Vector Graphics Editing with Interweaving and Penetrating

營造法式瑣文生成

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Abstract

Decorative patterns are common in traditional Chinese architectures as shown in Figure 1. However, scalable vector graphics (SVG) is not capable of representing interweaving and penetrating patterns. In this paper, we develop a web-based vector graphics interweaving and penetrating editing system. We propose a data structure to dealing with interweaving and penetrating, allowing users to assign depth value for each edge of a polygon. As a result, when we click on a polygon and move it to interweave with another one, the intersecting edge is calculated using linear interpolation of the depth values. In contrast, the conventional SVG format arranges layers to separate two polygons for interweaving and penetrating. In other words, users need to split a polygon into multiple polygons and assigning them to different layers to achieve interweaving and penetrating. As shown in Figure 2, the proposed system handles the interweaving and penetrating problem intuitively and maintains the topology of the polygons. After finish editing, the proposed system allows the user to save the drawing in both standard SVG format and the proposed augmented depth value format for future editing.

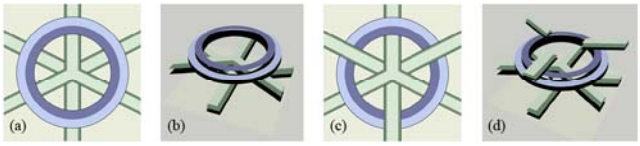

Figure 1: Depth value-based vector graphics. (a) Layered vector graphics without interweaving. (b) Perspective view of (a). (c) Layered vector graphics with interweaving. (d) Perspective view of (c).

Introduction

A variety of decorative patterns are used to decorate traditional Chinese wooden palace architectures. In addition, these paintings also play an important role in distinguishing the level of architecture. As shown in Figure 3 and 4, decorative patterns which have interweaving and penetrating structures can bring stereoscopic viewing effects to the viewers. It is difficult for users to draw the interweaving and penetrating patterns using the existing graphics softwares because of the limit of the standard vector graphics format which uses layers to deal with these problems. Our goal is to allow users to interactively edit the interweaving and penetrating. We propose a new data structure that adding depth values to polygons in vector graphics so that we can efficiently handle interweaving and penetrating.

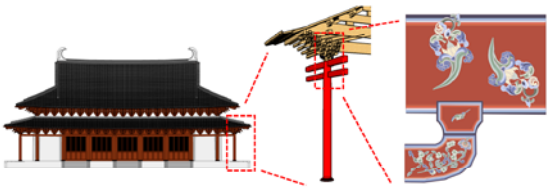

Figure 2: Chinese architectural decorative patterns distinguish the level of importance of an architecture.

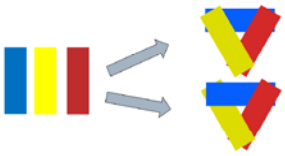

Figure 3: Interweaving means multiple polygons overlap each other such that one end is at the top and the other end is at the bottom.

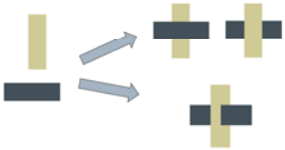

Figure 4: Penetrating means one polygon penetrate through the other polygon.

Interweaving Layers and Depth Values

The SVG is a layer-based XML that only has two-dimensional spatial representation ability of polygons. It is hard to use SVG to represent the interleaving and penetrating polygons. Editing interweaving and penetrating polygons in vector graphics is difficult. Most exiting methods divide a polygon into several parts and assign them to different layers. This process is time-consuming. As shown in Figure 5, there are two approaches to draw a rectangle with side stripes. Both of them looks the same when they are rendered in 2D although they are structurally different.

Figure 5: Two different approaches to draw a rectangle with side stripes. (left) Draw a rectangle followed by a narrower rectangle. (right) Draw a narrow rectangle followed by two side stripes.

We proposes a 2.5D data structure to overcome the interweaving problem. The proposed system allow users to assign depth values to the edges of a polygon in the vector graphics so that the painting process is in two-dimensional space embedded with layering concepts. The layering is computed automatically using linear interpolation. As a result, the upper layers obscure the lower layers.

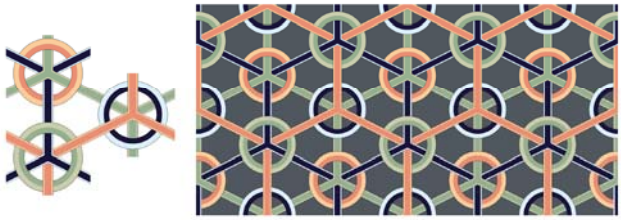

Figure 6: The primitive of Luodi octagon pattern and the synthesised patterns.

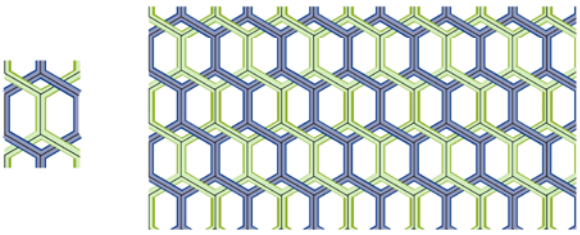

Figure 7: The primitive of Jiaojiao octagon pattern and the synthesised patterns.

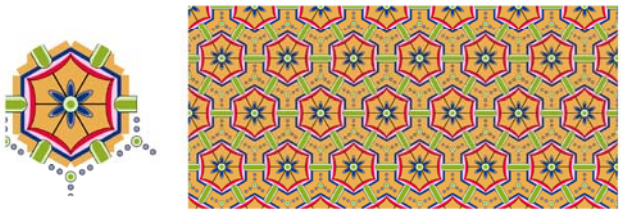

Figure 8: The primitive of Liouchu octagon pattern and the synthesised patterns.

As shown in Figure 6, 7, and 8, the interweaving octagon patterns can be drawn using the proposed system. When two polygons intersect with each other, patches will be generated and placed in the intersected locations. This paper proposes an augmented SVG editing system for drawing repeated patterns. The proposed method allows describing three-dimensional features such as interweaving and penetrating. The user can shift and adjust polygons to form a repeated pattern. After a primitive component is drawn, the three-dimensional attribute of depth value is assigned to edges for intersections while maintaining the original graphic structure. Finally, the primitive component can be repeated to fill the drawing area. The completed drawing can be saved in an augmented SVG format as a JSON file which can be loaded in the future for further editing.

A variety of decorative patterns are described in an ancient Chinese building code, titled "Yingzao Fashi". The proposed allows the users to draw primitive components mentioned in "Yingzao Fashi", and the system can repeated those patterns to fill the entire drawing area. In addition, the proposed system allow the users to capture a certain area and then download it. As shown in Figure 9, in order to draw an arc using the proposed system is to draw a circle first followed by drawing a rectangle on top of it. In other words, arcs must be drawn by combined an underlying circle and a polygon above it. The proposed system can deal with both intersecting polygons and intersecting of a rectangle with a circle. However, the proposed system can not deal with the intersecting of two circles.

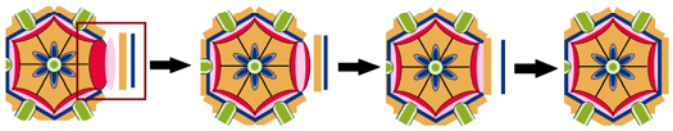

Figure 9: Our approach to draw an arc is to draw a circle first followed by drawing a rectangle on top of it.

Conclusions

This paper proposes a augmented SVG vector graphic drawing system for generating repeated patterns. Three octagon decorative patterns described in "Yingzao Fashi" is generated using the proposed system. The Luodi octagon pattern has an interweaving three-dimensional structure. The conventional SVG format uses layering to separate polygons which makes it difficult to deal with interweaving structures and maintaining the topology.

In this paper, the proposed system assign depth values to each edge of polygons for automatic layering. When dealing with interweaving, the proposed system not only maintain the depth values but also can be outputted to be compatible with standard SVG format. In addition, the proposed system allows the user to save the augmented SVG vector graphics in JSON format. The JSON file can be loaded into the proposed system for editing.

Acknowledgements

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