Chinese Sea Punica Granatum Floral Pattern Synthesis

營造法式海石榴華圖樣生成

Shih-Hao Liu & Tung-Ju Hsieh

National Taipei University of Technology

(a) user hand painting (b) convert to Bézier curve (c) generate stem and flower (d) generate leaves (e) generate random leafs (f) Markov matrix relaxing

Figure 1: The sequence of generating Chinese Sea Punica Floral Pattern.

Abstract

Architectural decorative painting of floral patterns on the surface of the Chinese traditional palace buildings is a sophisticated and time-consuming process. An ancient Chinese building code, titled "Yingzao Fashi", describes a variety of decorative floral patterns in the Song Dynasty (960-1279 AD). It is difficult to draw those floral patterns using existing digital vector graphics software because of their complexity. We developed a floral pattern synthesis system to ease the drawing process of decorative floral patterns. In this paper, a case study is presented to demonstrate that the proposed system is used to automatically draw the traditional Sea Punica Granatum architectural decorative patterns. The user moves the mouse cursor to draw the path of a stem. Then the leaves and flowers are synthesized. In addition, collision detection is implemented to control leaf density. Vector graphics pre-loading and threading techniques are used to achieve 0.3 ms rendering speed for user interaction.

Introduction

Decorated patterns are difficult to draw by hand using vector graphics software because of its complicated features. For example, filling the space with a floral pattern. Untrained users tend to make mistakes during the painting. Decorated patterns have typically been used in traditional Chinese palace building painting. It is important for people to understand those decorative paintings and to appreciate the significance of that aspect of the culture. In this paper, we present an interactive system using HTML5 for fast synthesis of Chinese architectural decorative patterns described in the Yingzao Fashi building codes. In order to generate the decorative patterns in a variety of display resolutions, we use SVG (Scalable Vector Graphics) for our rendering results. Controlled by parameters, the proposed system can automatically grow vines and leaves following a curve defined by the mouse movements input of a user. Then, the synthesized decorative patterns can be further adjusted in terms of leaf density and parameters that control the sizes and the orientations of leaves and flower components.

The pipeline of the proposed system is shown in Figure 1. Inspired by the decorative patterns generation method DecoBrush [1], the proposed system allows the user to hand draw and define the stem curve, then flowers and leaves are attached to the stem. We implemented a Magnetic Curves [3] to fill the space between the flowers and boundary of the HTML5 canvas. Magnetic Curves are tracks of the electric charge in a constant magnetic field. Dynamically changing the number of charges can form different curve trajectories. Adjusting parameters can obtain different curve tracks. During the electric charge movements, the opposite charges can be grown on both side of the stem. The parameters determine the length of the curves. Figure 2 shows the initial layout with overgrowth branches. To solve this problem, we add new leaves to a queue waiting to grow later when a collision has occurred. As a result, we relax the density of the leaves as shown in Figure 3.

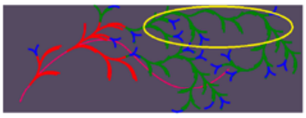


Figure 2: Comparison of overgrowth leaves and queuing. Yellow ellipse indicates overgrowth leaves.

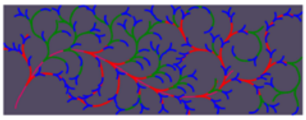


Figure 3: Relaxing of leaves density using Markov matrix.

Results and Conclusion

Table 1 shows the comparison of different synthesizing parameters. When the density parameter d increases, the leaves become more crowded. In contrast, the stem length parameter T controls the space between stems. The proposed system allows users to define the shape of the canvas boundary. A user can adjust the space filling parameters to modify the synthesized patterns. The color settings of the result patterns can be described using CSS style sheets. Figure 4 shows the result generated by our system and the original patterns in " Yingzao Fashi" [2] as shown in Figure 5. If the angle parameter is small, the first layer of the stem branch will be almost parallel to the stem trunk. Which makes the second layer of branches collides with the first layer branches. That impedes the space filling process and results in a non-uniform distribution layout of leaves. In addition, leaves are impeded by flowers, resulting in blank space. By changing the leaves density parameter d, We can adjust the blank space manually. We achieved an interactive rendering speed of 0.3 ms using a iMac with an Intel i5 CPU, 8GB DDR3, and NVIDIA GeForce GTX 660M graphics. We used MacOS 10.11.6 and Chrome 59.

Figure 4: Comparison of the Chinese Sea Punica Granatum Floral Pattern. The proposed system.

Figure 5: Comparison of the Chinese Sea Punica Granatum Floral Pattern. The original painting [2].

Conclusion

We present a system to assist users in drawing the Chinese Sea Punica Granatum Floral Pattern described in in the building codes "Yingzao Fashi" using "space filling" and "path following". The proposed system converts a user's hand-drawing curve into a Bezier curve, followed by thickening the curve to produce a stem. We implemented magnetic curves method to fill the space between the stem and the boundary of the HTML5 canvas. This allows us to automatically generate the Chinese Sea Punica Granatum Floral Pattern. Acceleration techniques are used to improve performance such as preloading SVG vector data, collision detection filtering, and multi-threading.

Acknowledgements

This work was supported by the Taiwan Ministry of Science and Technology under grant number MOST 107-2221-E-027-103 -.

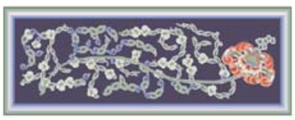
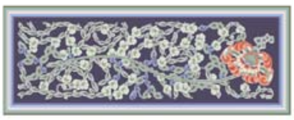
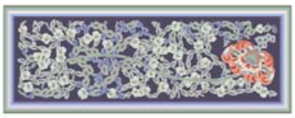
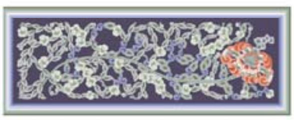
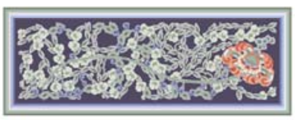
References

[1] Jingwan Lu, Connelly Barnes, Connie Wan, Paul Asente, Radomir Mech, and Adam Finkelstein. Decobrush: Drawing structured decorative patterns by example. *ACM Transactions on Graphics*, 33(4):90:1–90:9, 2014.

[2] Li Luke. *Studies on the Rules for Color Painted Works in Yingzao Fashi.* Southeast University Press, 2011.

[3] Ling Xu and David Mould. Magnetic curves: Curvature-controlled aesthetic curves using magnetic fields. In *Proceedings of the Fifth Eurographics Conference on Computational Aesthetics in Graphics, Visualization and Imaging*, pages 1–8. Eurographics Association, 2009.

Table 1: Comparison of parameters: (i) leaves density d, and (ii) stem length T.

T	$d = 0.9$	$d = 1.0$	$d = 1.1$	$d = 1.2$
70				
75				
80