Vector Pattern Synthesis from Spatial Elements Distribution

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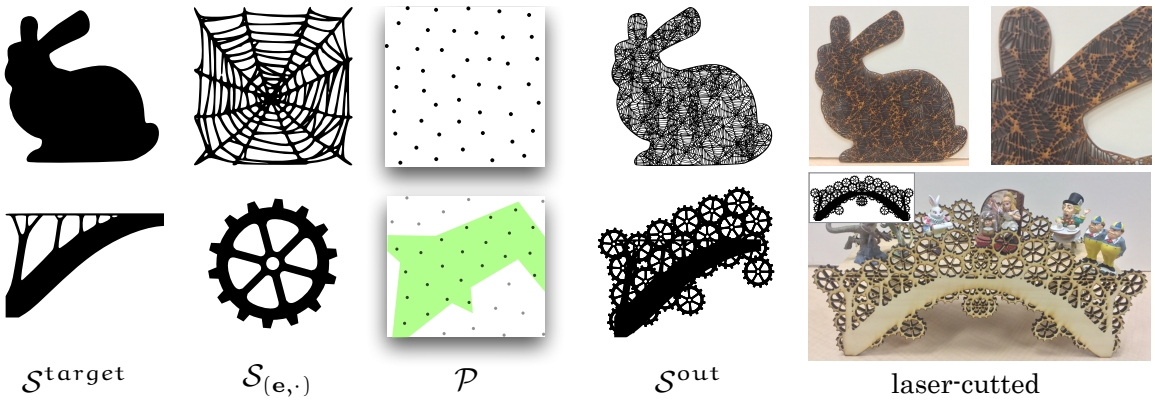

Figure 1. Given a target shape, elements, and an element distribution, we synthesize a vector pattern ready for fabrication.

Abstract : We propose an approach for a vector pattern generation. By employing shape synthesis approach from an elements distribution, the resulting patterns have preferable topology for manufacturing even though they have intricate patterns.

Keywords : vector pattern synthesis, manufacturing

1. Introduction

While regular patterns are preferable for mass production, in these days, we can utilize laser cutting or 3D printing to create original, unique, and intricate patterns. However, it is difficult for non-experts to create vector patterns ready for manufacturing. To this end, we propose a synthesis approach for vector patterns from an elements arrangement. Unlike previous approaches such as proposed in [1], we focus on filling a free-form target shape. Since we synthesize elements by shape operators upon vector data, the final result has sharp contours compared to that of contour extraction from pixel-based synthesis approach [2].

2. Approach

Given a target shape S^{target}, elements $\left\{\mathbf{e}_i \middle| 0 < i \le n\right\}$, and an element arrangement data (spatial distribution) P, we compute following formula to get synthesized shape S^{out}:

$$S^{\text{out}} \leftarrow S^{\text{target}} \circ \left(\bigcup_{\mathbf{p} \in P} S_{(\mathbf{e},\mathbf{p})} \right), \qquad (1)$$

where $\circ$ is a shape operator such as diff, union, or intersection, and $\bigcup_{\mathbf{p}\in P}(\cdot)$ represents a shape (elements) union. Then, an offset path of S^{target} is generated and merged with S^{out} to get the final result. Owing to the shape operators, the synthesized shape S^{out} is preferable topology; i.e., ready for laser cutting or 3D printing.

3. Results

The results are shown in Fig. 1. In Fig. 1 (top) we calculated shape diff for the shape operator $\circ$, which ensured that the resulting pattern was synthesized strictly inside the given shape. On the other hand, in Fig. 1 (bottom) we calculated the shape union for the operator $\circ$, which resulted in a decorative silhouette. Here we restricted each element's centroid to be inside a given design domain shown in green shaped region in Fig 1 (bottom) col. 3. In addition to single-element pattern synthesis shown in Fig. 1, we synthesized multi-elements pattern in Fig. 2.

References

[1] S. Zhou, C. Jiang, S. Lefebvre, 2014, "Topology-constrained synthesis of vector patterns", ACM Trans. Graph. 33, 6, 215:1-215:11.

[2] J. Martínez, J. Dumas, S. Lefebvre, L.-Y. Wei, 2015 "Structure and Appearance Optimization for Controllable Shape Design", ACM Trans. Graph. 34, 6, 229:1-229:11

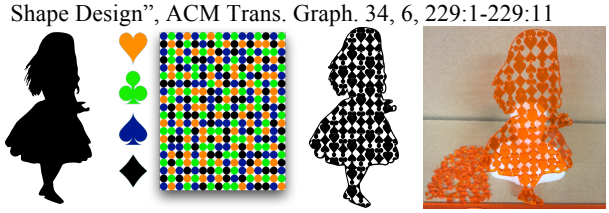

Figure 2. Multi-element vector pattern synthesis result.