Oil Painting Rendering Changeable by Light Effect

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ABSTRACT

Traditional oil painting works enable the spectators to feel the various impressions because it can be shown differently by the changes of light effect. The reason of oil painting's distinguishing feature is that it contains the texture and volume of color expressed by thickness of used pigments and brushing. In this paper, we present a novel method that reproduces oil painting-like image from a source picture based on a virtual light and non-photorealistic rendering technique. To generate the oil painting-like image as an output, the system first performs stroke distribution, which is to determine where a brush is located for stroking, using edge detection and image segmentation on an input picture. And the intermediate image is constructed with the suitable color, orientation and size of brush at each stroke point. At last, the system applies light effect to the intermediate image and generates the oil painting-like image.

KEYWORDS: Non-photorealistic Rendering, oil painting, aesthetic

INDEX TERMS: I.3.3 [Computer Graphics]: Picture/Image Generation — Display algorithms; I.4.0 [Image Processing and Computer Vision]: General

1 INTRODUCTION

In the recent decade, artists express their creativity not only through the intuitive expression but with the help of computer technologies such as image processing, computer vision, and computer graphics. And using these research fields, a more aesthetically evolution of digital art is being represented into a fascinating digital form. The aim of these researches, such as non-photorealistic rendering techniques [1][2], is to make use of computer techniques to reproduce an aesthetic digital art representation from a still image.

The lots of existing non-photorealistic rendering methods have a tendency to focus on intrinsic and technical aspects of how to paint the image similarly to real painting works. In these methods, it is important to determine the order, the direction, and the number of strokes for painterly rendered image generation. However, for the oil painting works, the extrinsic and environment points such as light effect also acts essentially, because the texture and the volume variable by the different light conditions enable to give spectators various impressions.

In this paper, we present a novel method that reproduces oil painting-like image from a source picture based on a virtual light and non-photorealistic rendering technique. The system first performs stroke distribution to determine the point to be stroke, by using edge detection and image segmentation [3] on an input picture. And the intermediate image is constructed with the suitable color, orientation and size of brush at each stroke point. At last, intermediate image transformation based on the light effect generates the oil painting-like image as an output of our system.

We give a detailed description about our algorithm in Section 2. The experimental results are illustrated in Section 3. We then conclude the paper in Section 4.

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2 PROPOSED SYSTEM

This paper proposes a non-photorealistic rendering system to create an oil painting-like image from an input picture. The system consists of three modules, stroke distribution, painterly rendering, and intermediate image transformation. Figure 1 shows the process of proposed system.

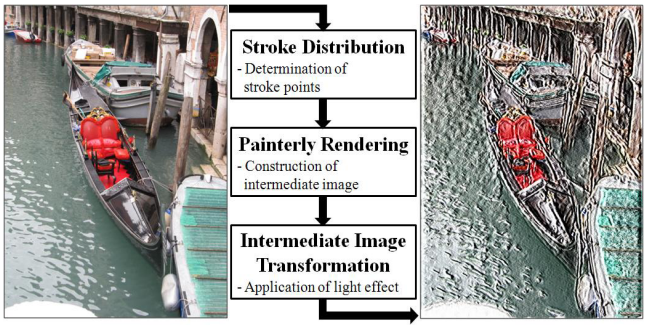

Figure 1. Process of proposed system

Stroke distribution process as the first step is to decide the stroke point where the brush texture defined by user is located. For the determination of stroke point, the system analyzes the local complexity of an input image using edge detection and image segmentation.

In painterly rendering process based on the existing method [2], the system draws an intermediate image from an input picture by using local image moments [4] and the stroke distribution.

Intermediate image transformation retouches the intermediate image by using light effect and the number of stroke times at each pixel. After this work, the oil painting-like image that changeable by light direction and light power is created.

2.1 Stroke Distribution

As artists decide initially where they paint, the proposed system also determines by first the stroke point to be painted. In order for stroke distribution, the system analyzes the local complexity of the input picture using edge detection and image segmentation. This process is based on two assumptions; 1) complicated region must be painted using lots of small and delicate brushes, 2) simple region must be painted using a suitable brush to the region.

Edge detection is used to extract the location where a rapid and complex color change between neighboring pixels is appeared. Through this method, it is possible to recognize the complicated region having large color variation.

In case of simple region extraction, the system applies image segmentation, which is generally used for grouping the neighbor pixels that consists of similar colors. And then the central points of segmented regions are defined as the stroke point.

2.2 Painterly Rendering

Painterly rendering as second process is to generate a painting-like image as an intermediate image based on the stroke distribution computed from the previous step and local image moments. For rendering the image, the following three properties must be defined; 1) brush texture, 2) stroke properties, 3) stroke order.

Brush texture that means the style of brush is defined by user. And stroke properties, such as suitable brush color, location, orientation, and size to each stoke point, can be obtained by local image moments which are used for calculating the centoid, width, height, orientation of local image. Stroke order is in order to paint large regions first, and depict small regions on the painted large regions based on the brush size at each stroke point.

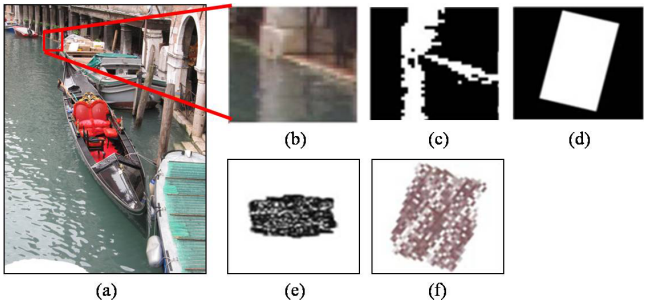

Figure 2. Stroke process: (a) input image, (b) local image, (c) local binary image, (d) equivalent ellipse based on local image moments(width: 33, length: 26, θ: 1.4358), (e) defined brush texture, (f) rendered brush style.

Figure 2 describes the image moments based painterly rendering process. For the calculation about image moments, the local image is converted to the binary image (Figure 2(c)). And then the width, the height, and the orientation of brush are computed by image moments (Figure 2(d)). After that, the color of brush is applied to brush texture (Figure 2(f)). All of these steps are computed at every stroke points.

2.3 Intermediate Image Transformation

To create the oil painting-like image, the system transforms the intermediate image by using light direction, light power, and the number of stoke times at each pixel.

For application of light effect, the system utilizes two kinds of data, depth map (D) and gradient map (G). Depth map contains the number of stroke times at each pixel, and gradient map is obtained by differentiation of depth map along the defined light direction. Through adding the gradient image to the intermediate image, a transformed image (T) as the oil painting-like image is completed. The following equations represent intermediate image transformation. In these equations, $T(x,y)$, $G(x,y)$, and $P(x,y)$ mean respectively a pixel value in the transformed image, the gradient image, and the intermediate image.

$$T(x,y) = \alpha \times G(x,y) + P(x,y),\ 0 \le \alpha. \quad (1)$$

Here, α is a light power parameter and $G(x,y)$ is calculated by the following equation,

$$G(x,y) = \begin{cases} D(x,y) - D(x+1,y) & \text{if left light} \\ D(x,y) - D(x-1,y) & \text{if right light} \\ D(x,y) - D(x,y+1) & \text{if bottom light} \\ D(x,y) - D(x,y-1) & \text{if top light} \end{cases}, \quad (2)$$

where $D(x,y)$ is a pixel value in the depth map.

Figure 3(a) and (b) are the results by using right light and top light respectively. As shown in Figure 3, the system enables to generate the oil painting-like image changeable by the light effect.

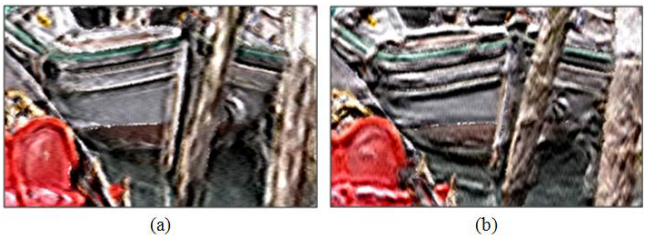

Figure 3. Results of different light directions; (a) right light, (b) top light

3 Experimental Results

We have tested 50 pictures obtained from the web for the experiments. Two examples of them are shown in Figure 4.

Figure 4. Result examples of our system.

4 Conclusion

This paper proposed a novel method of reproducing oil painting-like image from a source picture based on virtual light effect and non-photorealistic rendering technique. Computational methodology such as edge detection, color quantization based image segmentation, and image moments serves as the core engine for stroke distribution and painterly rendering. And through applying light effect into the intermediate image, the system generated oil painting-like image changeable by virtual light condition. For the future work corresponding to this, we will try to apply the more reasonable light effect through analysis of light flow on an input picture.

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