

GENERATIVE AI-BASED ARCHITECTURAL DESIGN SYSTEM

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Abstract

This project presents an intelligent Generative AI-based architectural design system that automates the creation of floor plans, interior layouts, and 3D building visualizations using advanced deep learning techniques. The system is built on the Stable Diffusion model, which enables high-quality image generation from textual descriptions. Users can provide inputs such as plot size, number of bedrooms, bathrooms, floors, kitchen type, and preferred design style. These inputs are converted into structured prompts that guide the model in generating relevant architectural outputs. The system uses a latent diffusion mechanism where random noise is gradually refined into meaningful images through an iterative denoising process. This approach significantly reduces manual effort, design time, and dependency on complex software tools. It also allows users to explore multiple design variations quickly, improving creativity and flexibility. Prompt engineering techniques enhance the accuracy and quality of outputs, while negative prompts help eliminate unwanted distortions. Although the system does not ensure precise structural measurements, it is highly effective for conceptual design and visualization. Overall, this project demonstrates the potential of Generative AI in transforming traditional architectural workflows into efficient and intelligent systems.

Keywords: Stable Diffusion, Generative AI, Text-to-Image, Architecture, Floor Plans, Interior Design, 3D Modeling, Deep Learning, Diffusion Models, Prompt Engineering, Image Synthesis, Computer Vision, Design Automation, Visualization, Smart Systems, Artificial Intelligence, Layout Generation, Digital Architecture, Design Optimization, AI-Based Planning.

I. Introduction

With the rapid advancement of Artificial Intelligence (AI), especially Generative AI, there has been a significant transformation in various industries, including architecture and design. Generative AI refers to a class of AI models that can create new content such as images, text, and designs based on learned patterns from large datasets. This technology has made it possible to automate design processes and generate realistic visual outputs using simple textual descriptions. By leveraging AI, designers can reduce manual effort, speed up workflows, and explore creative possibilities more efficiently.

This project focuses on developing an intelligent system capable of generating architectural designs such as floor plans, interior layouts, and 3D building visualizations based on user-defined inputs. The system aims to simplify the design process by allowing users to provide their requirements in a natural and intuitive manner. Instead of manually drawing layouts, users can

simply describe their needs, and the system generates corresponding visual representations. This makes the design process more accessible, efficient, and user-friendly.

The core technology used in this system is Stable Diffusion, a powerful deep learning model designed for generating images from text prompts. Stable Diffusion belongs to a class of models known as diffusion models, which work by gradually transforming random noise into meaningful images through a process called denoising. In the latent diffusion framework, the model operates in a compressed latent space, making it more efficient while maintaining high-quality outputs. This approach allows the system to generate detailed and realistic images that closely match the given textual descriptions.

One of the key advantages of this approach is flexibility. Unlike traditional architectural software that requires manual drafting and technical expertise, this system allows users to quickly experiment with different design variations. By simply modifying input parameters, users can generate multiple designs in a short amount of time. This significantly reduces design time and enables rapid prototyping. It also encourages creativity, as users can explore various styles and configurations without additional effort.

II. Literature Survey

Yang et al. [1], titled “Research Progress and Frontier Trends in Generative AI in Architectural Design”, et al., studied the advancements of generative AI in architecture. The dataset used was collected from the Web of Science (2005–2025), and methods included knowledge mapping using CiteSpace. Results showed improved efficiency and innovation in design processes. This is related to our project as it emphasizes AI-based automated architectural design generation.

Alamasi et al. [2], titled “Impact of Generative AI on Architectural Design Education”, et al., analyzed student performance using AI tools. The dataset involved student project data from KFUPM, and methods included experimental comparison and evaluation. Results showed a 14% improvement in design quality. This relates to our project as it proves AI enhances design creativity and efficiency.

Jiang et al. [3], titled “Impact of Generative AI on Architectural Conceptual Design”, et al., studied performance and cognitive load using student-based datasets. Methods included comparative analysis and expert evaluation. Results showed improved performance for beginners but varied outcomes overall. This supports our project’s concept of AI-assisted design generation.

Tanveer et al. [4], titled “Generative Design for Engineering Applications”, et al., reviewed AI-based design techniques. The study used multiple engineering datasets and methods like optimization and machine learning analysis. Results highlighted improved efficiency and innovative solutions. This relates to our project by supporting AI-driven automated design generation.

Lu et al. [5], titled “Design for Excellence in the Era of Generative AI”, et al., analyzed design frameworks using literature datasets. Methods include comparative analysis. Results showed improved design quality and collaboration between AI and humans. This is related to our project’s AI-assisted workflow.

This study focused on multi-level architectural datasets using generative AI. It used LoD datasets and computer vision techniques. Results showed high structural consistency (SSIM ~0.73). This relates to our project in generating structured architectural outputs.

Xiong et al. [7], studied AI integration in AEC workflows using survey datasets of professionals. Methods included socio-technical analysis. Results highlighted benefits and challenges of AI adoption. This relates to our project's practical application in architecture.

Talib et al. [8], analyzed architectural datasets for generative AI. Methods included dataset comparison and benchmarking. Results showed dataset limitations and gaps. This is relevant to our project as it highlights data dependency in AI models.

Lin et al. [9], proposed a VR-based interior design system using AI. Methods included parametric modeling and Stable Diffusion. Results showed improved design ideation and visualization. This directly relates to our project's interior generation system.

Berrezueta et al. [10], worked on AI-based space planning using BIM tools. Methods included integration with Revit and Dynamo. Results showed faster and optimized design generation. This aligns with our project's automated layout generation concept.

Alemrajabi et al. [11], titled "Generative AI for Assessing Biophilic Design Attributes", et al., evaluated AI-based analysis of interior design features. The dataset included images of LEED-certified buildings, and methods involved prompt-based evaluation using AI models. Results showed up to 88% accuracy compared to expert ratings. This relates to our project as it highlights AI's ability to analyze and generate architectural designs..

Navarese et al. [12], studied generative AI architecture in healthcare systems. The dataset involved patient data, and methods included AI-driven optimization models. Results showed improved efficiency and outcomes. Though in healthcare, it relates to our project by demonstrating AI-based system automation and decision-making.

Ojeda Ramirez et al. [13], focused on speculative design learning using generative AI. The dataset included student-generated designs, and methods involved qualitative and visual analysis. Results showed improved creativity and design thinking. This is related to our project as it enhances creative architectural generation.

Booranamaitree et al. [14], proposed a sketch-based facade renovation system. The dataset included building sketches and images, and methods used vision-language models and diffusion models. Results showed improved renovation design quality. This relates to our project as it uses similar text-to-image and image-based generation techniques.

Rane et al. [15], studied AI integration in sustainable construction materials. The dataset included various eco-friendly materials, and methods involved AI-driven analysis. Results highlighted improved sustainability. This relates indirectly to our project in applying AI for smart architectural solutions..

III. System Analysis

The Generative AI-Based Architectural Design System is developed to assist architects in creating innovative building designs using artificial intelligence. The system leverages

generative models to produce design layouts based on user inputs such as space requirements, style, and constraints. It reduces the time required for manual drafting and conceptualization. The system analyzes design patterns, spatial relationships, and architectural rules. It supports customization and interactive design refinement. Machine learning models generate multiple design variations for better decision-making. The system ensures efficient resource utilization and creativity enhancement. It can integrate with CAD tools for further development. It handles complex design constraints effectively. Overall, it transforms traditional architectural design into a smart, automated process.

Existing System

Traditional architectural design relies on manual drafting and CAD-based tools. Architects spend significant time creating and modifying designs. Existing systems lack automation in generating design ideas. They depend heavily on human creativity and experience. While CAD software provides precision, it does not suggest new design concepts. Iteration of designs is time-consuming. There is limited use of AI in conventional systems. Collaboration and real-time modifications are also challenging. Existing systems cannot automatically adapt to user preferences. As a result, the process is slow and less efficient.

Disadvantages of Existing System

- Time-consuming manual design process
- Lack of automated design generation
- Limited creativity support
- High dependency on human expertise
- Difficult to handle complex constraints
- No intelligent suggestions
- Slow iteration and modification
- Limited scalability

Proposed System

The proposed system uses generative AI techniques to automatically create architectural designs. Users provide inputs such as building type, dimensions, and style preferences. The system processes these inputs using deep learning models like GANs or diffusion models. It generates multiple design options with optimized layouts. The system allows interactive editing and refinement of generated designs. It integrates with CAD tools for further detailing. The system ensures faster design generation and improved creativity. It adapts to user feedback for continuous improvement. The solution is scalable and efficient. Overall, it enhances architectural innovation through automation.

Advantages of Proposed System

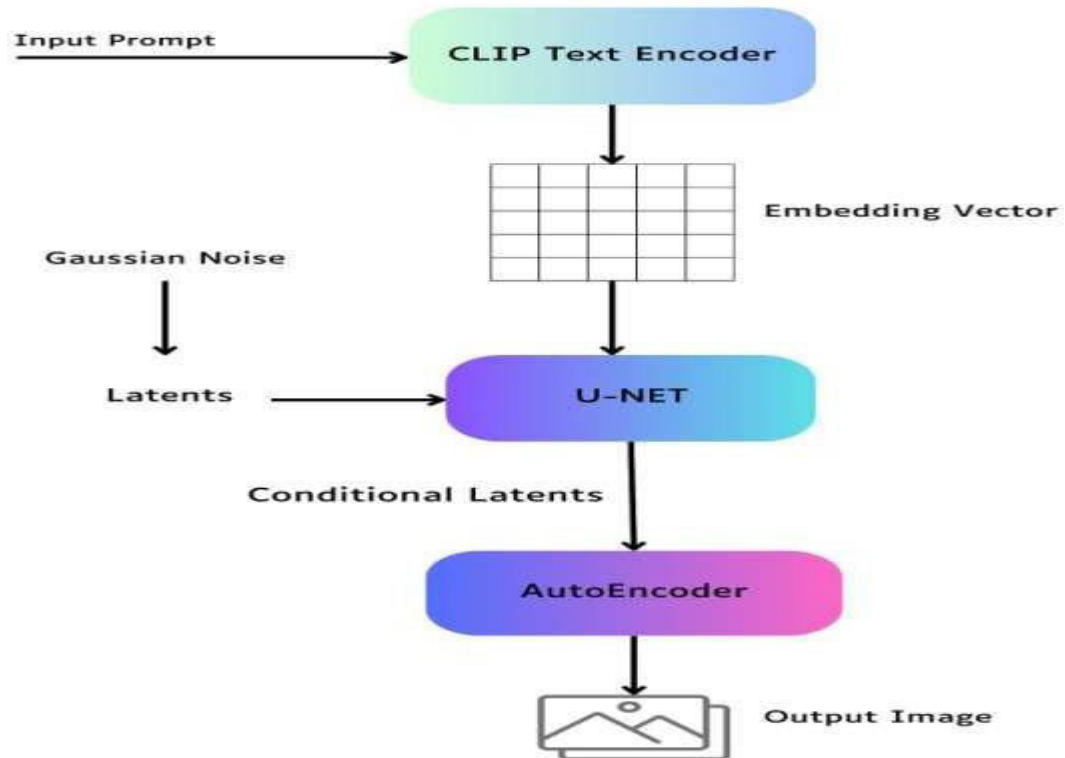
- Automated design generation
- Faster design process
- Multiple design variations
- Improved creativity
- Reduced human effort
- Handles complex constraints
- Interactive customization
- Scalable and efficient
- Better decision-making support

IV. Methodology

The methodology begins with collecting architectural design datasets. User inputs such as dimensions, layout, and style are taken. Data preprocessing is performed to standardize inputs. A generative AI model (GAN or diffusion) is trained on design data. The model learns spatial relationships and design patterns. Based on user input, the model generates design layouts. The generated designs are evaluated and refined. Feedback mechanisms improve output quality. The system integrates with visualization tools. Final designs are presented to users for selection and modification. User inputs such as building type, number of rooms, area size, budget, and style preferences are collected. These inputs are encoded into structured numerical or categorical formats for model processing. Deep learning models such as GANs (Generative Adversarial Networks) or diffusion models are selected for generating new designs. These models learn patterns from existing architectural data.

System Architecture

The system architecture for OCR-based newspaper classification is designed as a multi-stage pipeline that ensures efficient processing of image data into meaningful categories. Initially, the input layer accepts scanned newspaper images or PDF documents from various sources. These inputs are passed to the OCR module, where tools like Tesseract OCR convert the images into machine-readable text. The extracted text then moves to the preprocessing module, which performs operations such as noise removal, normalization, tokenization, and stop-word elimination to clean and standardize the data. After preprocessing, the feature extraction module transforms the cleaned text into numerical vectors using techniques like TF-IDF or Bag-of-Words. These vectors are fed into the machine learning classification module, where algorithms such as Naïve Bayes or SVM categorize the news content into predefined classes. The evaluation module assesses model performance using metrics like accuracy and F1-score to ensure reliability. The final output layer displays the classified category to the user in an understandable format. Additionally, a database layer is integrated to store extracted text, classification results, and historical data for future analysis and retrieval. This architecture ensures automation, scalability, and high accuracy in newspaper classification.



V. Result and Output





Floor Plan





VI. Conclusion

In conclusion, this project successfully demonstrates the application of generative Artificial Intelligence in automating architectural design processes. By utilizing the **Stable Diffusion**, the system generates floor plans, interior layouts, and 3D visualizations based on simple user inputs such as plot size, number of rooms, and design preferences. This approach significantly reduces manual effort, saves time, and eliminates the need for complex design tools, making it accessible to students, beginners, and professionals. The generated outputs are visually realistic and align well with user requirements, making the system highly effective for conceptual design and early-stage planning. However, the system has certain limitations, including the lack of precise measurements and structural validation required for real-world construction. Despite these challenges, it serves as a powerful tool for rapid prototyping and creative exploration. The project highlights the growing role of AI in modern architecture and design automation. With future improvements such as better layout control, integration with CAD software, and validation mechanisms, the system can be further enhanced for practical applications. Overall, this project represents an important step toward intelligent, efficient, and automated architectural design solutions.

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