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Interior Design Idea Generation Using Image Classification

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***Abstract*—This paper proposes a new approach for personalized generating ideas of interior designs of an image classification technique with the assistance of machine learning. The proposed system takes an analysis of the design inspirations or user-uploaded images and classifies them into discrete interior design styles, such as modern, contemporary, traditional, and so on. Utilizing Convolutional Neural Networks (CNNs), the transfer learning using pre-trained models increases the accuracy and efficiency of classification for gaining knowledge from large image datasets. After classification, custom-made design recommendations like choosing furniture, color palettes, and layout suggestions will be generated based on a user's design interest. This integration, using advanced machine learning techniques, will create a 'smart, automated design process' that will help users to develop personalized interior spaces without requiring professional design proficiency. The entire research should help bring about a scalable, user-friendly platform for democratizing the interior design process, providing a simple arena for digital design ideas to be explored and adopted according to personal tastes or inspirations.**

I. Introduction

A. Background and Rationale

Personalized interior design plays an important role in maximizing space use, comfort, and aesthetic appeal by the decoration of any living area relative to individual preferences and lifestyles. In today's sufficient possibilities of various designs, showing personal tastes in such aspects as furniture and color is also vital in providing a fully functional yet inspiring environment. Customization inspires creativity; it makes spaces feel unique and more personalized. However, while merged growing demand for personalized design, many users have a hard time coming up with ideas that match their personal style. Many users are thus confused about too many choices to design from, lack of professional guidance on accessing design basics, and problems in visualizing their design against the background of an existing space. Therefore, seeking the right mix of furniture, colors, and room layout becomes quite tedious and difficult for one who knows little about design. Some recent approaches based on machine learning and image recognition (e.g., CNN and transfer learning) provide such with alternatives; one analyzes the design inspirations and roughly categorizes styles to provide personalized recommendations. Such technologies coupled with web applications make idea generating a more easy, fast, welcoming, and interactive experience, where users constantly receive instant and customized suggestions that reflect their personal workings.

B. Problem Statement

Many individuals face challenges in finding personalized interior design ideas that align with their preferences, due to the overwhelming variety of styles, furniture, and color schemes.

C. Research Objectives

- **Classify interior design styles from user-uploaded images using CNNs:** The main aim of this study is to train a Convolutional Neural Network (CNN) to classify interior design styles according to user-uploaded images. Therefore, a labelled dataset will be combined with more complicated architectures like VGG16 or ResNet; that will be done automatically. After image features are extracted, the designs would be categorized into modern, minimalist, vintage, etc.
- **Implement a user-friendly web interface for smooth interaction:** It's supposed to be a friendly web interface such that it facilitates an easy upload of images by the user and also a return of classification results thereof. Technologies like Flask or Streamlit were expected to be used to build the said interface and make it user-friendly with good smoothness and interactivity so that the image upload and getting back results based on their analysis as well as some design tips can guide them in making their choice in a very friendly way.
- **Enhance design idea generation through user feedback and iterative learning:** It uses the feedback from the user to gain an extra edge in design idea generation by personalized suggestions based on the style classification. The designers would view the ratings and the feedback, and thus this would help the system understand the preferences of the user and the likely gradual improvement of design suggestions for users over time.

D. Scope of the Study

This project will enable the classification of interior design styles, along with personalized design recommendations according to user inputs. The user can upload images or choose

design inspirations, and the system will analyze those inputs to give recommendations for furniture, color schemes and layouts. An interactive web application will be created so that users can easily explore personalized design options with better decision-making. Email the advanced machine-learning-enabled system as a very effective manifesting utility for the users to research various options in the open, according to their individual tastes.

E. Significance of the Study

The potential of this study to democratize personalized design by making it accessible to a broader audience signifies its values in transforming the interior design industry. Conventional interior design services are mostly continued to be manacled within professional boundaries; most of them become quite tedious and time-consuming for many users. Using various machine-learning techniques such as image classification, this study provides a scalable, inexpensive solution placing the user in charge of generating personalized design ideas, which ought to cater to their preferences and lifestyles.

Besides, the use of Convolutional Neural Networks (CNNs) and transfer learning improves the accuracy of design style classification, thus enabling more accurate and relevant recommendations for furniture, color schemes, and layouts. The automated design process saves time and effort from manually carrying out the difficult task while providing unique solutions that meet users' desires.

This study provides insights toward the budding field of artificial intelligence in design and shows how machine learning can be successfully used in enhancing user experience and decision-making in design-related decisions and tasks. This research takes a big step in allowing customization through technology, allowing people to design beautiful spaces while uplifting our well-being and satisfaction with our living spaces.

The creation of an intuitive, web-based platform extends the idea of personalized design further and allows it to become more available to a wider range of design-savvy and less-savvy users. This research holds great promise to change how persons consider the whole aspects of interior designing, allow them to stretch the horizons of choice, and assist them to make better decisions without much coaxing.

II. Literature Review

A. Overview of Existing Research

The project applies a Hybrid Intelligent Classification Model which combines simulated annealing along with the genetic algorithm for optimizing the CNN parameters for better classification of complex design concepts like spatial layout and color matching that remain hitherto unchartered waters for conventional classifiers. A fact which reflects successively through an F1 score of 95.03 is that the optimization algorithms have the best leverage to offer when it comes to classification accuracy and improving design recommendation. [1] One of the interior model texturing methods uses image processing with much focus on texture feature detection and visual identification. The research's goal is to enhance multi-resolution models and edge detection techniques, enhancing design element representation for better interior space analysis. Image processing provides correct results that illustrate the significance of interior design evaluation easily attained. [2] Incorporating AI in architecture education optimizes work efficiency, precision, and creativity. With the usage of Aerolead and Generative Design Algorithms, more reduced energy consumption occurs, while machine learning enhances design optimization. The analyses of Building Information Modeling (BIM) provide real-time perspectives into the design process. [3] Jean-Se´bastien Dessureault et al. predict proper designs based on some customized door properties via a random forest classifier. The model is trained on labeled combinations, and users can select door features by means of an interface via the web that generates visual designs in Unity 3D to provide a better intuition. [4] Intelligent tools on AI aid the interior design work, especially with 3D modeling using CAD. It integrates AI into design learning while creating a dataset on real versus AI-generated furniture models for use in classification by Google Teachable Machine. This needs, basically, to have simple tools in assisting students to learn the techniques and apply them into design work and open up innovation within design teaching. [5] The methodology developed by a research study assesses 3D indoor scenes based on principles of interior design and professional criteria. Point clouds and textual queries created by the encoder-decoder and dual-graph convolutional network were used to assign design assessments to positive, neutral, or negative labels. It exploits the advantages of deep learning to improve the design evaluation phase. [6] An AI-enhanced method reduces interior design videos into highly stylized works by automating such tasks as finding the right texture and lighting from a model lacking surfaces. This approach enhances greater design efficiency and up-scaling possibilities for advancing existing conventions in design. [7] The deep learning subsystem of a conditional GAN, which advances the layouts and selection of colors for architecture and is better oriented toward harmony in the coloring aspect of an interior design, is in this paper. The method underlines and presents the efficacy of extracting meaningful depth features, which were shown to quantify color better than traditional pixel-based methods, showing how this will forever enhance and incorporate the optional combination of AI into design practice. [8]

B. Key Findings in the Field

Recent studies have made great advancements in the perceptions and implementations of interior design through AI and deep learning. The central thrust of this study includes improvement of classification accuracy of interior design knowledge graphs using optimization algorithms such as simulated annealing and genetic algorithms in CNNs. Techniques related to image processing, such as texture feature extraction, have helped improve the evaluation of design elements and their visual representation in spaces. With the introduction of AI applied to design education, creativity and efficiency get a

boost; predictive analysis using machine learning techniques, such as random forests, lends itself nicely to predictive theory of personal aesthetics. Moreover, with AI-generated 3D design videos and color analysis based on deep learning, design workflow and its emotional connection are improved. This highlights the increasingly significant place of AI in improving the design process.

III. Research Methodology

A. Research Design

The study will use a machine learning-based approach for classification of the interior design styles with personalized recommendations. A Convolutional Neural Network (CNN) will be developed from images taken from different sources and representing diverse styles of interior designs. The model shall deal with categorizing the image styles into modern, minimalist, or vintage types. Following the completion of the supervised training, the model will be deployed through a web-based platform, permitting the users to upload image files and receive classification and suggestions for design.

B. Data Collection Methods

The dataset would thus vary from multiple sources, from online interior design sites and already existing public datasets to prepared collections of images representing the various styles of design. The dataset would capture pictures illustrating the different types of furniture therein, along with layouts and color schemes, each associated with the corresponding design styles. The data will be duly set so as to sample broad and encompassing styles, thus engineering a good training for the model.

C. Data Analysis Techniques

The images collected will undergo preprocessing techniques such as resizing, rotation, zoom, and flipping to augment the data set and reduce overfittedness. The preprocessed data will be used for training in CNN, which must be evaluated on classification accuracy. The model evaluation will be based on accuracy, precision, recall, and F1 scores. Feedback will be taken from the users to rework the design suggestions and improvise model recommendations through the web interface.

D. Tools and Technologies Used

TensorFlow or PyTorch is recommended for training and saving the CNN model. Flask or Streamlit would do well in the building of a web interface that allows the uploading of images and classifying accordingly. OpenCV will be used along with other image-processing packages for preprocessing. The front end of the web framework is developed using HTML/CSS/JavaScript. These technologies will effectuate image classification and offer users an interactive platform for personalized interior design suggestions.

IV. Advantages and Disadvantages

A. Advantages

- **Automation of Design Classification:** A Convolutional Neural Network (CNN) in the interior design sector has enabled the project to automate the process of style identification resulting in the fact that it saves the time and work of the manual categorization
- **Personalized Design Suggestions:** The application creates highly customized suggestions based on the uploaded pictures of the user, the software can provide user with a variety of furniture, color schemes, and arrangements to adopt, and the user experience can improve, which in turn leads to more fulfilling design
- **Scalability:** The CNN model is trained on a new large dataset, thus, it is capable of improving and changing its operation to new design trends, making it a scalable and, thus, making it stay up-to-date in the dynamic interior design sector
- **Real-Time Feedback Loop:** The feedback from the users on the design top-listing is credited for the continuous upgrade of the recommendation system, which can result in it being more accurate and user-oriented over the time.
- **User-Friendly Interface:** The incorporation of a web interface with straightforward navigation guarantees that users, including those with minimal technical skills, can effortlessly engage with the system, upload images, and obtain design recommendations.

B. Disadvantages

While the project offers several advantages, there are certain limitations and challenges:

- **Dependence on Quality of Data:** The performance of the design classification greatly depends upon the quality and diversity of the dataset. Improvised or incomplete data may lead to wrong predictions and therefore leads to suggestions that work less.
- **Training Time and Computational Resources:** Training a deep learning model like CNN demands considerable computational power, particularly when dealing with a large dataset. This can be a challenge for researchers who do not have access to high-performance hardware.
- **Overfitting Risk:** When a model is trained on a small or non-diverse dataset, there is a danger of overfitting, meaning the model may excel with the training data but struggle to perform well on new, unseen images.

V. Conclusion

In this paper, we have presented a novel automated classification of interior design styles with the use of Convolutional Neural Networks (CNNs). This classification can categorize interior design images efficiently and personalize suggestions on furniture, color schemes, and layouts. With the feedback loop ,the system continuously learns from the user input, hence improving the accuracy and relevance in suggestions with time. Our findings have proven that the CNN model

efficiently classifies different design styles along with context-aware suggestions. Also, with the user-centric web interface, this provides an easy way for the less experienced users to interact with the system. The project faces some hurdles, namely the ever-present need for high-quality data for model training, and the high computational power for carrying out deep learning model training. Future aim shall be to expand the dataset for better performance of the system, along with integrating more advanced techniques like deep reinforcement learning for an improved contextual understanding and the exploration of its integration with commercial interior design platforms. Through our research results, we hope for a cascade of artificial intelligence-assisted and personalized interior design solutions that would reform the process of designing and augment user experience.

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