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AI Powered Interior Design and AR Visualization System

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***Abstract*— Interior design plays a crucial role in enhancing the aesthetics and functionality of living spaces. Traditionally, designing a room requires professional expertise, time, and cost. With advancements in web technologies, 3D visualization, Artificial Intelligence (AI), and Augmented Reality (AR), it is now possible to simplify and automate this process.**
The Interior Generator is a web-based application that allows users to design and visualize their rooms in an interactive 3D environment. The system enables users to input room dimensions, upload surface images, and customize walls, floors, and ceilings using various design options. Additionally, the platform integrates AI-based design generation and AR visualization to enhance user experience and decision-making.
This project aims to provide an easy-to-use, cost-effective solution for users to create, modify, and visualize interior designs without requiring professional skills.

***Index Terms*— 3D Visualization, Augmented Reality (AR), Artificial Intelligence (AI), Smart Painting, Room Modeling, Web Application, User Customization, Image Processing.**

I. INTRODUCTION

AI powered interior design and visualization system is designed in such a way that it creates functional, comfortable and visually appealing living spaces. It makes thoughtful arrangements using color schemes, textures, lightning and layouts such that it ensures feasibility in use. Usually Interior design requires expertise from professionals, monetary and time investments, which doesn't becomes a constraint to access or from taking help.

In advanced times like today technologies like 3D visualization, Artificial Intelligence(AI), and Augmented Reality(AR) are making the process of designing interiors more efficient, user-friendly and interactive. These technologies help users to visualize and experiment with various designs in real time such that it reduces dependency on professional intervention and planning manually.

AI powered interiors design and visualization system is a web-based application used to simplify and automate the process of interior designing. This interior Generator provides a perfect platform such that users can create and visualize room designs in a dynamic 3D environment. Users will be able to give inputs of room dimensions and upload images of surfaces and can also customize elements like walls, floors, and ceilings having a lot of design options. Integration of AI allows to generate intelligent design suggestions based on preferences of the users, while AR helps in making the visualizing experience better.

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Z. Ji and Y. Yu (2025) proposed an intelligent interior design system using CNN, GNN, and Transformer models to optimize layouts and aesthetics based on user data. Their approach achieved high personalization using Structured3D and SUN RGB-D datasets, though it involved complex integration.
J. Jiang et al. (2025) developed a human–machine collaborative design system combining CenterNet, StyleGAN3, and Transformer models. This method improved design accuracy and interaction quality but required high computational resources.
A 2025 survey published by Springer on floor plan image analysis provided a comprehensive study of layout recognition methods and datasets. While it offered a strong theoretical foundation, it was not directly focused on design generation.
Z. Huang (2025) introduced an adaptive interior design approach using generative AI based on MBTI personality types. The system enhanced personalization but depended heavily on user preference data.
S.-Y. Wang et al. (2024) proposed "Room Dreaming," a generative AI system with human-in-the-loop interaction for rapid interior design exploration. It enabled fast co-design but was limited to preliminary design stages.
A. Odiah and S. Gosling (2024) studied the use of generative AI tools such as DALL·E 2 in architectural research. Their findings showed that AI can effectively convey ambience, although realism remains a challenge.
J. Chen et al. (2024) introduced HyNet, a hybrid deep learning model for interior texture retrieval. It improved workflow efficiency but was dependent on the quality of the dataset.
Y. Fan et al. (2024) proposed a multimodal deep learning approach using Transformers for interior design evaluation. The system provided objective scoring but required high computational resources.
R. Singh and M. Patel (2023) developed an automated interior design recommendation system using CNN and recommender techniques. It provided practical solutions but had limited personalization capabilities.
S. Park et al. (2022) proposed a vision-based interior space understanding system using deep neural networks. It achieved accurate spatial modeling but required significant computational power.
X. Li et al. (2021) worked on aesthetic analysis of interior images using CNN-based scoring techniques. This enabled design recommendations but involved subjective evaluation challenges.

III. Proposed System

A. Manual Design Approach

The Manual Design Approach allows users to design their rooms according to their own preferences and creativity. Users can select furniture items such as sofas, chairs, tables, and decorative objects, and place them at desired locations within the 3D room. They can also rearrange furniture and experiment with different layouts before finalizing the design. This approach provides maximum flexibility and enables users to create personalized room arrangements that suit their needs and style.

B. AI-Based Design Approach

The AI-Based Design Approach simplifies the interior design process by automatically generating room layouts with minimal user effort. When the user selects the "Generate Using AI" option, the system analyzes the room dimensions and available space, selects appropriate furniture items, and arranges them within the room. A complete design proposal is then generated automatically, providing users with a quick and convenient starting point for room decoration.

C. Furniture Selection Mechanism

The system includes a dynamic furniture selection feature that allows users to choose from multiple furniture options available in each category. A checklist of furniture items is displayed, enabling users to browse and select their preferred models. Only the selected furniture pieces are loaded into the 3D environment, which keeps the design organized and prevents unnecessary objects from appearing in the room. This feature gives users greater control over the final design.

D. Augmented Reality (AR) Visualization

To enhance user experience, the system incorporates Augmented Reality (AR) technology. After completing the room design, either manually or through AI generation, users can activate AR mode. The device camera opens and places the selected furniture into the real-world environment, allowing users to view furniture placement and scale within their actual room. This realistic preview helps users make better design decisions and visualize the final arrangement before implementation.

E. 3D Room Generation

The virtual room is generated using Three.js, a JavaScript library used for creating interactive 3D graphics. After the user enters the room dimensions, the system automatically creates a 3D room model consisting of four walls, a floor, and a ceiling. Each surface is scaled according to the dimensions provided, ensuring that the virtual room closely resembles the actual room. The generated room serves as a realistic workspace where users can design and arrange furniture effectively.

F. Backend System

The backend of the application is developed using Flask and is responsible for managing the core operations of the system. It handles user registration and authentication, stores room dimensions and uploaded images, manages furniture-related data, and processes user requests. Whenever users perform actions such as uploading images, selecting furniture, or generating designs, the backend processes the data and communicates with the database as required. This ensures smooth system performance, efficient data management, and seamless interaction between different modules of the application.

Unlike existing interior design systems that mainly focus on either 3D visualization or design recommendation, the proposed system integrates room generation, manual customization, AI-assisted design generation, furniture selection, and AR-based visualization within a single web platform. This provides users with a more interactive and practical interior design experience.

IV. METHODOLOGY

This system simplifies interior design by combining 3D visualization and Augmented Reality (AR). Users first register and log in, then enter room dimensions and upload images of the walls, floor, and ceiling. Using this information, the system creates a virtual 3D room that matches the actual space.

Users can design the room manually by selecting and placing furniture or use the "Generate by AI" feature, which automatically creates a basic layout. A checklist allows users to choose only the furniture they need, keeping the design organized.

Once the design is complete, the AR feature enables users to view the selected furniture in their real surroundings through the device camera. The final output includes a designed 3D room and an AR preview, making the interior design process simple, interactive, and practical.

V. SYSTEM ARCHITECTURE

The interior design platform follows a layered architecture that integrates user interaction, backend processing, 3D visualization, and Augmented Reality (AR). This structure ensures smooth data flow, efficient system performance, and support for multiple users. The front end provides a user-friendly interface where users can register, log in, enter room dimensions, upload images, select design options, and choose furniture. It also displays the generated 3D room layout and AR visualization. The backend handles user authentication, data storage, and request processing. It securely stores user information, room details, and uploaded images, while managing room layout generation and supporting both manual and AI-based design approaches.

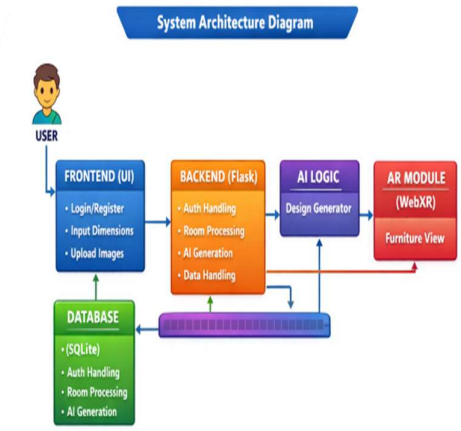

Fig.1 Block diagram

As shown in Fig.1, The system follows a layered architecture that includes the frontend, backend, database, AI module, 3D engine, and AR module. Users can enter room details, upload images, and select design options through the frontend. The backend handles data processing and storage, while the AI module can automatically generate a room layout when requested. The 3D engine creates the virtual room, and the AR module allows users to view selected furniture in a real-world environment. The final output consists of a 3D room design along with an AR preview.

Fig.2 Flow chart

As shown in Fig.2, The system starts with user login or registration, followed by entering room dimensions and uploading images. An empty 3D room layout is then generated. The user can either design the room manually or use the AI-based design option. After designing, the user selects furniture from available options. The selected furniture is then displayed in augmented reality using the device camera. The process ends after the AR view is shown.

VI. Implementation and Results

A. Manual Design

As shown in Fig.6.1The Manual Design mode allows users to create and customize their room from scratch. The system first generates an empty 3D room based on the dimensions provided by the user. From there, users can personalize the space step by step by selecting wall and floor textures, choosing furniture, and arranging items according to their preferences. This approach gives users complete creative control over the design process, making it ideal for those who already have a clear vision of how they want their room to look.

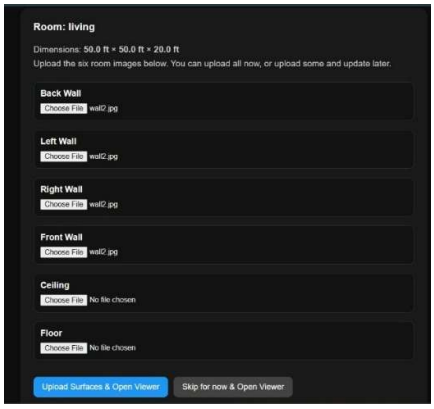

Fig. 3. Manual design

B. Generate by AI

As shown in Fig. 6.2, The Generate by AI feature offers a quick and convenient way to create an interior design. Once selected, the system automatically generates a basic room layout by placing furniture and applying a simple design arrangement. This feature is particularly useful for users who may not have a specific design idea or who are looking for inspiration. While the AI-generated design focuses on providing a practical starting point rather than a highly detailed solution, users can easily modify and customize the generated layout to better match their preferences.

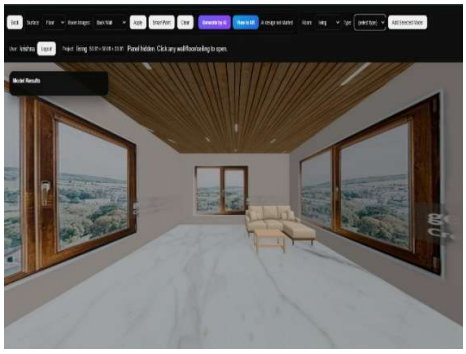

Fig.4 Generated by AI

C. Augmented Reality

As shown in Fig. 6.3, The Augmented Reality (AR) feature is one of the most practical and interactive components of the system. After selecting a furniture item, users can view it directly within their real-world environment using their device's camera. The system virtually places the chosen furniture in the surrounding space, allowing users to visualize its appearance, size, and placement before making a decision. At present, the AR functionality is designed to display individual furniture items rather than a complete room setup, which improves stability and provides a smoother user experience. This feature helps users make more informed decisions when purchasing or arranging furniture by giving them a realistic preview of how it will fit into their space.

Fig 5. Augmented reality

Feature	Manual Design	AI Generation	AR Visualization
Control	Full user control	Limited	No design control
Effort	High	Low	Very low
Time	More	Fast	Instant
Customization	High	Medium	None
Purpose	Detailed designing	Quick design suggestion	Real-world visualization
Output Type	3D designed room	Auto-generated layout	Real-world furniture view
User Skill Needed	Moderate	Beginner-friendly	Very easy

Table.6 comparison between features

VII. COMPARISON WITH EXISTING SYSTEMS

In existing interior design systems, most applications either provide only 2D design tools or require professional software that is difficult for normal users to operate. Many systems do not allow real-time interaction or require high-end devices and paid software. Some platforms offer 3D visualization, but they often lack flexibility and do not include augmented reality features.

In contrast, the proposed system is simple, accessible, and more interactive. It allows users to create a 3D room just by entering dimensions and uploading images, without needing technical expertise. Unlike traditional systems, it provides both manual design and AI-based design options, giving users more flexibility. The integration of augmented reality is a key improvement, as it allows users to visualize furniture in real-world conditions, which most basic systems do not support. Additionally, this system runs in a web environment, making it easier to access without installing heavy software.

VIII. Conclusion and Future Work

The proposed system provides an interactive platform for interior design using 3D visualization and Augmented Reality. It allows users to generate a room layout from given dimensions and design it either manually or using the AI-based "Generate by AI" feature. The system uses Three.js for creating the 3D environment and supports real-world visualization through Augmented Reality. Overall, the system offers a simple and efficient solution for designing and visualizing room interiors.

The system can be improved by enabling full room visualization in AR instead of only furniture. The AI module can be enhanced using advanced techniques from Machine Learning to generate more accurate and personalized designs. Future enhancements may also include support for multiple furniture objects in AR, integration with real furniture databases, and development of a mobile application for better performance and user experience.

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