

Personalized Virtual Interior Design Using Generative AI

Pranali Bhope, Mishri Gube*, Vidhi Khobragade

Abstract

This study presents an AI-driven virtual interior design system that allows users to effectively redesign their home or workspace with an integrated shopping experience. The system tailors designs according to room type, style, and purpose, ensuring that the created layouts are aesthetically pleasing, well-organized, and functional. In contrast to conventional interior design, which involves professional skill, hand labor, and much time consumption, this AI-based method uses technology to automate fundamental design features like lighting adjustment, and color matching, making it possible for users to achieve visually appealing and functional spaces with little effort. In addition, the system is able to recognize furniture and accessories in the output designs and associate them with online retailers so that users can easily browse and buy recommended items directly. This integration serves to close the gap between computer-generated design and actual implementation, and it provides a seamless and engaging experience. The AI guarantees realism and flexibility in the designs while ensuring coherence among varied elements and yet conforming to user interests. Future development will emphasize enhanced adaptability through the addition of real-time user input and sophisticated learning processes, enabling the system to further refine its suggestions and provide even more tailored results. Through the integration of automated design generation with a seamless shopping experience, this work offers a revolutionary solution that streamlines the interior design process while making it easy for users to realize their virtual designs in the real world.

Keywords: Interior design, generative AI, deep learning, stable diffusion, ecommerce

INTRODUCTION

Interior design is an essential process of developing functional, aesthetically pleasing, and comfortable living or work environments. Conventional interior design is a time-consuming and money-intensive process involving manual planning and numerous consultations with designers to result in the desired outcome. While professional designers use experience and creativity to design spaces, the technological revolution has brought forth AI-based solutions to automate and customize the interior design process. The advent of artificial intelligence has made it possible to create real, well-organized, and user-oriented interior designs, removing many of the issues that come with conventional methods.

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AI-based interior design solutions offer a low-cost and automated solution, enabling users to produce high-quality designs in a matter of minutes. One of the greatest benefits of AI in interior design is the speed and efficiency. Rather than taking weeks to plan a room, AI is able to create high-quality designs in a matter of seconds, so the process

is vastly quicker. Furthermore, AI systems give users several options for designs to compare and determine the best option for their requirements. Major capabilities of AI-based interior design are:

- *Automated furniture layout design:* AI can scan room measurements and propose optimum furniture positioning for maximum space use.
- *Color and lighting suggestions:* AI proposes complementary colors and optimal lighting configurations to create overall ambiance.
- *Personalization and customization:* People can personalize and customize their own styles, colors, and furniture arrangements to make their space their own.

One of the main challenges with classic interior design is searching for and choosing furniture and decorative items that suit a design concept. To make this process more efficient, the suggested system incorporates an e-commerce option, enabling users to buy directly suggested furniture and decor products from online retailers. With this feature, the overall interior design experience is improved by filling the gap between digital design and actual implementation. By integrating AI-powered design generation with e-commerce capabilities, this system presents an integrated interior design solution. Users can bring their dream rooms to life and make them a reality with minimal effort, and make interior design more efficient, and user-friendly.

OBJECTIVE

This research aims to develop an AI-driven Virtual Interior Design System that transforms room images based on user preferences using Stable Diffusion with ControlNet. The objective is to enhance design accuracy, speed, and customization while making interior design more accessible. This system can assist homeowners, designers, and businesses in visualizing and planning interiors efficiently.

LITERATURE SURVEY

The integration of artificial intelligence (AI) into interiors has achieved considerable traction, enabling automated, efficient, user-oriented design solutions. Various studies have explored AI-controlled approaches for interior design, highlighting generative models, virtual reality, and personalized recommendations [1]. Wu and Han explored how AI and Virtual Reality can improve interactive designs and ensure seamless user interaction [2]. Similarly, Wang *et al.* [3], and Thakkar *et al.* [4] proposed a generative AI-based system for interior design that emphasizes automation in spatial planning and decoration selection [5]. Furthermore, Ismail examined the integration of AI interior design into training and demonstrated its impact on student design [6]. Additionally, Phadke *et al.* utilized GANs to create realistic virtual interior designs, demonstrating deep learning's capability in design synthesis [7]. Cai and Xie investigated the impact of environmental psychology on modern interior design [8], aligning with AI's potential for user-oriented personalization [9]. Hanna analyzed AI-generated art on platforms such as MidJourney, highlighting AI's creative potential in artistic and advertising applications [10]. Research by Ren *et al.* introduced DesignGemini [11], which combines generative models with digital twin technology to enable highly personalized design solutions [12]. These studies collectively highlight the transformative potential of AI in interior design, paving the way for virtual interior design generators to automate layout creation and integrate seamless ecommerce experiences. The proposed AI-driven virtual interior design generator utilized computer vision, deep learning, and stable diffusion to improve interior accessibility, efficiency, and personalization [13].

METHODOLOGY

The proposed system is a combination of AI-based models and object detection techniques to generate optimized room interior designs based on user input. The workflow of the model is mentioned in Figure 1.

1. *Room Image Upload:* The process begins with users uploading an image of their current room.
2. *Edge Detection (Canny Algorithm):* To analyze the structural elements of the room, such as walls, doors, windows, and major furniture pieces, the Canny Edge Detection technique is applied.

3. *AI Model-ControlNet Integrated with Stable Diffusion*: The structural edge map obtained from the previous step is processed using a combination of Stable Diffusion models and ControlNet. As a result of AI processing, a realistic, AI-generated interior design image is produced.
4. *Object Detection using YOLOv8*: After the virtual design is finalized, YOLOv8, an advanced object detection model, is used to identify and label various elements within the design (e.g., chairs, tables, sofas, lighting fixtures).
5. *Mapping to E-commerce Platforms*: Once individual furniture and decor items are detected, the system matches each element to similar products available on popular e-commerce platforms like Amazon.
6. *Final Output: Design Visualization and Shopping Links*: Finally, the system presents users with the AI-generated interior design image along with clickable purchase links for each identified object.

Implementation

The Virtual Interior Design Generator has been implemented by integrating advanced AI models with image processing and object detection techniques to provide users with automated design suggestions and purchasable item lists. The key components of the system and their respective implementation details are:

Image Upload and Preprocessing

The system accepts room images in standard formats such as JPG or PNG. Once an image is uploaded, preprocessing steps such as resizing, normalization, and format conversion are applied to ensure compatibility with subsequent AI models.

Edge Detection using Canny Algorithm

To extract structural details, Canny Edge Detection is applied to the uploaded image using OpenCV, a widely used computer vision library. The Canny algorithm identifies edges that represent walls, doors, windows, and existing furniture outlines. This edge map serves as the input guide for the AI model, ensuring that generated designs maintain spatial coherence with the room's structure.

AI-Based Interior Design Generation

The processed edge map is fed into a combination of ControlNet and Stable Diffusion models:

- ControlNet ensures that the AI-generated design adheres to the room's existing layout by following the provided edge constraints.
- Stable Diffusion, a powerful text-to-image generative model, produces high-quality interior designs. Users can provide additional input such as preferred color themes, furniture styles, or decor choices, which are embedded as prompts in the AI model to influence the final output.

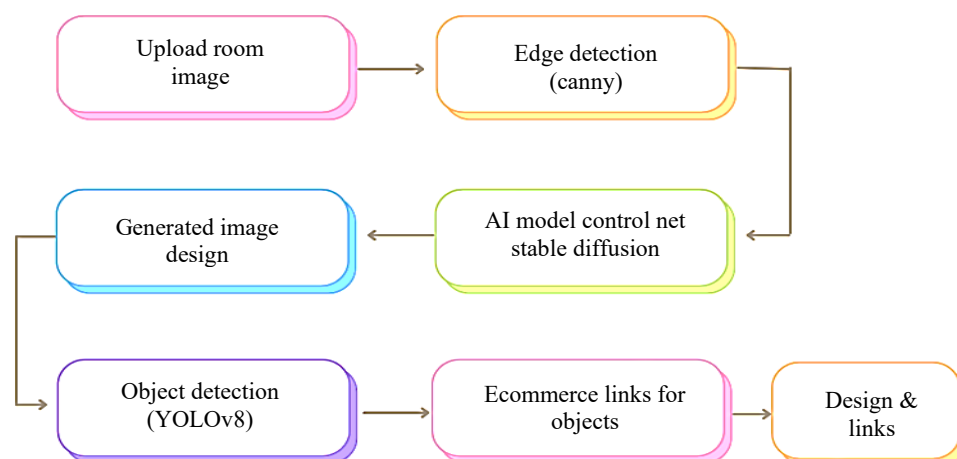


Figure 1. Working flow of the model.

Object Detection with YOLOv8

Once the AI-generated design is obtained, YOLOv8 (You Only Look Once version 8) is employed for object detection and segmentation. The model is fine-tuned on datasets to recognize key furniture elements such as sofas, tables, chairs, lamps etc.

- YOLOv8 is implemented using Ultralytics YOLOv8 library, which provides pre-trained weights and allows customization for furniture-specific datasets.
- Detected objects are annotated with bounding boxes and class labels.

Product Mapping to E-Commerce Platforms

The list of detected objects is passed to a mapping module that searches for similar products on popular e-commerce platforms such as Amazon. The system retrieves product images, names and direct purchase links.

Final User Interface (UI) Output

The final output is a web interface developed using Streamlit. Users can interactively view the design and explore options to purchase each piece of furniture and decor. Figures 2 and 3 show the final output displays on the User Interface.

Figure 4 and Figure 5 Comparison of original image and generated image.

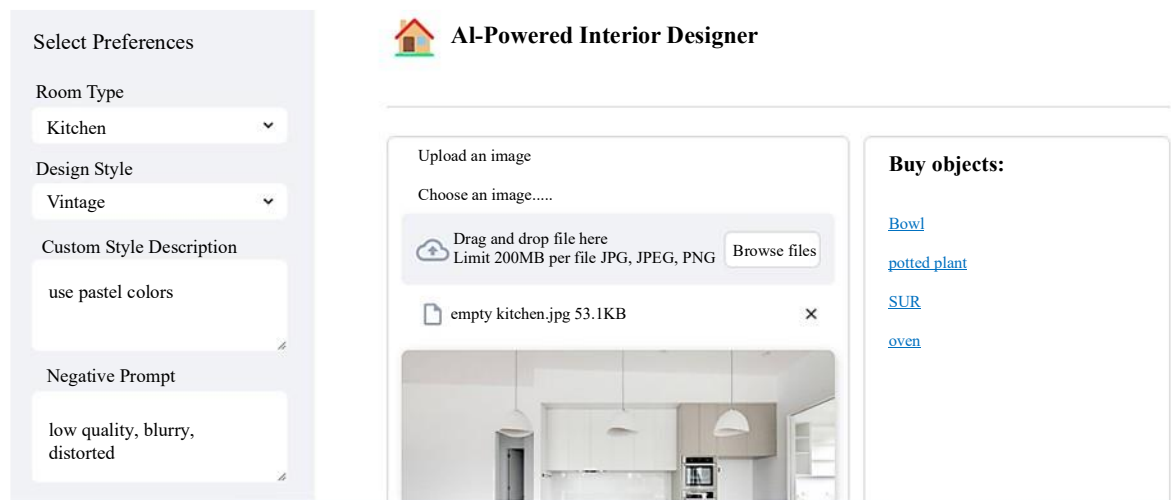


Figure 2. User interface displaying final output.

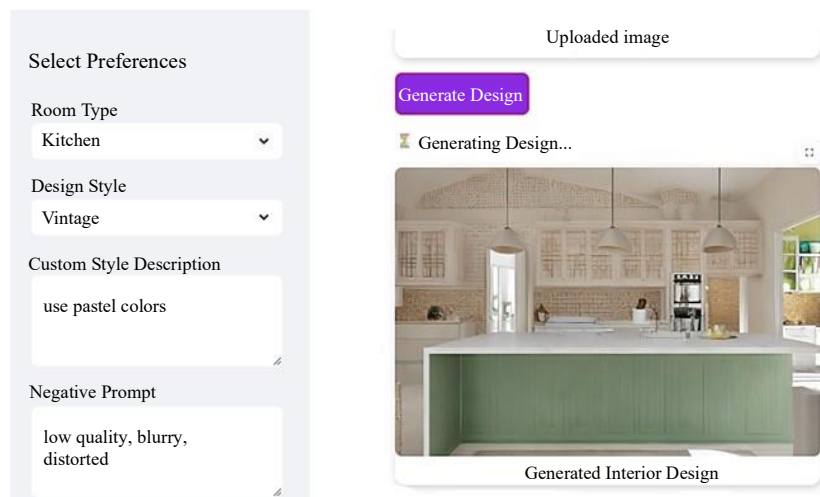


Figure 3. User interface output.



Figure 4. Original image.



Figure 5. Generated image.

RESULTS

The system successfully improves plain interiors by generating stylish and realistic designs. In the kitchen transformation as shown in Figures 4 and 5 the original simple white space was enhanced with a modern green island, better textures, and improved lighting. This shows that our model can create visually appealing and high-quality interior designs while keeping important elements like windows and room structure intact.

CONCLUSION

This research introduces a virtual interior designer generator that works with AI. This automates the interior design process, making it more accessible, more efficient and personalized. Using generative AI, computer vision, deep learning and stable diffusion, users can create aesthetically appealing and functional rooms with minimal effort. Additionally, e-commerce integration improves the user experience by seamlessly linking design elements with purchasable items. The proposed approach significantly reduces the time, cost, and expert knowledge required for interior decoration, while also

entailing high adjustment and adaptability. Future work will focus on including real-time user feedback and augmented learning mechanisms, further improving design recommendations and improving user satisfaction.

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