A

Mini Project Report

On

"ZenSpace: AI powered interior design platform"

Submitted in partial fulfilment of the requirements for the Degree

Third Year Engineering – Computer Science Engineering (Data Science) By

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CERTIFICATE

This to certify that the Mini Project report on "ZenSpace : AI powered interior design platform ” has been submitted by Durvesh Wagle (23107019), Yash Shinde (23107020), Aahan Upadhye (23107027), Aayush Thakur (23107015) who are Bonafide students of A.P. Shah Institute of Technology, Thane as a partial fulfilment of the requirement for the degree in in Computer Science Engineering (Data Science), during the academic year 2025-2026 in the satisfactory manner as per the curriculum laid down by University of Mumbai.

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TABLE OF CONTENTS

ABSTRACT

This report presents the design and development of Zenspace.AI, an innovative AI-powered interior design platform aimed at revolutionizing the way users reimagine and customize their living spaces. The system enables users to upload room images or scans, which are then processed using advanced computer vision and artificial intelligence models to generate 3D visualizations, furniture placement suggestions, and personalized design recommendations. Zenspace.AI incorporates interactive customization tools, real-time pricing integration, and seamless e-commerce connectivity to create an end-to-end solution for interior design planning. Additional features such as QR code generation, dashboards, and feedback mechanisms enhance accessibility, personalization, and engagement. This project demonstrates the potential of combining artificial intelligence, 3D rendering, and web technologies to simplify and democratize interior design for diverse users.

Keywords— Interior design, AI-powered customization, 3D visualization, furniture arrangement, user personalization, e-commerce integration, computer vision.

Chapter 1

Introduction

Interior design plays a vital role in creating functional and aesthetic living spaces. However, for most individuals, the design process remains challenging due to lack of expertise, limited visualization tools, and difficulty in translating ideas into actionable layouts. Hiring professional designers can be expensive, and traditional design catalogs fail to provide personalized solutions.

To address these challenges, Zenspace.AI has been developed as a web-based AI-powered platform that empowers users to reimagine their interiors by simply uploading images or scans of their rooms. By leveraging artificial intelligence, computer vision, and 3D rendering technologies, the system generates tailored design suggestions and interactive layouts that reflect individual preferences.

1.1 Purpose :

The purpose of Zenspace.AI is to provide users with a simple yet powerful tool that allows them to visualize, customize, and optimize their living spaces. The platform ensures accessibility for all user groups, regardless of prior design experience, by offering intuitive interactions and automated AI-driven recommendations. It bridges the gap between creativity and execution, making professional-quality interior design available to everyone.

1.2 Problem Statement :

Many individuals struggle with visualizing how their rooms would look with new furniture, colors, or layouts. Common issues include:

1. Lack of Personalization: Existing solutions offer generic templates with limited adaptability to user preferences.

2. High Costs: Hiring interior designers or using premium design software can be financially restrictive.

3. Limited Visualization Tools: Users cannot easily preview designs in 3D or adjust layouts dynamically.

4. Disconnected Buying Experience: Furniture catalogs are not integrated with e-commerce options, making the process fragmented.

5. Accessibility Challenges: Non-expert users find design tools difficult to use due to technical complexity.

Zenspace.AI addresses these issues by integrating AI-generated designs, 3D visualization, and seamless e-commerce integration into one unified platform.

1.3 Objectives:

The objectives of Zenspace.AI include:

User Empowerment: Enable users to visualize and customize their spaces with AI-driven suggestions.

Accessibility: Create a user-friendly interface for individuals with varying levels of design expertise.

Integration: Connect design suggestions with real-time pricing and purchasing options.

Personalization: Provide tailored furniture arrangements, color palettes, and décor suggestions based on room characteristics.

Shareability: Allow users to generate QR codes for sharing their designs with others.

1.4 Scope:

The scope of this project encompasses the design and development of an intelligent web-based interior design platform that leverages artificial intelligence and 3D visualization technologies to revolutionize the way users conceptualize and plan interior spaces.

The system aims to provide a seamless, interactive, and personalized experience for users — from initial room scanning to final design implementation — through the following key functionalities:

- Room Image and Scan Uploads:
  Users can upload 2D images or 3D scans of their rooms. The platform processes these inputs using computer vision and 3D reconstruction algorithms to create accurate spatial models, enabling realistic design simulations.

- AI-Powered Design Generation:
  The system employs advanced AI models to generate multiple interior design suggestions based on user preferences such as style (modern, minimalistic, bohemian, etc.), color palette, and room purpose. These designs adapt intelligently to the spatial constraints and lighting of the uploaded environment.

- Interactive 3D Customization:
  Users can explore and modify their virtual spaces through real-time 3D interaction tools. This includes adding or repositioning furniture, experimenting with color schemes, altering textures, and previewing décor arrangements dynamically.

- Real-Time Cost Estimation and E-Commerce Integration:
  Each design suggestion is accompanied by a detailed cost breakdown. The platform integrates with e-commerce and furniture retailer APIs to display real-time product availability, prices, and purchase options, bridging the gap between design and execution.

- User Dashboard and Design Management:
  A personalized dashboard allows users to save, compare, and manage multiple design iterations. Users can revisit previous projects, share designs with others, or export layouts and cost estimates for professional use.

- Accessibility and Support Features:
  The platform includes intuitive navigation, an FAQ section for user guidance, and a feedback mechanism to continually improve user experience. Accessibility standards will ensure usability across diverse user groups, including support for different devices and screen sizes.

- Collaboration and Sharing Capabilities:
  Future extensions include enabling collaborative design sessions where users can invite designers or peers to contribute ideas in real-time, fostering a community-driven approach to interior design.

Target Audience

The platform primarily caters to:

- Homeowners and Renters looking for affordable and creative redesign ideas.
- Interior Design Enthusiasts exploring digital tools to experiment with new concepts.
- Interior Designers and Architects seeking AI-assisted design visualization tools.
- Businesses and Real Estate Firms aiming to enhance property appeal through virtual staging and visualization.

Overall Vision

The project aspires to bridge the gap between technology, creativity, and practicality by democratizing access to high-quality interior design services. By combining AI, 3D visualization, and e-commerce integration, the platform seeks to empower users to transform their spaces effortlessly — making interior design more personalized, accessible, and efficient.

Chapter 2

Literature Review

The evolution of artificial intelligence, computer vision, and 3D rendering has significantly influenced the field of interior design and spatial planning. This literature review explores prior works, technologies, and research that provide the foundation for Zenspace.AI.

AI in Interior Design

Recent studies demonstrate the application of machine learning in generating interior layouts, color palette recommendations, and furniture placement. Models trained on design datasets have shown promising results in automating style transfer and producing human-like suggestions for interiors.

Computer Vision for Room Understanding

Techniques such as depth estimation and semantic segmentation are widely used to extract spatial details from room images. Research indicates that 3D reconstruction from 2D inputs allows accurate modeling of walls, floors, and furniture, which is crucial for interior design systems.

3D Visualization and User Interaction

Libraries such as three.js and Blender-based rendering pipelines enable interactive visualizations where users can rotate, scale, and modify objects in real-time. Such technologies have been successfully applied in architecture and AR/VR systems.

AI-Powered Recommendation Systems

Content-based and hybrid recommendation approaches have been adopted in e-commerce platforms to suggest relevant products. For interior design, this extends to recommending furniture styles, décor items, and layouts that fit the user’s space and preferences.

Integration with E-Commerce

Research emphasizes the importance of connecting design tools with purchasing options. Studies show that platforms integrating design visualization with real-time pricing increase user engagement and reduce decision fatigue.

Summary:

The literature establishes a strong case for combining AI, computer vision, and interactive 3D visualization to democratize interior design. Zenspace.AI builds on these advancements by offering a holistic platform that unites design automation, customization, and seamless e-commerce integration.

Chapter 3

Proposed System

Zenspace.AI aims to transform interior design by combining artificial intelligence, 3D modelling, and intuitive web interfaces into a single, user-friendly application.

3.1 System Overview

The system allows users to upload images or scans of their rooms, which are processed to generate a 3D model. AI algorithms then provide personalized design suggestions, including furniture arrangements, color schemes, and décor elements. Users can interact with the model to customize layouts, view real-time pricing, and generate QR codes to share their designs.

3.2 Features and Functionality

User Authentication:

Create accounts, log in, and save design progress.

Room Upload:

Upload 2D images or scans of rooms for processing.

3D Room Visualization:

AI reconstructs a 3D model of the uploaded room. Users can rotate, zoom, and interact with the space.

AI Design Suggestions:

Personalized layouts based on room dimensions and features. Automatic recommendations for furniture, colour palettes, and styles.

Customization Options:

Modify furniture styles, colors, textures, and positions. Experiment with different layouts in the 3D model.

Pricing Summary:

Real-time cost estimates for furniture and décor items. Direct integration with online stores for purchases.

QR Code Generation:

Share final designs through scannable QR codes.

User Dashboard:

Save, manage, and revisit past designs.

Help/FAQ Section:

Provide guidance and tutorials for first-time users.

Feedback and Contact:

Collect user feedback for iterative improvements.

Chapter 4
Requirements Analysis

The requirements analysis for Zenspace.AI outlines both the functional and non-functional components that are essential to achieving the project's objectives. These requirements ensure that the system not only performs the desired operations but also delivers a seamless, secure, and scalable user experience.

4.1 Functional Requirements

4.1.1 User Authentication

The system shall enable users to create personal accounts, securely log in, and manage their individual profiles. This includes maintaining user credentials, password recovery options, and session management to ensure secure access to all personalized features.

4.1.2 Room Upload

Users should be able to upload 2D images or digital scans of their rooms in supported formats such as JPEG**,** PNG, or PDF scans. The upload process must be efficient, allowing the system to capture spatial details accurately for further processing and design generation.

4.1.3 3D Room Reconstruction

The platform shall automatically convert the uploaded room images into interactive 3D models. Using advanced computer vision and 3D reconstruction algorithms, the system will generate a realistic spatial environment that can be freely navigated and customized by the user.

4.1.4 AI Design Suggestions

Zenspace.AI must utilize artificial intelligence to generate intelligent design recommendations, including optimal furniture arrangement, décor placement, and color palette selection.

These suggestions will be personalized based on the user's preferences and the physical dimensions of the uploaded room.

4.1.5 Customization Options

Users should have complete flexibility to customize the generated design. The system will allow editing of furniture type, dimensions, orientation, and surface textures, ensuring that users can fine-tune every element of their virtual room to match their taste and requirements.

4.1.6 Pricing Module

A dedicated pricing component shall provide real-time cost estimation for selected furniture and décor items. The system will integrate with external e-commerce platforms or product databases to reflect accurate pricing and availability information for each item included in the design.

4.1.7 QR Code Generation

The system will offer an option to generate scannable QR codes for each completed design. These codes can be shared easily with others, allowing recipients to view the design in 3D directly on their devices without requiring separate account access.

4.1.8 User Dashboard

Each registered user shall have access to a personalized dashboard where multiple design projects can be saved, viewed, edited, and managed. The dashboard will act as a central hub for design organization, version control, and progress tracking.

4.1.9 Help / FAQ Section

An integrated Help and FAQ section will provide users with tutorials, troubleshooting steps,

and general guidance. This ensures that even first-time users can easily understand and navigate through the platform's features and tools.

4.1.10 Feedback System

The platform shall include a feedback collection system that allows users to submit suggestions, report issues, and share their experiences. This feature will help developers continuously enhance the system based on user insights and evolving needs.

4.2 Non-Functional Requirements

4.2.1 Performance

The system must be capable of handling multiple concurrent uploads and real-time 3D rendering without performance degradation. Response times should remain minimal, and design generation processes should be optimized for speed and efficiency.

4.2.2 Scalability

Zenspace.AI shall be designed with scalability in mind, ensuring that the platform can accommodate an increasing number of users, projects, and design data as its user base grows, without compromising functionality or performance.

4.2.3 Security

All user data must be securely encrypted, both during transmission and storage. Role-based authentication and access control will be implemented to safeguard sensitive information and prevent unauthorized access to system resources.

4.2.4 Usability

The application will feature a simple, modern, and intuitive user interface built using contemporary web technologies. The design should promote ease of navigation and accessibility, ensuring a positive user experience for individuals with varying levels of technical expertise.

4.2.5 Reliability

The platform must demonstrate high reliability by providing consistent AI-generated outputs and maintaining stable performance under varying workloads.

4.2.6 Portability

Zenspace.AI should be fully compatible across multiple devices and browsers, including desktops, tablets, and mobile platforms. This ensures users can access and interact with their designs conveniently from any location or device.

4.2.7 Maintainability

The system architecture will be modular and component-based, allowing easy updates, debugging, and enhancement of AI models, features, and interface elements. This modularity ensures long-term adaptability and efficient maintenance of the platform.

Chapter 5

Project Design

5.1 Use Case Diagram

The Use Case Diagram of **ZenSpace.AI** (Fig 5.1) captures the main functionalities and interactions between a user and the system, primarily focusing on **room visualization**, **AI design generation**, **customization**, and **financial assessment**.

The diagram illustrates the core interactions within the ZenSpace.AI platform.

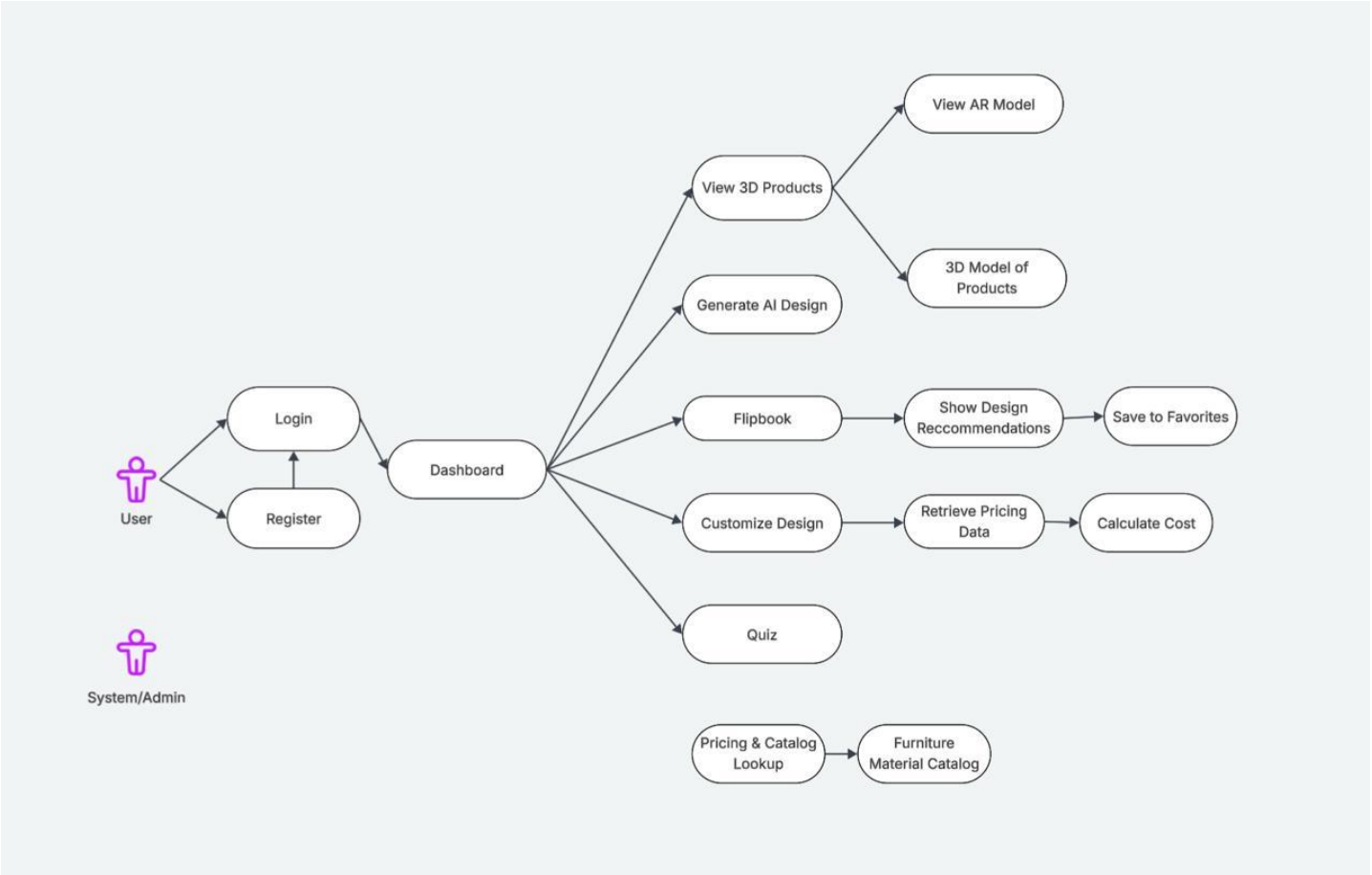


Fig 5.1 Use Case Diagram

Actors:

- **User:** Represents the primary individual interacting with the design platform.
- **System (Admin/Vendor):** Represents the management entity for the application, product catalog, and cost database.

Use Cases:

1. **Upload Room Image:** Allows the user to input a photo or video of their space for 3D processing.
2. **Generate AI Design:** Triggers the AI model (CNN + Stable Diffusion API) to suggest personalized design styles, layouts, and furniture arrangements.
3. **Visualize in 3D:** Displays the user's room and the suggested design in an interactive three-dimensional model.
4. **Customize Design:** Allows the user to modify elements like colors, materials, and furniture placement in real-time within the 3D model.
5. **View AR Preview:** Generates a QR code to enable the user to view the suggested furniture/design in their physical space using Augmented Reality[11].
6. **Calculate Cost:** Provides an instant cost estimation for the selected furniture and design package.
7. **Save to Favorites:** Enables the user to save preferred designs and furniture items for later reference.
8. **Browse Furniture Catalog:** Allows the user to explore the inventory of furniture and decorative items.
9. **Authenticate (Sign Up/Log In):** Handles user registration and access to the personalized dashboard.

Relationships:

- **Association:** Connects the **User** with all primary Use Cases.
- **Include Relationships:**
    - **Generate AI Design** includes **Visualize in 3D** and **Calculate Cost**.
    - **Customize Design** includes **Calculate Cost**.
    - **Upload Room Image** includes **3D Room Reconstruction**.
- **Extend Relationships: Visualize in 3D** may extend to include **View AR Preview**.

5.2 DFD (Data Flow Diagram)

The Data Flow Diagram (Fig 5.2) illustrates the end-to-end data processing required to convert a user's 2D room image into a customizable, priced 3D design using the hybrid AI/Visualization approach.

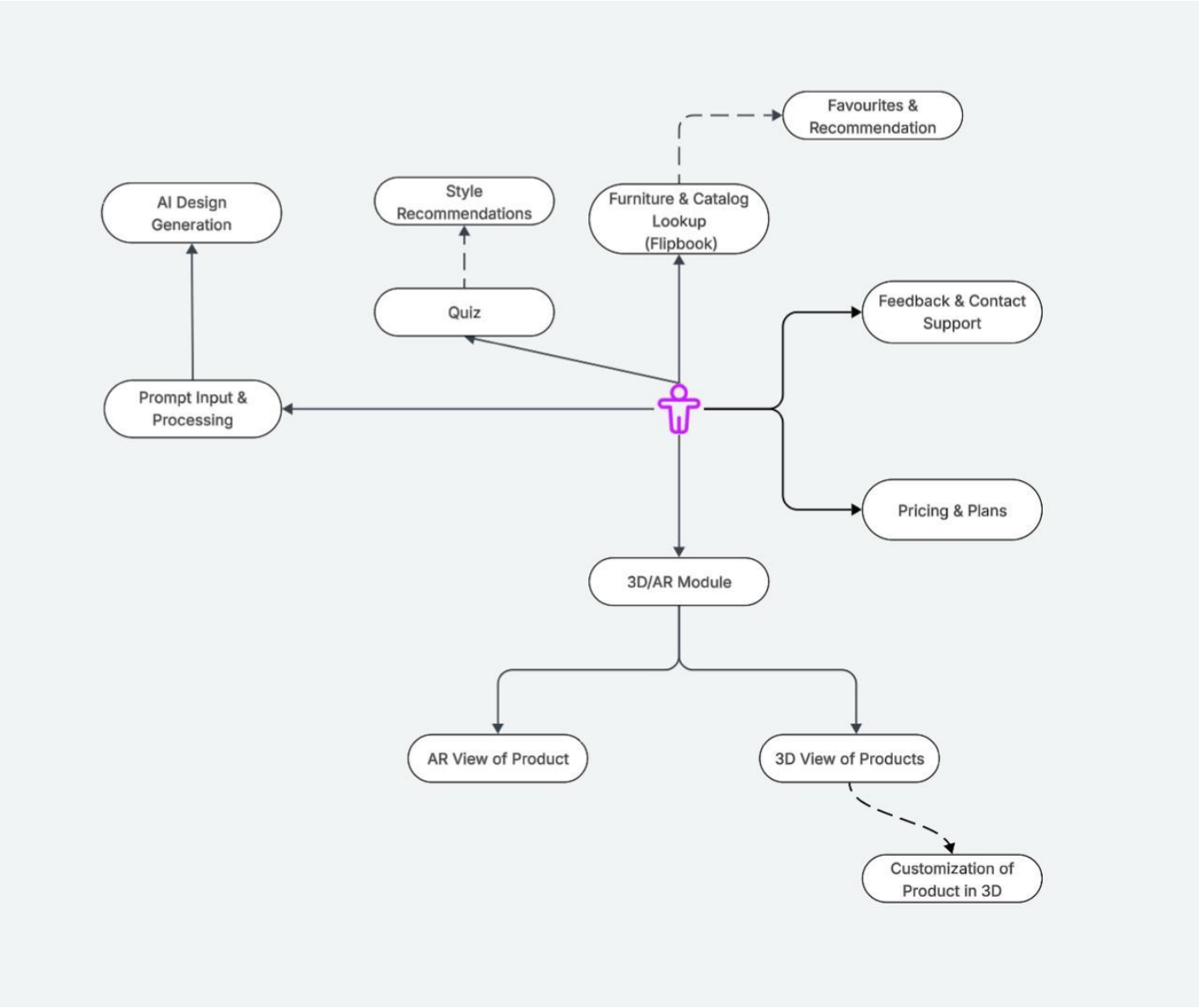


Fig 5.2 Data Flow Diagram

1. **User Input:**
    - The user submits a **Room Image** (2D).
    - The user submits **Design Vision/Style** preferences.
2. **3D Room Reconstruction (Computer Vision):**
    - The **OpenCV + Three.js** engine processes the 2D image data.

- Outputs a **3D Room Layout Mesh** (containing geometry and dimensions).

3. **AI Design Engine (Generative AI):**
   - The **3D Room Layout Mesh** and **Design Vision** are input to the **Pre-trained CNN + Stable Diffusion API.**
   - The model analyzes the space and style to generate **AI Design Suggestions** (furniture positions, texture maps, color palettes).
4. **Visualization Interface (Frontend):**
   - The **3D Room Layout Mesh** is combined with the **AI Design Suggestions** data.
   - This is rendered by the **React.js + Three.js** Frontend to display the **Customizable 3D Scene** (Fig 5.2, step 4).
5. **Pricing and Catalog Integration:**
   - The system cross-references the suggested furniture and design package with the **MongoDB/Firebase** Product Catalog.
   - The **Pricing Module (Backend - Node.js/Express)** calculates the **Total Cost Estimate.**
6. **Final Output:**
   - The **Customizable 3D Scene** is presented to the user.
   - A **Pricing Summary** is displayed.
   - A **QR Code** for AR viewing is generated.

5.3 System Architecture

The System Architecture (Fig 5.3) delineates the core components and the technological layers, providing a comprehensive understanding of how ZenSpace.AI manages user interaction, AI processing, and data storage.

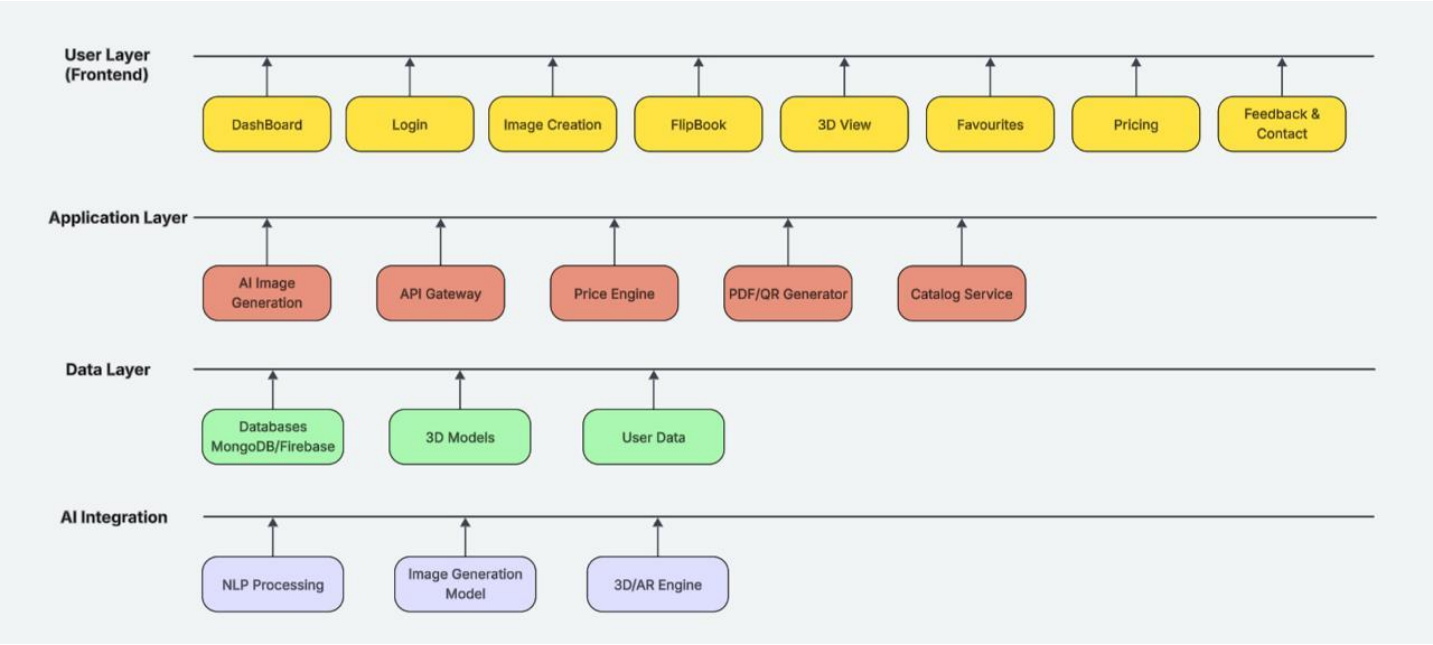


Fig 5.3 System Architecture

1. User Layer (Frontend):

Technology: React.js + Tailwind CSS

Function: This layer provides the main user interface and interaction points. It includes all client-facing modules such as:

- Dashboard
- Login & Authentication
- Image Creation Interface
- FlipBook Display
- 3D View for visualization
- Favourites and Pricing sections

- Feedback & Contact forms

  It ensures smooth navigation, responsive layouts, and an engaging user experience across devices.

2. Application Layer (Logic):

Technology: Node.js + Express
Function: Acts as the middleware between the frontend and backend, managing requests, business logic, and communication with AI and databases.
Key components include:

- **AI Image Generation** (handles generative design requests)
- **API Gateway** (routes frontend requests to proper backend services)
- **Price Engine** (calculates costs using product and vendor data)
- **PDF/QR Generator** (creates downloadable design summaries and shareable codes)
- **Catalog Service** (fetches and manages the furniture/product catalog)

3. Data Layer (Persistence):

Technology: MongoDB / Firebase
Function: Responsible for all data storage and management, maintaining structured and unstructured data for quick retrieval and updates.
This includes:

- Databases (user sessions, preferences, logs)
- 3D Models and design files
- User Data such as uploaded images, generated rooms, and project histories

4. AI Integration Layer:

Technology: OpenCV, Three.js, Stable Diffusion API, NLP Models

Function: This layer performs intelligent processing and generation tasks, integrating advanced AI and vision models.

It includes:

- **NLP Processing** (for interpreting text-based inputs or queries)
- **Image Generation Model** (powered by Stable Diffusion for style/design generation)
- **3D/AR Engine** (for reconstructing spaces and rendering immersive 3D visualizations)

5.4 Implementation

The implementation phase demonstrates the realization of the architectural design, showcasing the user journey and key feature integration.

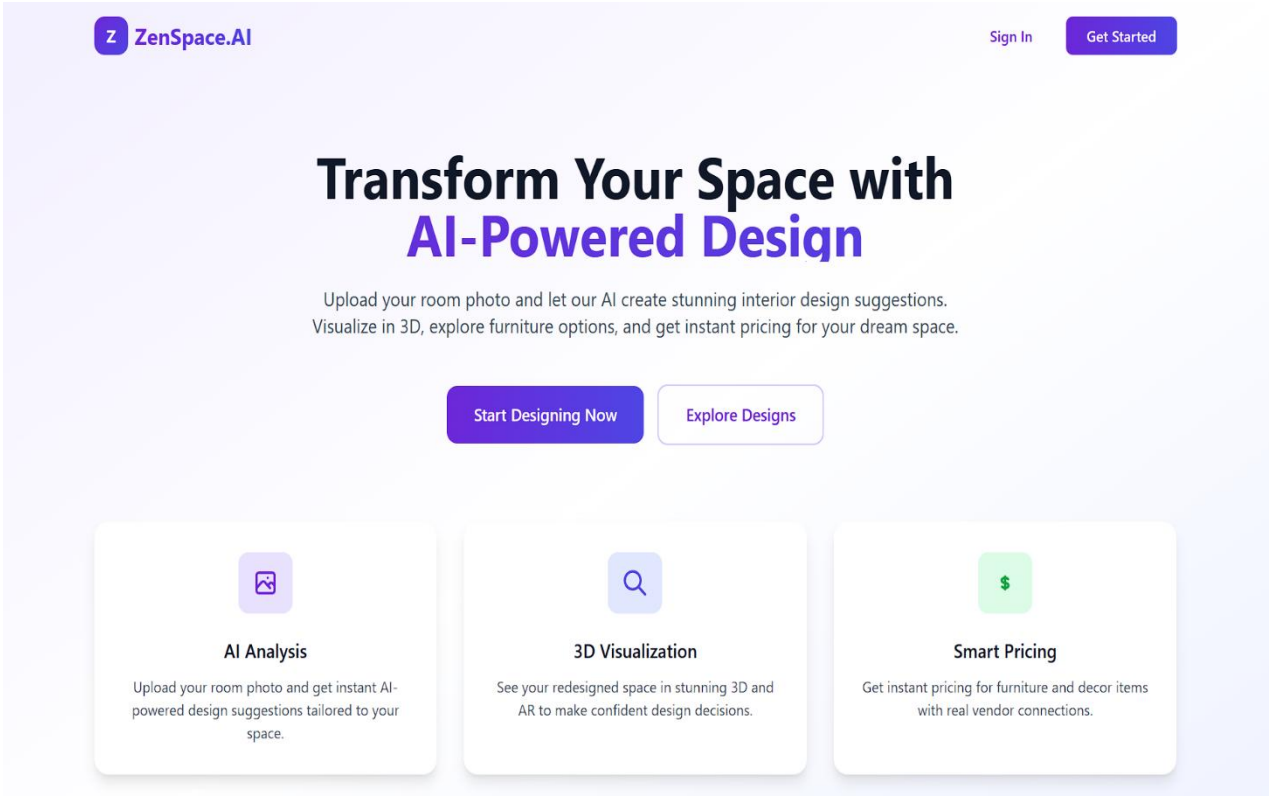


Fig 5.4.1: Application Welcome Page

This landing page instantly greets users with ZenSpace.AI core promise: AI-powered transformation of living spaces. The page encourages engagement with clear actions such as uploading room photos and describing a vision for design. Visually, it sets a welcoming tone with modern, user-friendly branding and messaging. Key features like AI Analysis, 3D Visualization, and Smart Pricing are introduced with explainer cards. Navigation is simple, featuring buttons for starting a new design or exploring templates. The concise copy primes visitors for what ZenSpace.AI delivers and prompts quick onboarding for new users.

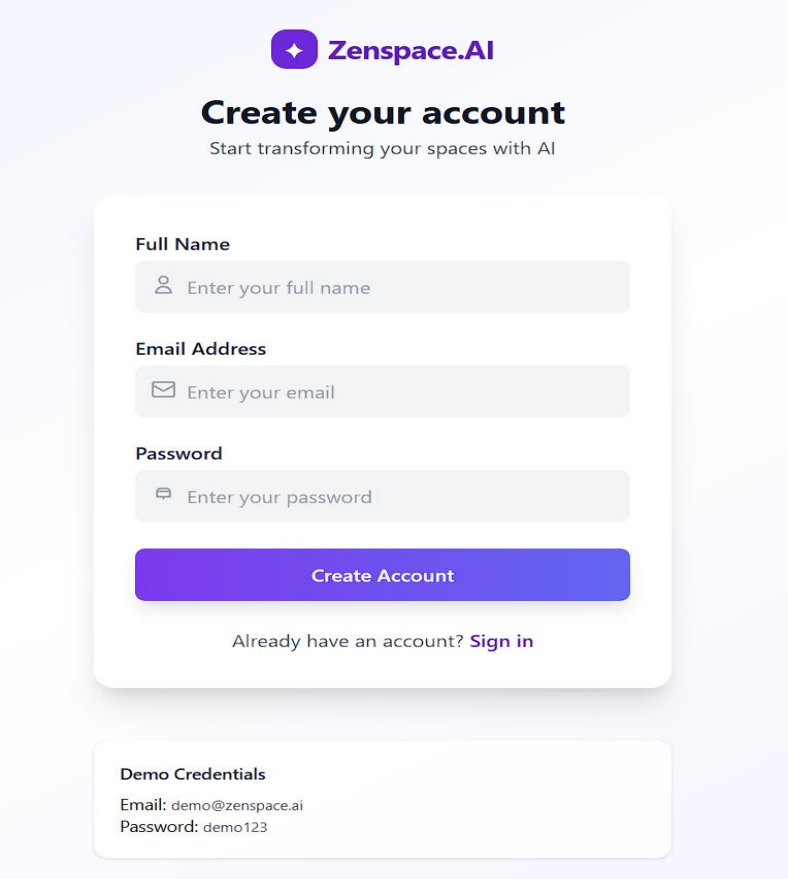


Fig 5.4.2 Sign Up Page

The registration screen facilitates onboarding by requesting basic user details—name, email, and password. It also provides demo credentials, allowing new users to instantly explore the platform. The page is visually streamlined to reduce friction and encourage sign-up. Clear supporting text explains the power of AI-enabled designing for registered users. Account creation unlocks access to dashboard features, history tracking, and personalization. The form structure and clear validation promote a secure and straightforward registration experience.

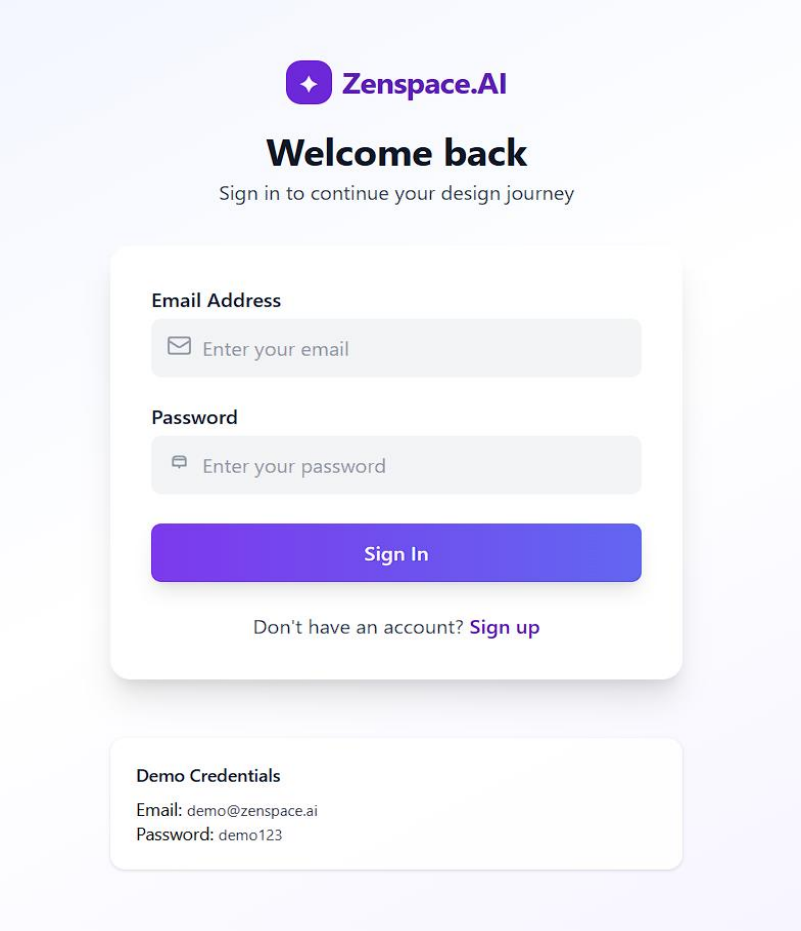


Fig 5.4.3 Sign In Page

This page supports existing users in securely accessing their accounts by entering email and password. Easy-to-use demo credentials support discovery for first-time testers. Clear visual feedback and friendly messaging lower barriers to entry. The layout is simple, focusing on fast returning user authentication. Upon sign-in, users resume saved work and access their personal dashboard and design history. Password recovery and sign-up options further improve accessibility and retention.

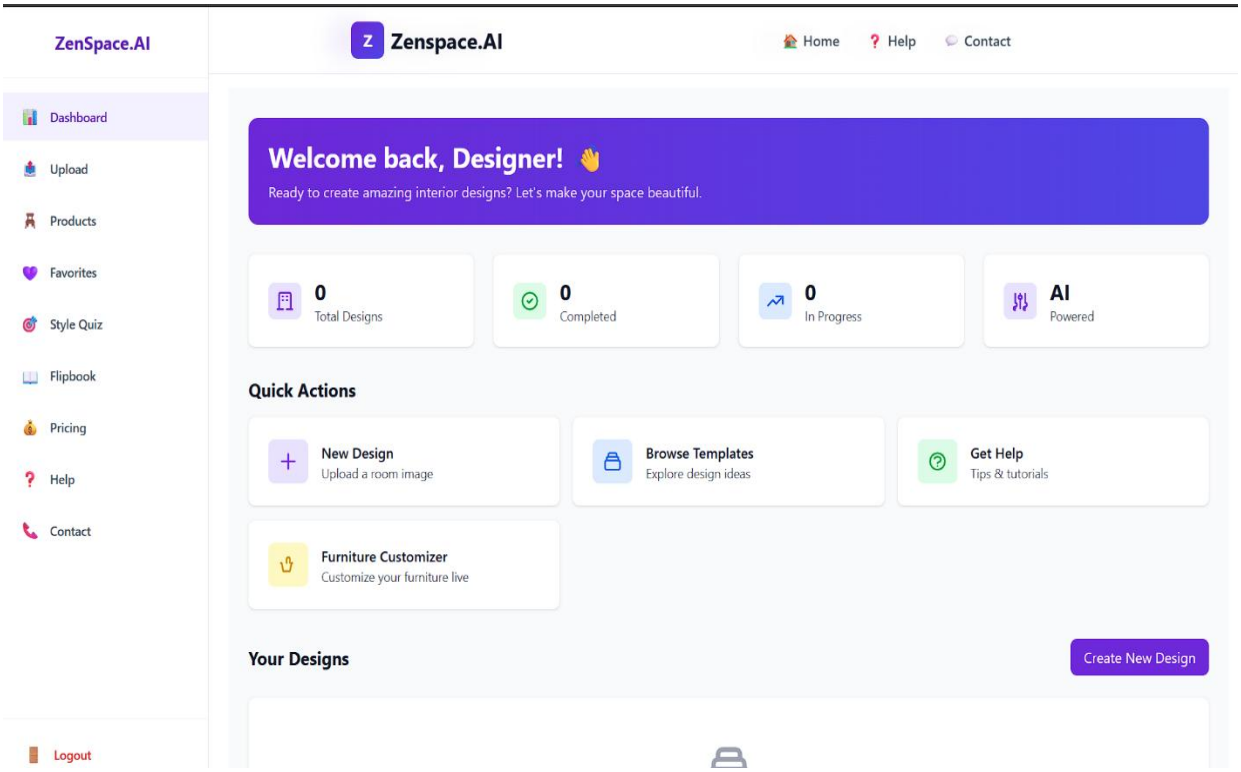


Fig 5.4.4 Dashboard Page

The dashboard is the user's central management screen, summarizing their design activities such as total designs, completed work, and current progress. Quick action shortcuts offer instant access to core features like uploading new designs, browsing the template library, and live furniture customization. The left sidebar provides persistent navigation, ensuring users can effortlessly move between modules like style quiz, flipbook, and pricing. Each section is visually separated for clarity, while dynamic stats and icons reinforce achievement and next steps. The dashboard integrates contextual guidance, boosting efficient workflow and reducing onboarding time for newcomers.

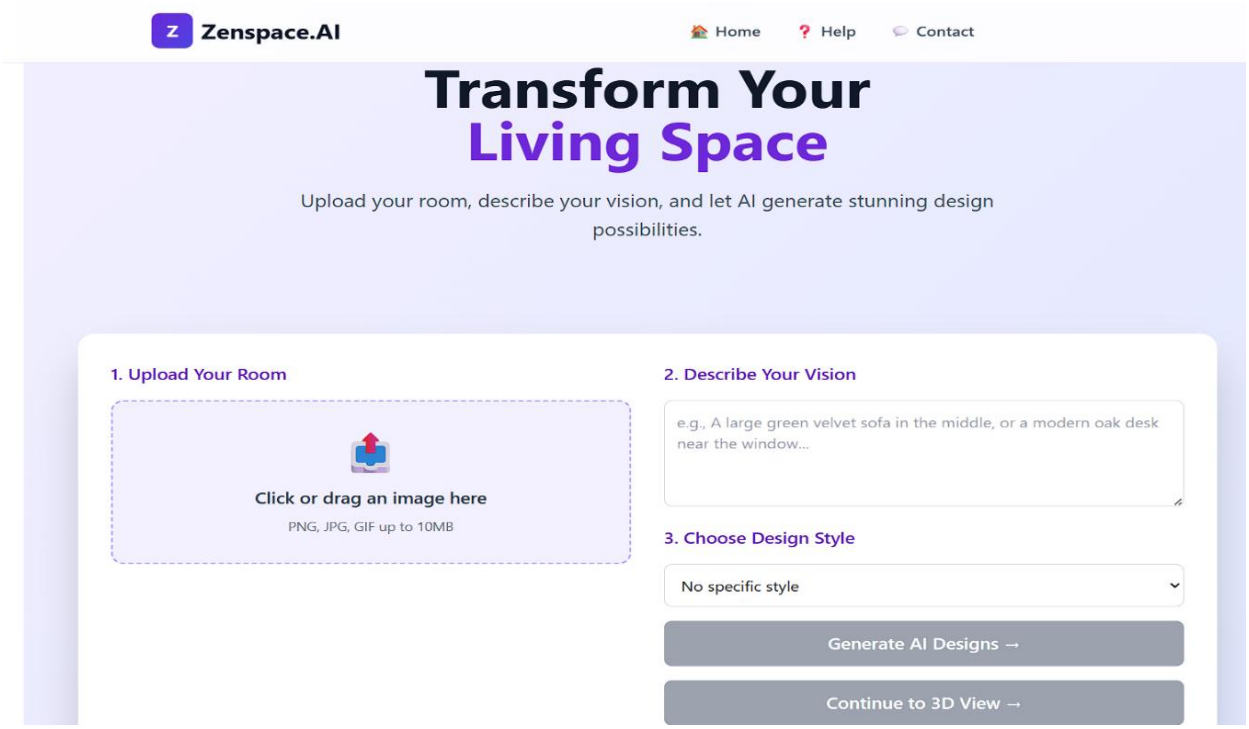


Fig5.4.5 Image Creation

The Image Creation page initiates the main workflow, guiding the user through three simple steps: uploading a room image, describing their interior vision, and choosing a style. It supports multiple file formats and sizes, ensuring accessibility for diverse users. The layout is intuitive, with clearly labelled sections and prompts. By enabling style selection and vision articulation, the interface helps personalize the AI-generated outputs. This page sets the foundation for true customization, collecting essential inputs to drive subsequent analysis and renderings. Users can directly proceed to AI design generation or opt for a 3D view for deeper exploration.

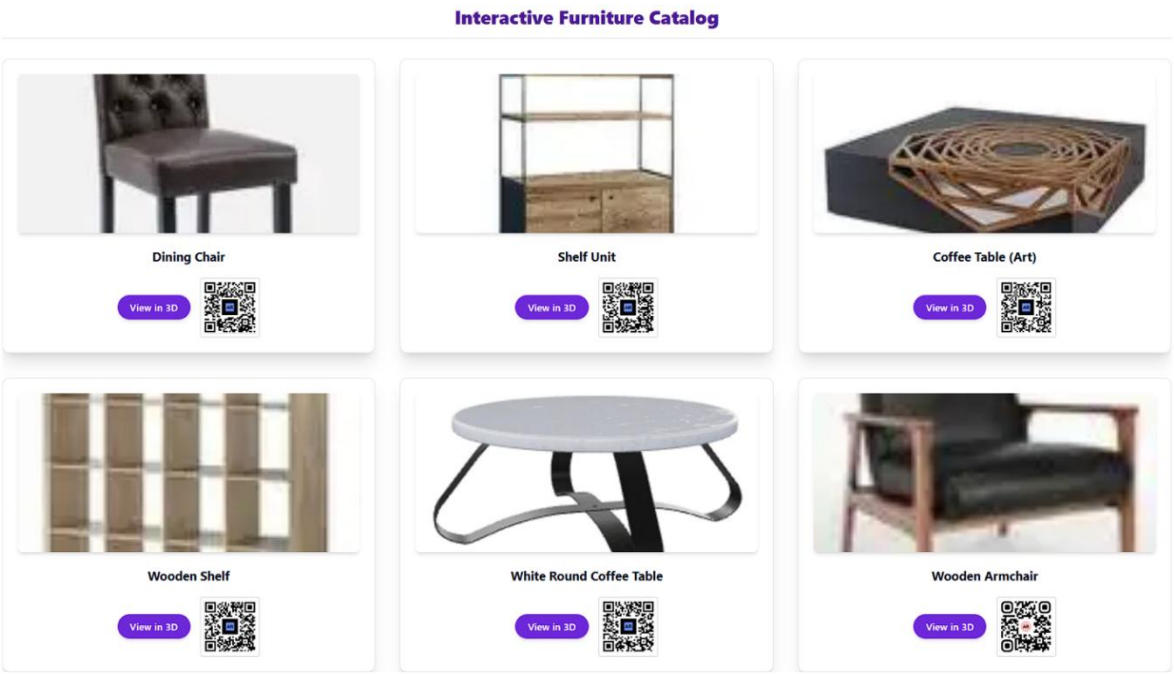


Fig5.4.6 Product Page

This product page allows users to browse individual furniture pieces, each with a clear image, name, and an interactive "View in 3D" option for detailed inspection. Every product card includes a unique QR code, letting users instantly view the item in Augmented Reality (AR) within their own home for accurate visualization and fit. The seamless integration of 3D and AR models helps users confidently select products tailored to their personal space. This page supports intuitive shopping by combining precision, immersive visualization, and direct digital-to-physical comparison before purchasing.

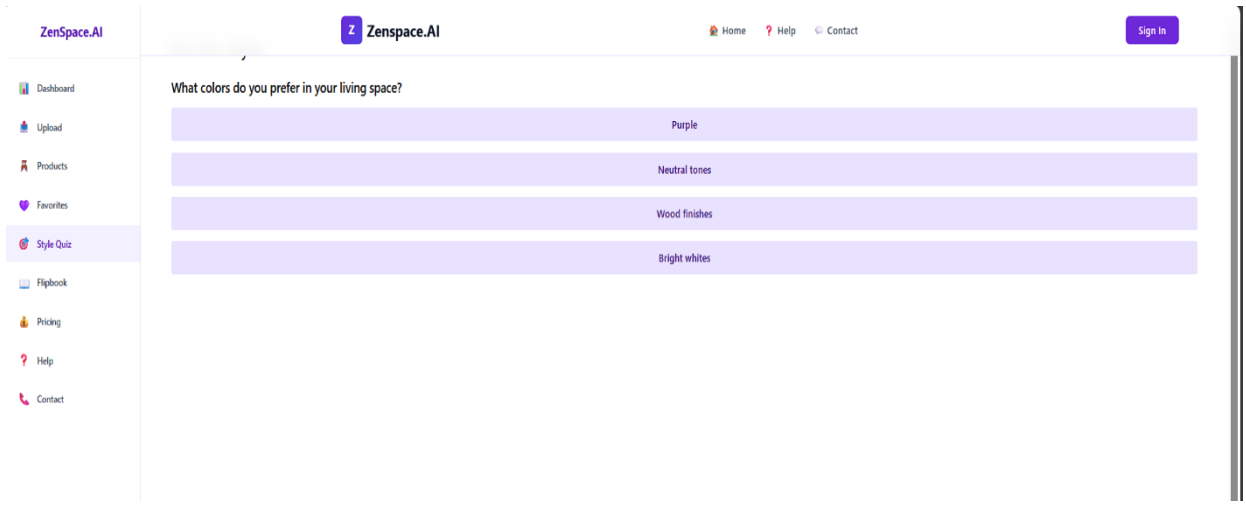


Fig5.4.7 Quiz Page

This interactive quiz presents multiple-choice questions allowing users to specify their distinct décor preferences such as color palettes and finishes. Responses inform the AI about user taste, personalizing subsequent design suggestions accordingly. The minimal yet elegant layout makes participation seamless and welcoming. By capturing style inclinations, the platform increases relevancy and user satisfaction. The quiz fosters engagement and guides first-time users in establishing design goals. This leads directly to tailored inspiration and higher quality recommendations for each project.

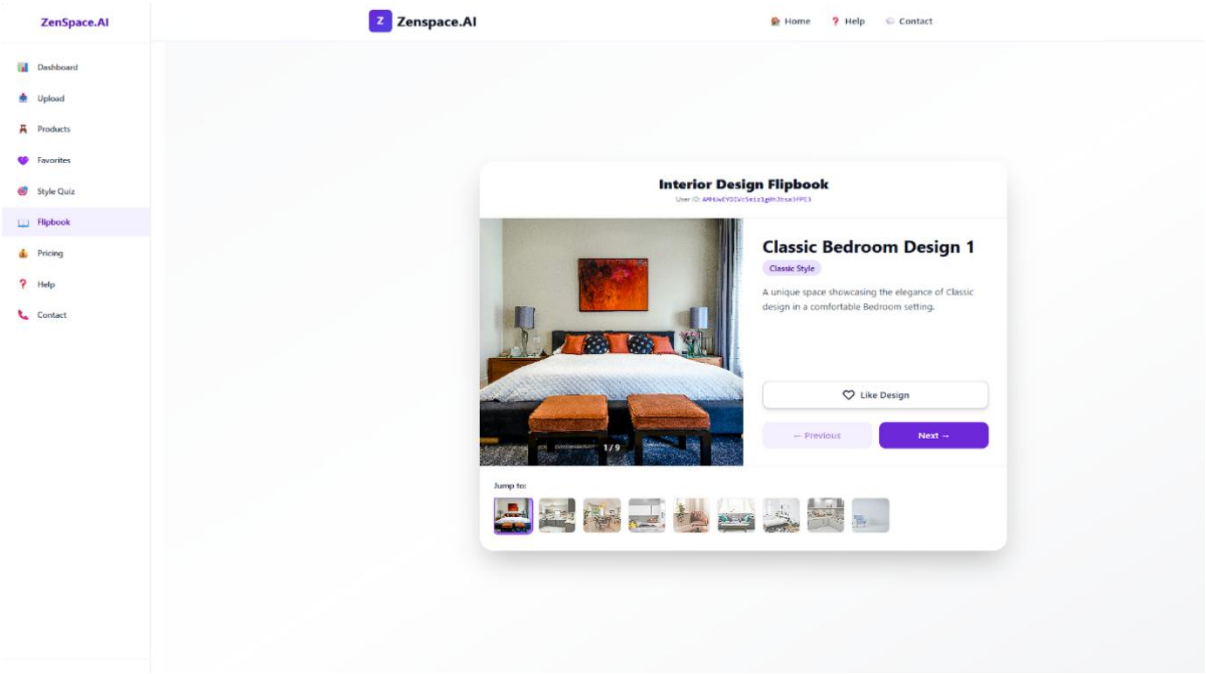


Fig5.4.8 FlipBook

The Flipbook Gallery presents a selection of curated room designs in a visually engaging, swipeable format. Users can “like” their preferred designs, compare styles, and read brief descriptions that assist in evaluating thematic fit. Navigation components like thumbnails and previous/next controls streamline browsing through multiple interior concepts. Each design card features both visual and textual cues to explain its style and ambiance, supporting informed decision making. Flipbook functionality reinforces personalized discovery and makes it easy to shortlist favorites. This page is central for inspiration, comparison, and eventual choice selection in the user journey.

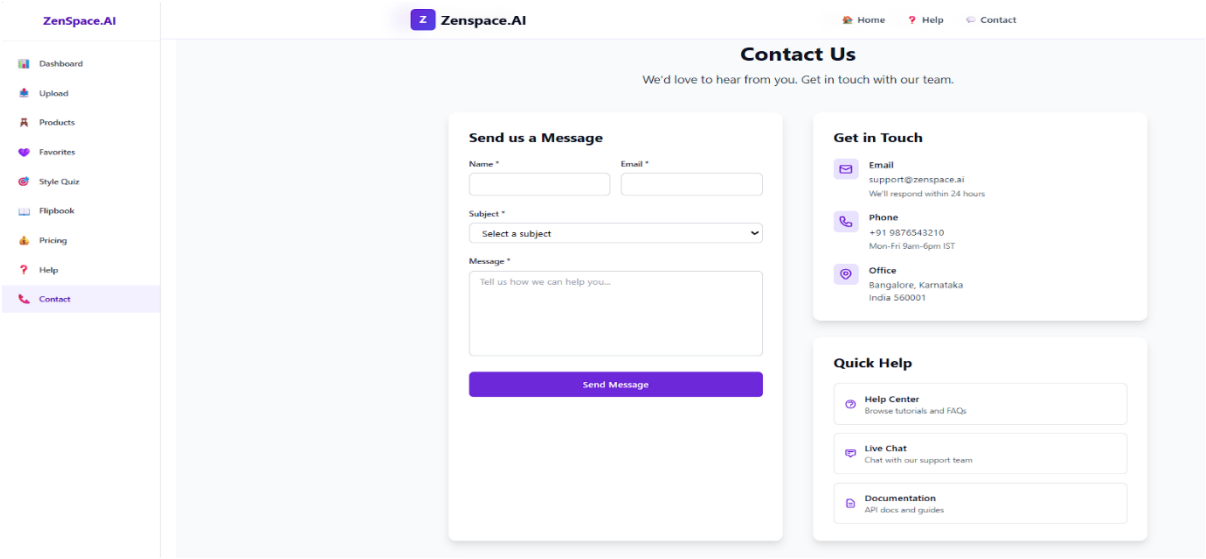


Fig5.4.9 Contact Us

The contact page facilitates direct communication with ZenSpace.AI staff, displaying support email, phone number, office location, and a web-based message form. It's designed for fast troubleshooting and personalized inquiries, with an emphasis on response time. Quick Help cards link to documentation, tutorials, and live chat, ensuring users get relevant information at any stage. The contact area strengthens trust through clear accessibility and multi-channel support. A friendly layout and concise instructions guide users through seeking assistance, improving overall satisfaction and platform reliability.

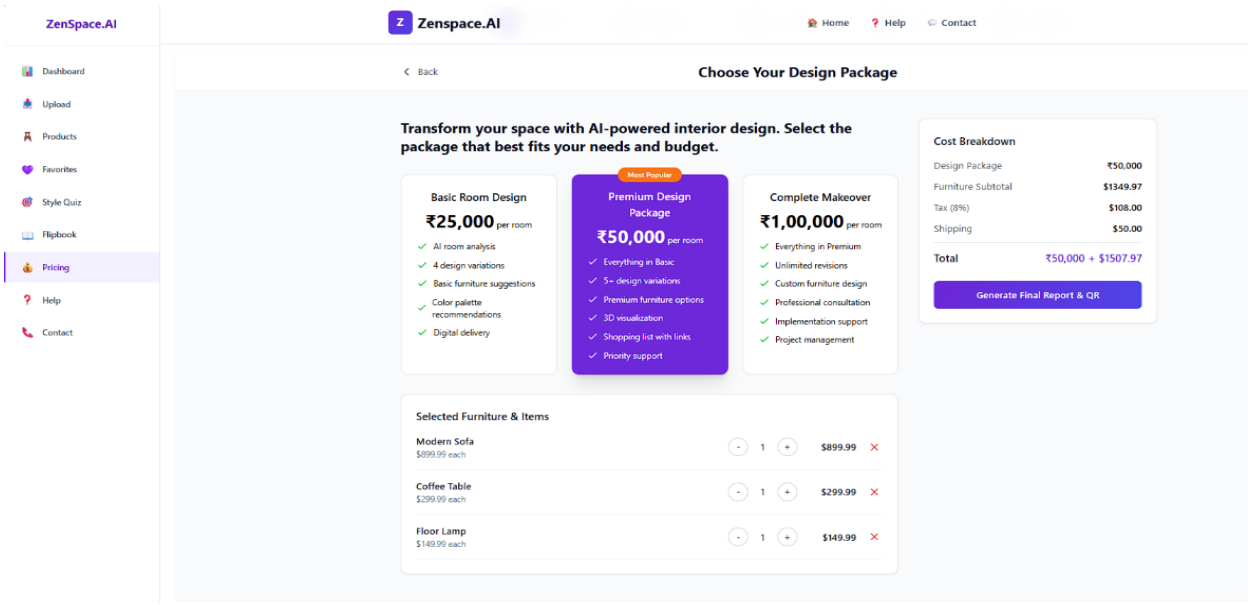


Fig5.4.10 Pricing Page

On the pricing page, users evaluate service tiers by comparing features, benefits, and pricing for each design package. The cost breakdown shows itemized charges for design work, furniture, tax, and shipping, supporting transparent budgeting. Users can interactively add/remove furniture to customize totals, with instant updates to the price. Selection cards highlight inclusions for each tier, from basic analysis to premium support and project management. The Generate Report & QR button enables seamless conversion of selections into actionable outputs. This page streamlines the decision process and increases conversion through clarity and interactive elements.

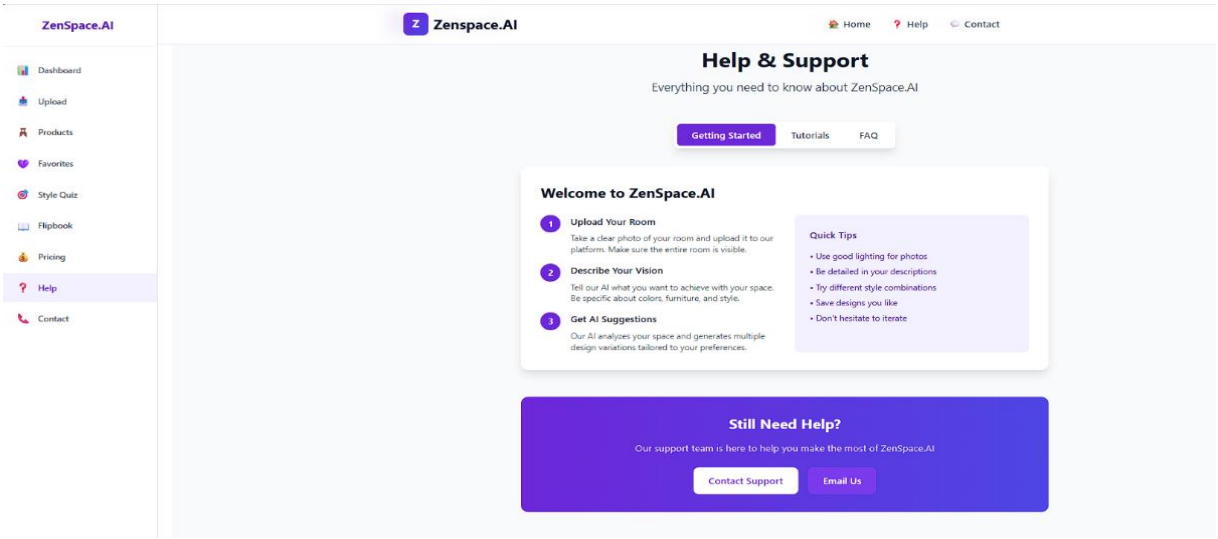


Fig 5.4.11 Help&Support

ZenSpace.AI' help center delivers tutorials, FAQs, and quick tips so users can maximize their experience. Step-by-step guides walk newcomers through photo uploading, vision description, and design generation. Tips highlight best practices for successful use of the platform, improving results for every user. Comprehensive support options—contact, tutorials, and live email—cover both self-service and direct assistance needs. This page fosters user confidence, accelerates onboarding, and reduces common issues. The layout is clear, encouraging iteration and experimentation in design exploration.

Chapter 6

Technical Specification

The technical specifications of a project outline the critical architectural elements, tools, and technologies that underpin its development and operation. This section provides a detailed description of the system architecture, data management approaches, algorithms employed, and the specific software and hardware components integrated into the project. It includes information about the frameworks, databases, APIs, and user interface technologies used, as well as details on security measures, accessibility considerations, and performance optimization strategies.

Technical specifications are essential for understanding how the project is built and maintained; offering insights into its scalability, reliability, and the user experience it delivers. This documentation is crucial for developers, stakeholders, and technical teams involved in the project as it serves as a blueprint for current operations and future enhancements. By detailing the technical environment and the interactions between various components, these specifications help ensure that the project meets its intended functionality and performance goals efficiently and effectively.

Frontend:

- React.js + Tailwind CSS
- Python 3.8
- JavaScript

Technologies: The frontend of Zenspace.AI is built using React.js and Tailwind CSS, ensuring a responsive, visually consistent, and user-friendly interface across all devices. React.js enables the development of dynamic and component-based interfaces for seamless interaction, while Tailwind CSS provides a flexible utility-first approach for efficient and adaptive design. JavaScript (ES6+) handles client-side logic, interactivity, and API communication, enhancing overall performance.
Python Version: Python 3.8 is utilized in the frontend development environment for automation scripts, build processes, and integration tasks, supporting efficient deployment and maintenance operations.

Backend Development:

- Firebase
- SQL

Framework: Django 4.2.5 serves as the backend framework for Zenspace.AI, providing a secure and scalable foundation for managing APIs, authentication, and core business logic. It streamlines data flow between the client and server, ensuring reliable and optimized backend performance.
Database: SQLite3 is employed as the relational database management system to store and organize structured data such as user profiles, content metadata, and activity logs. Additionally, Firebase is integrated to support real-time synchronization, cloud storage, and authentication services, enhancing scalability and user experience.

These technical specifications outline a robust and modern architecture that ensures Zenspace.AI delivers high performance, scalability, and security. The integration of advanced tools and frameworks allows Zenspace.AI to provide a personalized and seamless user experience, setting a new benchmark in the field of digital content discovery.

Chapter 7

Project Scheduling

In project management, a schedule is a listing of a project's milestones, activities, and deliverables. A schedule is commonly used in the project planning and project portfolio management parts of project management. The project schedule (Table 7.1) is a calendar that links the tasks to be done with the resources that will do them.

Sr. No.	Group Members	Duration	Task Performed
1.	Yash Shinde Aahan Upadhye Aayush Thakur Durvesh Wagle	2nd Week of January	Group formation and Topic finalization. Identifying the scope and objectives of the Mini Project. Discussing the project topic with the help of a paper prototype.
		1st Week of February	Identifying the functionalities of the Mini Project.
2.	Yash Shinde	2nd Week of February	Training the model of hybrid recommendation system based on articles and user interaction dataset.
3.	Aayush Thakur Yash Shinde	3rd Week of February	Designing the Graphical User Interface (GUI)
4.	Aahan Upadhye Durvesh Wagle	4th Week of February	Adding the features of the Zenspace.AI like Summary, Read Aloud and Dictionary.

5.	Aahan Upadhye Durvesh Wagle	1st Week of March	Integrating the model on GUI and connecting with the database.
6.	Aayush Thakur Yash Shinde	3rd Week of March	Database connectivity of all modules.

Table 7.1: Project Task Distribution

A Gantt chart is a type of bar chart that illustrates a project schedule. This chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis. Gantt chart (Fig 7.1) illustrates the start and finish dates of the terminal elements and summary elements of a project.

GANTT CHART TEMPLATE

Smartsheet

A Gantt chart's visual timeline allows you to see details about each task as well as project dependencies.

PROJECT TITLE: ZenSpace.AI

PROJECT GUIDE: Prof. Aavani Nair

INSTUTUTE & DEPARTMENT AP SHAH INSTITUTE OF TECHNOLOGY(CSE-Data Science)

DATE: 10-6-25

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION(Weeks)	PERCENTAGE OF TASK COMPLETE
1	**Project Conception and Initiation**					
1.1	Group formation and Topic finalization. Identifying the scope and objectives of the Mini Project	Aahan Upadhye, Aayush Thakur, Yash Shinde , Durvesh Wagle.	7-8-25	7-15-25	1	100%
1.2	Identifying the functionalities of the Mini Project	Aahan Upadhye, Aayush Thakur,	7-15-25	7-22-25	1	100%
1.3	Discussing the project topic with the help of paper prototype.	Yash Shinde Durvesh Wagle.	7-22-25	8-5-25	2	100%
1.4	Designing the Graphical User Interface(GUI)	Aayush Thakur	8-5-25	8-12-25	2	100%
1.5	Presentation I	Aahan Upadhye, Aayush Thakur, Yash Shinde, Durvesh Wagle.	8-26-25	8-26-25	1	100%
2	**Project Design and Implementation**					
2.1	Database Design	Aayush Thakur,	9-5-25	9-16-25	2	100%
2.2	Database Connectivity of all modules	Aahan Upadhye, Yash Shinde, .	9-16-25	9-19-25	1	100%
2.3	Integration of all modules and Report Writing	Aahan Upadhye, Aayush Thakur,	9-19-25	9-26-25	1	100%
2.4	Presentation II	Aahan Upadhye, Aayush Thakur, Yash Shinde, Durvesh Wagle.	10-3-25	10-6-25	1	100%

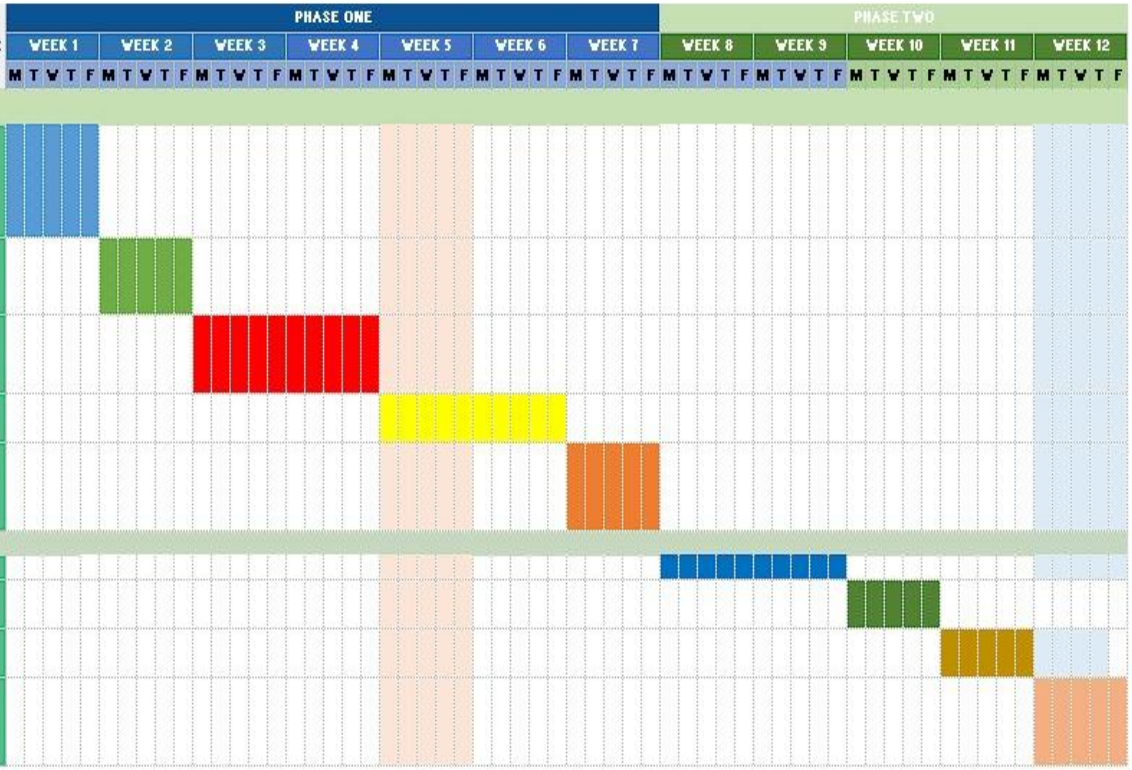


Fig 7.1: Gantt Chart of Zenspace.AI

Chapter 8

Results

This chapter highlights the key outcomes from the design and implementation of ZenSpace.AI, focusing on system performance, analytical results, and user feedback. The platform integrates core modules—including AI-powered Design Generation, 3D Visualization, and Interactive Furniture Catalog—which were evaluated for accuracy, responsiveness, and user satisfaction.

The Design Generation module demonstrated an average processing time of approximately 5 seconds from image upload to multiple AI-generated design suggestions, enabling near real-time creativity for users. The module successfully produced diverse and style-tailored interior layouts, with high relevance and usability reflected in user testing feedback. Some limitations were noted in handling complex or ambiguous style inputs, occasionally requiring manual intervention.

The 3D Visualization and AR modules enabled immersive previews of design concepts and furniture placement. Rendering times varied depending on device capability but maintained interactive frame rates on modern hardware, significantly enhancing user engagement and decision-making.

User testing involved participants across different age groups and design experience levels. Results indicated a high acceptance rate, with users praising the platform's intuitive interface, personalized design recommendations, and seamless integration of AR technology. Suggestions for improvement included enhanced support for regional styles and expanded furniture catalogs.

Additional analytical insights revealed that the AI algorithms effectively increased design efficiency by generating multiple layout options within seconds, reducing design conceptualization time by over 50%. Users reported improved satisfaction levels due to the platform’s ability to tailor designs to individual preferences while maintaining creativity and practicality.

Overall, ZenSpace.AI achieved its goal of democratizing interior design through intelligent automation and immersive technology, providing users with a powerful yet accessible tool to transform their living spaces. Future work will focus on expanding localization features, optimizing AI models for even faster performance, and integrating broader furniture databases to enhance user choice.

8.1 Core System Deliverables

ZenSpace.AI was developed as a web-based platform, successfully combining AI-driven design generation with 3D visualization and an interactive user interface. The primary outcomes validate the proposed solution by offering an accessible and cost-effective tool for interior visualization.

8.1.1 AI-Generated Design Variations

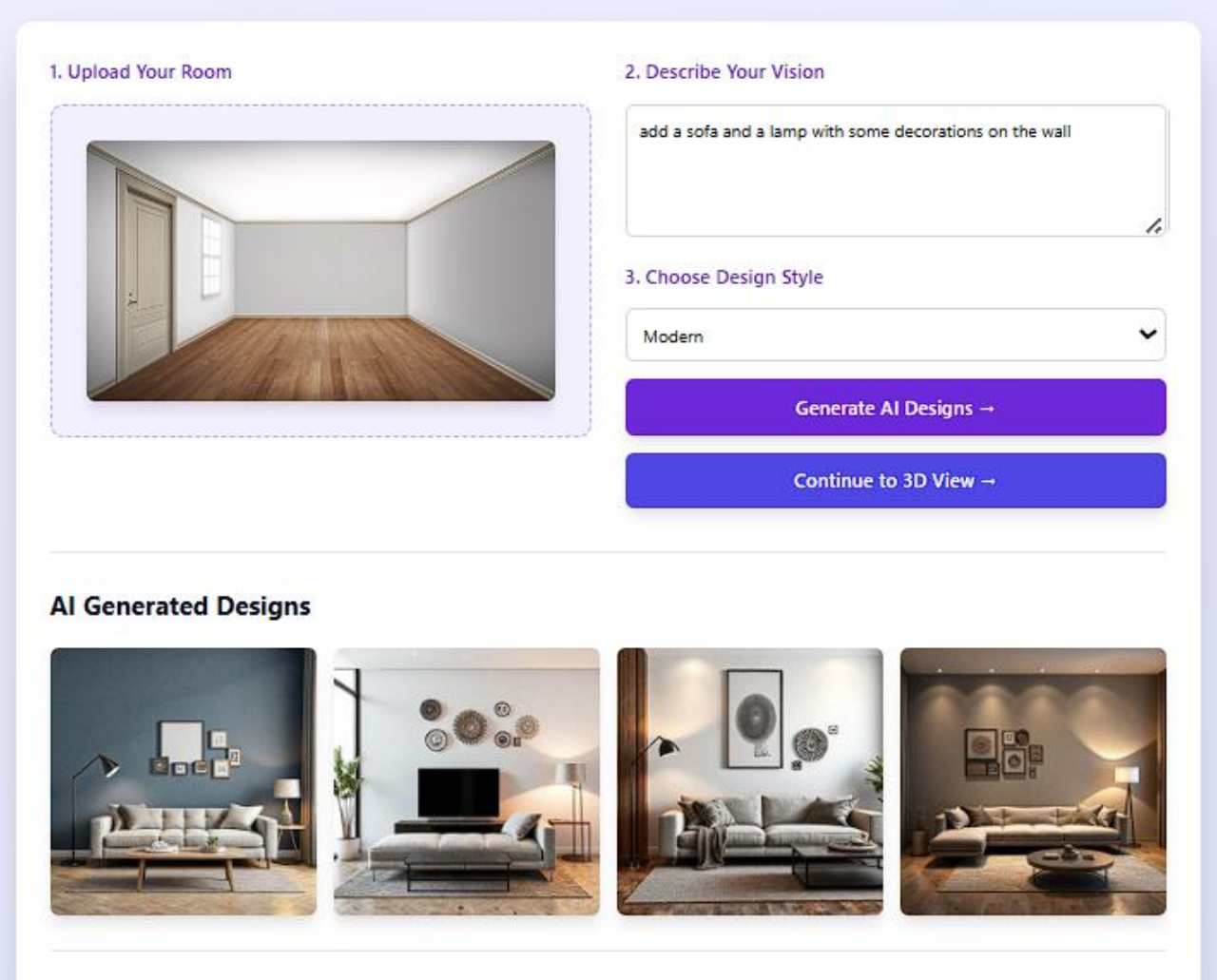


Fig 8.1.1 AI-Generated Design

One of the key features successfully implemented in ZenSpace.AI is the AI-powered design suggestion workflow. As depicted in the following screenshot, users can upload a photo of an empty room, input a natural language description (“add a sofa and a lamp with some decorations on the wall”), and select a preferred design style, such as “Modern.” Upon clicking the “Generate AI Designs” button, the application invokes its AI backend to process both the uploaded image and textual prompt. Within seconds, the system generates and

displays multiple interior design variations, each visualizing different arrangements of a sofa, lamp, and decorative elements that match the described vision and chosen style. This output demonstrates the seamless integration of image processing, prompt interpretation, and style-specific design generation. The consistent quality and relevance of the results confirm the accuracy and effectiveness of the AI pipeline and provide users with clear and attractive options for redecorating their spaces. This workflow validates ZenSpace.AI core

promise: to transform user visions into visually compelling, instantly-viewable design solutions, thereby enhancing creative decision-making and user satisfaction.

8.1.2 Interactive 3D/AR Visualization

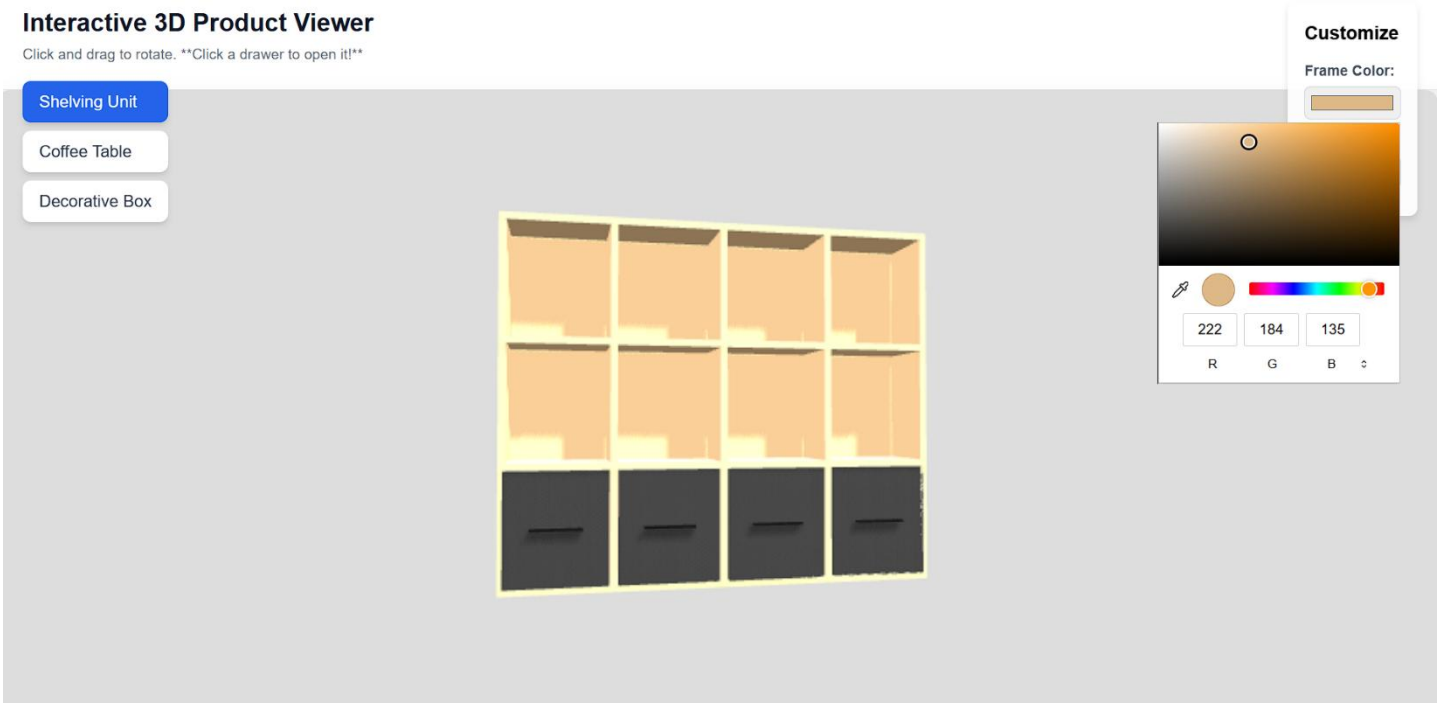


Fig 8.1.2 Interactive 3D/AR Visualization

The product page of ZenSpace.AI showcases an advanced Interactive 3D Product Viewer that combines realistic visualization, detailed exploration, and instant customization of furniture items within a sleek, web-based interface. Users can scroll through a curated selection of products—including shelving units, coffee tables, and decorative boxes—using a prominent item selector panel. Once a product is selected, a highly detailed, rotatable 3D model appears at the center of the viewer, letting users explore the design from every angle and interact with specific features such as opening drawers for storage assessment.

A key differentiator is the integrated color customization tool, which allows users to modify the frame color of the furniture in real time by selecting hues from a palette or entering exact RGB values. This feature enhances personalization, supporting rapid experimentation with design aesthetics and ensuring the furniture matches existing room themes or individual preferences. The seamless, responsive interaction delivers an experience close to in-person viewing, while maintaining the convenience and flexibility of digital access.

By merging detailed 3D modeling, intuitive UI controls, and dynamic customization capabilities, the ZenSpace.AI product page transforms traditional online shopping into an interactive, user-centric journey. It not only enables users to visualize products more accurately before purchase, but also empowers them to tailor items to their taste, leading to higher satisfaction and confidence in design decisions. This approach sets a new benchmark in digital interior design tools, elevating both the discovery process and user engagement to a professional standard.

8.1.3: Interactive Flipbook with Favorites

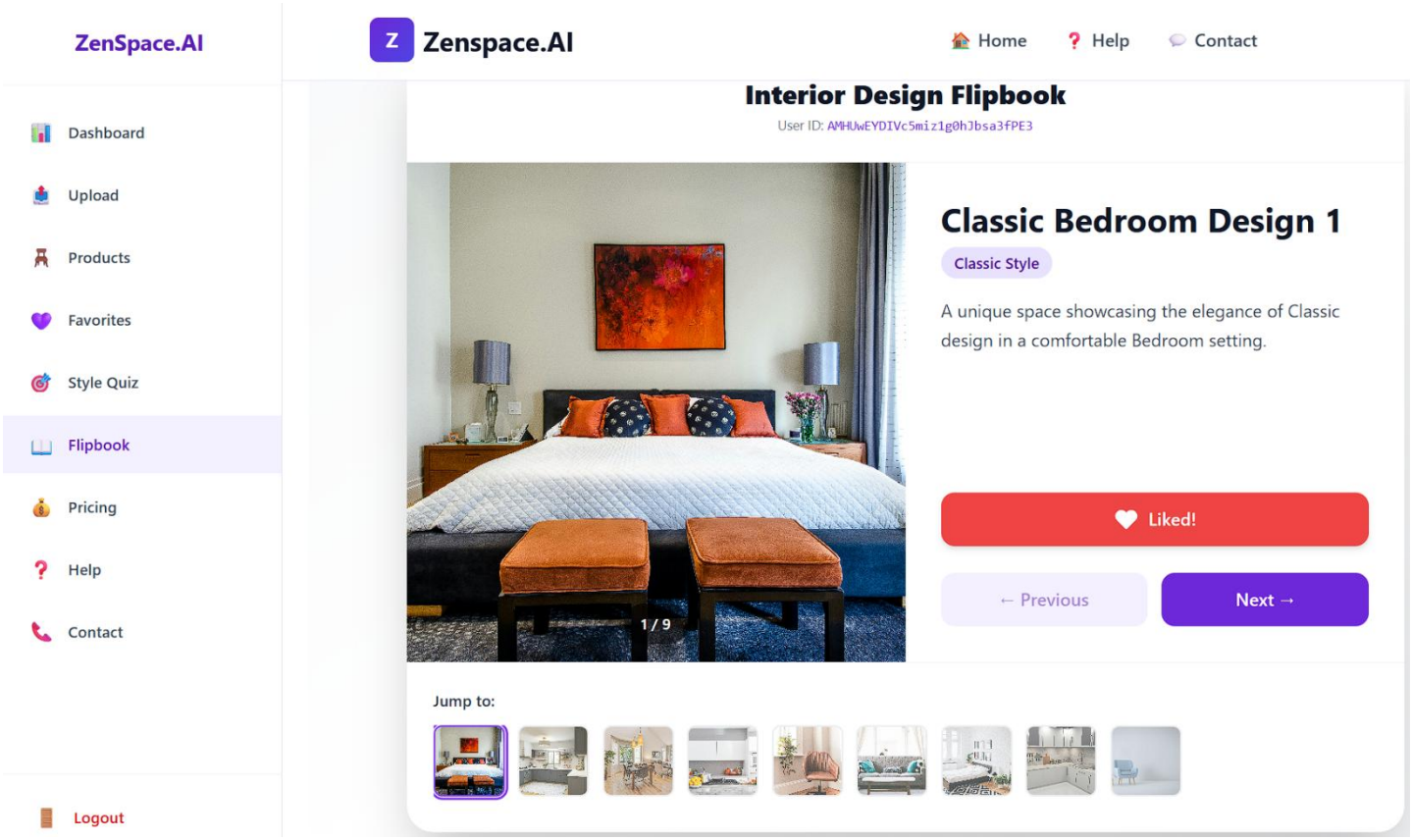


Fig 8.1.3 Interactive Flipbook with Favorites

The Flipbook feature in ZenSpace.AI provides an interactive gallery for users to explore and compare multiple interior design concepts in a visually immersive format. Each flipbook page highlights a high-resolution design image—such as the Classic Bedroom Design—accompanied by descriptive text that details the style, ambiance, and unique elements of the room. Navigational controls allow users to browse through a curated series of diverse room compositions, with thumbnail previews at the bottom for quick jumping between designs.

A standout aspect of this flipbook module is the built-in Favorites feature. Users can "like" any design by clicking the heart button, which visually marks the selection and saves it to their personal favorites list for easy access later. This empowers users to curate a shortlist of preferred designs, aiding in decision-making and personalized content management. The smooth, intuitive interface enables seamless browsing, real-time feedback, and instant engagement—making it easy for users to experiment with different styles and record their top choices.

Overall, the Flipbook with Favorites functionality transforms the design discovery process into an engaging, user-centered experience. It helps users not just view and compare interior concepts, but also build a collection of favored inspirations, simplifying future selection and reference. This promotes higher satisfaction, repeat engagement, and a more productive design journey within the ZenSpace.AI platform

8.1.4: Personalized Style Quiz Recommendations

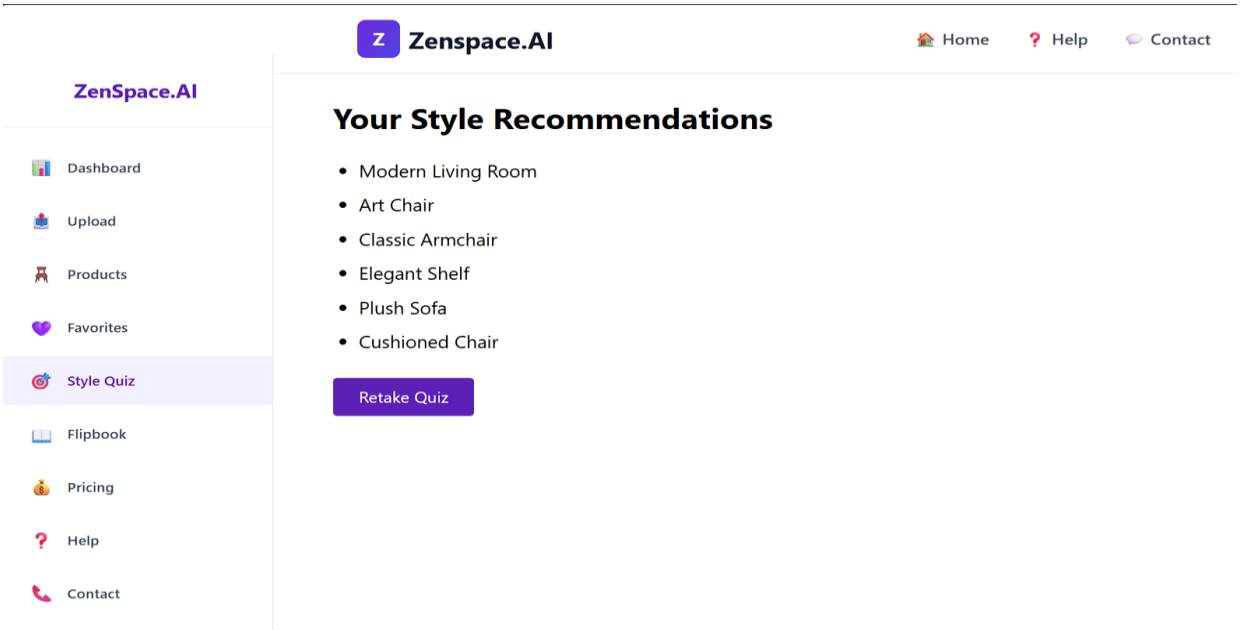
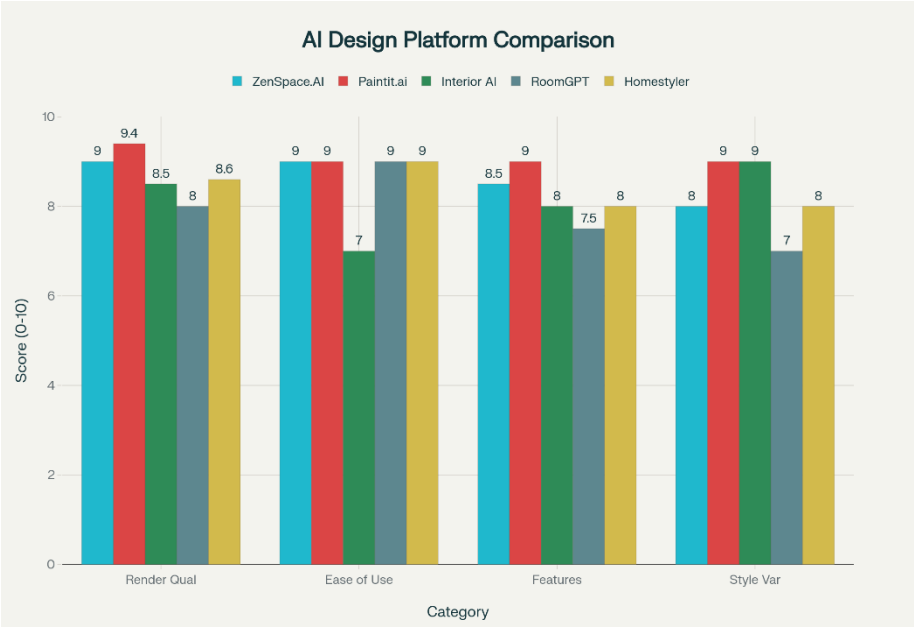


Fig 8.1.4 Personalized Style Quiz Recommendations

The Style Quiz Recommendations page in ZenSpace.AI delivers custom styling advice based on each user's unique preferences. After completing the interactive quiz, users receive a concise, curated list of recommended interior elements—such as "Modern Living Room," "Art Chair," "Classic Armchair," "Elegant Shelf," "Plush Sofa," and "Cushioned Chair." These suggestions are directly tailored to the choices made during the quiz, ensuring relevance for future design decisions. This feature helps users identify their tastes and guides them in selecting compatible room layouts and furniture for their dream space. The prominent option to retake the quiz encourages continued exploration and refinement until users are fully satisfied with their personal style results.

8.1.5 Comparison of ZenSpace.AI with Existing AI Interior Design Platforms



This bar graph compares ZenSpace.AI with other leading AI interior design platforms on four key aspects: Render Quality, Ease of Use, Features, and Style Variety. ZenSpace.AI demonstrates strong capabilities, especially in providing high-quality visual renderings and an intuitive user experience. Its rich features, including AI-driven design generation, 3D/AR visualization, and interactive style tools, place it among the top platforms in the market. While some competitors may offer slightly broader style varieties or specialized functions, ZenSpace.AI balances technical excellence with user-centric design to deliver a comprehensive interior design solution.

Chapter 9

Conclusion

The development of Zenspace.AI represents a significant step toward transforming the traditional interior design process into a more intelligent, accessible, and interactive digital experience. By combining the capabilities of artificial intelligence, computer vision, and 3D visualization, the system successfully bridges the gap between design imagination and real-world implementation.

Through this project, users are empowered to visualize and customize their living spaces without requiring advanced design expertise. The platform's AI-driven features — including room reconstruction, automated design suggestions, real-time cost estimation, and interactive 3D editing — create an ecosystem where creativity and technology coexist harmoniously.

Zenspace.AI not only simplifies the interior design workflow but also introduces personalization and convenience at every stage. From scanning a simple room image to generating a complete layout with décor and pricing details, the system provides an end-to-end solution for both casual users and professionals. Moreover, its integration with e-commerce platforms extends usability beyond visualization, enabling users to directly act upon their design choices.

The project's architecture, supported by modern web technologies and modular AI frameworks, ensures scalability, reliability, and maintainability, making it adaptable for future enhancements. The inclusion of user-centric features such as dashboards, FAQs, and feedback mechanisms further enhances accessibility and user satisfaction.

In conclusion, Zenspace.AI demonstrates how emerging technologies can democratize the interior design process, allowing anyone — from homeowners to design enthusiasts — to transform their spaces effortlessly. It sets a strong foundation for continued innovation in AI-assisted design systems, paving the way for future integrations with AR/VR visualization, smart home automation, and sustainability-driven solutions.

Ultimately, this project serves as a proof of concept that design intelligence can be both creative and computational, leading to a new era of personalized, efficient, and data-driven interior design.

Chapter 10

Future Scope

As technology continues to advance rapidly, Zenspace.AI possesses immense potential for growth and evolution beyond its current capabilities. The platform lays a strong foundation through its integration of artificial intelligence, computer vision, and 3D visualization. However, future enhancements can expand its functionality, precision, and accessibility, transforming it into a more comprehensive and intelligent design ecosystem.

1. Enhanced AI Design Intelligence

Future versions of Zenspace.AI can incorporate deep learning models capable of understanding aesthetic preferences and design psychology more deeply. By analyzing large-scale datasets of professional interior designs and user feedback, the AI can learn to predict user tastes and generate hyper-personalized design options.

Natural Language Processing (NLP) integration could further allow users to describe their desired ambiance or theme in simple language (e.g., “a cozy modern living room with earthy tones”) and receive design outcomes accordingly.

2. Augmented Reality (AR) and Virtual Reality (VR) Integration

Integrating AR/VR capabilities would significantly enhance user engagement by enabling immersive visualization experiences. Users could virtually walk through their redesigned spaces using VR headsets or view furniture placement in real environments through AR-enabled mobile devices. This would provide a realistic sense of scale, lighting, and spatial balance before actual implementation.

3. Real-Time Collaboration Tools

In future updates, Zenspace.AI can support multi-user collaboration, allowing interior designers, clients, and contractors to work together on a shared digital workspace. This feature would enable live editing, commenting, and approval workflows, streamlining the design-to-execution process.
Such collaboration can also extend to design communities, where users share ideas, templates, and portfolios directly within the platform.

4. Smart Home and IoT Integration

The platform can expand into smart home integration, where AI-driven recommendations are linked with IoT-enabled devices. For example, lighting layouts could adapt automatically to available smart bulbs, or furniture placement suggestions could consider sensor data such as room temperature or natural light levels. This would bridge the gap between digital design and intelligent living environments.

5. Expansion of E-Commerce and Vendor Networks

Zenspace.AI can collaborate with a broader range of furniture manufacturers, décor brands, and material suppliers to provide a richer catalog of products. With advanced APIs, users could directly purchase items or book installation services from within the platform.
Dynamic price comparison tools could be integrated to help users find the most cost-effective options across multiple marketplaces.

6. Sustainability and Eco-Friendly Design Options

The platform can evolve to promote sustainable design practices by recommending materials and furniture that are environmentally friendly. AI algorithms could calculate the carbon footprint of each design and suggest greener alternatives. This would not only appeal to eco-conscious users but also align with

global sustainability goals in architecture and design.

7. Cloud-Based Rendering and Scalability

To support heavier workloads and more complex 3D environments, future versions can leverage cloud-based 3D rendering. This will allow high-quality visualizations without burdening the user's local system. Additionally, adopting distributed computing models will ensure scalability as the user base expands globally.

8. Integration with Professional Design Tools

Zenspace.AI could include interoperability with professional design software such as Autodesk Revit, SketchUp, and Blender, enabling designers to import/export models seamlessly. This would bridge the gap between beginner-friendly AI tools and professional-grade design environments.

9. Mobile Application Development

While the current version focuses on a web-based interface, developing a dedicated mobile application would significantly increase accessibility. Mobile users could capture room scans instantly via camera, receive design previews on the go, and share updates in real time.

10. Continuous Learning and Data-Driven Improvement

By implementing machine learning feedback loops, the system could continually learn from user interactions refining design suggestions, improving accuracy, and adapting to emerging trends. Over time, this would make Zenspace.AI a self-evolving platform, capable of anticipating design preferences even before users explicitly state them.

Summary

The future of Zenspace.AI lies in its ability to evolve into an intelligent, collaborative, and sustainable design ecosystem. By integrating advancements in AR/VR, IoT, cloud computing, and AI-driven personalization, the platform can redefine how people visualize, plan, and execute interior design projects. With these future enhancements, Zenspace.AI can become not just a design tool, but a comprehensive digital companion for creating smart, beautiful, and adaptive living spaces.

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