A Model Based Technique for Realistic Oriental Painting

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Abstract

Realistic representation of various effects which are appeared in the real world paintings can be used for several applications like as animation or education. To generate Oriental paintings, numerous studies have focused on model-based approaches. In this paper, a new model-based approach for Oriental paintings is described. To represent the diffusion effects, we propose local equilibrium model (LEM) which is a method to calculate the movement of water and ink effectively. In addition, we propose a paper model with fiber mesh structure and three layers structure on each cell. With this layer model, overlapped strokes can be well represented. A brush model proposed supports several brush effects like as shading.

1 Introduction

Oriental painting rendering is non-photo realistic rendering which stands in contrast to conventional computer graphics rendering methods. Oriental painting typically consists of just a few simple strokes intended to convey the artist’s deep feelings regarding the painted object. Until now, most studies simulating Oriental painting generally have been based on the modeling of brush, diffusion, and paper.

Curtis et al. [1] proposed a simple paper model with layer structure to simulate watercolor painting. A paper model with fiber structure was shown by Kallmes and Corte[3]. As a paper model for generating Oriental painting, Guo and Kunii[2] proposed a 2D fiber structure. Lee[6, 7] improved the Kunii’s model, and generated a paper with fiber structure using sin curves. Strassmann[8] proposed a rendering model to describe a stroke which is generated by a spline curve which allows control points. Lee[5, 6] proposed a 3D brush model which is an elastic model, to calculate the position of bristles. Kunii et al.[4] proposed a multidimensional diffusion model to animate complicated phenomenon of diffusion on the surface of a paper. Zhang et al.[9] presented a behavioral model of water and ink particles based on a 2D cellular automaton computational model known as “tanks” model. Lee[6, 7] developed a “wave” schema for representing how ink flows through a fiber mesh. In this paper, a model based approach for the brush, paper, and diffusion is also proposed.

2 Painting Models

Paper

The fiber mesh structure is employed for the paper model. And, each cell on the paper is divided into three layers to simulate phenomenon in the intersected parts of several strokes.

Brush

The 2D brush model is used for the fast calculation of position of each bristle. With this brush model, several brush effects can be generated. Water and ink stored in each bristle are gradually exhausted over time if it is not replenished. To simulate this phenomenon, we used piecewise linear function. Fig.1 shows an example of the ink decreasing effect. In the original paintings, the shading effect is generated due to the difference of ink density in a bristle. To do this, we use a spline curve with several control points which represent the ratio of ink density in a bristle.

Diffusion

To simulate diffusion effect, LEM(Local Equilibrium Model) is used. In the time step $i$, the quantity of water and ink moving from $i_{j}$ to $i_{j}$ is determined by the following equations.

$$W_{i,j}(i_{j}) = f \cdot \frac{\sum W_{i,j}(i_{j}) \cdot (f_{i,j})}{\sum_{a} (f_{a,j})}, \quad f > 0$$
The movement of water and ink follows the LEM. The absorbed water and ink is desorbed to the surface layer or absorbed in the absorption layer. The absorbed quantity of water in the deposition layer is determined by the following equations.

\[ W_{i,j}^{a} = W_{i,j}^{a} (1 - \alpha) \cdot W_{i,j}^{d} \]

where \( W_{i,j}^{a} \) denotes the absorbed quantity of water(ink), \( W_{i,j}^{a} \) denotes the maximum and minimum absorption ratio, and \( W_{i,j}^{d} \) denotes the desorbed quantity to the surface layer or absorbed in the absorption layer. The movement of water and ink follow the LEM. The quantity of water and ink absorbed is determined by the following equations.

\[ W_{i,j}^{a} = \sum_{c} \left( f_{o,c} \right), \]

where \( f_{o,c} \) denotes the difference of water pressure between the cell \( i,j \) and the number of output fibers which is connected to the cell \( i,j \). \( f_{o,c} \) denotes the number of fibers which connects the cell \( i,j \).

Each cell on the paper is divided into three layers: surface layer, absorption layer, and deposition layer. During the time interval \( \Delta t \), water and ink in the surface layer is moved to the neighboring cells or absorbed in the absorption layer. The movement of water and ink follow the LEM. The quantity of water and ink absorbed is determined by the following equations.

\[ W_{i,j}^{a} = W_{i,j}^{a} (1 - \alpha) \cdot \left( - \Delta t \cdot W_{i,j}^{d} \right), \]

where \( W_{i,j}^{a} \) denotes the absorbed quantity of water(ink), and \( W_{i,j}^{a} \) denotes the maximum and minimum absorption ratio, respectively. \( W_{i,j}^{d} \) denotes the desorbed quantity to the surface layer or deposited in the deposition layer in the next time step. The desorbed quantity to the surface layer is determined by the following equations.

\[ W_{i,j}^{d} = W_{i,j}^{d} \left( - \Delta t \cdot \frac{W_{i,j}^{d}}{W_{i,j}^{a}} \right), \]

where \( W_{i,j}^{d} \) denotes the desorbed quantity, \( \gamma \) and \( \rho \) denote the minimum and maximum desorption ratio, respectively. The quantity deposited in the deposition layer is determined by the constant ratio \( d \) given by a user.

\[ W_{i,j}^{d} = W_{i,j}^{d} \left( - \Delta t \cdot \frac{W_{i,j}^{d}}{W_{i,j}^{a}} \right), \]

where \( W_{i,j}^{a} \) denotes the deposited quantity of water(ink) deposited and \( d \) is the deposited ratio.

### 3 Experimental Results and Conclusion

In this paper, we proposed models for paper, brush, and diffusion to describe how to generate realistic Oriental paintings. The proposed models were implemented with Pentium III 600MHz PC and Visual-C++ 6.0. Our system can be used as a drawing tool for Oriental paintings. Fig. 2 generated images of the Four Gracious Plants, traditional material of Oriental paintings. Future studies are the improvement of speed to calculate diffusion of water and ink and the development of method to use input material effectively.

**Figure 1. An simulated ink decreasing effect by the proposed method.**

**Figure 2. Four Gracious Plants**

### References


