AI Carpet: Automatic Generation of Aesthetic Carpet Pattern

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ABSTRACT

Stylized pattern generation is challenging and has received increasing attention in recent studies. However, it requires further exploration in pattern generation that matches the given scenes. This paper proposes a demonstration that automatically generates carpet patterns with input home scenes and other user preferences. Besides meeting the individual needs of users and providing highly editable output, the critical challenge of the system is to make the output pattern coordinate with the input home scene, which distinguishes our approach from others. The carpets generated by the system also permit easy modification or extension to various interior design styles.

CCS CONCEPTS

• **Human-centered computing** → **Interface design prototyping**.

KEYWORDS

carpet pattern generation, color composition modification, aesthetic style collocation

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1 INTRODUCTION

With the rapid development of personalized customization demand in design, people show a strong personal preference for the choice of decorative patterns in daily life. Aesthetician Rudolf Arnheim proposed that color and shape determine what we see. Moreover, their elements and combinations determine how we feel[7]. The choice of a designed carpet reflects one's aesthetic taste and attitudes towards life. As a typical interior soft decoration design, carpet effectively integrates the visual proportion of space. Harmonious carpet matching coordinates home elements and creates a better home atmosphere. Injecting emotional triggers into carpet design also brings an excellent emotional experience to the user[4].

Recently, in the field of computer-aided interior design, researchers proposed a novel search engine that can recommend users based on image features [6].In terms of algorithms, GAN has gained a lot of attention and is widely used in the field of interior and house design[1].

This work aims to establish a design system that automatically generates a series of aesthetic carpet patterns from a user-given description (including style preference and inspirational words) and an image of the home scene. To summarize, we focus on three key capabilities in the proposed system.

- Presents a novel framework to generate aesthetic carpet pattern which is consistent with the home scene.
- Provides carpet patterns generation on a specified category.
- Supports color composition modification of the carpet to meet the user's personalized emotional needs.

2 DEMONSTRATION

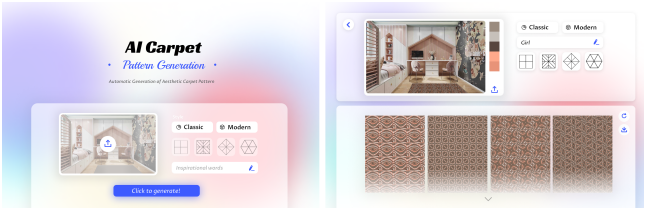

Figure 1: User Interface of AI Carpet

The input user interface of our system includes four parts 1) "Classic" and "Modern" buttons for style preference; 2) four basic tessellation rules for users to select; 3) an input box for users to describe personalized emotional needs by text; 4) an upload box for uploading home scene photos. Our system will show the generated carpet patterns with a preview page. Users can download their favorite designs.

3 SYSTEM FRAMEWORK

The proposed system includes (1) corresponding pattern generation based on style preference, (2) image synthesis based on style composition rules, and (3) image color modification based on home scenes and inspirational words.

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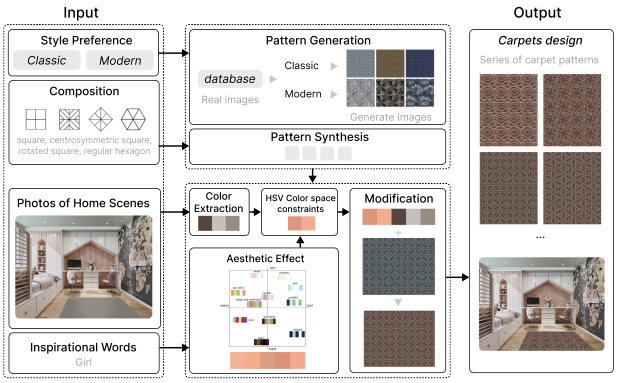

Figure 2: System Framework of AI Carpet

3.1 Style Preference

In the system, we provide two typical interior design styles for users to choose from: 'Classic' and 'Modern'. The system generates the corresponding pattern texture features according to the style selected by the user.

3.2 Pattern Generation

To generate basic patterns of the output carpet images, we first prepared a database containing about 26000 digital pictures of carpets, subdivided into 92 categories based on aesthetic features (e.g., artistic schools, basic patterns, etc.).

We then applied the StyleGAN3 model [2] to the dataset, enabling the conditional model option to allow the trained model to generate carpet patterns on a specified category.

When the user chooses a preferred style between "Classic" and "Modern", our system randomly selects a category corresponded to the style, adopting the trained model to generate patterns that will be used as basic patterns in the synthesis step.

3.3 Pattern Synthesis

In this step, our system crops the generated basic patterns to tiles and then tessellates them to form the output carpet pictures. Users can choose from the following four types of tessellation:

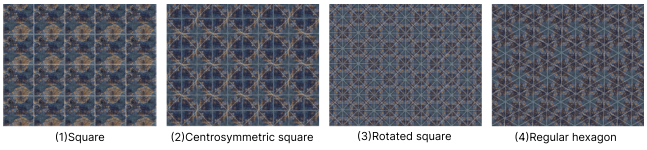

Figure 3: Four Types of Tessellation Rules

3.4 Color Modification

Color composition is of vital importance in conveying the emotion of an image, as shown by aesthetic research. We developed a color extraction mode that automatically modifies the carpet colors according to home scene photos and the user's personalized emotional needs.

Firstly, we extract three main colors C_1, C_2, C_3 from the input photo as the dominant hue of the carpet. We then apply the input words to the Color Image Scale to decide on a color combination that semantically and visually matches. More specifically, the Color Image Scale, which was originally constructed by Kobayashi [3] and improved by Xiaohui WANG [8], provides two-dimensional aesthetic coordinates of 180 keywords and 45476 five-color combinations. We calculate the distance between the input word and the words in the dataset by the Word2Vec model [5] and locate it at the weighted average of its five nearest neighbors. Given the location of input description, we search the nearest color neighbor (t_1, t_2, t_3, t_4, t_5) by the Euclidean distance. To ensure that T is consistent with the home scene, we place extra constraints in the HSV color space as follows:

$$\forall t_j, j \in \{1,2,3,4,5\}, \exists C_i, i \in \{1,2,3\}, s.t. \begin{cases} |H_{t_j} - H_{C_i}| \leq 15 \\ |V_{t_j} - V_{C_i}| \leq 2.17 \end{cases} \tag{1}$$

We then extract T_1, T_2 as two main colors of T. Eventually, we adopt the Welsh Color Transfer algorithm [9] to modify the output carpet colors to the target color composition (C_1, C_2, C_3, T_1, T_2).

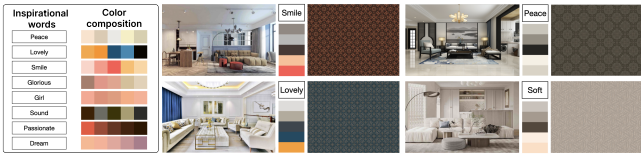

Figure 4: Samples of Color Modification

4 USER STUDY

Ten designers experienced the system and were asked to use the 5-point scale("5" means the most satisfied) to evaluate questions:

- To what extent does the carpet pattern matches the aesthetic of the "Classic" and "Modern" style? We got 3.84(standard deviation=0.19) and 3.96(standard deviation=0.32), which indicates that our patterns meet the needs of style preferences.
- How consistent is the carpet pattern with the inspirational words and home scene? The result we got was 4.12 (standard deviation=0.44). It implies that the patterns generated by our system are aesthetic and appropriate.

5 CONCLUSION

This article proposes a carpet design system that generates carpets based on user style preference, inspirational words, and home scene images. The patterns generated by our system can provide designers with home interior design schemes. Besides, the generated patterns can also be used in texture design in virtual reality scenes in the future.

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