Oriental Color Ink Rendering for Landscape*

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Abstract

Researchers of oriental color ink painting have concentrated on physical models such as brushes, papers, and ink diffusion. These models can be effective when painter depict a painting by tablet pen. Abstraction is main notion of oriental color ink painting. More than thousand years, oriental color ink painter uses this notion for representing their feelings. If a painter has poor skill to use tablet pen or drawing ability, result should be not satisfied. In this paper, we propose an interactive painting method for oriental color ink painting. We use a computational approach to abstract landscape image and reproduce a painting by oriental color ink painting method. The reason why we use landscape image, landscape painting is a major theme of oriental ink painting.

1. Introduction

Abstraction is a main notion of oriental color ink painting. More than thousand years, oriental color ink painter uses this notion for representing their feelings. Figure 1 shows the notion of abstraction. The figure was made by Hong-do Kim who's famous painter in Korea. He drew mountains as main point. And the others is removed. This is difference between oriental and western paintings. Most of western paintings concentrate how they draw exactly same scene. However, oriental painters concentrate how they represent their feeling.

Early studies in oriental ink painting used 3D modeling techniques because 3D model has more information than 2D model. Other researchers of oriental ink painting have focused on models such as brushes, papers, and ink diffusion. A painter uses these models to put their feeling to canvas. But peoples who's not expert in painting have difficulties.

In this paper, we present a novel method for oriental color ink painting. This method doesn't require any user's skill for painting. We use landscape image which is a main theme in oriental color

Figure 1. Oriental color ink painting by Hong-do Kim

ink painting. Our system uses this image as reference image and result is made as oriental color ink painting.

The rest of this paper is organized as follows. Section 2 introduces related work for oriental color ink painting. Section 3 then describe our proposed method. Next, section 4 show you result of our research. And section 5 summarizes this paper and present areas for future research.

2. Related Works

Most works for brush modeling simulate physical brushes. So a painter can choose a brush style and directions. Strassmann[1] proposed a 1D array of bristles and the brushes moved such that it is always perpendicular to the path of the stroke defined by a set of position and pressure parameters in which pressure determines stroke width. Shan-Zan Wen at el.[2] proposed a 2D brush model. They used circle-shaped brush on the region where the brush contacts and the bristles are distributed uniformly in it. Lin[3] used two types of brush model. The first type is normal brush, which includes median thick brush and thick brush. The second type is contour brush which is used to depict the contours or details of an

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object. Lee[4] proposed a 3D brush model which is an elastic model, to calculate the position of bristles. The model, however, requires a great deal of time to calculate the elastic equation.

Paper model is for mixing water and ink. The paper for oriental painting is different with western. Western painting style in non-photorealistic rendering use mainly oil painting. Otherwise oriental painting style is similar with watercolor effect. Therefore early studies of oriental ink painting used Curtis's algorithm. Curtis[5] proposed a simple paper model to simulate watercolor painting. He used three layers model for each cell on paper. Guo and Kunii[6] proposed a 2D fiber structure for generating oriental ink painting. Water and ink of the initial cell on paper move to the neighboring cells by way of the fiber structure. Lee[4] improved the Kunii's model, and generated paper with fiber structure using sin curves. Zhang[7] presented a behavioral model of water and ink particles based on a 2D cellular automation computational model known as "tanks" model.

Ink diffusion is widely used in oriental ink painting and there is differentiation between oriental ink painting and western painting. Ink diffusion is related with paper model. In proportion to paper capability of absorbing water and ink, effectiveness of ink diffusion is changed. Curtis[5] proposed sophisticated paper model. With a more complex shallow water simulation, they can simulate realistic diffusion effects of watercolor. A technique proposed by Lee[8] efficiently rendered oriental black ink paintings with realistic diffusion effects. The system proposed by Lee can simulate ink diffusion based on a variety of paper types and ink properties.

3. Rendering

The flow of the whole process is shown in Figure 2 below. Our system uses landscape image as reference image and processes region segmentation and color edge detection process. After region segmentation and color edge detection, user choose regions which the most important region in the image. While rendering new image, ink diffusion and paper model are applied.

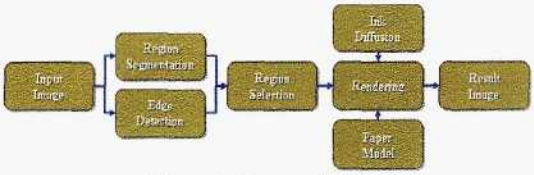

Figure 2. System Architecture

3.1. Region segmentation

Main notion of this paper is abstraction. To represent abstraction, we use region segmentation method. A region segmentation method is simply a partition of an image into contiguous region of pixels that have similar appearance, such as color. Each region has aggregate properties associated with it, such as its average color. We use a simple algorithm to partition regions. An input image is segmented by selecting an unvisited pixel, and searching outward for nearby unvisited pixels with similar color. Similar color is defined by the number of segmentation levels. Pixels are marked as visited, and a new unvisited pixel is chosen. This is repeated until the entire image is quantized into independent segments. Segments of similar color are not connected. This was useful in highly complex regions because we were able to use the higher-level merging operations to choose stroke size rather than the intensity operations. Given the importance of segmentation on the final result, we think that more sophisticated segmentation strategies might prove beneficial..

Figure 3. Result of region segmentation

3.2. Edge Detection

In this paper, detected edges are used for rendering brush effects. Edge detection is the process of extracting out locations of high contrast in an image that are likely to form the boundary of object in a scene. We use a color edge detection method which is based on RGB color space. The method separates RGB color space to each red, green, and blue channel. Sobel operator is applied to each channel. Then Sobeled color channel is summed up.

Each edge points are used for edge chain. While rendering brush, contour lines of objects are represented by edge chain.

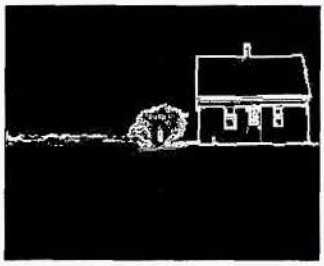

Figure 4. Result of color edge detection

3.3. Region Selection

Two method of previous is automatic technique. It doesn't need any help from user. But this region selection method is interactive method. Segmented regions are shown to user and user chooses a segment which is a main segment in user's mind. When main segment is chosen, last of regions are abstracted.

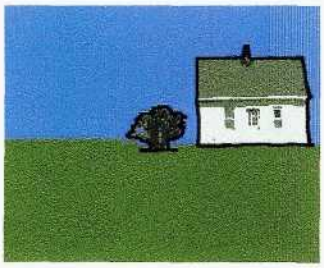

Figure 5. Result of region selection

3.4. Rendering

Paper model is an important factor in oriental color ink painting. Character of oriental paper is absorbency. Oriental paintings use water, ink, and color ink. When a painter uses water, the paper absorbs water and ink. According to pressure of brush, amount of water in paper is different. In automatic way, it is hard to implement brush pressure. In this paper, we use paper structure which is represented for fibers. The typical paper is composed of fibers which are positioned in random position and random direction in which small holes and spaces between fibers act as thin capillary tubes for carrying water away from the initial area, and create diffusion. Figure 6 describe paper structure which is proposed by Lee[8]. This fiber is made by sine curve and randomly generated.

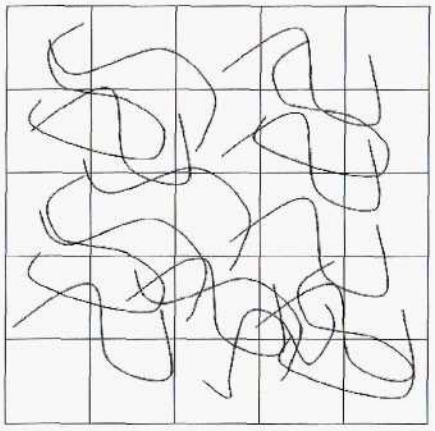

Figure 6. Paper structure with sine

Paper model used in this paper is consisted of cells. Each cell has 8 neighbor cell and is connected in neighbor cell at least one.

In manual method, when a painter uses brush with water and ink, water and ink are spread just like real painting. Our method is automatic method. so that we don't have to simulate ink diffusion. However, if we don't use ink diffusion method at all, result image doesn't look like oriental color ink painting.

We define little different algorithm for simulating ink diffusion. We don't use the whole process of ink diffusion but final state of ink diffusion. The equation of our ink diffusion is below.

$$IDA(i) = C(i) + D(i) \times a$$

where IDA(i) denotes i-th fiber's diffusion area, C(i) denotes i-th fiber's center pixel, D(i) denotes default diffusion circles, and a denotes diffusion ration. Figure 7 below describe ink diffusion effect.

Figure 7. Water Absorbency

For realistic composition of water and ink, Curtis and Lin used Kubelka-Munk(KM) model. This model is to perform the optical composition of pigment layers. In KM model, there are two coefficients to be defined for each pigment, namely absorption coefficient K and scattering coefficient S. A certain fraction, K, of the light traveling in each direction will be absorbed by the pigment material, and another portion, S, will be scattered. In fact, the K and S coefficients for a given pigment are determined experimentally using spectral measurements in typical

applications of KM theory. But we can observe that all that matters in KM model is the ratio of these two coefficients, not the values. Therefore, we set the scattering coefficient S to 1 and only compute the absorption coefficient K by the following equation, which is referred in KM theory.

$$\frac{K}{S} = \frac{(1-R)^2}{2R}$$

where R is the reflectance of the pigment in each RGB color channel and its value is between zero and one. For a pigmented layer of given thickness x (where x is the ratio of the number of the remaining carbon particles to the maximum carbon capacity in each papel) with absorption and scattering coefficients K and S, the KM model can compute reflectance R and transmittance T through the layer [15]:

$$R = \sinh bSx / c$$
$$T = b / c$$

Where c = asinhbSx + bcoshbSx, a=(S+K)/S and b=$\sqrt{a^2+1}$.

Then we use the optical compositing equations in KM model to determine the overall reflectance R and transmittance T of two layers with reflectance's R_1, R_2 and T_1, T_2, respectively:

$$R = R_1 + \frac{T_1^2 R_2}{1 - R_1 R_2}$$
$$T = \frac{T_1 T_2}{1 - R_1 R_2}$$

Figure 7 shows the mixture result of three colors.

Figure 7. Mixture result of three colors

4. Implementation Results

The implementation results of our proposed system are presented in this chapter. The system is written in JAVA language and runs on the PC platform with a Pentium4 266MHz CPU and 512MB RAM.

Figure 8 shows a result of using our proposed system.

(a)

(b)

Figure 8 Result of our system
(a) Original Image (b) Result Image

(a)

(b)

Figure 9 Result of our system
(a) Original Image (b) Result Image

5. Conclusion and future work

Abstraction is a main notion of oriental color ink painting and this paper. Most studies of oriental color ink painting have concentrated on modeling of brush, paper, and ink diffusion. These models have been used for interactive rendering of oriental color ink painting.

In this paper, we proposed a novel method using abstraction. To represent abstraction, we used a important object in segmented regions, Indeed, edge chain has been used for rendering brush effect and KM model for color ink effect.

The algorithm in this paper doesn't need a good skill for painting and artistic skills. We used computer vision technique so

that we overcome previous matters.

There is few more work to be done in the future. First, we used simple region segmentation algorithm but it is time-consuming. So we need to develop more sophisticated algorithm. Second, we rendered oriental landscape. We could expand this algorithm to oriental portrait painting.

6. References

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