provides new possibilities for architectural practice, driving innovation and development in the design field.

KEYWORDS: montage, artificial Intelligence, architectural Design

INTRODUCTION

In contemporary architectural practice, integrating Artificial Intelligence (AI) with design redefines the concept of architectural montage. With the rapid development of technology, AI has become an essential tool for designers and plays an increasingly significant role in the architectural design process (Brennan & Lovell, 2017,490). Architectural montage, traditionally a technique of blending different elements to create new forms, has been a critical way for architects to express creativity. However, the introduction of AI is transforming this traditional concept. AI's data processing and pattern recognition capabilities provide unprecedented perspectives and tools for architectural design, enabling designers to explore more complex and dynamic design possibilities (Georgios, 2021,62).

Recent research indicates that the application of AI in architectural design is becoming increasingly widespread. For instance, AI has generated complex design concepts, optimised architectural parameters, and rendered architectural models. The work of (Krizhevsky et al. 2017:8) showcases deep learning's capability in image recognition and classification. These studies demonstrate AI's immense potential in understanding and processing complex information, bringing new perspectives and tools to architectural design. AI affects architectural design not only technically but also in terms of visual expression. Architects can experiment with new visual languages and combinatory methods using AI to create unprecedented design works. Researchers explored the potential of machine learning as a conceptual design tool in interdisciplinary collaboration and participation, highlighting the significance of AI in advancing architectural montage (Güvenç Özel 2020:385). The study by (Jonathan H et al., 2022,12) demonstrated the capability of AI diffusion models in generating high-definition videos, offering new possibilities in architectural design visualisation and animation. The research by (Yuan et al. 2020:207) discussed the relationship between AI and automation in architecture, emphasising the future interaction between humans and intelligent machines. The application of AI in architectural design transcends mere efficiency; it is deeply intertwined with expression and artistic considerations. This viewpoint reveals the potential of AI as an innovative tool in architectural montage and its impact on the development of architectural design and theory. The study by (Harapan et al., 2021,4) examined the application of AI in architectural design, particularly in forming complex conceptual designs. Their research shows that AI can assist architects in effectively analysing data and drafting in the conceptual design stage. However, it also raises concerns about the potential automation of the architect's role.

Despite the rapid development of AI applications in architectural design, research on how AI impacts and reshapes architectural montage is relatively limited. Current literature primarily focuses on the technical applications of AI, needing deep exploration into how AI integrates with architects' creative processes and affects the artistic and cultural significance of architectural design. Additionally, studies on the ethical and aesthetic aspects of AI in architectural design and its impact on the role of designers are also scarce.

Overall, this study aims to fill this research gap, exploring the collaborative role of AI in contemporary architectural practice, particularly its impact on the concept of architectural montage. By analysing existing literature and combining case studies, this research provides new insights into the role of AI in modern architectural design.





1.0 AI GENERATION TOOLS IN ARCHITECTURAL DESIGN

1.1 AI tools to aid architectural design

Some AI tools in the architectural field are utilized across various stages, including pre-construction planning, architectural conceptual design, building floor plan generation, and post-construction drawings. These applications enhance the efficiency and accuracy of the entire design and construction process. Among the various types of GAI tools, image generation tools are the most relevant to the field of architecture. As shown in Table 1, three examples of image-based GAI tools use text or images as prompts and have the capabilities of text-to-image and image-to-image generation. As research in image generation advances, 3D shape generation is emerging as a breakthrough, simplifying the design process and freeing designers from modelling tasks despite the technical challenges in collecting 3D training sets and training models.

Each tool also possesses distinct specialized functions and preferred styles. By analyzing the characteristics of the images generated by these GAI tools and comparing their applicability in architectural design, we can identify the most suitable GAI tools for architectural work. Once we understand the advantages of these tools and platforms, we can combine them into more flexible workflows.

Table 1: AI tools to aid architectural design. Source: (Author’s elaboration 2024)

AI tool	Midjourney	DALL-E	Stable Diffusion	Point-E	Dreamfields-3D
					
Release time	2022	2021	2022	2022	2021
Announcer	David Holz	OpenAI	Stability AI	Alex Nichol	Google Research
Application stage	Concept Design			Conceptual design and modeling	
Generate categories	image			3D point clouds	3D model

1.2. AI in architectural design process

The architectural design process typically involves several stages, including research, proposal, modelling, and drafting, which require substantial time and effort (Figure 1). Today, the maturity of applied generative AI in image generation enables users to utilize AI for creative assistance, design proposals, rapid rendering, and batch drawing without mastering complex technologies. Thus, Designers are freed from repetitive tasks, allowing them to focus more on innovation. The architectural design workflow using image-based GAI tools resembles the conventional process but substitutes AI for humans in interpreting image information, sketching, and refining sketches.

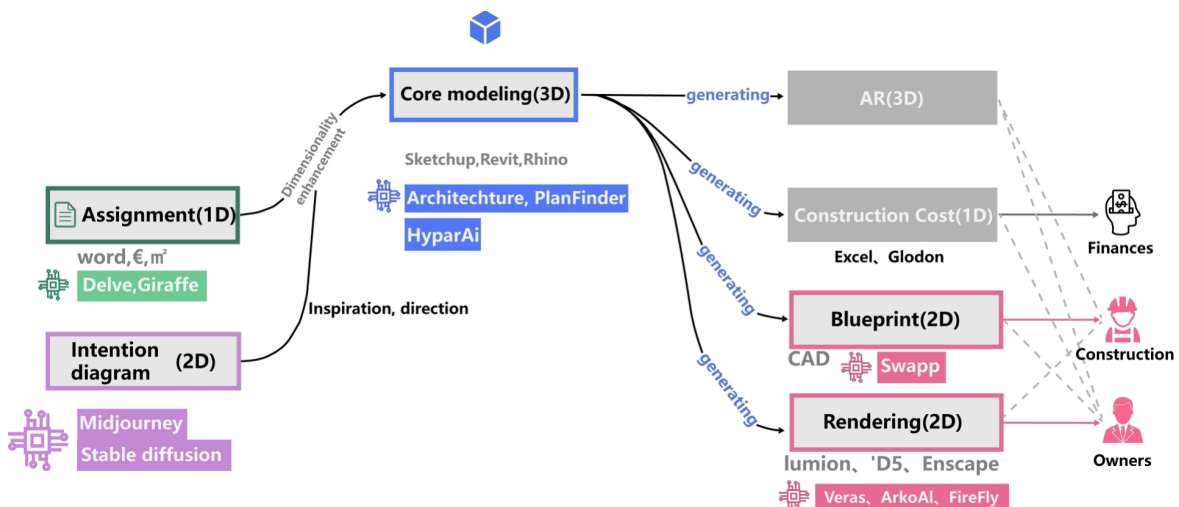


Figure 1: AI in architectural design process. Source: (Yang,2024)

2.0 GENERATION OF ARCHITECTURAL CONTENT BETWEEN LOW INFORMATION AND HIGH INFORMATION

2.1. Text to model

Figure 2 demonstrates using HyPar AI to generate building models from text prompts. HyPar AI allows architects to input specific requirements and design intents as text prompts, which the system then translates into detailed 3D building models. This capability streamlines the initial design phase, enabling rapid iteration and exploring various design options. By leveraging AI, architects can efficiently produce conceptual models that meet precise criteria, thus enhancing the overall design process and reducing the time spent on manual modelling tasks.

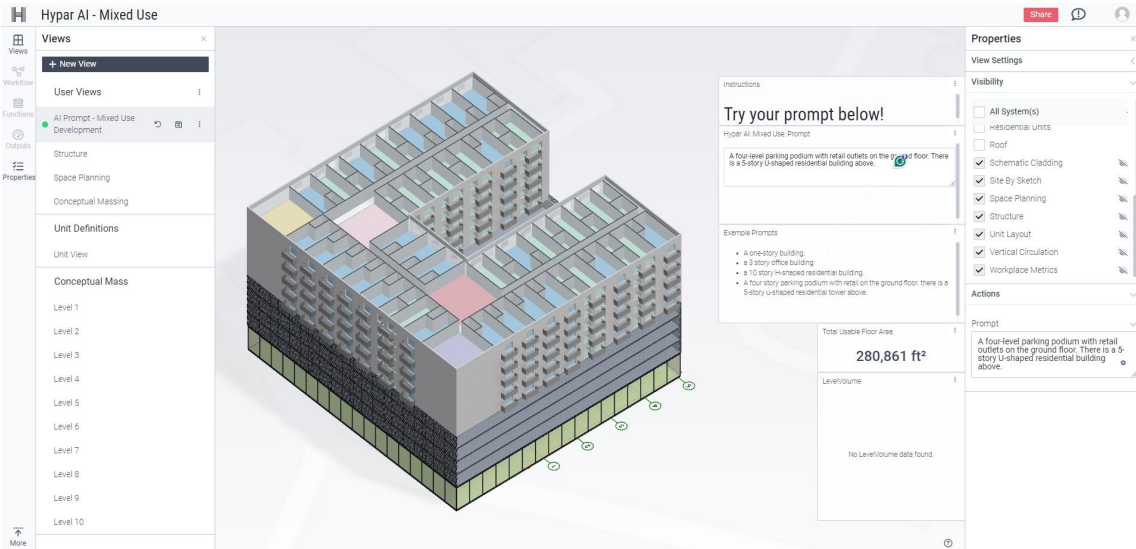


Figure 2: Use text prompts to generate building models on HyPar AI. Source: (Screenshot of HyPar AI’s website 2024)

2.2. Text to image

A brief description can instantly yield several images that highly match the description. These images can then be used to select more satisfactory results or generate similar images to compare proposals. For instance, an architect can input descriptions of a building's desired style, structural elements, or environmental context. Midjourney generates corresponding visual drafts, providing a rapid, intuitive, and creative approach to early-stage design. This AI tool excels in image style transfer, contour generation, and colour rendition, particularly useful in exploring diverse architectural aesthetics and scenarios. Its integration with platforms like Discord for command-based operations adds to its accessibility and ease of use, making it an invaluable asset for professionals seeking to push the boundaries of conventional architectural design with AI-driven creativity and efficiency (Figure 3).



Figure 3: Midjourney’s operation steps of *Text to Image*. Source: (Screenshot of Midjourney, re-elaboration by the author 2024)

2.3. Image to text

Architects usually collect many design intention drawings in the early stages of architectural design. However, since the GAI tool can only accept one image as an image prompt, it must combine the CLIP algorithm with manual

conception to convert the remaining image information into text information and classify it according to the architectural professional terminology category table as text prompts (Figure 4).

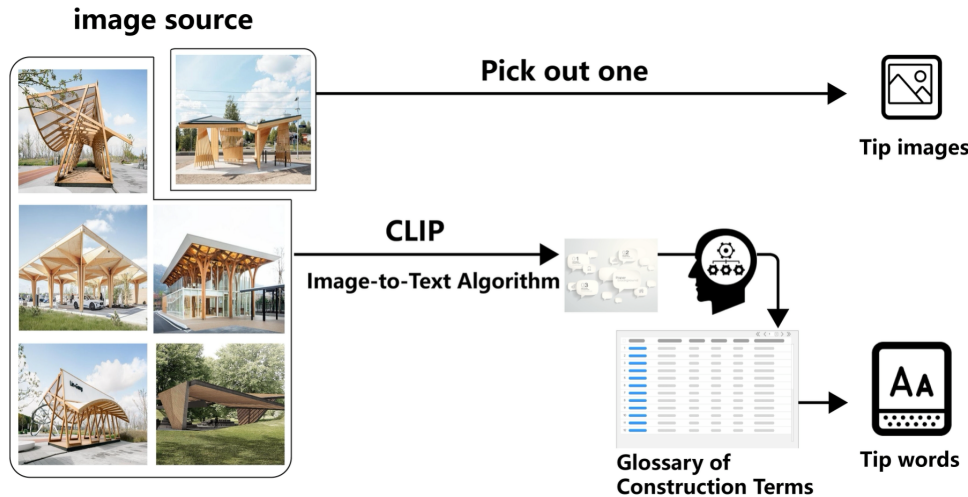


Figure 4: Use the CLIP algorithm to convert multiple images into text information and classify them according to the architectural terminology category table as text prompt words. Source: (Liu 2023)

2.4. Image to Image

AI tools can generate architectural design concept sketches based on descriptions and enrich and deepen architectural design details through their advanced image understanding and generation capabilities. For example, users can provide descriptions of architectural styles, materials, and environments, and DALL-E can generate architectural effect images that meet these requirements. Additionally, DALL-E can transform image style, converting existing architectural photos into different styles or periods, thereby inspiring architects. Unlike Midjourney, DALL-E emphasises adding creative elements while maintaining image realism and detail accuracy. Its capabilities extend beyond static image generation to include editing and transforming existing images, such as changing features of objects in an image or adding new elements (Figure 5). This makes DALL-E a powerful tool for architects exploring innovative design concepts. The functionalities of DALL-E, especially its ability to understand complex and abstract ideas, make it a valuable asset in architectural design. It gives architects a powerful tool to explore and present new design concepts creatively and efficiently.

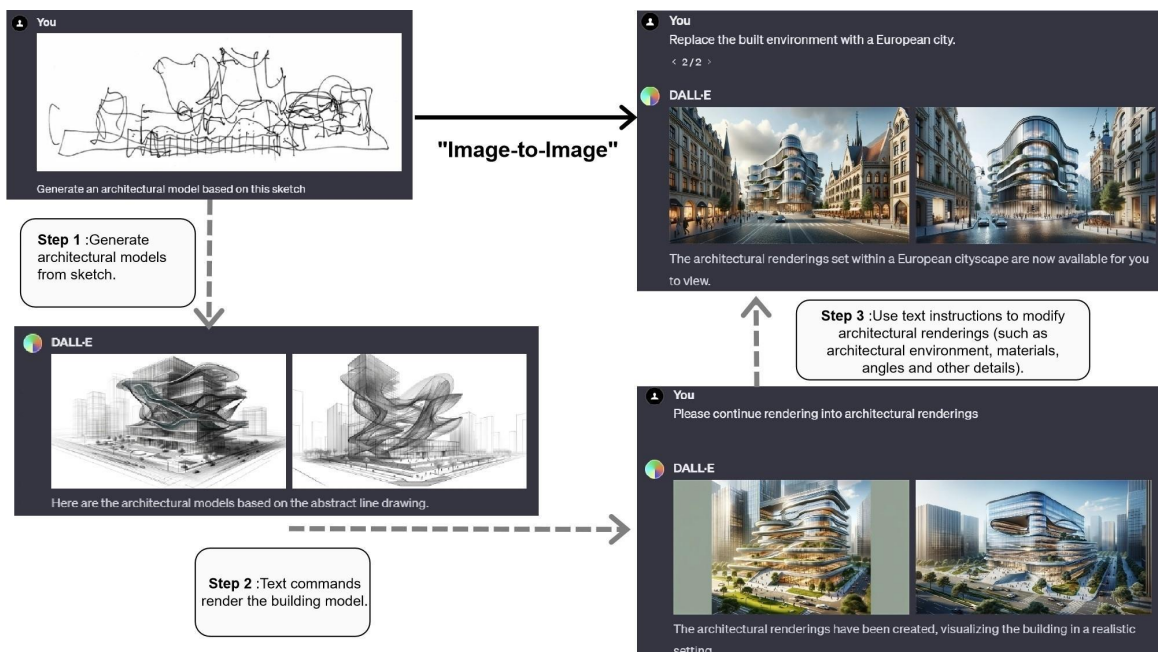


Figure 5: DALL-E's operation steps of *Image to Image*. Source: (Screenshot of DALL-E re-elaboration by the author 2024)

In 2019, Yang Liu from the South China University of Technology combined previous research and split the process from building-defined design boundaries to floor plan generation into two steps: generating floor plan annotations based on the design boundaries and then generating floor plans based on floor plan annotations. In the same year, Stanislas Chaillou from Harvard University split the experiment into multiple steps, including base, red line, doors and windows, furniture, and floor plans, and gradually added annotations of detailed information during the experiment to guide the generation of results (Figure 6). This study completed the entire generative design process

in a relatively detailed manner. Furthermore, in subsequent experiments, the room shape was more flexibly expanded into atypical flexible shapes, and based on this, the possibility of its application in outdoor spaces was explored.

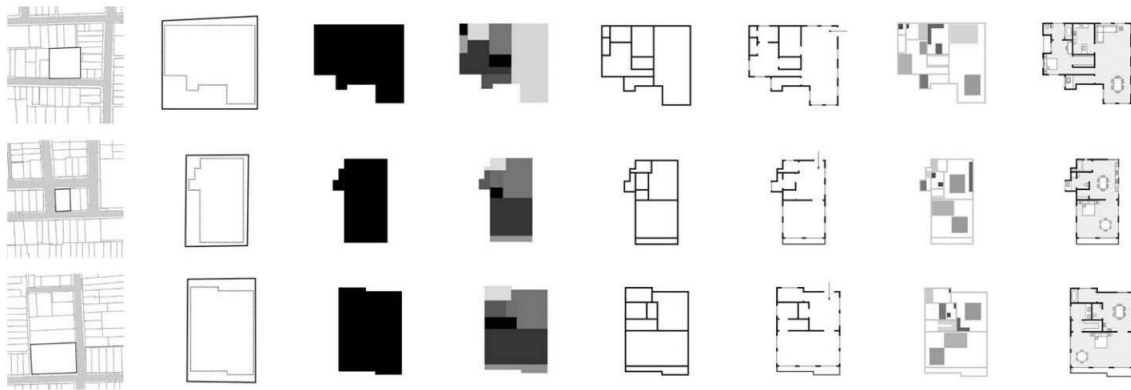


Figure 6: Multi-step indoor space design plan generation. Source: (Chaillou 2021)

2.5. Image to video

Through generative AI techniques, videos can be generated using a single architectural rendering image and an associated text description. As shown in the Figure 7, the first and second rows describe the rendering demonstration videos generated from the input image, in which the building is slightly moved and scaled while maintaining consistency with the surrounding environment. As shown in the third row, the model predicts the architectural style with different angles and ensures consistent generation. In the outlook for future technologies, the application of generative AI in partial style transfer in architectural video content paves the way for a new frontier in architectural visual presentation. This technology enables designers to replicate an overall style and, more importantly, precisely select which parts of the video should be style-transferred. Designers and researchers can explore and present architecture and urban spaces unprecedentedly.

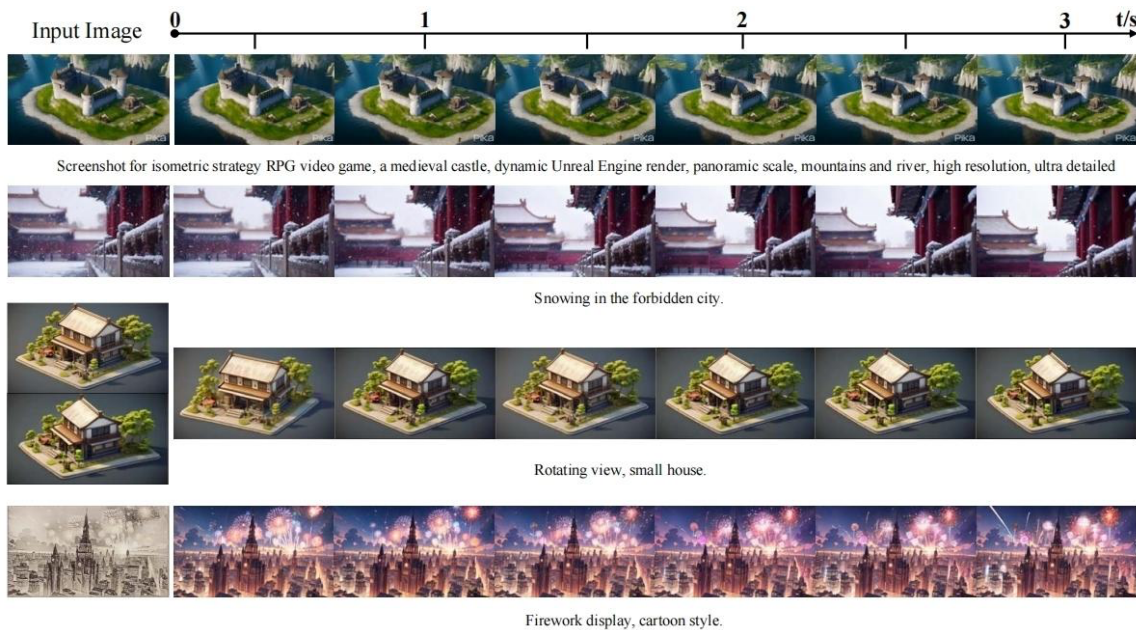


Figure 7: Generative models, such as PiKA and DynamiCrater, are capable of generating high-quality videos from images, supporting multi-angle rotation, and style transfer. Source: (Chaillou2021)

3.0 TRANSITION BETWEEN NON-ARCHITECTURAL AND ARCHITECTURAL INFORMATION

3.1. Animal to architecture

In architectural design, inspiration often comes from the most unusual elements in the human and natural world. This transition from non-architectural to architectural information can now be achieved through generative architectural design AI tools, which can transform atypical design inspirations into actual architectural plans. Generative AI models, especially those capable of style transfer, are vital in this process. These models perform exceptionally well in AI drawing, transforming objects or phenomena unrelated to architecture into inspiration for architectural design. The research attempted an architectural design related to cats. First, a basic model was designed, and then images of the model were fitted with the intended image of a cat, ultimately forming an architectural shape (Figure 8).

3.2. Items to architecture

The Architectural Intelligence Group's AI experiments, depicted here, show how randomly placed items can generate architectural designs, potentially revolutionizing design methodology by allowing an app to create architectural designs from photos, enhancing the massing study phase and making architectural creativity more accessible and controlled. Style transfer enables the generation of stylized images by blending one image's style with another's content. This technique, where initial architectural models provide content guidance and the styles of renowned architects like Corbusier, and Zaha Hadid serve as style guides, deepens the detail of manual models, allowing for innovative architectural designs that harmoniously integrate distinct styles (Figure 9).

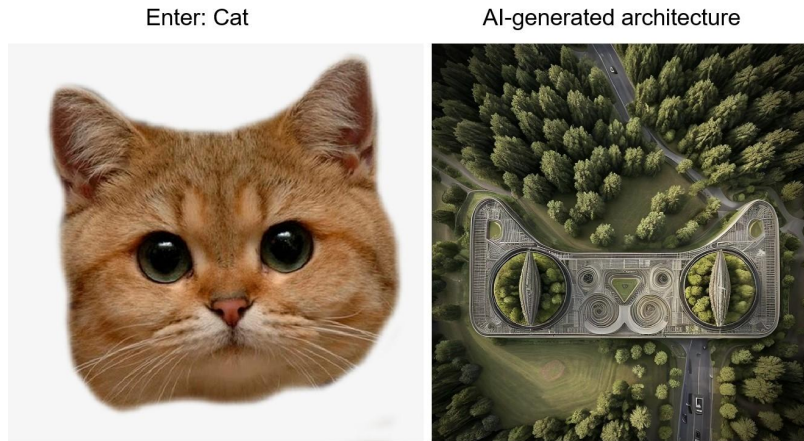


Figure 8: An architecture generated by a cat based on AI. Source: (Stable Diffusion re-elaboration by the author 2024)

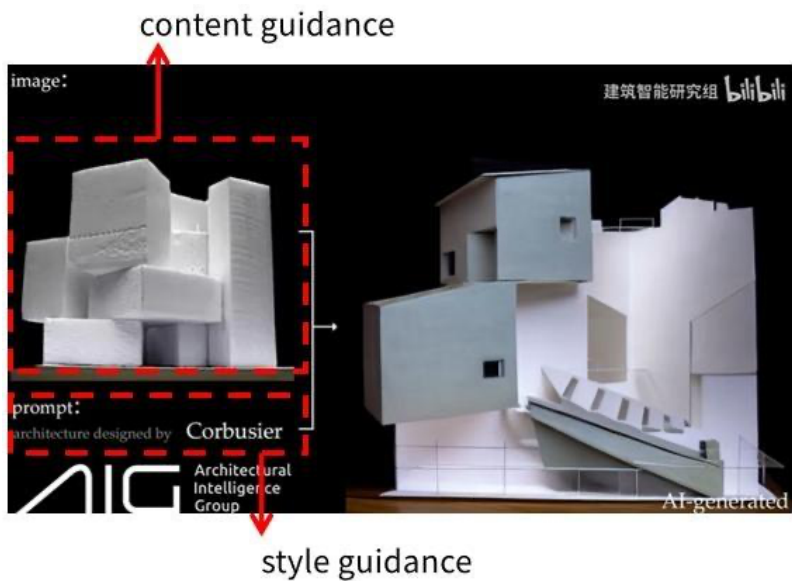


Figure 9: AI deepens the details of manual models. Source: (Architectural Intelligence Group2023)

3.3. The mycelium to urban planning

Another notable example is the research of Dr. Hao Zheng, an Assistant Professor at the City University of Hong Kong. On the left of each image is the growth process of mushroom mycelium in a petri dish, and on the right is the AI-generated urban design. Dr. Zheng used generative AI models to transform videos of the morphological changes of mycelium growth on circular agar plates into urban settlement planning models. This method demonstrates AI's ability to simulate natural phenomena and provides a new perspective for urban planning (Figure 10). In Dr Zheng's research, the AI model analysed the growth patterns of fungi in Petri dishes and applied this pattern to generate urban plans. Concepts like "biomimetic design" and "growing cities" are now more achievable with AI. The AI generates corresponding city plans from videos of colony growth, perfectly matching each stage—from inception to prosperity, saturation, and even decline. The uniqueness of this method lies in its analogy between the expansion patterns of fungi and human activities in limited spaces, analysed through the 'eyes' of AI. This analysis not only enhances the understanding of urban development but also provides urban planners with new tools and perspectives for more effective planning and design of urban spaces.

Enter: fungal growth

AI-generated urban design

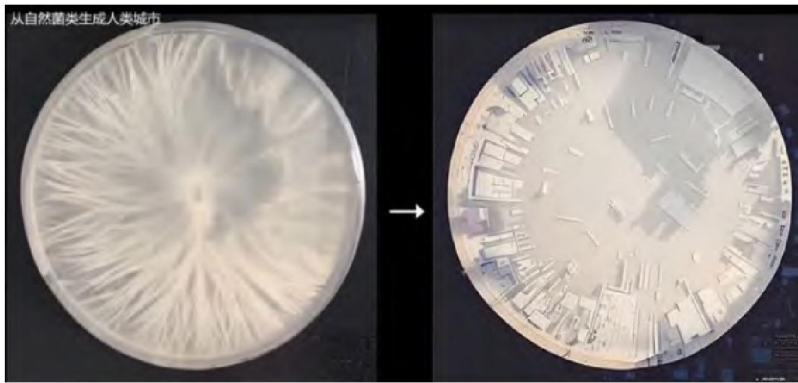


Figure 10: A city generated by natural colonies based on AI. Source: (Zheng 2023)

3.4. Building facade to music

The Project Arch to Music is innovative in blending architectural design with music composition (Figure 11). AI learns to generate musical scores based on architectural images, analyzes the pixel RGB values of the generated images, and then converts them into midi note data. The project uses datasets of architectural images and classical music and advanced machine learning models such as GANs to create a unique interdisciplinary transformation where architectural forms are interpreted and transformed into musical compositions. This method bridges the gap between visual and auditory arts and opens new avenues for creative expression and analysis.

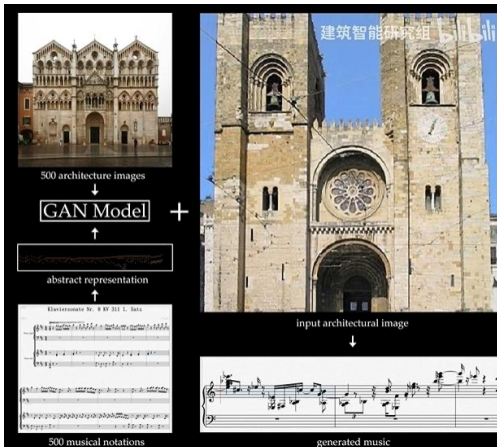


Figure 11: Training AI to turn architecture into music. Source: (Architectural Intelligence Group)

CONCLUSION

By analysing the application of various AI tools, such as Midjourney and DALL-E, in architectural design, we find that AI significantly enhances design efficiency while providing designers with a broader creative space. The application of AI in architectural montage, generating content from "low information" to "high information," showcases its ability to handle and present complex design concepts. Particularly in the transition from "non-architectural information" to "architectural information," AI's style transfer capability provides new sources of inspiration for architects. These advancements not only drive technological innovation in the field of architectural design but also open up new possibilities for architects' creative processes. However, the application of AI in architectural design also presents challenges, especially in maintaining the creative role of designers and addressing ethical issues related to AI in architectural design. While AI tools can provide rapid and diverse design solutions, architects' creativity and critical thinking remain indispensable in the design process. Overall, the application of AI in architectural practice is opening up new fields and bringing a new definition to the concept of architectural montage. This transformation is evident in technology and tools, design thinking, and creative expression. Future research should explore how AI can more deeply integrate with architects' creative processes and how to balance technological innovation with designers' roles to fully utilise AI's potential in architectural design.

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