Animated Construction of Ink-Wash Paintings

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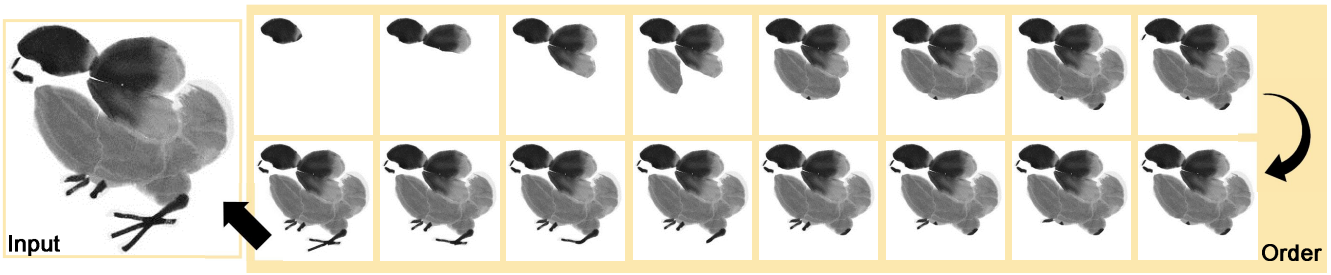

Figure 1: *Guided by painting principles, we derive a plausible order of an ink-wash painting to automatically animate the drawing process.*

1 Introduction

Chinese ink-wash painting is a unique and fascinating form of art. Revealing the drawing process of an ink-wash artwork is visually intriguing and useful for training of painting skills. Recording the sequences of strokes by camera during the creation of paintings is either laborious or even unavailable especially for some ancient paintings. In this work, we propose an effective solution for estimating an order given a number of 2D strokes extracted from ink-wash painting images (Figure 1). The understanding of art varies with people, so our objective is finding a *reasonable* solution that is plausible to human eyes, instead of searching for the *best* drawing sequence. We formulate the ordering of strokes as breadth first search on a graph encoding both the individual features of strokes (e.g., size, shade, position, etc.) and their spatial relationships. Compared with the work of recovering the drawing order of line artworks [Fu et al. 2011], our problem is more difficult since the art form of ink-wash painting is more complicated than line drawing.

2 Algorithm

Input Since it is hard for current image segmentation methods to automatically distinguish strokes from an ink-wash painting, in our current system we only consider cleanly defined strokes. That is, our input is an image composed of an unordered set of 2D ink-wash strokes. We use k-means method ($k = 2$) to group the input strokes according to their areas, the ones with larger areas are called prime strokes and the other set contains detail strokes.

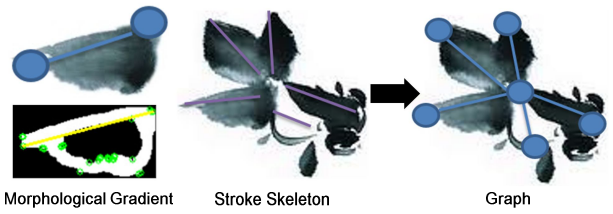

Figure 2: *Find the stroke skeletons and construct a graph.*

Graph construction As shown in Figure 2, for each stroke, we first use Canny detector to detect the edges and compute the morphological gradient image. Then we use Harris corner detector to get the corner points and set the pairs of points with the largest Euclidean distance as the skeleton points of a stroke. Finally we combine the skeleton points of which distances are smaller than $d = 0.1$ and construct a graph for the painting image. Every edge in the graph represents a prime stroke. We treat the average value of edge slopes as the direction of the painting.

Stroke orders According to the basic drawing principles, we formulate the property weight of i-th prime stroke as:

$$W_i = \frac{L_i}{L_{\max}} + \frac{A_i}{A_{\max}} + \frac{S_i}{S_{\max}} + \frac{T_i}{T_{\max}}, \quad (1)$$

where L is the length of the stroke, A is area, S is position saliency, and T is average intensity. We utilize the Euclidean distance between stroke center P_i and painting image center O_i to compute the position saliency of a stroke as $S_i = \frac{1.0}{1.0+\|P_i - O_i\|}$. Thus, we choose the stroke with the maximum property weight as the first stroke to be displayed. Note that a stroke can be treated as a candidate of the first stroke only when it does not connect with any other stroke at either of its skeleton point. Starting from the first stroke, we perform a breadth first search on the graph to get the drawing orders of other prime strokes. During the searching process, for the strokes at the same layer, a stroke will get higher priority if the angle between it and the previous stroke is less than 90°. While for the strokes with the same priority, we primarily draw the ones with higher property weight. Another rule is for two strokes if $|W_i - W_j| < \epsilon (\epsilon = W_{\max} - 2.0 \cdot W_{\min})$, we will draw them in the scan line order. Note that in one painting there may exist more than one graph, in this case we just choose the stroke with the maximum property among all the remaining strokes as another starting stroke and then continue the revealing process. After drawing all the prime strokes, we display the detail strokes in scan line order.

3 Conclusion and Future Work

We present an effective method for animating construction of ink-wash painting, with the aide of stroke property evaluation. In the future work, we will integrate more drawing principles into the optimization process to get more accurate stroke orders.

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