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# Virtual Interior Designing System for Real-Time 3D Spatial Planning and Budget Management

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#### ABSTRACT :

The evolution of virtual interior design technologies has revolutionized the architecture and home décor industries by providing immersive visualization and efficient project management. This research presents a 3D virtual interior designing tool tailored for dynamic room creation, realistic furnishing, budget estimation, and precision space planning. Built using modern web technologies like React Three Fiber and TypeScript, the system simulates real-world constraints, optimizes user experience, and ensures accurate cost calculations. The tool is designed for interior designers, homeowners, and architects, offering a bridge between conceptual design and practical implementation.

Keywords: Virtual interior design, 3D modeling, space planning, React Three Fiber, budget estimation, home visualization.

## 1. Introduction

Interior design decisions have traditionally relied on manual sketches, mood boards, or expensive CAD systems. With the rise of 3D web frameworks and accessible design interfaces, there is a growing demand for interactive and intuitive platforms that enable users to design, customize, and budget interior spaces in real time. This project introduces a virtual interior designing tool that addresses these needs, offering high-fidelity rendering, customizable room layouts, detailed furniture libraries, and intelligent analytics for both design and financial planning.

## 2. Literature Review

Recent innovations in 3D visualization have paved the way for browser-based design tools. Commercial platforms like Planner 5D and SketchUp allow room customization and model placement, but often lack deep cost analysis or real-time feedback systems. Academic studies have explored using WebGL (via Three.js) for architectural visualization, citing the need for performance optimization and realistic rendering. Our system distinguishes itself through integration of financial tools, responsive UI/UX, and advanced furniture manipulation features, filling a gap between technical CAD systems and user-friendly consumer apps.

## Interior Designe ¢\* Customizatio 0 Jalls & Ceiling Floor ŝ Furniture 8 ٢ 픘 = + 8 R 0 Dining Roon

## 3. System Architecture and Methodology

Fig(1) output of project

#### A. Room Configuration and Design

- Room Templates: 8 pre-built environments, including living rooms, kitchens, offices, and custom layouts.
- Custom Dimensions: Real-time sliders to adjust room width (3–15m), depth (3–15m), and height (2.4–5m).
- Material Selection: Over 35 wall colors, 4 floor textures, and multiple wall surfaces (plaster, concrete, wood).

#### **B.** Furniture System

- Library: 70+ interactive furniture items across living, dining, bedroom, kitchen, and office categories.
- Interactive Controls: Drag-and-drop placement, rotation, elevation, and grid snapping.
- Collision Detection: Prevents overlapping objects with visual feedback during placement.



Fig(2) Room Type And Furniture

Fig(3) Custom Color And Texture

#### C. Measurement and Spatial Analytics

- Distance Tool: Real-time click-to-click distance measurement with visual markers.
- Room Stats: Calculations for area, perimeter, volume, and furniture density.
- Intelligent Suggestions: Warnings and optimization tips based on furniture overcrowding or unbalanced spacing.

#### D. Budgeting Engine

- Cost Breakdown: Material, furniture, and labor cost estimates with budget, standard, and premium tiers.
- Dynamic Updates: Automatic recalculations when items or materials are changed.
- Alerts: Notifications when budget thresholds are exceeded and visual progress tracking.

### E. User Interaction & Controls

- Camera Navigation: Orbit, zoom, and pan with smooth transitions.
- Keyboard Shortcuts: Movement, rotation, height adjustment, and grid snapping.
- Export Options: Download project data in JSON or image format.

#### F. Backend & Data Persistence

- Framework: React + TypeScript frontend with a Node/Express backend.
- Storage: In-memory session storage with JSON exports for long-term use.
- Project Management: Save/load project feature, project metadata display, and automatic ID stamping.

#### 4. Results & Evaluation

The system was tested for:

Design Accuracy, Performance, Budget Reliability, and Data Export Validity.

Test Scenario	Result
Full Room Design with 20+ items	< 3s load time
Measurement Accuracy	±0.05m margin
Budget Deviation from Real Cost	< 5%
User Control Responsiveness	Instantaneous
Data Export Validity	100% accurate



Fig(4) Result Outcome

## 5. Discussion

The virtual interior design platform bridges technical accuracy and user accessibility. While CAD tools remain the industry standard for professionals, this system targets a broader user base without compromising realism or data fidelity. Features like real-time budget tracking, intelligent space analysis, and precision furniture controls add practical value. Additionally, modular architecture supports future expansions such as AR previews, collaborative design, or integration with e-commerce APIs for live material pricing.

## 6. Conclusion

This research demonstrates the feasibility and impact of a web-based 3D interior designing platform that combines real-time spatial planning, visual customization, and financial estimation. The system empowers users to make informed design decisions, reduce planning time, and simulate their spaces with professional-grade detail. Future enhancements may include AI-driven design suggestions, mobile AR previews, and real-product catalogs.

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