

A Novel Geometric Pattern Extraction by Means of a Level-Set Method

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Abstract

Geometric and arabesque patterns have been used extensively in Persian architecture. Documentation of these patterns is very important for repair and conservation purposes. With recent progresses in automatic object recognition methods, automatic mapping can be used as a fast and low cost method for documentation of cultural heritage monuments. In this paper a novel feature extraction method by means of level sets is used for detecting patterns in Persian architecture. Experimental results suggest that our proposed method is effective and outperforms common edge detection methods, such as Canny.

Keywords: Geometric patterns, Arabesque patterns, Level Set Method, Segmentation.

Introduction

Geometric and arabesque patterns have been used extensively in Persian architecture. Arabesque patterns and spirals, all representing the generation of the cosmos, universal love and rebirth, suggest the concept of infinity, while geometric patterns represent the idea of the Absolute Reality. Fast and low cost mapping is very useful for documentation and evaluation of the erosion effects on old tile walls. Drawing the details of various objects was usually prepared manually which was a very time consuming task. Moreover, accuracy of the produced map depended on the operator skill. With recent progresses in automatic object recognition methods, automatic mapping can be used as a fast and low cost method for documentation of cultural heritage monuments. There are many feature extraction methods in the literature. The most famous one is Canny [1]. In recent years, new approaches such as neural networks [2], statistics [3] and fuzzy morphological concepts [4] have been explored. In this paper a novel Level-Set Method (LSM) is applied to extract features in arabesque and geometric Persian patterns.

Level-Set Method

LSM is a technique for tracking and extracting features in the image. The first step of this method takes a curve input by the user and uses this curve to split the image into two segments: inside and outside: positive interior, negative exterior. Considering the signs, new grey levels are assigned to each pixel proportional to the pixel distance from the nearest pixel located on the curve. At the next step, each point on the curve will be shrunk to the center of the curve at variable speeds depending on their distance from the centre of the curve. Nearer points move faster while further points move at lower speeds. In the case of having no features in the image, the curve will shrink and eventually collapse to a point. In the case of having a feature in the image, shrinking curve will stop at the boundary of the shape. This process will continue until all boundaries are detected. The boundary of shapes in the new vector field will be considered the zero level. In another words, zero level, which was the initial boundary, identifies the boundaries of the objects in the image.

Experimental Results

The proposed method has been evaluated on a dataset of 60 images including geometric and arabesque patterns and is compared with Canny method (Figure 1). Canny method has "double-edge" effect and over

segmentation problems (Figure 1-b,b'), while the proposed method extracts features more precisely (figure 1-c,c')

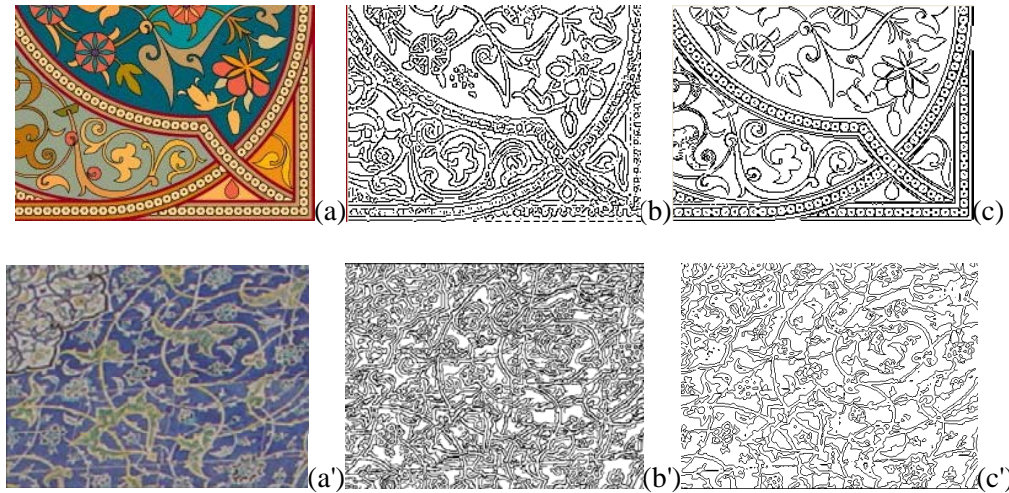


Figure 1. (a) Original image, Extracted edges by (b) Canny method, (c) the proposed method.

For quantitative evaluation, three factors were used: completeness, precision and accuracy. Completeness measures the number of identified edge pixels by each method to the total number of expected edge pixels, which will be identified manually. Precision is the ratio of correctly identified edge pixels to the total expected. And accuracy is the complement of the ratio of wrongly detected pixels to the total number expected.

Table 1. Comparison completeness, precision and accuracy between proposed method and Canny method.

Quality analysis	Canny method	Proposed method
Completeness (%)	92.54	86.25
Precision (%)	29.98	88.13
Accuracy (%)	80.71	94.40

As it can be seen in table 1, Canny method is more complete because it can detect more pixels as edges, however it does not have enough precision and accuracy.

Conclusion

In this paper, a new feature extraction method by means of a LSM was proposed for geometric and arabesque patterns in Persian monument images. Experimental results, in comparison to the most common edge detection methods, such as Canny method, demonstrate the effectiveness of the proposed method.

References

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