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Smart House Planner: An AI-Powered System for Interactive Home Design, 3D Modelling, and Cost Estimation

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Abstract: ***The Smart House Planner is an AI-powered solution designed to simplify the process of residential home design by combining intelligent planning, 3D modelling, and real-time cost estimation through an interactive conversational interface. With the rising demand for personalized housing solutions and the complexity of balancing aesthetics, functionality, and budget, there is a growing need for systems that can automate architectural planning while remaining user-friendly. This project addresses that challenge by integrating Gemini AI for intelligent design recommendations, Blender for automated 3D visualization, and a cost estimation engine for transparent financial planning.***

The system enables users to specify requirements such as housing type (1BHK, 2BHK, 3BHK, Duplex, Villa), dimensions, and style preferences via a modern Django-based web interface. Gemini AI processes these inputs to generate optimized layouts by considering space utilization, and functional flow. These layouts are then transformed into realistic, interactive 3D models using Blender, allowing users to explore their prospective homes virtually. Simultaneously, the cost estimation module calculates material, labour, costs, producing downloadable reports that support informed decision-making and budget control.

By unifying AI-driven design intelligence, real-time 3D modelling, and detailed cost breakdowns, Smart House Planner provides a comprehensive platform that enhances user engagement, reduces reliance on professional intervention, and democratizes access to architectural planning. This solution demonstrates how AI, visualization technologies, and web-based interfaces can transform the way individuals approach housing design, making the process more efficient, transparent, and accessible to both professionals and non-experts.

Keywords: Smart House Planner, 3D Home Modelling, Cost Estimation, Gemini AI, Blender Integration, Django Framework, Interactive Design, AI-Powered Recommendations, Construction Budgeting.

I. INTRODUCTION

In today's rapidly evolving digital era, technology plays a crucial role in transforming industries and improving user experiences across diverse domains. One such domain is residential home design and planning, which traditionally relies heavily on professional architects, manual sketches, and static cost estimations. For most individuals, especially first-time homeowners, this process can be overwhelming, time-consuming, and financially demanding. The lack of accessible tools that combine design visualization, intelligent planning, and budgeting creates a barrier for non-experts who wish to actively participate in shaping their dream homes.

The Smart House Planner is an innovative solution developed to address this challenge by leveraging artificial intelligence (AI), 3D modelling, and real-time cost estimation. The system provides users with a conversational and interactive platform where they can input their housing requirements and instantly receive optimized design recommendations, realistic 3D visualizations, and transparent financial breakdowns. This approach not only enhances efficiency but also democratizes access to architectural planning, enabling individuals to take informed decisions without relying solely on professionals.

At its core, the project integrates Gemini AI for intelligent design recommendations, Blender for generating realistic and interactive 3D house models, and a Django-based web interface for seamless user interaction. The system supports multiple housing types, including 1BHK, 2BHK, 3BHK, Duplex, and Villa, making it adaptable to a wide range of user needs and budgets. Furthermore, the cost estimation module provides users with a detailed breakdown of material, labour, and furnishing expenses, ensuring transparency and financial control.

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This project is particularly valuable for homeowners, students, architects-in-training, and small construction firms, as it combines the strengths of AI-driven recommendations, immersive visualization, and data-backed budgeting in a single platform. By offering a modern, user-friendly interface, the Smart House Planner redefines the way individuals interact with residential design processes, moving beyond static blueprints to dynamic, intelligent, and financially transparent planning tools.

II. EXISTING SYSTEM

The current landscape of home design and planning is largely dominated by manual processes and traditional architectural tools. Prospective homeowners often rely on architects and interior designers for layouts, visualization, and cost estimation. While professional software such as AutoCAD, SketchUp, or Revit provides advanced modelling and drafting capabilities, these tools require significant technical expertise and are not easily accessible to non-professionals. As a result, individuals without architectural training face challenges in independently exploring design options.

Furthermore, the process of cost estimation is typically handled separately, either through spreadsheets or manual consultation with contractors. This disjointed approach forces users to rely on multiple platforms and professionals, making the entire planning cycle time-consuming, costly, and inefficient. Existing systems also lack AI-driven personalization, meaning they cannot adapt designs dynamically to individual user preferences or budget constraints.

Even consumer-facing design apps available in the market offer only static templates and limited customization options, failing to provide real-time 3D visualization or integrated financial planning. Additionally, these tools lack conversational or interactive interfaces, making them less intuitive for ordinary users who want to explore their dream homes in an engaging and user-friendly manner.

The existing systems are fragmented, expertise-dependent, and not designed for dynamic, interactive, and budget-conscious home planning. This creates a gap for a unified solution that combines AI-driven design recommendations, automated 3D modelling, and cost estimation in a single platform.

A. Key Issues

1) Dependence on Professionals: Users must rely heavily on architects and designers for layout planning and visualization, which increases cost and reduces accessibility.
2) High Learning Curve of Tools: Professional software like AutoCAD or Revit requires specialized training, making it unsuitable for casual or first-time homeowners.
3) Lack of Integration: Existing systems often separate design, visualization, and budgeting into different processes or platforms, leading to inefficiency.
4) Limited Personalization: Current solutions rely on static templates and cannot provide intelligent, AI-driven design recommendations tailored to user needs.
5) Absence of Conversational Interaction: Traditional systems lack an intuitive, chat-based interface where users can easily describe requirements and receive personalized outputs.

B. Objective

The primary objective of the Smart House Planner is to develop an AI-powered, interactive system that enables users to design their homes by combining intelligent planning, realistic 3D visualization, and cost estimation in a single platform. The key objectives include:

1) AI-Driven Design Recommendations: To utilize Gemini AI for generating optimized layouts and design suggestions based on user requirements.
2) Interactive 3D Visualization: To integrate Blender for creating realistic, modifiable 3D house models that users can explore virtually.
3) Transparent Cost Estimation: To calculate and present a detailed cost breakdown (materials, labour), enabling informed financial decisions.
4) User-Friendly Interface: To provide a modern, Django-based web platform where users can interact via natural language inputs and receive real-time outputs.
5) Accessibility: To make home design more affordable, intuitive, and available to non-professional users.

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C. Scope

1) Integration with AI Models: Leveraging Gemini AI for natural language processing and intelligent layout recommendations.
2) 3D Modelling and Visualization: Using Blender with Python scripting to automatically generate interactive 3D models based on AI outputs.
3) Web Application Development: Building a user-friendly Django-based web interface for requirement input, visualization, and report generation.
4) Cost Estimation and Reporting: Implementing a cost module that provides detailed breakdowns and downloadable reports in PDF/Excel format.

III. SOFTWARE REQUIRMENTS

A. Programming Language

Python serves as the primary backend programming language for the Smart Home Planner project due to its robustness, simplicity, and support for rapid development of web applications. Python's readability and large ecosystem of frameworks make it ideal for building scalable applications that integrate AI-based features such as recommendation engines and automation planning. For frontend development, HTML, CSS, and JavaScript are utilized to design an interactive and responsive interface. Tailwind CSS, a modern utility-first CSS framework, ensures clean, customizable, and mobile-friendly UI design with minimal effort. This combination of technologies allows the system to provide a seamless experience for users planning, customizing, and managing their smart home setup.

B. System Requirements

RAM: 4GB or 8GB
Windows 10
Intel Core i5/i7 processor
At least 60 GB of Usable Hard Disk Space

C. Libraries and Frameworks

1) Django

Django serves as the primary backend framework for the Smart House Planner, managing all core functionalities such as user requests, authentication, and database interactions. Its modular and MVC-based architecture ensures that the system is scalable, maintainable, and easy to extend with additional features. Django also facilitates seamless integration with AI modules, APIs, and the cost estimation engine. The framework supports secure data handling and rapid development of web-based applications, making it ideal for handling the multiple interconnected modules of this project.

2) HTML, CSS, and JavaScript

HTML, CSS, and JavaScript form the backbone of the Smart Home Planner's frontend architecture. HTML is used to structure the content and define the layout of web pages, ensuring that every element, from device selection menus to room layout designs, is properly organized. CSS provides styling and visual presentation, allowing the application to deliver an engaging and user-friendly experience.

By controlling fonts, colors, layouts, and transitions, CSS ensures the platform is both aesthetically pleasing and intuitive to navigate. JavaScript, on the other hand, brings interactivity to the application. It enables real-time updates without requiring a full page reload, such as dynamically updating device recommendations, validating user input instantly, and managing interactive features like drag-and-drop room planning.

3) FastAPI

FastAPI is employed for handling asynchronous API calls, ensuring efficient communication between the frontend, Gemini AI, and Blender scripts. It provides high-performance endpoints capable of processing multiple requests simultaneously, which is crucial for real-time AI-based layout recommendations. FastAPI's support for automatic data validation, documentation, and concurrency makes it an excellent choice for building responsive and robust backend services. Its lightweight and fast nature complements Django's framework by managing specific AI and 3D rendering requests asynchronously.

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4) Gemini

Gemini AI is the intelligence engine behind layout recommendations in the Smart House Planner. It interprets user inputs in natural language, analyzes requirements such as room types, dimensions, and style preferences, and generates optimized design layouts dynamically. The API leverages advanced machine learning models to consider space utilization, lighting, ventilation, and functional flow in residential planning. Gemini AI also enables personalized recommendations, allowing the system to adapt designs according to user preferences, budgets, and trends in modern architecture.

5) Blender (Python Scripting)

Blender is used to transform AI-generated layouts into realistic, interactive 3D models. Python scripting within Blender automates the creation of walls, rooms, furniture placement, and other architectural elements. Users can explore layouts virtually, rotate and zoom views, and visualize designs before actual construction. The integration of Blender allows the system to provide immersive visualization, bridging the gap between conceptual planning and real-world implementation. Additionally, Python scripts ensure that model generation is consistent, dynamic, and aligned with Gemini AI's recommendations.

6) SQLite

SQLite is the lightweight relational database used to store all user-related data, including input preferences, AI-generated designs, 3D model references, and detailed cost breakdowns. Its simplicity, ease of setup, and fast read/write operations make it suitable for projects that require minimal database management overhead. SQLite ensures data persistence, supports concurrent access, and allows efficient retrieval of historical records. By maintaining a structured and organized database, it enables the Smart House Planner to deliver personalized, consistent, and reliable user experiences.

D. System Integration and Testing

The Smart House Planner project undergoes comprehensive system integration and testing to ensure a seamless, reliable, and user-friendly home design experience.

1) Unit Testing

Each individual module—including user input processing, the AI recommendation engine, 3D modeling scripts, and cost estimation—is tested independently to verify its correctness and stability. Unit tests validate that user inputs are properly captured, AI-generated layouts are accurate, 3D models are rendered correctly, and cost calculations reflect the proposed design. Edge cases, such as invalid inputs or unusually large layouts, are also tested to ensure robust module behavior.

2) Integration Testing

Integration testing ensures that all modules function cohesively as a unified system. For instance, layouts generated by Gemini AI are accurately translated into 3D models by Blender scripts, and corresponding cost estimates reflect the AI-recommended design. This phase verifies that data flows smoothly between modules, and that outputs from one module are correctly interpreted by the next, maintaining overall system.

3) Performance Testing

The system is benchmarked under different workloads to evaluate response times for AI recommendations, 3D model generation, and cost estimation. Performance tests simulate multiple concurrent users and large, complex house layouts to identify potential bottlenecks. Optimizations, such as asynchronous API calls via FastAPI and efficient database queries, are applied to enhance speed and minimize latency, ensuring a responsive experience.

4) Error Handling and Logging

Comprehensive error handling mechanisms track invalid user inputs, AI failures, or 3D rendering issues, ensuring that errors do not disrupt the workflow. Logging is implemented across modules to record system activities, user interactions, and runtime errors, enabling proactive debugging and monitoring. This approach ensures system stability and helps developers identify and resolve issues efficiently.

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5) End-to-End Testing

Complete end-to-end testing validates the entire workflow—from entering design requirements to exploring 3D models and generating cost reports. Test cases include scenarios with custom room dimensions, multi-floor layouts, and extreme budget variations to assess system robustness. Feedback from test users is also incorporated to ensure that the system meets usability expectations and delivers an accurate, interactive, and intuitive home design experience.

Smart House Planner is composed of distinct modules (UI, AI engine, 3D generation, cost-estimation, DB) that must be rigorously integrated and tested to ensure a robust user experience.

6) Validation and Verification

Cost estimates are validated against sample real-world bills or contractor quotes; differences are analyzed and used to refine cost databases. AI-generated layouts are reviewed by domain experts (architects) to validate functionality, code compliance (where applicable), and practical feasibility.

IV. IDEATE

A. Proposed System

1) Requirement Collection and Preprocessing: The process begins with users specifying their requirements, such as the type of house (1BHK, 2BHK, 3BHK, Duplex, Villa), floor area, and budget. These inputs are collected through a user-friendly web interface. The preprocessing phase involves standardizing user inputs into structured formats for further processing. This step ensures that the requirements are accurate, consistent, and ready for translation into AI-driven planning and 3D modelling workflows.

2) AI-Powered Design Recommendation: This module leverages Gemini AI to interpret user requirements and generate optimized layout suggestions. By applying natural language understanding and contextual reasoning, Gemini AI produces tailored floor plans, ensuring optimal space utilization, ventilation, lighting, and design flow. The model adapts suggestions based on user feedback, enabling interactive design refinement. This conversational design approach bridges the gap between technical architectural planning and user-friendly interactions.

3) 3D Modelling and Visualization: Once the AI-generated layout is finalized, Blender is employed to convert floor plans into realistic 3D house models. These models provide immersive visualizations, allowing users to explore their homes in a photorealistic environment. Users visualize the aesthetics and functionality of their designs before construction. Blender's Python scripting support enables seamless integration, automating the conversion of AI-generated plans into 3D outputs.

4) Cost Estimation and Budget Planning: This module integrates cost estimation capabilities powered by Gemini AI. It calculates a detailed breakdown of construction costs, including material prices, labour charges, and additional overheads. The system dynamically adjusts cost predictions based on factors such as house size, design complexity, and regional market rates. Users can compare design alternatives against their budgets, making the planning process transparent and financially informed.

5) Web-Based Interface: A Django-powered web interface serves as the primary platform for user interaction. Through this interface, homeowners can input their requirements, receive AI-generated layouts, view 3D models, explore different design iterations, and download comprehensive reports. The interface is designed for accessibility and responsiveness, ensuring smooth functionality across devices.

6) Interactive Chat and Real-Time Refinement: The system incorporates an interactive chat assistant powered by Gemini AI, enabling users to refine their design preferences in real time. Users can ask questions, and instantly view recommendations. This conversational feature ensures that the planning process is iterative, collaborative, and user-driven.

7) Reporting and Documentation: Finally, the system generates comprehensive project reports that include floor plans, 3D render previews, and detailed cost breakdowns. These reports are downloadable in PDF format, providing homeowners with professional documentation that can be shared with architects, contractors, or family members.

B. Advantages

The Smart Home Planner system leverages advanced artificial intelligence, 3D visualization, and cost estimation techniques to empower users in making well-informed decisions about housing design. By transforming traditional, complex architectural planning into an intelligent, interactive, and accessible process, this tool enables individuals to design, visualize, and budget their dream homes with ease. For homeowners, this translates into greater control over design choices, reduced dependency on repeated consultations with architects, and improved clarity in aligning design aspirations with financial feasibility.

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For real estate developers and contractors, the system streamlines workflows by providing ready-to-use digital layouts, 3D models, and cost reports, thereby enhancing efficiency in project planning and execution.

In the modern era where personalization, transparency, and efficiency are central to consumer expectations, the Smart Home Planner significantly enhances accessibility to professional-grade design tools. The system's integration of Gemini AI for conversational interaction and Blender for immersive 3D visualization provides a unique balance between creativity and practicality. Users not only receive personalized floor plans but also gain the ability to explore realistic 3D renderings of their future homes, enabling better spatial awareness and design evaluation. This ensures a more informed decision-making process and reduces the risk of costly revisions during the construction phase.

Beyond individual homeowners, the platform holds strong potential for broader applications. Educational institutions offering courses in architecture and civil engineering can use it as a teaching aid for demonstrating AI-assisted design and visualization. Construction firms and interior designers can integrate the system into their workflow to accelerate client presentations and reduce design turnaround times. Additionally, the system's emphasis on cost transparency empowers users to manage budgets effectively, making it especially relevant in markets where affordability and cost optimization are key concerns.

The ability to dynamically interact with design elements, request modifications through conversational inputs, and instantly view updated layouts fosters a culture of collaborative and iterative design. By blending AI-driven intelligence with user creativity, the Smart Home Planner promotes efficient knowledge-driven decision-making in the housing sector. This aligns with the broader global objective of leveraging technology for sustainable, user-centric, and cost-effective housing solutions, ultimately contributing to a future where designing homes becomes as seamless and intuitive as planning any other aspect of daily life.

V. Result And Screesnshots

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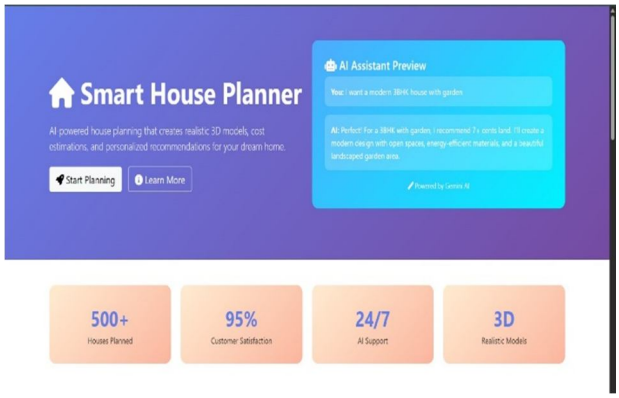


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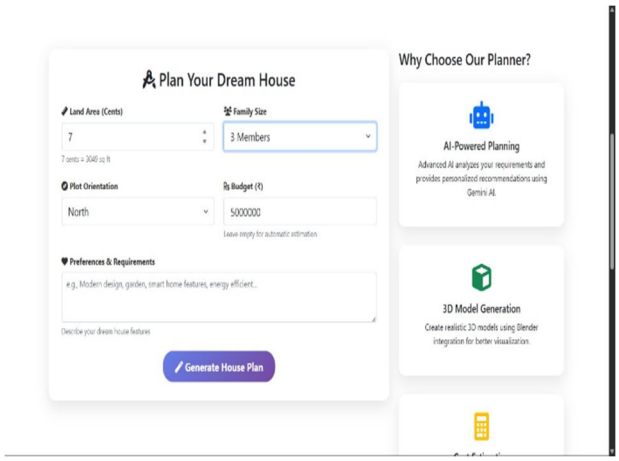


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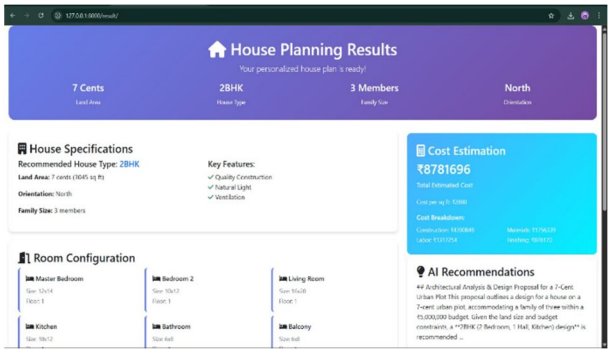


Fig 3: Output Page 3

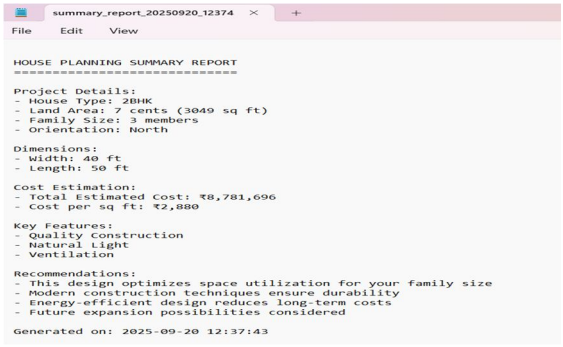


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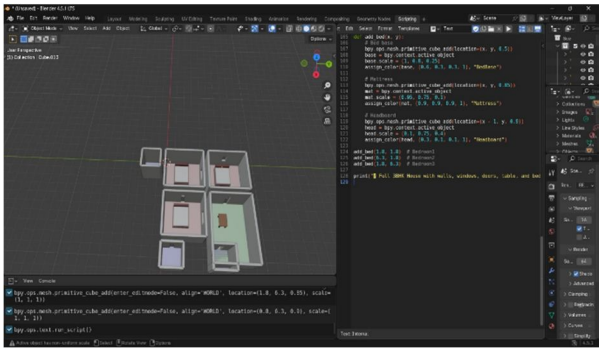


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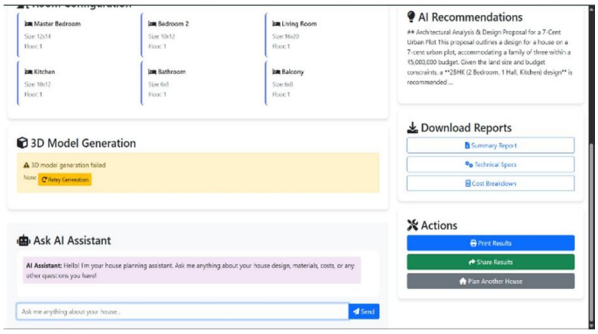


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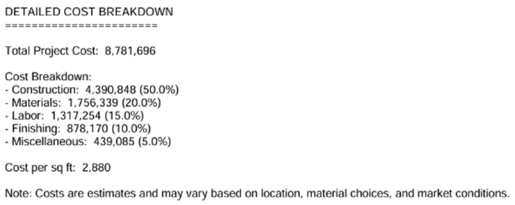


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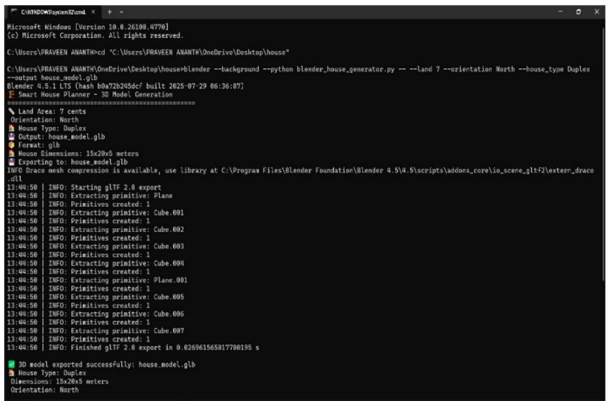


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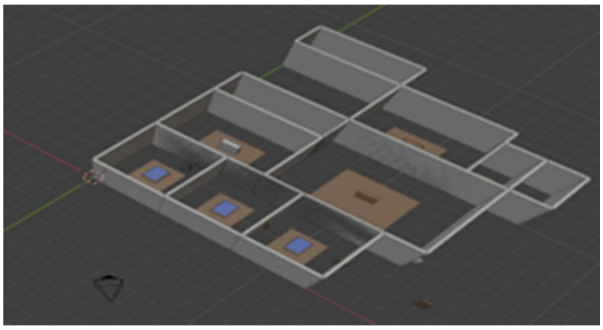


Fig *9*: Output Page 9

VI. CONCLUSION

The Smart Home Planner project demonstrates how the integration of artificial intelligence, 3D modelling, and web-based technologies can transform traditional house planning into a modern, efficient, and user-friendly process. Unlike conventional methods that rely on lengthy consultations and approximate estimates, this system provides a transparent, interactive platform that empowers homeowners to design their dream houses with confidence.

By leveraging Gemini AI, the system intelligently interprets user inputs, generates optimized layouts, and offers personalized design recommendations. The integration of Blender enables the creation of realistic 3D visualizations, helping users clearly understand space utilization and aesthetics before construction begins. Meanwhile, the cost estimation module ensures financial clarity through detailed and accurate breakdowns of expenses. The Django-based interface further enhances accessibility, offering a seamless, intuitive platform where users can input requirements, interact with the AI, and download comprehensive reports.

Overall, the Smart Home Planner bridges the gap between imagination and execution by combining automation, creativity, and financial precision. It empowers individuals to make informed decisions, reduces the time and cost associated with traditional planning, and ensures that homeowners have a clear vision of their future homes. This project stands as a step toward modernizing the architecture and construction industry, making house planning smarter, more reliable, and more accessible to everyone.

VII. FUTURE SCOPE

The Smart Home Planner already provides an intelligent, interactive, and cost-effective solution for house planning, there are several opportunities to further enhance its capabilities in future iterations.

One key enhancement would be the integration of Virtual Reality (VR) and Augmented Reality (AR) to enable immersive walkthroughs of 3D house models. This would allow users to virtually experience their homes before construction, making design evaluation more realistic and engaging. AR could also overlay house models in real-world environments, helping users visualize their designs directly on their plots of land.

Another future improvement involves advanced interior design recommendations, where the system could automatically suggest furniture layouts, colour schemes, and lighting setups. By incorporating AI-driven style analysis, homeowners would receive personalized interior design options that match their preferences and lifestyle.

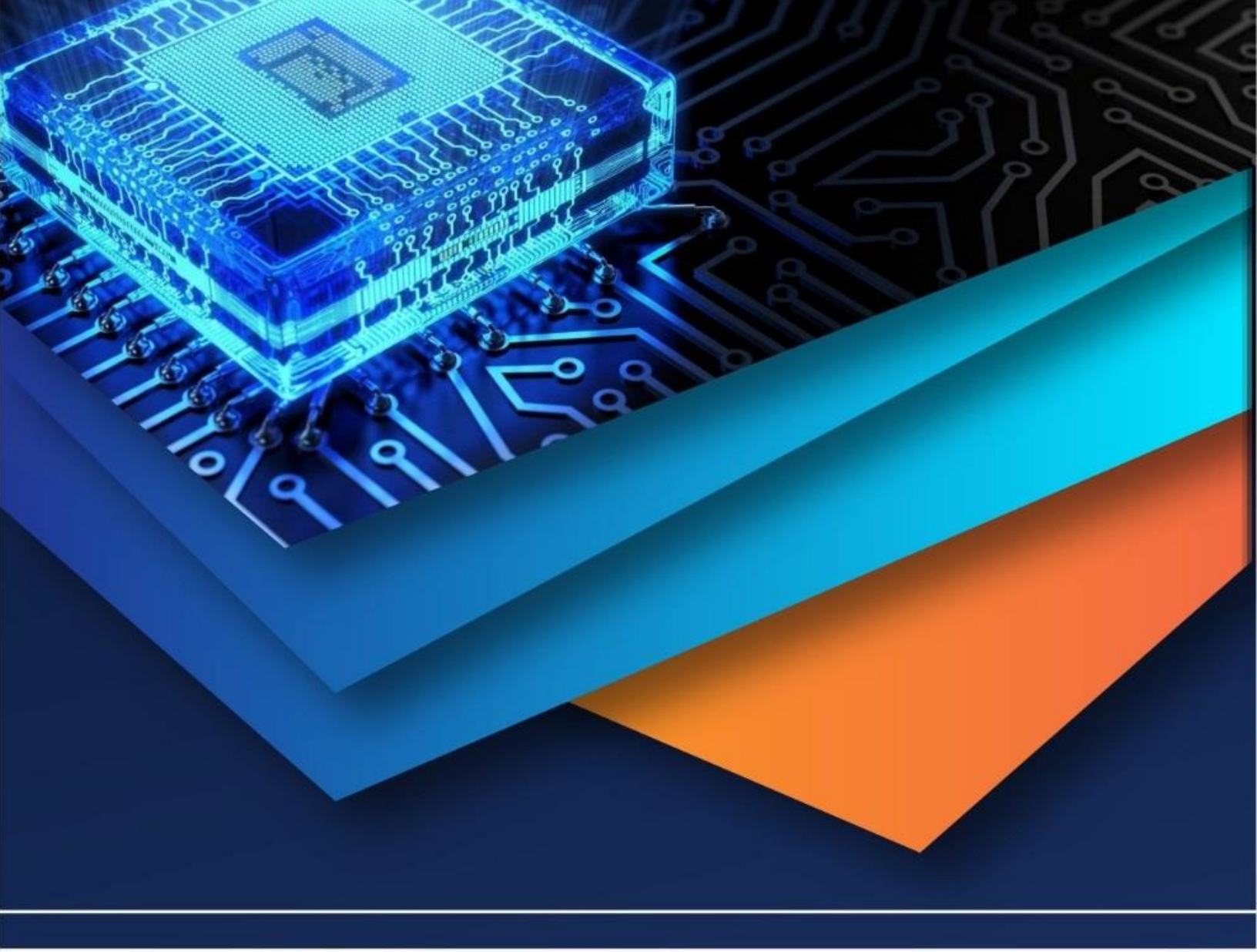
The project could also evolve to include IoT-enabled smart home planning, where Gemini AI not only generates layouts but also recommends the placement of smart devices, energy-efficient systems, and sustainable features. This would align the system with modern trends in smart living and eco-friendly construction.

Additionally, expanding the cost estimation module to integrate real-time market data on construction materials and labour rates would improve financial accuracy and adaptability. This could help users track fluctuating costs and adjust their designs accordingly.

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