Intelligent system embedding design rules for vector-based textile pattern generation

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1. INTRODUCTION

The use of vector patterns in the textile industry is widespread due to their ability to be easily edited or scaled to any size without any loss in quality or details (Dominici et al., 2020; Lu et al., 2014; Selinger, 2003). This makes them ideal for accommodating multiple revisions in the textile design process (Briggs-Goode & Townsend, 2011). However, developing new vector textile patterns from scratch is often time-consuming, tedious, and involves many repetitive tasks, despite the widely use of computer-aided design (CAD) software in the industry. Therefore, there is a pressing need to establish an intelligent system for vector-based textile pattern generation that can better assist design.

Currently, research is being conducted to explore the design layout rules (Guo et al., 2021; O'Donovan et al., 2014) and to convert pixel-based design images into vector representations (Dominici et al., 2020; Reddy et al., 2021). Nevertheless, few works have focused on automatically generating vector-based textile patterns. The work that has been done has focused on content-specific pattern generation, such as marbling (Lu et al., 2014) and fractal patterns (Wang et al., 2019). Additionally, the majority of CAD software currently in use disregards aesthetics and makes it challenging to use their outputs directly. To better assist the design and enrich the research in this field, a new intelligent design assistance system is proposed in this paper. The system's outputs are editable, meeting human aesthetic requirements and covering the most common patterns. The proposed system aims to simplify the design process and accelerate the development of textile patterns while ensuring that the resulting patterns meet aesthetic requirements.

2. METHOD

This research proposes an automatic system for generating textile patterns based on existing design rules. The system focuses on three common types of patterns, namely stripe, check, and motif patterns, which are modeled parametrically to automate the design process.

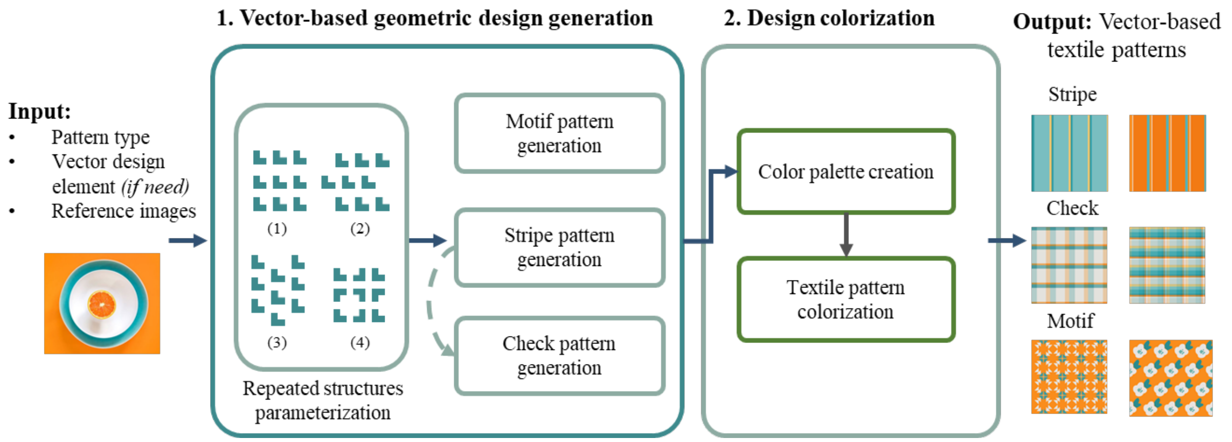

Figure 1 Illustration of the system

Each vector graphic comprises vector paths with geometric and color parameters. The geometric parameters represent the location and shape of a region enclosed by a vector path, while the color parameter represents the fill color of the region. The proposed system generates patterns from both vector-based geometric design generation and design colorization perspectives.

To generate stripe and check patterns, the system splits a square into multiple parallel bands and converts them into vector paths to generate geometric information. Two stripe patterns are then orthogonalized to create a vector-based check pattern. These patterns are repeated to meet size requirements. For motif patterns, the system lays out a single input vector design element following the four repeat structures (Wilson, 2001) to form various textile patterns. Subsequently, the system colorizes the generated patterns according to a given reference image to ensure the color combination meets human aesthetics. An illustration of the overall pipeline is shown in Figure 1.

3. RESULTS

After inputting the color reference images downloaded from the internet and defining the required pattern category, the system generated vector-based textile patterns, including stripe, check, and motif patterns. Parts of the outputs are shown in Figure 2(a). The average time to generate a motif pattern with a size of 1714 × 1713 pixels was around 0.7 seconds, while a stripe and a check pattern with 400 × 400 pixels in size required about 8 and 6.5 seconds, respectively. The design generation was conducted on a standard PC with an Intel i7-6700k CPU and 16GB of memory, without a GPU. However, it is expected that the process will be faster with a better hardware configuration.

To demonstrate the applicability of the developed patterns in the textile industry, the study simulated the application effect in a 3D apron model (see Figure 2(b)). Furthermore, a questionnaire survey of 30 fashion-related experts confirmed that the outputs are in line with basic human aesthetics and can assist in textile design.

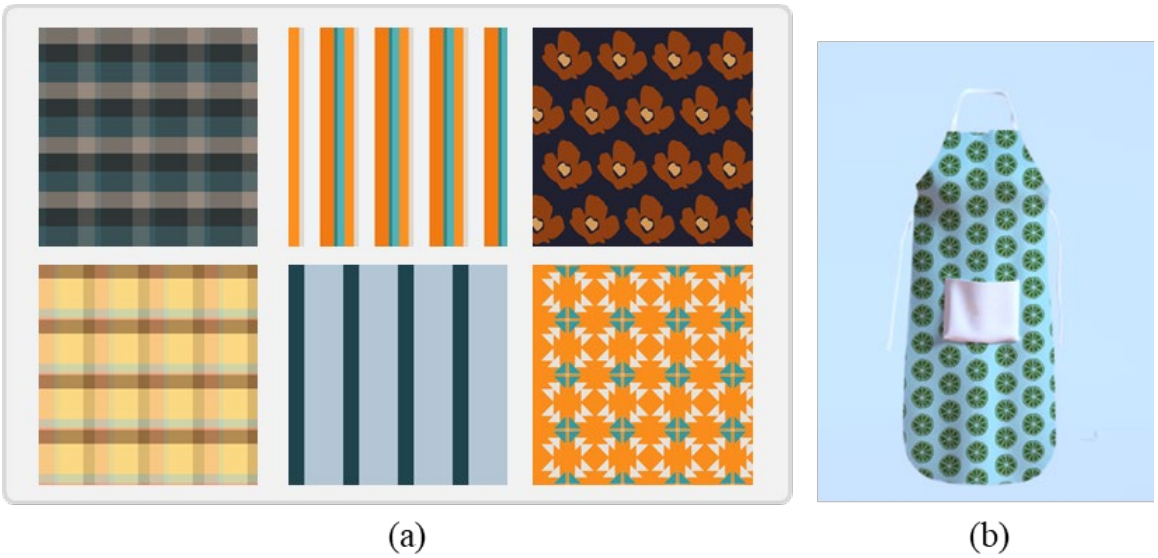

Figure 2 (a) Examples of output; (b) an application example on a 3D apron model

4. CONCLUSIONS

In summary, the system mainly embeds the design rules about layout and color in textile design, and makes full use of the editable nature of vector graphics to automate the design of the three main patterns. The designers can simply edit the outputs to get what he or she wants, which greatly shortens the design time. Although only motif pattern generation for a single design element under four classical layout rules is considered, this study demonstrates the feasibility of automatic motif pattern generation, and more complex and diverse motif patterns can be generated if multiple design rules are defined. Overall, the proposed system has the potential to significantly simplify the design process and accelerate the development of textile patterns, which could have important implications for the textile industry.

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