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**Title:** "The Impact of Using Artificial Intelligence in the Design Process of Interior Spaces"

**Abstract:** Artificial intelligence is the technology of the future and one of the most prominent achievements of the Fourth Industrial Revolution, thanks to its diverse applications in many fields. These applications have contributed to providing multiple alternatives and innovative solutions. The main goal of artificial intelligence is to develop the mental capabilities of machines.

With regard to interior design, this field has gained great functional importance in the industry, especially with the emergence of modern technologies such as artificial intelligence, virtual reality, and augmented reality, which have provided broader and better opportunities for development. Many of these technologies have helped reduce the time and effort required for design, thanks to their ability to process huge amounts of data and test various ideas in a short time, with ease, objectivity, and high accuracy.

**العنوان:** أثر استخدام الذكاء الاصطناعي في العملية التصميمية للحيزات الداخلية.

**الخلاصة:** الذكاء الاصطناعي يُعد تقنية المستقبل وأحد أبرز إنجازات الثورة الصناعية الرابعة، بفضل تطبيقاته المتنوعة في العديد من المجالات. وقد ساهمت هذه التطبيقات في توفير بدائل متعددة وحلول مبتكرة. ويتمثل الهدف الرئيسي للذكاء الاصطناعي في تطوير القدرات الذهنية للألات. فيما يخص التصميم الداخلي، اكتسب هذا المجال أهمية وظيفية كبيرة في الصناعة، خاصة مع ظهور تقنيات حديثة مثل الذكاء الاصطناعي، الواقع الافتراضي، والواقع المعزز، مما أتاح فرصاً أوسع وأفضل للتطوير. لقد ساعدت العديد من هذه التقنيات في تقليل الوقت والجهد اللازمين للتصميم، بفضل قدرتها على معالجة كميات هائلة من البيانات واختبار أفكار متنوعة خلال وقت قصير، بسهولة وموضوعية ودقة عالية.

**الكلمات المفتاحية:** الثورة المعلوماتية - الذكاء الاصطناعي - التصميم الداخلي - الحيزات الذكية - العمارة الرقمية - الخوارزميات - تطبيقات الذكاء الاصطناعي.

**Introduction:** In recent decades, the world has witnessed a profound transformation driven by the digital revolution and rapid technological advancements. Technology has become an integral part of daily life, influencing various sectors and industries. This transformation is rooted in the Fourth Industrial Revolution, which is characterized by cutting-edge digital innovations, cloud computing, and big data. Among the most groundbreaking developments is Artificial Intelligence (AI), which has emerged as a powerful tool for reshaping human thinking and productivity.

Artificial Intelligence, defined as the ability of machines to mimic human intelligence in learning and decision-making, is no longer a futuristic concept but a tangible reality with significant impacts on numerous fields. From healthcare to transportation, and education to creative design, AI plays a crucial role in driving efficiency and innovation. It has also transformed how humans interact with technology, enabling individuals and organizations to achieve unprecedented milestones.

**Research Simple:** Within this context, the integration of AI into interior design stands out as a prime example of this transformative shift. AI offers innovative solutions for analyzing user needs and designing interactive spaces that balance comfort, aesthetics, and functionality. The synergy between the digital revolution and AI presents a golden opportunity for a more advanced and creative future, with ongoing advancements expected to shape human life for decades to come.

**The Scientific Methodology of Research:** The research follows the descriptive analytical approach in studying and analyzing the concepts and programs of artificial intelligence and the capabilities and functions it offers that facilitate design processes.

**Research Problem:** Limitations in design methodologies hinder the planning of innovative design ideas that align with digital trends. Designers' creativity has been constrained by an overreliance on and saturation with traditional forms.

Furthermore, there is a significant lack of awareness among designers, engineering consultancy firms, and contracting companies regarding the advantages of utilizing Artificial Intelligence applications in managing interior design processes effectively.

**Research Objectives:** The current study aims to shed light on artificial intelligence and explore how to benefit from its applications, by employing it in the field of interior design to enhance creativity and innovation.

**Research Hypotheses:**

1. Artificial Intelligence (AI) effectively contributes to enhancing interior design skills and meeting the requirements of the design process across all stages of implementation.
2. Modern digital trends play a significant role in advancing design thinking within interior spaces.
3. AI applications greatly contribute to developing creative abilities and improving design skills.
4. The relationship between the designer and AI tools is complementary, and these tools cannot replace the designer.

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### **Research Importance:**

- Familiarity with the importance of keeping up with technology and modern trends such as Artificial Intelligence.
- Leveraging modern technology applications in managing interior design processes.
- Highlighting the capabilities of Artificial Intelligence in various stages of the design process.
- Understanding the concept of Artificial Intelligence and its techniques.
- Exploring its effectiveness in enhancing interior design skills, saving designers considerable time and effort.
- Achieving optimal innovative results through the use of Artificial Intelligence applications.

### **Research Sections:**

- A historical overview of Artificial Intelligence in Interior Design.
- Terminology and types of Artificial Intelligence.
- Advantages and disadvantages of using Artificial Intelligence tools in design.
- AI-enhanced design applications.
- Example about how to use AI design applications.

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## **A Historical Overview of Artificial Intelligence in Interior Architecture**

### **Phase 1: Theoretical Foundations and Establishment (1950s - 1970s)**

The concept of artificial intelligence began to emerge in architecture and interior design during the 1950s, alongside the general development of the field. At this stage, the primary focus was on exploring the potential to transform human ideas into programs capable of analyzing designs and making decisions.

In the 1970s, the introduction of Computer-Aided Design (CAD) systems in interior architecture provided designers with tools to enhance designs and plan spaces with greater precision.

### **Phase 2: Emergence of Intelligent Systems (1980s - 1990s)**

In the 1980s, expert systems—an early form of artificial intelligence—emerged. AI applications in interior design began to rely on these systems to offer design suggestions based on programmed rules and knowledge.

By the 1990s, smart software like Autodesk Revit and SketchUp revolutionized interior design by simplifying the process and offering 3D visualizations of spaces, enabling designers to improve productivity and quality.

### **Phase 3: Integration with Virtual and Augmented Reality (2000s)**

At the start of the 21st century, interior design experienced significant advancements due to the integration of AI with modern technologies such as Virtual Reality (VR) and Augmented Reality (AR).

Interior design tools began leveraging these technologies to provide realistic simulations of designs before implementation, enhancing client experiences and reducing design errors.

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#### **Phase 4: Artificial Intelligence and Big Data (2010s)**

In the 2010s, AI software started utilizing big data to analyze client needs and deliver customized design solutions.

Tools like Houzz and Planner 5D began using AI algorithms to recommend designs tailored to clients' previous preferences.

Software capabilities expanded to include the analysis of lighting, ventilation, and space distribution, enabling optimal functional and aesthetic use of interior spaces.

#### **Phase 5: Generative AI in Interior Architecture (2020s)**

Over the last decade, generative AI systems such as MidJourney and DALL-E have enabled the creation of innovative interior designs based solely on textual inputs.

Design tools have evolved to offer intelligent proposals that combine data, aesthetics, and functionality, enhancing creativity in the field.

Modern software like Enscape and Twinmotion now relies on AI to provide dynamic 3D visualizations and realistic simulations of interior projects.

#### **Current Phase and Future Outlook**

Today, AI plays a direct role in managing design projects, leveraging data analysis to improve resource allocation and select sustainable materials.

There is a clear trend toward designing smart spaces that respond to user behaviors through AI and the Internet of Things (IoT).

The future promises further integration between AI and collaborative design processes involving both humans and machines, which will enhance innovation and efficiency in interior architecture.



Figure (1 ,2) Illustrates The Difference Between Design Methods in the Past and Present created by using ChatGPT AI Application.

## Terminology of Artificial Intelligence

### The Design Process

It is difficult to define the design process precisely due to the diversity of approaches and models, as well as the variety of architectural design teaching methods. However, all these methods share one main goal: to achieve a successful architectural product that meets the needs of all the parties involved in the design process.

All participants in this process, whether architects, architecture students, or professors, aim to enhance the impact of the architect. This is done by stimulating the architect to think deeply about the various aspects of design and organizing the process in a way that makes it clearer and more effective. The design process is no longer exclusive to the architect, as it has a significant impact on the end-user of the architectural product as well.



## Digital Technology

Digital technology is defined as the process of converting specific information such as images, sound, or text into binary codes consisting of the digits (0) and (1). This technology serves as a technical language used to transmit and convert messages electronically via a computer. Digital technology allows for the storage of data in its original form using binary patterns (0 and 1), which facilitates more accurate processing. It significantly contributes to the enhancement of digital production, sound effects, and lighting effects.

## Artificial Intelligence (AI)

Artificial Intelligence (AI) is a technological field focused on developing systems and software that can perform tasks typically associated with human intelligence. AI relies on algorithms and mathematical models to analyze data and make intelligent decisions. The goal is to simulate human capabilities in reasoning, learning, adapting, and decision-making.

## Virtual Reality (VR)

Virtual reality is a technology that integrates digital elements with the real world. It uses hardware and software to enhance the interaction between the user and the real world by adding digital elements, which are displayed through devices such as smartphones, tablets, or special VR headsets. This system allows users to interact with virtual environments designed within a real-world context.



**Figure (3) Illustrates The use of virtual reality in interior design, where the designer wears a VR headset and interacts with 3D models of furniture and decor elements, allowing them to adjust colors and layouts in an advanced digital environment. Created by using ChatGPT (AI).**



## Digital Manufacturing and Production Processes

Digital manufacturing involves a set of processes that help solve implementation-related issues. These processes follow two directions: the first is from the digital model to the real building, which is the main direction of manufacturing. The second involves transferring the miniature model (a large-scale model) to the digital model using scanners in a process known as Reverse Engineering.

## Augmented Reality (AR)

Augmented reality allows the user to see the real world around them while adding synchronized digital elements in real-time. These elements are displayed through special devices worn or held by the user, allowing them to interact with virtual objects in their real environment. AR ensures the integration of digital data with the real world.



**Figure (4) Illustrates The use of Augmented Reality (AR) in interior design, where the designer uses a tablet to place and adjust virtual furniture within a real room, with a 3D sofa clearly appearing on the screen. You can see how digital elements blend seamlessly with reality. Created by using ChatGPT (AI).**

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## Three-Dimensional Digital Systems

Digital systems are dynamic systems that often require effective display to interact with the user.

Some of the characteristics of these systems include:

- Output is visualized like 3D animations on a computer.
- Creation of an interactive visual environment that conveys concepts in an engaging manner.
- Supporting the designer's ability to handle large amounts of data and create optimal results.
- A quick response to human, environmental, and design needs, allowing fast input modifications.
- Advanced computer capabilities to display lighting, colors, and materials that surpass many designers' abilities.
- Adding stunning elements such as lighting, materials, and color gradients to create more impressive works using computer power.

## Types of Artificial Intelligence.

### Data-Driven AI

This type of artificial intelligence relies on analyzing large datasets to identify trends and patterns that can be used to improve the design of products or spaces. In interior design, for example, it is used to analyze customer preferences or to design visual interfaces that are more aligned with market demands.

### Generative Design

In this type, AI uses algorithms to generate new design solutions based on a set of inputs. The system generates a variety of innovative designs based on specific constraints such as dimensions, materials, or functions. This approach is applied in manufacturing and 3D printing, as well as in architectural design.

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## Machine Learning

Machine learning helps train systems to improve their performance over time by recognizing patterns. In design, it can be used to analyze previous design data, helping to improve future designs. For instance, machine learning can be used in website design to enhance user experience based on past user interactions.

## AI for Decision Support

This type of AI helps designers make better design decisions by providing intelligent recommendations based on the analysis of current data. This could include suggesting colors, materials, or configurations based on the collected data.

## AI in UI/UX Design

AI contributes to improving user interface design by learning from users' interactions with applications and websites. AI is used to provide personalized user experiences that adapt to users' behaviors and needs.

## AI in Simulation and VR

In architectural or interior design, AI can be used to enhance virtual reality simulations and provide interactive experiences for users. The system can help conduct realistic assessments of spaces, materials, or lighting, allowing designers to interact with designs in a realistic way before implementation.

## AI for Interactive Design

In this type, AI is integrated into interactive designs, such as interactive applications or exhibitions. This may involve providing instant feedback to user inputs or adapting to individual needs during interaction with the design

Concept	Field	What Does It Do?
<b>AI in Simulation and VR</b>	AI+ Virtual Reality	Uses AI to develop advanced simulation and VR environments.
<b>AI in UI/UX Design</b>	AI + Design	Uses AI to analyze and improve user experience and interface design.
<b>Augmented Reality (AR)</b>	Augmented Reality	Adds digital elements to the real world without isolating the user.
<b>Virtual Reality (VR)</b>	Virtual Reality	Fully immerses the user in a digital environment, separate from reality.

Table (A) illustrates the difference between types of Artificial Intelligence.

## **Advantages of Artificial Intelligence in Interior Design**

### **Improving Efficiency and Speed**

AI can automate many tasks that used to take a long time when done manually. By using smart tools, designers can speed up the design process, such as selecting colors, arranging furniture, or organizing spaces.

### **Customization and Adapting to Client Needs**

AI can analyze client preferences through inputted data, allowing for the creation of custom designs that meet their specific needs. The system can also adapt to changes during the design process to align with the client's desires.

### **Data Analysis and Decision Improvement**

With the ability to process and analyze large amounts of data, AI helps designers make data-driven decisions. It can be used to examine client preferences, market studies, or global design trends in interior design.

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## **Creating New Design Ideas**

With generative design systems, AI can generate innovative design ideas that may not have occurred to the designer. Using algorithms, the system can suggest entirely new design solutions based on a set of inputs like dimensions, materials, and functions.

## **Interaction with Virtual Reality (VR) and Augmented Reality (AR)**

AI can be integrated with virtual reality and augmented reality technologies to enhance design simulations realistically. This helps designers provide an interactive experience for their clients, allowing them to see designs in a 3D environment before implementation.

## **Improving Environmental Performance**

Through the ability to analyze environmental data (such as lighting or ventilation), AI can improve the efficiency of using interior spaces. The system can recommend adjustments to reduce energy consumption or improve environmental comfort in the space.

## **Disadvantages of Artificial Intelligence in Interior Design**

### **Lack of Human Creativity**

Although AI can generate design ideas, it cannot replace the human creativity and unique imagination that designers possess. Sometimes, the generative solutions provided by AI may lack inspiration or the artistic dimension that distinguishes handcrafted or personally designed works.

### **Dependence on Input Data**

AI relies on the data fed into it. If this data is inaccurate or incomplete, the results the designer receives may be incorrect or not reflect reality accurately. In interior design, this can lead to outcomes that do not meet the client's needs or do not suit the local environment.

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## Technical Challenges

Despite significant advancements in AI, there are technical challenges designers may face when using smart tools, such as integration issues between different systems or technical failures that can affect the workflow.

### Over-reliance on Technology

Over-relying on AI can lead to a decline in traditional design skills. Designers may become more dependent on automation rather than their personal creativity, which could affect the development of their professional skills.

### High Cost of Technology

While AI can help reduce long-term costs, the initial investment in AI technologies may be expensive. From purchasing hardware and software to training on how to use smart tools, the cost can be a barrier for small companies or independent designers.

### Limited Impact on Cultural Diversity and Local Design

AI may struggle to comprehend the cultural and local differences that play a significant role in interior design. It may overlook some social or cultural aspects that are part of the identity of the space or the client.

### Privacy and Security Concerns

Since AI relies on analyzing data, there may be concerns about privacy. If the input data contains sensitive information, there may be risks related to data leakage or improper use of this data.

## Example of AI-enhanced design applications

### REImagineHome

#### Steps to Use ReImagine Home

##### 1. Accessing the Platform

Open your browser and go to the ReImagine Home website (you can search for it on Google or visit the official site directly).

If you are a new user, you need to create an account using your email or a Google/Facebook account. If you already have an account, log in.

##### 2. Uploading an Image

After logging in, click on "Upload Image".

Choose an image of the space you want to redesign, such as a living room, kitchen, office, or any other interior space.

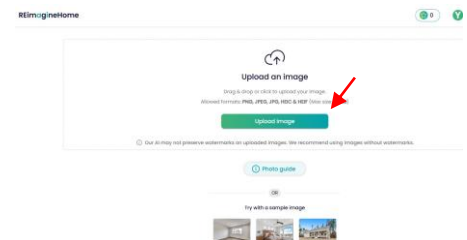


Figure (5) illustrates the first step of uploading the original image of the space to be redesigned.

##### 3. Selecting the Style and Preferences

Once the image is uploaded, the program will ask you to select the design style, such as:

Modern, Classic, Boho, Minimalist, Industrial, and more.

You can also choose a color palette, materials, and the overall ambiance you prefer.

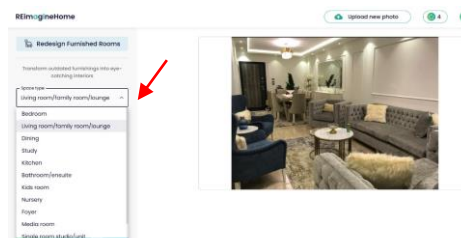


Figure (6) illustrates the second step, which is selecting the type of space to redesign.

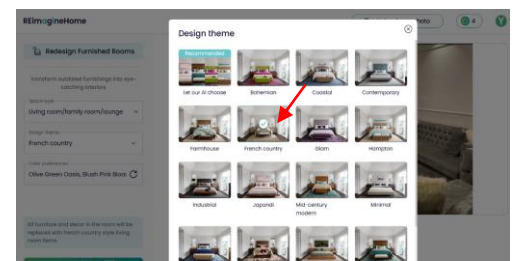


Figure (7) illustrates the third step, which is selecting the desired style for the redesign.



#### 4. Using AI Tools

After selecting the style, click on "Generate".

The AI will redesign the space based on your preferences.

If you don't like the first result, you can regenerate the design or adjust some options for better results.

#### 5. Downloading the Final Design

Once you are satisfied with the design, you can download the modified image in high quality by clicking "Download".

In premium versions, you may get multiple designs or higher-quality images.

#### 6. Sharing or Editing the Design

You can share the design with your clients or colleagues for discussion.

Some tools offer additional editing options, such as changing colors or rearranging furniture.

#### Result:

This application used AI tools to change the style of the original image effectively, creating a realistic representation. However, it was unable to fully understand the space correctly and did not modify all design elements to align with the new style and colors, such as ceilings, walls, and doors.

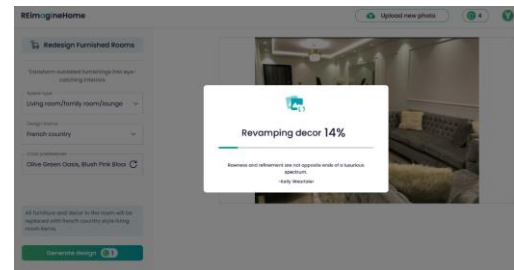


Figure (8) illustrates the fourth step, which is the redesign process.

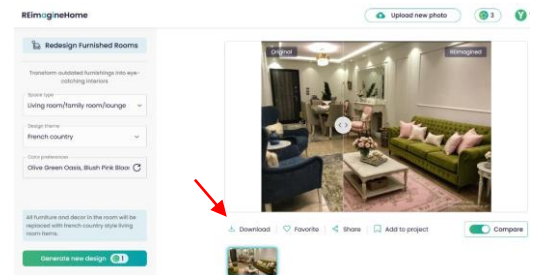


Figure (9) illustrates the fifth step, which is a comparison between the original design and the final result after redesigning.



Figure (10) illustrates the design before edits.



Figure (11) illustrates the design after edits which is the final

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## **AI-enhanced design applications.**

### **1. Autodesk Revit + AI Tools**

How to use: Revit is one of the most popular engineering and architectural design programs, and it uses artificial intelligence to improve space designs. AI tools in Revit can be used to analyze and customize building and facility designs. Users can input data about the space and desired patterns, and the program then uses AI to provide automatic design improvement suggestions.

Advantages: Smart designs based on multiple standards. Helps reduce errors and improve performance.

### **2. Artificial Intelligence in Autodesk AutoCAD**

How to use: Autodesk AutoCAD offers smart tools that can be used to analyze interior designs through AI applications that provide more efficient building solutions.

Advantages: Helps achieve precise designs while improving resource use.

### **3. SketchUp with AI Integration**

How to use: SketchUp is used to create 3D models, and integrating AI helps improve these models. You can download smart plugins like "Sefaira" for environmental and dynamic analysis of spaces.

Advantages: Easy to use, with AI support for energy efficiency analysis and smart space optimization.

### **4. Reimagine Home**

How to use: This program uses AI to transform room images into new interior designs. You can upload pictures of a specific space, and AI will suggest adjustments that match the furniture and decor.

Advantages: Precise improvements to interior designs based on images.

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