

AI-Generated Interior Design Identification System using Deep Learning

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ABSTARCT: The AI-Generated Interior Design Identification System is an innovative web-based application developed to automate the classification of interior design styles using Convolutional Neural Network (CNN) technology. This project addresses the growing need for intelligent, AI-assisted tools in the interior design and real estate sectors. By leveraging deep learning techniques, the system analyzes room photographs and accurately identifies the predominant interior design style among five categories: Modern, Traditional, Minimalist, Luxury, and Industrial. The system is built on a robust technology stack comprising Python and Flask for the backend, SQLite3 for persistent data storage, and HTML5, CSS3, and JavaScript for a responsive frontend user interface. The CNN model processes uploaded room images through multiple convolutional and pooling layers to extract hierarchical visual features, enabling precise style classification with associated confidence scores. Key features of the application include a dual-role authentication system with separate User and Administrator portals, real-time image upload and classification, detailed prediction history tracking, administrative dashboards with analytics, and a model training management interface. Users can upload interior room images and receive instant style predictions along with descriptive information about the identified design style. The application employs secure password hashing using Werkzeug's security utilities, session-based authentication, and file-type validation to ensure data integrity and user security. The administrative module provides comprehensive oversight of user activity, prediction statistics, style distribution analytics, and dataset management for model retraining.

KEYWORDS: Artificial intelligence, classification, convolutional neural network, deep learning, feature extraction, interior design

I. INTRODUCTION

The integration of Artificial Intelligence (AI) in interior design has revolutionized how spaces are conceptualized, visualized, and classified. As digital tools and generative design models become increasingly sophisticated, distinguishing between AI-generated and real-world interior design images has emerged as a critical challenge. This classification is essential for ensuring authenticity in design visualization, improving recommendation systems, and enhancing virtual and augmented reality applications in architectural planning. Convolutional Neural Networks (CNNs) have proven to be highly effective in image classification tasks due to their ability to learn complex spatial hierarchies, making them particularly well-suited for differentiating between AI-rendered and real interior spaces. However, recent advancements in deep learning, including hybrid AI models and transformer-based vision networks, have further enhanced classification accuracy by integrating multimodal learning techniques. This study explores the use of advanced pre-trained CNN models, including DenseNet, RegNet, and SqueezeNet architecture, to classify interior design images. By leveraging a proprietary dataset composed of diverse AI-generated and real-world interior designs, our model achieved a peak classification accuracy of 97%, demonstrating superior performance compared to traditional deep learning techniques. Additionally, we introduce a novel image preprocessing technique that enhances feature extraction by adjusting lighting, texture, and noise levels, thereby reducing discrepancies between AI-rendered and real images. The results indicate that AI approaches, CNNs, hold immense potential for further improving classification robustness. This study contributes to the growing field of AI-driven interior design classification by presenting a high-accuracy model capable of distinguishing between real and AI-generated environments with unprecedented precision.

II. LITERATURE REVIEW

1. Research on the Application of Artificial Intelligence in Interior Design

This paper explores the transformative impact of artificial intelligence (AI) on interior design, examining how AI technologies are revolutionizing traditional design processes and enhancing creative capabilities. By integrating machine learning algorithms, generative design techniques, and advanced data analytics, AI offers innovative solutions for optimizing spatial layouts, selecting color schemes, and personalizing interior aesthetics. This research delves into key applications such as virtual staging, smart home integrations, and AI-driven design assistants that enable designers to craft functional and aesthetically pleasing environments with greater efficiency. Furthermore, the study investigates the role of AI in sustainable design, highlighting its potential to minimize waste and promote eco-friendly materials. Through case studies and practical examples, the paper demonstrates the benefits and challenges of AI adoption in interior design, emphasizing the importance of maintaining a balance between technological advancements and human creativity. The findings suggest that while AI tools significantly enhance design accuracy and productivity, they also necessitate a redefinition of the designer's role in the creative process. This research contributes to the growing body of knowledge on AI in design, offering insights for practitioners and academics seeking to understand and leverage AI's potential in shaping the future of interior design.

2.A Deep Learning Approach for Interior Design Style Classification and Idea Generation

This paper introduces an AI-based system for classifying interior design styles and providing personalized design suggestions using deep learning and web technologies. The project solves the dilemma of most users in defining and communicating their design taste due to limited knowledge and paralyzing options. Utilizing Convolutional Neural Networks (CNNs), more precisely the InceptionV3 model with transfer learning, the system categorizes pictures of a room into one of twelve pre-defined styles, i.e., Modern, Bohemian, Minimalist, and Traditional. The process consists of automated image scraping, removal of duplicates via perceptual hashing, and feature extraction via InceptionV3. A fully connected neural network classifier is trained on extracted features to make design style predictions. The model is incorporated in a Flask-based web application with the ability for users to upload room images, get style predictions, and see curated recommendations for furniture, color schemes, and layouts. The site also includes user registration, authentication, and a feedback loop for enhancing the quality of recommendations over time. This work illustrates how artificial intelligence can make the design ideation process easy and facilitate interior design for non-experts. Through the integration of CNN-based image classification with an interactive web interface, the system fosters creativity, personalization, and productivity, providing a scalable platform for intelligent design assistance in real-world applications.

III. IMPLEMENTATION

EXISTING SYSTEM

Prior to intelligent AI-driven solutions, the identification and classification of interior design styles relied primarily on human expertise and manual processes. The existing systems and approaches in the domain had several significant limitations that this project aims to address. Traditional interior design consultation required clients to engage professional designers who would physically visit the space or review photographs to provide style assessments. This approach is time-consuming, expensive, and not scalable. The assessment was inherently subjective, varying considerably between different designers based on their training, experience, and personal aesthetic preferences. Online design tools and platforms offered questionnaire-based style identification systems where users would answer questions about their preferences. These systems, while more accessible, were limited in accuracy because they relied on self-reported data rather than actual visual analysis of the space. Users often struggled to articulate design preferences in abstract terms, leading to misclassifications and unsatisfactory recommendations.

3.1. DISADVANTAGES OF EXISTING SYSTEM

- High cost and time requirements for professional human consultation and assessment.
- Subjectivity and inconsistency in style identification due to varying human expertise and bias.
- Questionnaire-based tools cannot analyze actual visual characteristics of the interior space.
- Lack of scalability as human-based systems cannot handle large volumes of simultaneous requests.
- No centralized platform for tracking and comparing multiple interior spaces or designs.

3.2. PROPOSED SYSTEM

The proposed AI-Generated Interior Design Identification System overcomes the limitations of existing approaches by leveraging deep learning and a modern web application framework to deliver accurate, fast, and accessible interior style classification. The system employs a Convolutional Neural Network trained on a comprehensive dataset of categorized interior design images to learn discriminative visual features associated with each design style.

The proposed system operates as a full-stack web application accessible through any modern web browser without requiring specialized software installation. Users can register for an account, upload room photographs, and receive instant AI-powered style classifications with confidence scores. The system maintains a complete prediction history, allowing users to track and compare assessments over time.

3.2.1. ADVANTAGES

- Automated, real-time interior style classification eliminating the need for human expert consultation.
- High accuracy and consistency through CNN-based deep learning model trained on extensive datasets.
- Quantitative confidence scores for all five design style categories providing transparent predictions.
- Scalable web architecture capable of handling multiple simultaneous users efficiently.
- Secure user authentication with role-based access control for users and administrators.

IV. WORKING

Module 1: User Authentication and Authorization

The User Authentication and Authorization module manages all aspects of user identity verification and access control within the system. This module implements a secure registration workflow where new users provide their full name, email address, and password. The system validates the uniqueness of the email address against existing records and stores the password as a cryptographic hash using PBKDF2-SHA256 algorithm with a random salt via Werkzeug's security utilities.

During login, the module retrieves the stored password hash corresponding to the submitted email address and verifies it against the provided password using constant-time comparison to prevent timing attacks. Upon successful authentication, the system establishes a server-side session containing the user's ID, display name, and role identifier. This session data drives authorization decisions throughout the application, with role-based access control differentiating between regular users and administrators.

The module implements route protection through session validation checks at the beginning of every protected endpoint. Unauthenticated requests are redirected to the login page with appropriate flash messages. The logout function clears the entire session, invalidating all authentication tokens. The module also handles edge cases such as duplicate email registration attempts, invalid credential submissions, and session expiration.

Module 2: Image Upload and Preprocessing

The Image Upload and Preprocessing module handles the secure reception, validation, and storage of room images submitted by users for style classification. The module implements multiple layers of validation to ensure data integrity and system security. File type validation restricts accepted formats to PNG, JPEG, JPG, and WEBP, preventing non-image files from entering the processing pipeline. File size is limited to 16 megabytes per upload to manage server storage and processing resources.

Upon receiving a valid image, the module generates a unique filename by prepending a timestamp in YYYYMMDDHHMMSS format to the sanitized original filename using Werkzeug's `secure_filename` function. This naming convention prevents filename collisions and eliminates potential path traversal vulnerabilities. The processed file is saved to the designated static/uploads directory, where it remains accessible for display in the user interface and for processing by the classification module.

The module coordinates with the CNN Prediction Module by passing the full file path to the prediction function. After obtaining classification results, it persists the prediction record in the SQLite3 database, associating the image path, predicted style, confidence score, and full score distribution with the authenticated user's account. The module then redirects the user to the result display page.

Module3:CNNClassificationEngine

The CNN Classification Engine is the core intelligent component of the system, responsible for analyzing uploaded room images and producing style classification predictions. The module implements a Convolutional Neural Network architecture designed for visual feature extraction and multi-class classification across five interior design style categories: Modern, Traditional, Minimalist, Luxury, and Industrial.

The CNN architecture processes input images resized to 224x224 pixels through multiple convolutional blocks, each consisting of convolutional layers with ReLU activation, batch normalization, and max pooling. These blocks progressively extract hierarchical features from low-level edges and textures to high-level semantic patterns. The convolutional layers use learned filter banks that automatically identify design-relevant features such as clean lines for Modern style, ornate patterns for Traditional style, and raw materials for Industrial style. The classification head comprises global average pooling followed by fully connected dense layers with dropout regularization to prevent overfitting. The output layer uses Softmax activation to produce a probability distribution across all five style categories, with each value representing the model's confidence that the image belongs to that style. The module returns the predicted style label (highest probability category), its confidence percentage, and the complete score dictionary for all styles.

Module4:UserDashboardandHistory

The User Dashboard and History module provides authenticated users with a personalized interface for viewing their classification activity, accessing prediction results, and monitoring their interaction history with the system. The dashboard serves as the primary landing page after successful login, presenting a summary of the user's prediction activity including the total number of classifications performed and the ten most recent predictions.

V. CONCLUSION

This project aims to automate and customize home décor by incorporating artificial intelligence (AI) into interior design. While AI-driven tools offer intelligent, personalized design recommendations, traditional design methods are expensive and time-consuming. Our system generates optimized interior layouts by analyzing user-uploaded images and text prompts using AI models such as Stable Diffusion. For improved aesthetics, important components like color schemes, furniture arrangement, and lighting are refined. AI also forecasts user preferences, studies design patterns, and encourages sustainability by suggesting environmentally friendly materials. AI-powered smart home integration for automated lighting and décor changes could be one of the future advancements. This study illustrates how artificial intelligence (AI) revolutionizes interior design by increasing its effectiveness, affordability, and scalability.

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