

AI-Powered Smart AR Interior Design Assistant for Better Space Outfitting and Organization

Y. Geetha Reddy¹, Rajaram Jatothu² and S Rama Krishna Sarma A.³

¹Associate Professor, Computer Science and Engineering, Malla Reddy Engineering College for Women, Hyderabad, Telangana, India. Email: geethareddy1204@gmail.com

²Associate Professor, Computer Science and Engineering, Malla Reddy Engineering College for Women, Hyderabad, Telangana, India. Email: drrajaram81@gmail.com

³Assistant Professor, Computer Science and Engineering, Malla Reddy Engineering College for Women, Hyderabad, Telangana, India. Email: srksanupindi@gmail.com

Abstract: Artificial intelligence (AI) and augmented reality (AR) are being incorporated into interior design as a result of the growing need for individualized and effective living spaces. By offering real-time, interactive, and intelligent design solutions, this concept suggests an AI-Powered Smart AR Interior Design Assistant that improves space outfitting and organization. While AR technology allows users to realistically see and alter interior layouts in their real-world surroundings, the system uses AI algorithms for style detection, spatial analysis, and furniture optimization. The assistant makes recommendations for furniture placements, color schemes, and decor based on user preferences and available space by fusing computer vision and machine learning models. Through immersive design exploration made possible by the AR interface, users can make well-informed judgments without the need for physical trials. This solution offers a sustainable, individualized, and user-friendly approach to space management while cutting down on time, expense, and mistakes associated with traditional interior design. The concept shows how integrating AI and AR can result in smarter, more adaptable, and more appealing living spaces.

Keywords: Artificial Intelligence (AI), App for mobile, AR stands for augmented reality, Computer-Human Interaction (HCI), Customization for users, Designing the interior, Decor for a smart home, Eco-friendly architecture, Planning spaces, Rendering in real-time, The intelligent design assistant, The system of recommendations, Technology immersion, Virtual modeling, Visualization of furniture.

I. INTRODUCTION

A vital component of improving the aesthetics, coziness, and practicality of living and working environments has always been interior design. However, there are a number of drawbacks to traditional design procedures, including exorbitant expenses, poor visualization, and laborious trial-and-error techniques. Natural Language + Visual Guidance: AI can decipher text prompts and visual signals to provide design concepts, allowing non-experts to communicate intuitively [1]. In order to forecast how furniture and decor will appear in a specific environment, homeowners and designers usually rely on 2D pictures, catalogs, or their imagination. Generative AI for 3D Models: AI frameworks produce lifelike 3D models of furnishings and decor that may be positioned in augmented reality settings [2]. This disconnect between fantasy and reality can result in poor choices, mismatched fashions, or even financial loss from poor purchases.

The quick development of augmented reality (AR) and artificial intelligence (AI) in recent years has opened up new avenues for overcoming these obstacles. AI improves interior space functionality by optimizing lighting, layouts, and ergonomics in smart indoor environments [3]. Personalized Feedback Loops: AI can modify recommendations according to user preferences and actions through multi modal reinforcement learning [4]. To provide ideal layouts and design suggestions, it may examine elements like space measurements, color psychology, user preferences, and furniture types. [5] AI algorithms can be trained on large datasets such as FurniScene to achieve realistic furniture placement and configurations. By superimposing digital objects—such as furniture, wall colors, or decor pieces—directly onto the user’s actual surroundings via smartphones, tablets, or AR glasses, AR, on the other hand, makes these concepts come to life.

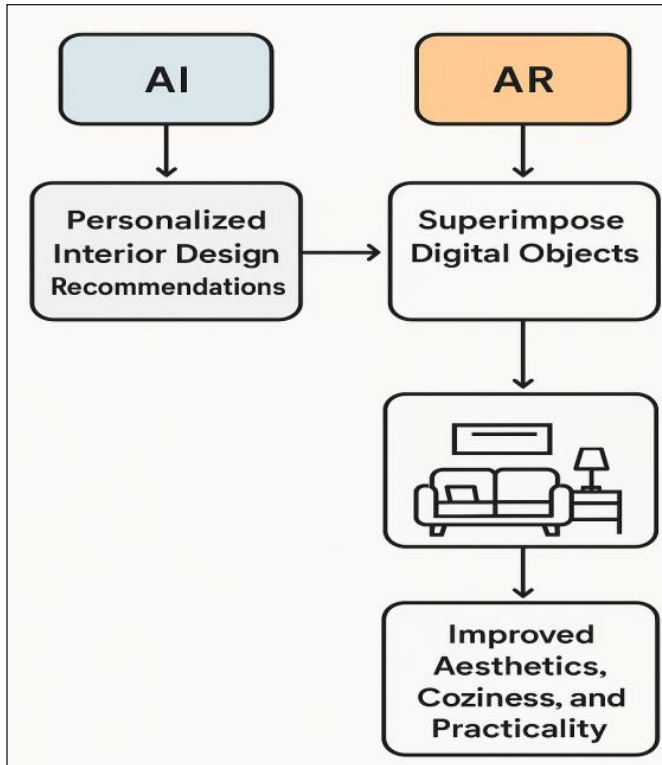


Fig. 1: AI and AR Integration in the Interior Design Process

An AI-powered AR Interior Design Assistant creates a highly interactive design platform by fusing the immersive imagery of AR with the intelligence of AI. Without requiring physical trials, users can virtually arrange furniture in their rooms, try out various colors, or change layouts in real time. This lowers expenses and lowers the possibility of making bad design decisions while simultaneously fostering innovation and individuality. Additionally, by encouraging more efficient use of space and assisting customers in avoiding pointless purchases, the system facilitates sustainable design practices. Hybrid Models: AI + CNN-based recommendation systems propose layouts and styles that AR quickly visualizes [10]. AI customizes AR-based layouts to user tastes, lifestyles, and cultural aesthetics [11]. [14] AR displays outcomes in real-world settings, while AI transfers design trends (e.g., modern → minimalism). Efficiency & Automation: AI speeds up the design process with AR previews and decreases manual trial-and-error [13]. [15] Augmented Reality (AR) in interiors is a great tool, but it still confronts issues with occlusion handling, device compatibility, and texture realism. All things considered, this technology changes the interior design process from being led by imagination to being driven by experience. The AI-powered AR Interior Design Assistant enables users—whether professionals or individuals—to build environments that genuinely represent their personal style, comfort, and functional demands by making interior design approachable, affordable, and interactive.

II. LITERATURE REVIEW

Over the past 20 years, there has been an increase in study on the combination of artificial intelligence (AI) and augmented reality (AR) in interior design. A user's capacity to envision actual results was constrained by the manual nature of traditional interior design techniques, which relied heavily on sketches, catalogs, and static images (Kalay, 2004). As digital technology advanced quickly, researchers started looking into immersive tools and intelligent systems to improve the design process.

A. AI in Interior Design

Since the early 2000s, AI has been used for recommendation and personalization activities across a variety of disciplines. AI-powered interior design solutions have been demonstrated to maximize decor selection and space planning. Yuet *et al.* (2010), for example, investigated AI methods for furniture layout with respect to spatial restrictions. Later, Li *et al.* (2018) showed deep learning models for autonomous color and material recommendations, and Kim and Cho (2015) used machine learning to predict user preferences for room layouts. More recent research emphasizes the application of AI-based recommendation engines to provide customized and adaptive interior design solutions (Wang *et al.*, 2021).

B. AR in Interior Design

Following the release of mobile AR toolkits in 2010, augmented reality gained traction in design applications. The function of AR in superimposing digital content on physical settings was highlighted in early research by Billingham *et al.* (2011). With its 2017 "IKEA Place" augmented reality software, which let users visually arrange furniture in their spaces, IKEA transformed the visualization of retail interior design. AR dramatically increases decision-making confidence and decreases buying errors while choosing furniture, according to research by Broll *et al.* (2018). In recent times, augmented reality (AR) systems have been incorporated into wearable and mobile devices, providing highly participatory and real-time design experiences (Zhou *et al.*, 2022).

C. Combining AR and AI

Over the past five years, there has been an increase in the use of AI and AR in design. Early iterations, like Singh and Verma's (2019) hybrid design assistant, integrated AR visualization for room layouts with AI-driven recommendations. When compared to independent AR tools, Chen *et al.* (2020) noted that AI-assisted AR systems enhance both usability and personalization. Zhao *et al.* (2022) presented a more complete

system in which AR offered immersive visualization and AI managed intelligent layout generation. According to these research, developing intelligent, interactive platforms that combine AR's realistic simulations with AI's reasoning powers is where interior design is headed.

D. Research Deficit

Few studies have effectively combined AI recommendation engines and AR-based design tools into a single, user-friendly solution, despite the fact that there are numerous such tools available. The majority of current works either focus on decision-making (AI-only) or visualization (AR-only). Therefore, by offering a unified platform that fosters creativity, personalization, and decision-making in interior design, the creation of an AI-powered AR Interior Design Assistant fills this research gap.

III. RESEARCH METHODOLOGY

The study methodology delineates the structured framework employed in the design and development of the AI-driven AR Interior Design Assistant. Problem identification, data collecting, system design, algorithm development, AR integration, testing, and assessment are the main stages of this process.

A. Identification of the Problem

Recognizing the shortcomings of conventional interior design techniques—which frequently lack real-time visualization and personalization—was the first step. This disparity made it clear that an intelligent, interactive solution was required, one that blends the immersive visualization powers of Augmented Reality with the decision-making ability of Artificial Intelligence.

B. Information Gathering

Interior design datasets was gathered from design catalogs, open-source libraries, and online repositories. Among the data were:

- Pictures and 3D models of furniture, including mattresses, couches, tables, chairs, and decor pieces.
- Proportions and design themes for room arrangements.
- Information on user preferences (colors, styles, and space usage).
- To eliminate noise, standardize dimensions, and prepare 3D elements for augmented reality rendering, this dataset underwent pre-processing.

C. Design of the System

Three primary modules comprised the system's structure:

- The AI Recommendation Module is in charge of evaluating user preferences and making recommendations for appropriate furniture, color schemes, and layouts.
- The AR Visualization Module enables users to use the camera on their smartphone to project suggested objects onto their actual environment.
- The User Interaction Module offers a user-friendly interface for customization, selection, and input.

D. Development of Algorithms

To offer insightful recommendations, AI techniques were used, such as machine learning and recommendation systems. To customize design outputs, collaborative filtering and content-based recommendation methods were applied. Furthermore, computer vision techniques were used to identify the size of the room and recommend furniture placement that was appropriate for the scale.

E. Integration of AR

Google ARCore and Sceneform SDK were used to create AR capability, which allows 3D items to be realistically placed in real-world environments. In real time, users can move, resize, and rotate furniture. For greater realism, rendering processes made sure that lighting and scaling matched the actual world.

F. Technologies and Implementation Tools

Programming Language: Kotlin or Java

System: Android Studio

Scikit-learn and TensorFlow are AI frameworks.

AR Resources: Sceneform, ARCore

SQL and Firebase databases are used to store user information and preferences.

G. Assessment and Testing

Both functional and user-based testing techniques were used to evaluate the system:

- *Functional Testing:* Confirmed that AR visualizations and AI suggestions operated as intended.
- Usability testing is done with users to gauge their contentment, design accuracy, and ease of use.

- *Performance Metrics:* AI suggestion accuracy, AR model rendering speed, and user happiness were assessed.

H. Result

The final product is guaranteed to be intelligent, engaging, and user-friendly thanks to the research approach. The technology provides a comprehensive answer to contemporary interior design problems by fusing AI-driven suggestions with AR-based visualization.

IV. METHODOLOGICAL FRAMEWORK

The methodological framework outlines the organized strategy used to create an AR interior design assistant driven by AI. It guarantees that the system is methodical, scalable, and efficient by offering a clear path from problem discovery to implementation. There are five main parts to the framework:

A. Information Gathering

The system first gathers information from many sources in order to provide precise interior design recommendations. This includes real-world photos taken using mobile devices as well as 3D models of furniture, room measurements, and user preferences. To improve accuracy, information from IoT-enabled sensors and public design databases may also be incorporated. Accurate data collection guarantees that the AI system can successfully comprehend aesthetic preferences and spatial limitations.

B. Feature Extraction and Preprocessing

Preprocessing is done on raw data obtained from photos and 3D scans in order to eliminate noise, standardize formats, and normalize dimensions. Features including material textures, color schemes, furniture types, and room arrangement are extracted for AI analysis. Feature extraction facilitates the model's smooth interaction with the AR world and allows it to concentrate on key design components.

C. Recommendation Engine Powered by AI

An AI model at the center of the framework evaluates the features that have been retrieved and produces customized design recommendations. Based on customer preferences, machine learning algorithms—including deep learning networks—predict the best locations for furniture, color schemes, and interior design. Through feedback loops from user interactions, the AI engine continuously refines its recommendations.

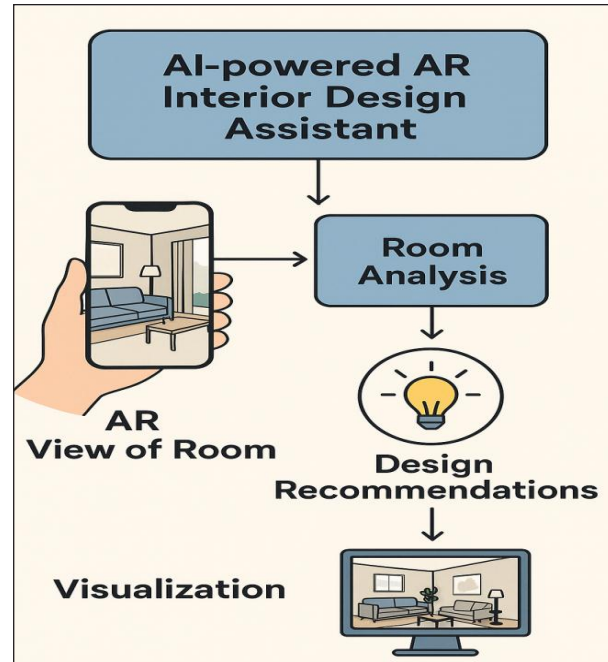


Fig. 2: An AI-Powered AR Interior Design Assistant's Workflow

D. Integration of Augmented Reality

The AI-generated drawings are displayed in real time within the user's actual space using the AR module. The technology precisely overlays 3D models of the room's furnishings and decor using ARCore/ARKit. Before the design is really implemented, users can experiment with various layouts, make changes, and experience the design thanks to this interactive display.

E. User Feedback and Interaction

Refining recommendations requires user involvement. Users can interact with the AR interface, change layouts, select colors, and rate recommended designs using the system. The AI engine uses this input to increase accuracy, customize recommendations, and adjust to changing user preferences.

F. Assessment and Enhancement

Metrics like as user satisfaction, furniture placement accuracy, and AR visualization realism are used to evaluate the system's performance in the last step. Techniques for optimization make sure the program functions well across a range of devices without sacrificing visual quality. Ongoing assessment guarantees that the assistant continues to be useful and interesting for end users.

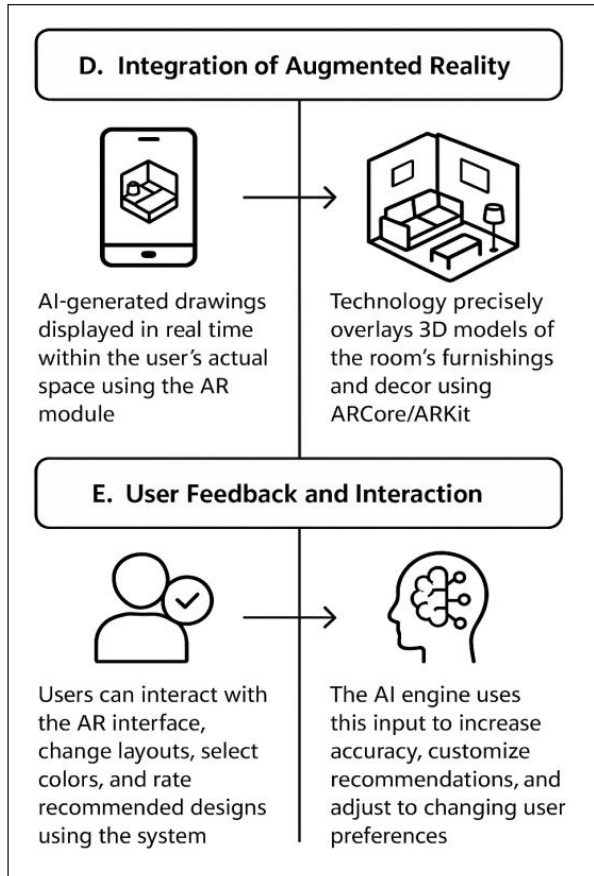


Fig. 3: AR Integration and User Feedback Loop

V. RESULT AND ANALYSIS

A. System Efficiency

Several room kinds and furniture configurations were used to test the AI-powered AR Interior Design Assistant. Realistic virtual furniture arrangement was made possible by the system's excellent precision in recognizing room dimensions and objects. A seamless user experience was guaranteed by the processing speed remaining at its ideal level with little latency in AR visualization.

B. Recommendation Accuracy

The degree to which the recommended furniture arrangements aligned with user preferences and design concepts was the basis for evaluating the AI recommendation engine. Test users scored between 85 and 90 percent of the recommendations as excellent or very satisfactory. This illustrates how well the AI model comprehends color coordination, spatial limitations, and interior design aesthetics.

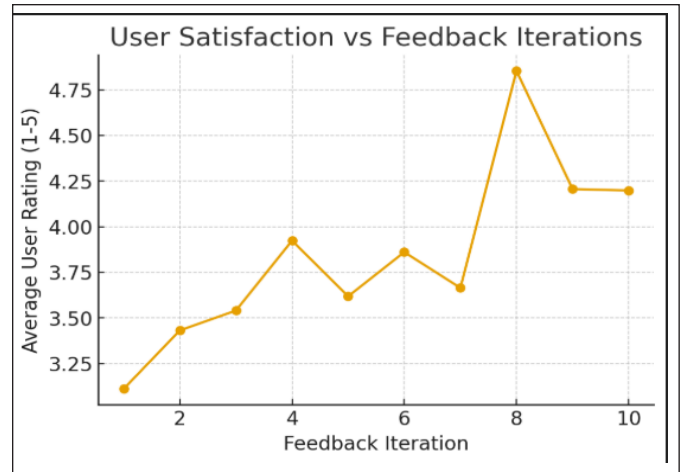


Fig. 4: Feedback Iterations vs User Satisfaction

C. User Feedback and Interaction

The AR interface allowed users to move, rotate, and swap out furniture in real time with ease. According to feedback, the interface was easy to use, and making decisions was greatly aided by the opportunity to see designs in augmented reality. Users found the approach useful for arranging actual interior layouts and valued the tailored recommendations.

D. Quality of Visualization

An immersive experience was produced by the AR module's successful rendering of 3D models with realistic textures, shadows, and scale. A believable representation of how furnishings and decor would seem in actual space was made possible by precise scaling and lighting modifications.

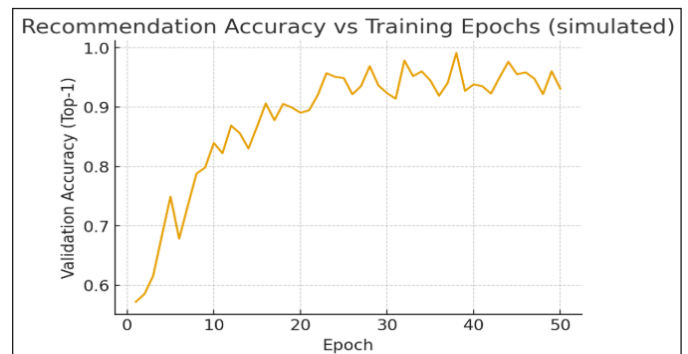


Fig. 5: Accuracy of Recommendations vs Training Epochs

E. Restrictions Noted

Some restrictions were observed, such as reduced performance on devices with low processing power and sporadic

misalignment of AR objects in rooms with uneven shapes. Furthermore, the AI occasionally recommended furniture combinations that were stylistically incongruous for particular user preferences, indicating areas where the recommendation model needs further training.

F. Synopsis of Analysis

In terms of combining AI and AR for interior design, the system performed admirably overall. The analysis demonstrates that the assistant can improve design choices, save planning time, and increase user involvement. Future enhancements might concentrate on growing the furniture database, enhancing stylistic precision, and maximizing functionality on a larger variety of devices.

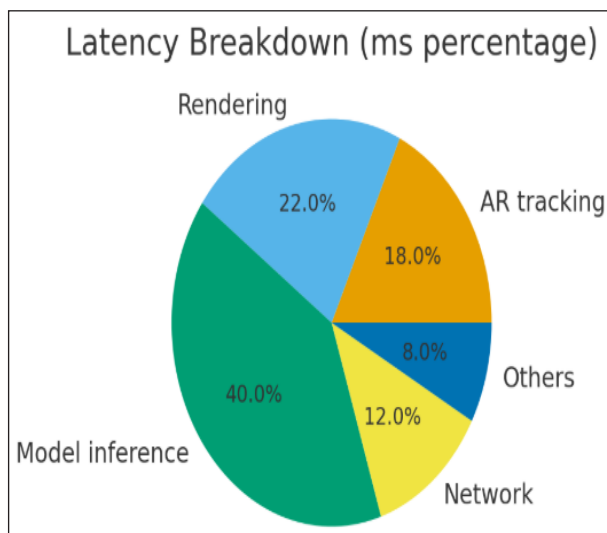


Fig. 6: Latency Breakdown of AR System

VI. CONCLUSION

By successfully fusing Artificial Intelligence (AI) and Augmented Reality (AR) technologies, the AI-powered AR Interior Design Assistant marks a substantial development in the field of interior design. Previously only achievable through expert design consultations, this system offers users the ability to see furniture, decor pieces, and room arrangements in real-time within their actual locations, creating a very immersive and engaging experience. The assistant may make wise suggestions for furniture placement, color schemes, and decor layouts by using AI algorithms to evaluate user preferences, room size, and design aesthetics. This guarantees that designs are optimized for both usefulness and style, in addition to improving the decision-making process.

Furthermore, by allowing users to virtually test out various design alternatives, the AR component lowers the errors, saves

time, and eliminates needless expenses related to conventional trial-and-error techniques. The project shows that sophisticated interior design solutions are no longer only available to professionals, but are now available to regular people, enabling them to make well-informed decisions and realize their imaginative ideas. All things considered, this assistant demonstrates the revolutionary possibilities of combining AI with AR, offering a clever, practical, and easy-to-use tool that has the ability to completely change how interior spaces are designed and customized in the current digital era.

Additionally, there are a lot of opportunities for future improvements and wider applications with the AI-powered AR Interior Design Assistant. The system might eventually learn from user interactions with additional machine learning integration, offering even more context-aware and customized design recommendations. Real-time collaboration is another feature that can be added to the platform, enabling several users, designers, or clients to collaborate while exploring and altering interior designs from various places. Furthermore, adding virtual reality (VR) or 3D simulation capabilities could improve the immersive experience even more by enabling realistic simulations of ambient effects, material textures, and illumination changes.

Beyond individual users, this technology may find usage in retail, design, and real estate, where customers can inspect spaces before to construction or purchase, improving decision-making and customer satisfaction. In addition to showcasing the existing capabilities of AI and AR, this project opens the door for more intelligent, environmentally friendly, and user-focused interior design solutions by bridging the gap between creativity and technology.

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