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New Guidelines in Designing Buildings Through the Study of the Key Abilities of AI in Architectural Design Process

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ABSTRACT

The idea of artificial intelligence has changed as a result of technological developments and a better comprehension of the human mind. It now focuses on simulating human behavior rather than just carrying out intricate computations. As a result, there are numerous initiatives to incorporate AI technology into the architecture domain, interior designs encompassing design, administration, construction, real estate, and urban planning. The majority of AI solutions in this field are only somewhat intelligent at the moment, and crucial jobs still need a great deal of human supervision and involvement. There is Impact of Artificial Intelligence on Architectural Design and Construction wish provide more opportunities and challenges and could help in shaping a new design process through the integration of the artificial intelligent uses with the design process. This research highlights analytics for the ability of AI in Architecture by offering a new approach that could serve as new guidelines in designing building and inhabit our world

Keywords: AI in architecture, design process, designing building, technological development, Transforming Architecture.

INTRODUCTION

The idea of artificial intelligence has evolved as a result of the quick development of technology and a greater comprehension of how the human mind functions. AI increasingly concentrates on simulating human behavior rather than doing intricate computations only.

In recent years, Artificial Intelligence (AI) has transformed numerous industries, including architecture. AI technology integration has significantly advanced the field, providing designers, architects, and construction professionals with new tools and skills to improve their work. AI is changing the design, construction, and operation of buildings from concept design to project management. While the technology did not reach an AI that closely resembles a human, the current AI necessitates careful consideration on its future development, since it is anticipated to significantly influence our society. (Borglund, 2022) AI can assist the human brain in recognizing the world more rapidly and clearly in artificial environments and forecasting potential outcomes based on this information, but it is unable to generate autonomous or creative thought. (Cai, 2018)

This article presents an approach for architects seeking to integrate AI into various phases of the design process by examining the core capabilities of both AI and each stage of design processes and approve that the human presence is important and can't be replaced.

This paper aims to analyze the potential integration of AI within the design processes of building design phases. Specifically, it seeks to address the role of AI in the design process phases as an approach in architectural design and its impact on creativity by indicating a novel guideline.

The most important impacts of AI's capacity is to improve the design process among its most important effects on architecture. Architects have historically relied on their expertise and instincts to produce designs that satisfy practical, aesthetic, and legal specifications. But AI is significantly more capable than humans in analyzing large volumes of data, finding patterns and producing design possibilities that may not be immediately obvious. Architects may utilize AI to investigate a wider range of options by entering characteristics like site circumstances, material availability, and energy efficiency goals. This will ultimately result in more creative and optimized solutions. (Mona M., 2024)

LITERATURE REVIEW

To understand the significance of Artificial Intelligence (AI) in integrating architectural design and the built environment, it is first necessary to define AI and examine its historical development, as well as to study the main phases of the architectural design process. In general, the word "design" has too many connotations. It can be understood as either the final products or the design processes. (El-Attar, 1997) Broadbent, a professor at the University of Plymouth in the UK, divides the design process into five major phases: analysis, synthesis, evaluation, selection, and expression. (Broadbent, 1988) The design process serves as a tool to assist designers in taking into account a variety of restrictions that impact the shape, dimensions, and character of the suggested architectural space as viewed by its users. There are five design phases to architectural services.

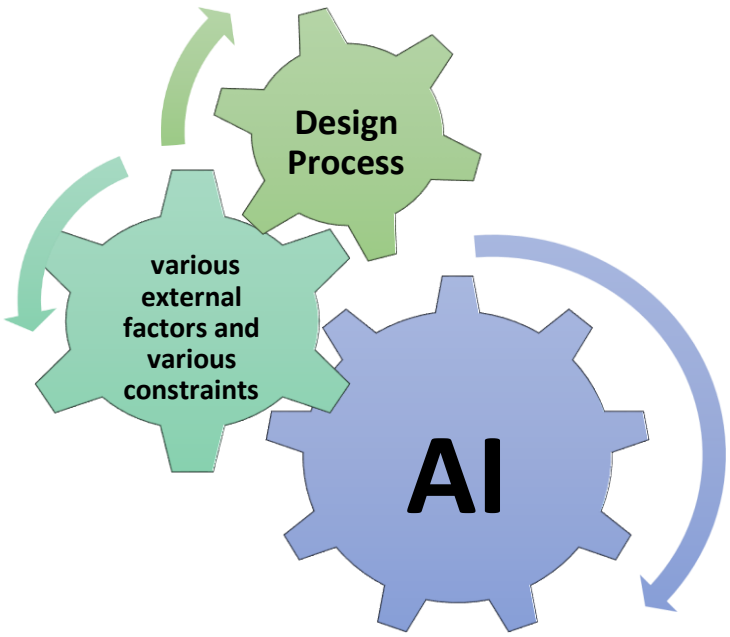

Figure 1.1 a diagram shown the integration of the AI in the design process.

AI will serve as an architect's assistant, able to resolve particular issues that the architect has specified. Though they can help generate a variety of solutions, sophisticated AI systems cannot take the position of humans as architects. There is no end to the architectural engineer's desire for inventiveness and command over the design environment. As a result, designers need to accept the important distinctions between the current AI techniques used in architectural engineering and earlier digital technologies. (Gallo, G., & wirz, f., 2020) John McCarthy, the inventor of artificial intelligence, claims that it is "The science and engineering of making intelligent machines, especially intelligent computer programs" (Jamal Malaeb, Professor Wejung Ma, 2019) AI has gradually increased its penetration into the creative work of architectural design, and instead of repetitive labor, it is can be involved maybe in all the staged mentioned by Broadbent. (Jamal Malaeb, Professor Wejung Ma, 2019)

METHODOLOGY

A comparative and qualitative methodology were adopted in this paper first by the analysis of the different key abilities of the AI in Architecture and the main stages of the design process trying to create a new approach of designing building that coop with the technological development. Artificial intelligence (AI) is rapidly transforming various industries, and architecture is no exception. From conceptual design to construction and beyond, AI is poised to revolutionize how we approach building and inhabit our world.

THE STAGES OF THE DESIGN PROCESS AND THE AI IN ARCHITECTURE

The process of designing a building, space or structure typically consists of five design phases. They are the steps of an architect's role in design. They are (in order): programming, schematic design, design development, construction documents, construction administration.

Programming

In architecture is the pre-design phase or the articulation of a building's required functionalities and needs. It is a systematic process involving the gathering and analysis of information about the intended building or environment. This information is then used to establish guidelines for the performance of that setting. Programming is often referred to as the problem-seeking stage. Programming concerns five steps: establish goals, collect and analyze facts, test concepts., determine needs and state the problem.

Schematic Design

The creative phase of the design process, when the primary ideas of shape and space are developed, marks the beginning of the problem-solving phase. The project's overall "scheme" is the main emphasis throughout the schematic design phase. At this point, it's critical to ignore little issues and focus on creating a clear, all-encompassing solution that covers the project as a whole.

Design Development

The architects transform the conceptual drawings into permission documents as decisions are still being made. At this stage, the visuals change from diagrams to the actual architecture. The methods and details of the drawings have been refined.

Construction Documents

A condensed collection of construction drawings is called a set of permission drawings. The building permit is submitted, coordinated, and obtained from the municipal or county using the permit documentation. Even down to the smallest details, the drawings are ever evolving.

Construction Administration

This phase mean that the project's drawings and documentation are finished, construction can start. Generally, the architect is hired to respond to inquiries, handle clarifications, and make changes if needed for a project of any complexity. (William M. Peña, Steven A. Parshall, 2012) By studying these main five steps of the design process facilitate the integration of the AI in each phase.in consequence. An accurate architectural design will be produced by identifying each of these five phases and incorporating AI technology.

Artificial intelligence (AI) is defined as the ability of digital devices and computers to perform particular activities that replicate the cognitive processes of intelligent beings including the human mind. These challenges cover a variety of skills, including as thinking, imitating different brain processes, and learning from prior experiences. Artificial intelligence's main goal is to build intelligent computers that can learn and comprehend like humans. These kinds of systems hope to provide its users with a wide range of services, including instruction, counseling, communication, and more. (wenjun, M., & malaeb, J., sep 2019) The AI's role in the design process is one of the most important impacts of ai in architecture is its ability to enhance the design process.

A COMPARATIVE ANALYSIS OF THE KEY ABILITIES OF AI IN ARCHITECTURE

Architecture is changing quickly as a result of artificial intelligence's many potent capabilities. With remarkable speed, AI is able to generate design ideas, frequently investigating possibilities that human designers might overlook. Large datasets pertaining to construction codes, material characteristics, and environmental conditions can also be analyzed by it, producing better and more efficient designs. AI also makes performance simulation easier, enabling architects to test a building's structural integrity and energy usage under different scenarios. The efficiency and inventiveness of the design process are eventually improved by AI, which frees up architects to concentrate on the creative and conceptual elements of their job by automating tedious processes and offering insightful data.

Design Exploration and Optimization

AI's ability to rapidly generate and analyze numerous design variations allows for a more thorough exploration of the design space. Architects can use AI to test a wide range of parameters and constraints, leading to optimized solutions that balance aesthetics, functionality, and performance. This process can involve:

- **Generative Design:** Generative design is among the most important uses of AI in architecture. Based on predetermined characteristics, including site conditions, building requirements, and aesthetic preferences, this technology generates thousands of design choices using algorithms and data inputs. Then, by investigating these design options, architects can discover creative answers that might have gone unnoticed using more conventional design techniques.

- **Parametric Modeling:** Architects may experiment with complicated designs and swiftly adjust to changing requirements because to AI's ability to automate the generation and adjustment of complex geometric forms.

Construction and Project Management

In construction and project management, AI's key abilities lie in streamlining processes and improving outcomes through enhanced project scheduling, resource allocation, and cost estimation. AI-powered tools enable more efficient and cost-effective project execution, while real-time site monitoring improves safety and reduces risks. By analyzing data from past projects, AI can also predict potential delays or issues, allowing project managers to take proactive measures and ensure timely completion such as:

- **Construction Robotics:** AI-powered robots can automate repetitive tasks on construction sites, such as bricklaying, concrete pouring, and welding, improving efficiency and safety.
- **Predictive Analytics:** AI can analyze data from various sources, such as weather patterns, material availability, and construction schedules, to predict potential delays and optimize project timelines.
- **Cost Estimation:** AI algorithms can accurately estimate construction costs by analyzing historical data, material prices, and labor rates, helping to improve project budgets and minimize financial risks.

Building Performance and Sustainability

AI plays a crucial role in enhancing building performance and sustainability. AI algorithms can analyze vast amounts of data related to energy consumption, occupancy patterns, and environmental conditions to optimize building systems like HVAC and lighting for peak efficiency. This leads to significant energy savings and a reduced carbon footprint. Furthermore, AI aids in the selection of sustainable materials and construction methods by evaluating their environmental impact throughout the building's lifecycle. By optimizing resource usage and minimizing waste, AI contributes to more environmentally responsible and sustainable building practices.

- **Energy Modeling:** AI can simulate building performance, such as energy consumption, daylighting, and indoor air quality, to identify areas for improvement and optimize building designs for energy efficiency.
- **Environmental Impact Assessment:** AI can analyze the environmental impact of building materials and construction processes, helping architects make more sustainable design choices.

Client Engagement and Communication

AI is also enhancing communication and client involvement in architectural design. Clients can better comprehend and engage with suggested ideas because to the immersive virtual experiences that AI-powered visualization tools can produce. AI can also improve communication by producing automatic reports, giving real-time updates, and even creating virtual design assistants that can respond to inquiries from clients. More client participation is encouraged by this technology, which also guarantees that the finished design closely reflects the client's vision.

- **Virtual and Augmented Reality:** AI can be used to create immersive virtual and augmented reality experiences, allowing clients to visualize and interact with building designs in a more engaging and intuitive way.
- **Design Communication:** AI can help architects communicate their design intent more effectively through the use of interactive visualizations, animations, and simulations.

NEW GUIDELINES IN DESIGNING BUILDINGS

AI integration into the architectural design process is a paradigm shift where technology and human creativity work together. The following table1.1 combines the fundamental capabilities of artificial intelligence in architecture with the different phases of the architectural design process.

In this phase and after the detailed study of both the design process stages in atrchitecture and the application of AI Capabilities a set of new guidelines using the technological solutions and suggested as a new approach in designing building and thinking by mix and match each point with its equivalent application to suggest new matrix serves as guidelines and set the importance of both the human think and the technological solution especially in architecture.

When architects use AI as a tool to investigate, optimize, and overcome design difficulties in dynamic and inventive environments, they reap the benefits of synergy. As a result, human inventiveness and technological proficiency in the realm of architectural innovation are harmoniously combined. The integration of AI into architectural design has produced a number of successes, such as: Helping Architects Process Data; Contributing AI Algorithms to Design Interpretation; Improving Efficiency Throughout Architectural Design Stages; AI Patterns Improving Efficiency in Architectural Design Stages; and Importance of AI in Architectural Design Stages.

Table 1.1 indicate the new guidelines for the integration of the AI Capabilities with the design process in architecture

The stages of the design Process	Key Abilities of AI in Architecture	Applications	New guilines
1 Programming (establish goals, collect and analyze facts, test concepts., determine needs and state the problem)	(a) Design Exploration and Optimization	(a) Generative Design (b) Environmental Impact Assessment	1.A.a
2 Schematic design	(b) Construction and Project Management	(c) Construction Robotics (d) Predictive Analytics (e) Cost Estimation	2.D.i 2.A.b
3 Design Development	(c) Building Performance and Sustainability	(f) Energy Modeling (g) Environmental Impact Assessment	3.B.f 3.B.d 3.B.e
4 Construction documents 5 Construction administration	(d) Client Engagement and Communication	(h) Virtual and Augmented Reality (i) Design Communication	4.B.c 5.C.g 5.D.h

Consequently, AI Will Not Take the Place of Architects: While AI can be a useful tool during the design process, it won't replace architects especially with the new guidelines created a new approach of design thinking.

CHALLENGES AND CONSIDERATIONS

AI algorithms rely heavily on data, and the quality and availability of data can significantly impact the accuracy and effectiveness of AI applications in architecture. It's crucial to address ethical concerns related to AI in architecture, such as data privacy, job displacement, and the potential for algorithmic bias. While AI can offer valuable insights and automation, human expertise and creativity remain essential in the architectural design process.

Even while AI has a lot of promise, there are significant ethical concerns. The human element in architecture runs the risk of being diminished as robots play a bigger part in design and decisionmaking. Making sure AI enhances human creativity and judgment rather than takes its place is the difficult part. Data privacy, the effects of AI technologies on the environment, and the possibility of algorithmic bias are more issues.

CONCLUSION

AI has the potential to significantly enhance the practice of architecture, from the initial design phase to construction and beyond. By embracing AI technologies and addressing the associated challenges, architects can unlock new possibilities for creativity, efficiency, and sustainability in the built environment. The integration of AI technologies in architecture is opening up new possibilities for creativity, efficiency, and sustainability in the built environment. By harnessing the power of AI-driven tools and algorithms, architects can innovate, design more resilient structures, and deliver enhanced experiences for building occupants.

This paper introduces a novel paradigm in architectural design by proposing a framework that integrates fundamental design process methodologies with contemporary applications of Artificial Intelligence. The suggested guidelines delineate a synergistic relationship between established architectural design principles and the emergent capabilities of AI, aiming to redefine and potentially enhance conventional design workflows.

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