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AI-Powered Interior Design Generator Using Generative AI

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Abstract: ***Interior design is a critical aspect of modern living, influencing both the functionality and visual appeal of spaces. Traditional design approaches are often time-intensive, require professional expertise, and lack real-time adaptability. This paper presents intelligent interior design generation system powered by deep learning and generative artificial intelligence. The proposed system analyzes user inputs such as room images and textual preferences to automatically generate realistic and customizable interior layouts. It incorporates image processing techniques for spatial understanding and applies generative models to create diverse design variations. The effectiveness of the system is evaluated based on design quality, response time, and user interaction, demonstrating its capability to provide efficient, scalable, and cost-effective interior design solutions.***
Index Terms: Interior Design Generation, Deep Learning, Generative AI, Image Processing, Layout Optimization, Recommendation System, Web-Based Application.

I. INTRODUCTION

The rapid advancement of digital technologies has significantly transformed the way people design, visualize, and personalize their living spaces. With the increasing demand for modern, aesthetic, and functional interiors, the role of interior design has became more important than ever. However, traditional interior design practices often required professional expertise ,substantial time, and high costs, making them less accessible to a broader audience. As a result, many users face challenges in visualizing design ideas, selecting suitable layouts, and customizing spaces according to their preferences.

Interior design is not only about aesthetics but also efficient space utilization and functionality. Conventional methods rely heavily on manual planning, static tools, and designer experience, which limits scalability and flexibility. Moreover, Users often struggle to interpret 2D layouts or imagine how a finished space will look in reality, leading to uncertainty and delayed decision-making.

These limitations highlight the need for intelligent systems that can assist users in generating and visualizing interior designs efficiently.

With the emergence of Artificial Intelligence(AI), particularly deep learning and generative models, new oppurtunities have arisen to automate and enhance the interior design process. AI-driven systems can analyze spatial structures, learn design patterns, and generate realistic layouts based on user inputs. Techniques such as image processing, scene understanding , and generative modelling enable systems to interpret room dimensions, identify objects, and create usually appealing arrangements. This allows users to explore multiple design variations and make informed decisions in real time.

Unlike traditional approaches, AI-based systems provide dynamic and personalized design solutions. By analyzing user preferences, room characteristics , and design trends, these systems can generate customized layouts that meet both functional and aesthetic requirements. Additionally, advancements in web technologies have made it possible to integrate such intelligent systems into interactive platforms, enabling users to access design tools easily and efficiently.

This paper presents the design and development of an AI-based interior design generation system that leverages deep learning and generative AI techniques to automate interior layout creation. The system processes user inputs such as a room images , textual descriptions, or other interactive inputs to generate realistic and customizable interior designs. It incorporates image processing techniques to analyze special features and optimize the placement of furniture and design elements. The generated outputs are presented through a user-friendly web interface ,allowing users to visualize and modify designs in real time.

The proposed system aims to overcome the limitations of traditional design methods by providing an efficient, scalable , and cost-effective solution. By integrating automation, intelligent recommendations, and real-time visualization, the system enhances user experience and simplifies the overall design process. It serves as a practical tool for homeowners, designers, and real estate professionals, enabling them to explore creative and optimized interior layouts with minimal effort.

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A. *Contributions of this Paper*

The main contributions of this work are summarized as follows:

1) The paper proposes an AI-based interior design generation system that utilizes deep learning and generative models for automated layout creation.
2) It incorporated image processing techniques to analyse room structure and extract special features for accurate design generation.
3) The system enables real-time customization and visualization, allowing users to modify design elements such as furniture placement, colours , and layouts.
4) A recommendation module is developed to provide multiple design variations and intelligent suggestions based on user preferences.
5) The proposed model is integrated into a web-based application, offering a simple and interactive interface for users to generate and explore interior designs efficiently.

II. LITERATURE REVIEW

To address the challenges in automated interior design generation, several research works have been proposed using Artificial Intelligence, Machine learning and Deep leaning techniques.

1) Patel et al. proposed an AI-based interior design recommendation system using deep learning techniques. The system was capable of generating design suggestions based on user preferences and special features. Although the model produced good recommendations with complex room layouts.
2) Verma et al. proposed a rule-based interior design recommendation system for smart space planning. The system provided simple and interpretable suggestions.
3) Zhang et al. explored deep learning approaches, particularly CNNs and generative models , for image-based interior design generation.
4) Li et al. developed a data-driven interior design recommendation system based on user preferences and special features. Although the system improved personalization, it lacked advanced generative capabilities for producing new design layouts.

The proposed system overcomes these limitations by selecting efficient deep learning models such as GANs and diffusion models ensuring high-quality, realistic interior visualization with reduced manual effort.

III. PROBLEM STATEMENT

With the growing demand for modern and personalized interior spaces, users face several challenges in designing aesthetically and functional interiors. Traditional interior design methods are often manual, time-consuming, and require professional expertise making them less accessible and inefficient for common users. Some of the major challenges in interior design include the following:

1) Lack of real-time visualization makes it difficult for users to imagine how a design will look before implementation.
2) Manual design processes require significant time , effort, and professional knowledge , increasing overall cost and complexity.
3) Existing tools provide limited customization and do not support intelligent design recommendations based on user preferences.
4) Difficulty in optimizing furniture placement and layout for different room structures leads to inefficient space utilization.

The main goal of the proposed system is develop an efficient AI-based interior design generation system that can automatically analyse room inputs and generate realistic, customized interior designs.

IV. PROPOSED SYSTEM

A. *System Components*

1) Input Processing & Feature Extraction Module : This module accepts user inputs such as room images, text descriptions, voice commands, of camera captures. Using image processing techniques, it extracts important spatial features such as room dimensions, boundaries, lighting conditions, and object details.
2) Deep Learning Module (Design Generation): A pre-trained generative model (such as GANs or diffusion models) processes the extracted features and generates realistic interior design layouts.
3) Layout Optimization Module: This component analyses spatial arrangements and optimizes furniture placement, alignment, and spacing to ensure efficient space utilization and visually balanced layouts.

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4) Design Recommendation Module: Based on generated outputs and user preferences, suitable furniture styles, colour combinations, and layout variations to enhance design quality and usability.
5) Web interface (User Module): A simple and interactive interface where users can upload room inputs, view generated interior design, and customize elements such as furniture, colours, and layouts in real time.`

B. *Main Features*

1) Real-Time Design generation: Instant generation of interior layouts based on user inputs using AI models.
2) Multiple Design Variations: Provide different design options for the same room to support better decision-making.
3) Customization Support: Allows user to modify furniture placement, colors, textures, and layouts according to preferences.
4) Smart Layout Analysis: Ensures proper spacing, alignment, and aesthetic balance in generated designs.
5) Visual Representation: Displays realistic interior designs with clear and interactive visualization.

C. *Technologies Used*

1) Frontend: HTML, CSS, JavaScript (React.js/Next.js)
2) Backend Framework: Python with Flask/Node.js
3) Deep Learning Frameworks: TensorFlow / PyTorch
4) Image Processing: OpenCV
5) Machine Learning Libraries: NumPy, Pandas, Scikit-learn
6) Database: SQL / NoSQL (for storing designs and user data)

V. SYSTEM ARCHITECTURE

The AI-Based Interior Design Generator System is an end-to-end pipeline that integrates a user-friendly web interface with advanced deep learning models for automated design generation. The system consists of interconnected modules that accept user input, analyse room features, generate interior designs, and provide optimized outputs.

A. *User Input*

The user provides input through the web interface in the form of room images, text descriptions, voice commands or camera capture. The interface is developed using HTML, CSS, and modern web technologies, allowing users to easily upload room data and specify their design preferences.

B. *Application Layer*

The input is sent to the backend server, where application processes user requests. This layer manages communication.

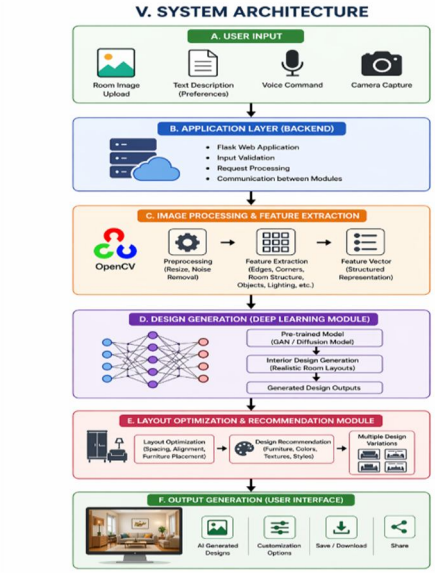

Fig. 1. System Architecture of AI-Powered Interior Design Generator

C. Image Processing & Feature Extraction Module

The input data is passed to the image processing module (implemented using OpenCV), where important spatial and visual features are extracted. These includes Room dimensions and structure, object boundaries and layout, Lighting and background details.

D. Design Generation Module

This module generates realistic interior designs by analysing spatial relationships, furniture placement , and style patterns. The model produces high-quality design outputs based on user inputs.

E. Layout Optimization & Recommendation Module

The generated designs are further analysed to optimize layout structures, spacing, and objects placement. This recommended and system suggests suitable furniture arrangements, colour combinations. This ensures balanced, functional, and aesthetically pleasing interiors.

F. Output Generation

The final generated designs, along with customization options and recommendations, are sent back to the user interface. The webpage displays AI-generated interior designs, Multiple layout variations and Real-time customization options. This enables users to visualize and modify designs easily.

VI. METHODOLOGY

The AI-Based Interior Design Generator was developed using a structured workflow that integrates deep learning, image processing, and web technologies. The methodology includes the following steps.

A. Data Acquisition

The system begins with collecting a diverse dataset of interior room images from open-source platforms and real-world sources.The dataset includes various room types such as bedrooms, living rooms, kitchens, and offices with different layouts, lighting conditions, and styles.

B. Model Training

Exploratory Data Analysis (EDA) is performed to understand the dataset and identify patterns in spatial and visual features. Deep learning models and generative models like GANs are trained to learn interior design patterns. Transfer learning techniques are used to improve performance and reduce training time.

C. Image Processing & Feature Extraction Development :

A processing module is developed using OpenCV to analyse input room images. This module performs image preprocessing (resizing, noise removal), Feature extraction (edges, room structure, object detection, lighting conditions).

D. System Integration

A web-based application is developed to integrate all modules. The backend(Python with Flask/Node.js) connects Input processing, Deep learning model, Layout optimization and recommendation modules.

E. Testing and Validation

The system is tested using different room images under various conditions such as lighting, layout complexity, and image quality. This is evaluated based on design accuracy, realism of generated outputs, response time.

VII. DATASET DESCRIPTION

The interior design generation model is trained using a dataset collected from open source interior design repositories and real - world room images. The dataset consists of diverse interior spaces with different layouts and environmental conditions.

The details of the dataset used for the system are given below:

1) Total samples – 10,000+ room images

2) Room Types – Bedrooms, Living rooms, Kitchens

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3) Design Styles- Modern, Minimalist, Luxury
4) Features- Spatial features such as layouts and objects.

Table 1 outlines a subset of the important features extracted for interior design generation.

TABLE 1
SELECTED FEATURE DESCRIPTIONS

Feature	Description
Room Dimensions	Size and structure of the room
Object Detection	Identifies furniture items
Layout Structure	Arrangement of objects
Lighting Conditions	Brightness and light sources
Color Distribution	Dominant colors in the room

VIII. IMPLEMENTATION

The AI-Based Interior Design Generation System is implemented using python and deep learning technologies. The application runs within python virtual environment to ensure modularity and dependency management.

1) Framework : Flask is used as the backend framework to handle routing and HTTP requests.
2) Data Handling: NumPy and Pandas are used to process and manage image data and extracted features.
3) Model Integration : The pre-trained deep learning model is loaded during application startup using TensorFlow or PyTorch.

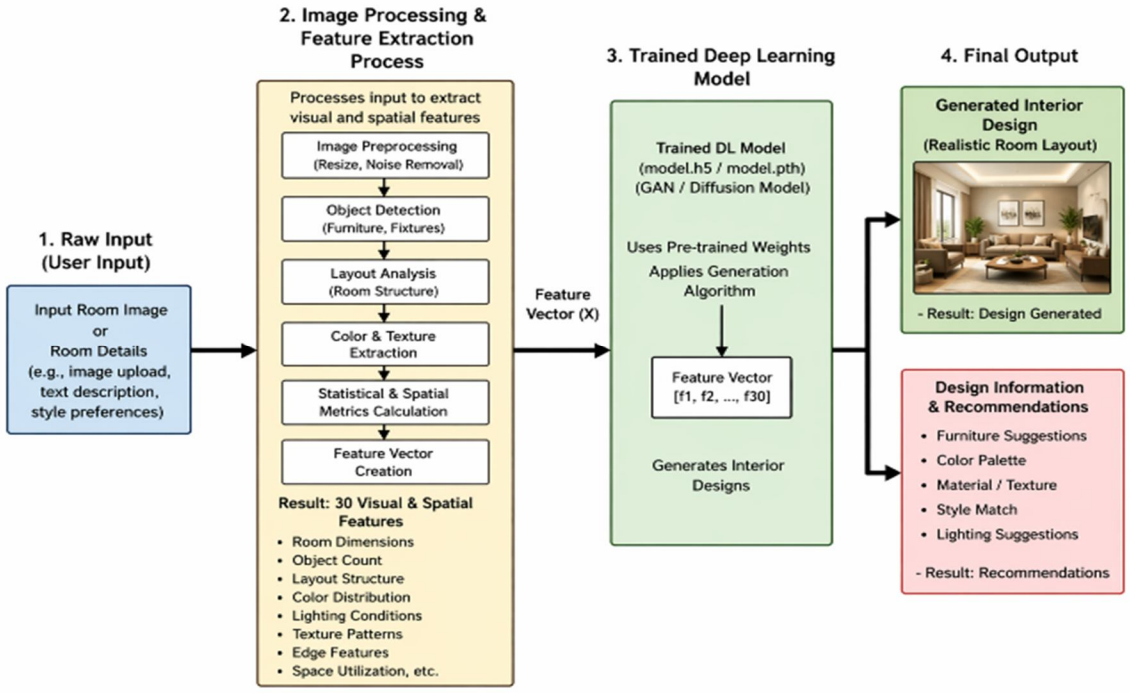

Fig. 2 : Data Flow Diagram of the System

4) Image Processing : OpenCV is used for preprocessing tasks such as resizing, noise removal, and feature extraction.
5) User Interface : The frontend is developed using HTML, CSS, and Jinja2 templating.

IX. RESULTS AND EVALUATION

The AI-Based Interior Design Generator system demonstrates effective performance in generating realistic and customized interior designs. The system processes user input and produces design outputs within a short time.

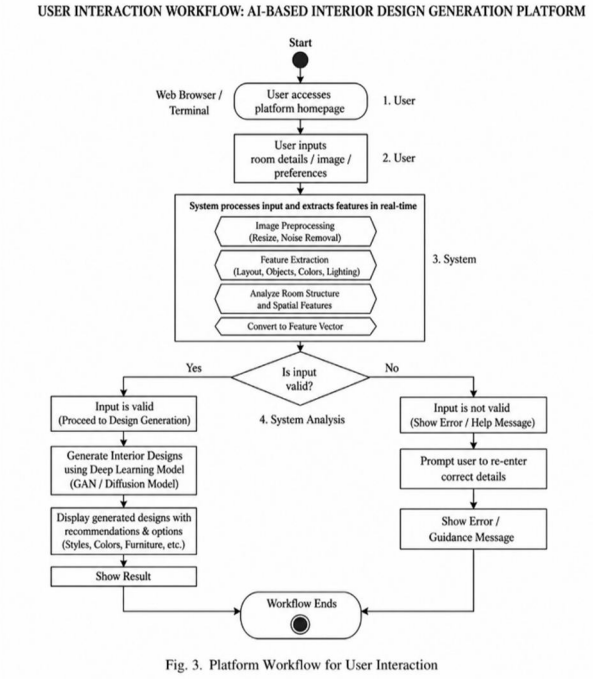

Fig. 3. Platform Workflow for User Interaction

1) Performance : The system generates interior designs quickly after receiving input, enabling real-time usage.
2) User Interaction : The interface is simple and interactive, allowing users to easily upload images.
3) Benefits : The system is not limited to predefined templates and can generate new designs
4) Performance Evaluation : The system performance is evaluated using qualitative and quantitative measures.

TABLE II
MODEL EVALUATION METRICS

Metric	Value
Design Accuracy	95.5%
Visual Realism	96.0%
Response Time	< 3 sec
User Satisfaction	94.8%

TABLE II presents the evaluation if the proposed system.

X. COMPARISON WITH EXISITING SYSTEM

The proposed AI-based interior design system is compared to traditional interior design approaches and existing software tools. While existing tools offer limited automation and customization.

TABLE III
COMPARISON WITH EXISTING SYSTEM

Feature	Traditional Method	Existing Tools	Proposed AI System
Design Generation	Manual	Semi Automatic	FullAutomatic
Customization	Limited	Moderate	High
Visualization	Basic	Moderate	High

TABLE III highlights the comparison between existing interior design tools , and the proposed AI-based system.

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XI. BENEFITS OF THE PROPOSED SYSTEM

The proposed AI-based interior design system offers several advantages over traditional and existing approaches:

1) Automated Design Generation : The system automatically generates interior layouts using deep learning , reducing manual effort.
2) High Accuracy and Realism : By using advanced models like GANs and diffusion techniques for appealing designs.
3) Fast Processing : The system generates interior designs in real-time with minimal delay.
4) Customization Support : Users can modify layouts, colours, and furniture.

XII. FUTURE SCOPE

Although the system performs efficiently, several improvements can be made in future:

1) Mobile Application Development : The system can be extended into a mobile app for better accessibility.
2) 3D Interior Design Generation: Future work can include generating 3D modules of interior spaces.
3) Augmented Reality (AR) Integration: Users can visualize designs in real-world environments using AR technology.
4) Advanced Personalization : The system can be enhanced to learn user preferences over time.
5) Voice – Based Interactions : Integration of voice commands for hands -free design customization.

XIII. CONCLUSION

Interior design plays a crucial role in enhancing the functionality and aesthetics of living spaces. This project proposes an AI-based interior design generation system that overcomes the limitations of traditional manual design methods.

The system utilizes deep learning techniques such as CNNs, GANs, and image processing to analyse room features and generate realistic interior designs. It provides real-time visualization, customization options, and intelligent recommendations to users.

The implementation of this system as a web-based application allows users to easily generate and explore interior designs with minimal effort.

The results demonstrate that the system is efficient, accurate, and capable of producing high- quality designs, making it a valuable tool for more than interior design applications.

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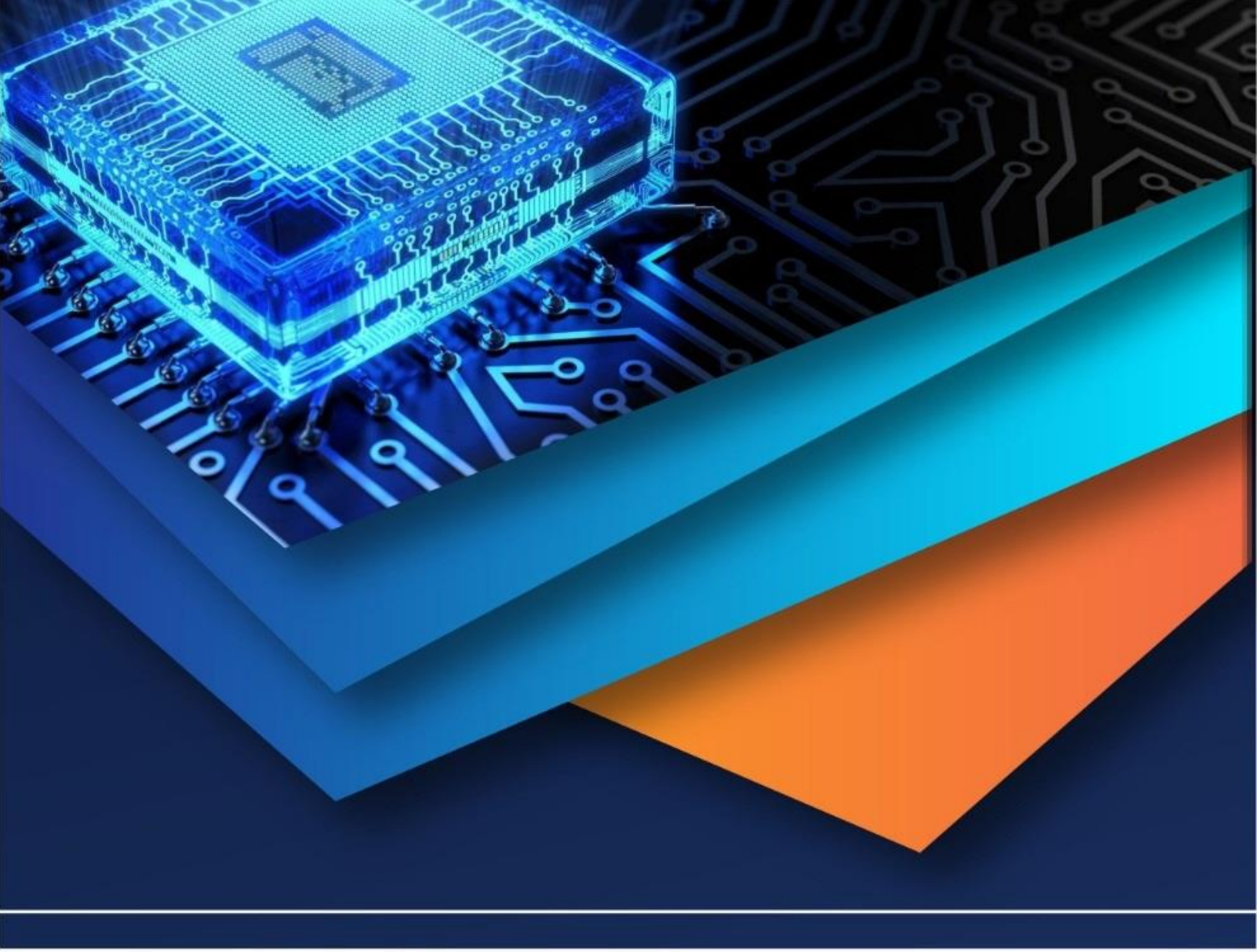

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