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Technical Section

Humanistic Oriental art created using automated computer processing and non-photorealistic rendering

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Abstract

In this paper, we present a new system of non-photorealistic rendering which allows landscape photographs to be automatically converted to look like Oriental paintings. Using various computer vision and image processing techniques, we can generate images with the rules and features commonly found in Oriental paintings. With such a system, anyone can create realistic Oriental paintings easily, without the years of practice that are usually required by Oriental artists.

Keywords: Non-photorealistic rendering; Image segmentation; Image interpolation; Rendering

1. Introduction

For a long period of time, the main goal in computer graphics was to strive for photorealism. While this goal has generally been achieved in recent years, a new form of computer graphics research called non-photorealistic rendering (NPR) emerged. NPR is any process that does not render objects realistically, but rather simulates different artistic styles [1].

In the few years that NPR research has been carried out, various types of artistic styles such as sketching, pen-and-ink [2], watercolors [3] and oil painting have been simulated. However, these styles tend to suit Western art, since Oriental art is rather different. Oriental art is less concerned with the actual physical appearance of the objects, but rather is more focused on painting the perception that the artist has of the scene. Oriental art also has an element of simplicity. Paintings are usually achieved with a minimum of strokes, with the emotion and thought of the artist conveyed through the speed, movement, placement and pressure of the brush strokes.

There has previously been some NPR research carried out on Oriental art. However, the research mainly either focuses on rendering pre-constructed 3D models [1,4,5] or provides an interactive painting system that allows users to control a simulated painting brush [6–8]. The disadvantage of these methods of NPR make it relatively difficult for non-experts to use, since they require knowledge of computer graphics or Oriental art in order to use them.

Thus, we propose in this paper a new system which can automatically generate Oriental paintings from normal landscape photographs which are taken in a stereo pair. The system will create images that follow the painting rules found in Oriental landscape paintings. Using this system, any person will be able to create realistic Oriental landscape paintings from photographs, without requiring knowledge of Oriental landscape paintings.

The paper is organized as follows. Section 2 details the background information as well as the principles and rules of Oriental paintings. Section 3 introduces the work previously done by other researchers in the area of NPR, particularly for Oriental paintings. Section 4 describes the different steps in our proposed system. Section 5 concludes our proposed system.

2. Background

Oriental painting as a traditional art form has evolved continuously over thousands of years. It originated from Chinese calligraphy and shares with it several similar

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characteristics. There are four main elements in Chinese paintings and calligraphy: the brush, ink, inkstone and paper. These are also known as the "four treasures" [9].

There are three popular types of subjects in Chinese paintings. They are landscapes, flowers and plants, birds and animals. Landscape paintings are considered to be the highest level in Chinese paintings, on the same level with Chinese calligraphy, and landscapes were the subject of the earliest paintings by the intellectual class, the scholars and officials. Traditional landscape paintings consist of six different objects: rocks, trees, mountains, water, people and buildings [10].

There are several different features which are commonly found in Chinese paintings, which we try to reproduce in our NPR system.

- Atmospheric depth—Background objects in Chinese paintings are usually painted with more dilute ink to add a feeling of depth to the painting, since distant objects usually appear hazy and blurred due to atmospheric effects.
- Irregularity—Due to the unpredictable nature of the interactions of the ink and the paper surface, brush strokes are never completely uniform in intensity. The edges of a stroke are also not distinct, but appear blurred, due to the effects of ink diffusion.
- Blank space—Long brush strokes will exhibit empty spaces in between. This occurs when the brush runs out of ink due to the limited amount of ink that the brush can store at one time. Omission of the background is also acceptable and commonly found in Chinese paintings.
- Seal—Most Chinese paintings contain one or more red imprints of seals, and perhaps some calligraphy expressing the author's thoughts and feelings. The seals are an important part of the painting, and are usually found near an edge of the painting.
- Composition—Chinese paintings do not require artists to strictly follow reality or a particular angle of view. The artist is free to rearrange the objects in a scene or paint objects from a different point of view. In landscape paintings, Oriental artists try to convey the impression that the scene is viewed from a high vantage point.

We use the above rules in Chinese landscape painting to generate Oriental paintings from a stereo pair landscape image. The detail of our proposed method is described in Section 4.

3. Previous works

One of the earliest works in NPR was the modelling of hairy brushes by Strassmann in 1986 [11]. His model had four classes of objects: brush, stroke, dip and paper. Using a 1D array, he modelled brush strokes using cubic splines and polygons. However, the user interface required users to enter and edit strokes using a mouse which was quite unnatural.

Yeh and Ouhyoung [1] created a set of algorithms to automatically render 3D animal models in the Chinese painting style. Their process used borderline stroke making and interior shading together with special effects like dry brush effect and turning effect to create the Chinese painting effect. This NPR process produces realistic Oriental painting images, but it requires 3D models of the objects prior to the NPR process.

Ink diffusion effects in Chinese paintings have been modelled by Huang et al. [12] using a physical based model. They simulated the effect of ink diffusion by taking into account four factors, the gradient of water, absorbency of paper, paper texture and the inertia of water. This system can create realistic diffusion effects, but has the disadvantage that it is very computationally intensive.

Lee [6] created an interactive painting system that enabled users to paint virtually on the computer. His system used a 3D brush model that used Hooke's law to calculate the deformation of the brush under pressure. Due to the use of a complex brush model, the output looks very similar to real Oriental paintings, but the user needs to be experienced in Oriental paintings to use it effectively (in effect the screen brush replaces the real one, and thus the user must have a similar skill to the true Oriental brush artist). Yeh et al. [7] went a step further and included the use of haptic feedback in their interactive painting system.

There has also been research on how to render individual elements found in Oriental landscape paintings. Way [13] proposed a hemp-fiber stroke to synthesize rock textures in Chinese landscape painting and to synthesize portraits in Chinese figure painting. A system to automatically draw trees in the Chinese ink painting style from 3D polygonal models was presented by Way [14]. By focusing on particular elements, the objects are rendered very realistically, but the NPR process is limited to only those class of objects, and cannot be applied to other kinds of objects.

4. Proposed Oriental painting algorithm

The algorithm used for the NPR in this research comprises five main parts. The overall block diagram of the algorithm is shown in Fig. 1. The input to the system is a pair of stereo photographs of the same scene. The algorithm operates as follows: first, all the objects in the image are segmented. This is because for Oriental landscape paintings, the individual objects are extracted and rearranged in the painting to follow the composition rules. Once the objects are segmented, their relative depths are determined using stereo depth information. This depth information is used later in the composition stage. Next, the objects which are partially occluded and have missing regions are filled in automatically using interpolation techniques. This is necessary as the missing regions should be visible after the rearrangement of the objects.