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Modeling the Diffuse Paintings of 'Sumie'

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1. INTRODUCTION

Diffuse painting, or 'Nijimi', which is the most remarkable feature of black ink painting (called 'Sumie' in Japanese), is produced by letting the ink diffuse into the absorbent paper. The diffusion of the ink usually results in a delicate blurred image. A model for simulating the nijimi effect with computers has been developed. It is based on the physical analysis of the construction of the paper - the mesh of fibers, the characteristics of liquid flow and particle adsorption, and the interaction between the liquid and the paper. The images generated by this model are proved to fit well with the observed patterns.

2. CONSTRUCTION OF THE MESH

For constructing the paper with the property of fibers distribution, the principles of disordered systems (Ziman 1979) are used. The basic idea of the disordered systems is that: the physical situation at some point r is exactly or approximately reproduced at every other point which are regularly positioned like lattices. It can be mathematically represented as

$$F(r + R) \sim F(r).$$

The situation function F and the range R are related to the properties of the systems. Hence, a mesh is created by dividing a field into several regions and distributing the fibers according to the rule that for each region, the average fiber distribution is the same, but within each region, the fiber distribution varies randomly. In Fig. 1, a mesh created with different fiber quantities is shown.

3. CHANGE OF INK DENSITY

During the formation of nijimi, the change in liquid density occurs because of interaction with the mesh. Colloidal liquid is made by mixing particles of solid with water. For instance, ink is made by mixing powdered carbon and glue with water. The density of a colloidal liquid is decided by the average size of the particles in it. When the liquid begins to diffuse into the mesh, an observable change of liquid density will occur at the start points. This is because only those particles that are smaller than the space between fibers can seep into the mesh along with water. It is as if a filter is embedded in the mesh. The influence of the filter effect results in a change in liquid density, as well as in a global change in image intensity.

From the time a drop of liquid ink falls on the paper, until the diffusion process is completed, three areas of different in liquid density are formed. First is the initial area where ink is applied. Then there is the filter area through which the ink seeps into the paper. The third is the diffusion area where only the particles smaller than the average size of the spaces between fibers exist. The change of liquid density during the filter area can be calculated form the change in the range of particles size.

4. THE LOCAL VARIATION OF IMAGE INTENSITY

For the pixels in diffusion area, their image intensities depend not only on the liquid density but on the characteristic of liquid flow and particle adsorption in the mesh. The characteristic of liquid flow will cause some points of the empty spaces to be untouched by the ink when a limited liquid remains. According to the physical principle of adsorption the quantity of adsorbed particles is in proportion to the surface area of the solid. It is easy to understand that there will be more particles adsorbed at the points through which fibers pass than that at the points with no fibers passing through. In other words, the state of particle adsorption varies with the structure of the mesh. Due to the characteristics of liquid flow and uneven particle adsorption in the mesh, the delicate local variation of intensity (the blur) is produced in the diffusion images.

For modeling the image intensity variation, we applied statistical analysis on the construction of meshes, and classified the states of the fiber structure at each point into a number of individually distinct cases (Fig. 2). For each case, the state of liquid flow and particle adsorption is decided dynamically, and then the intensity is calculated to generate the image.

5. IMAGE GENERATION PROCEDURE

For generating the delicate images of nijimi, it is required to illustrate the details which go beyond the resolution of the screen. Our simulation schema, as illustrated in Fig. 3, is therefore designed to complete an image in two steps. The first is to generate a fine and detailed image on the microscopic domain based on the modeling introduced in previous sections. The second step is to transform the detailed image to the true nijimi image on the resolution domain of the screen. The transformation can be completed simply by averaging the intensities of neighboring pixels from the final image.

We have used our this model to generate nijimi on painting strokes. The original stroke corresponds to the initial area, while the extended parts denote the filter and diffusion areas. Figure 4 shows an example of black ink painting generated by computer. In the upper part of the painting, there are some strokes, which describe the fog over the lake. These blurred strokes are created with the effect of nijimi.

7. CONCLUSIONS

The current version of the model is limited to the two dimensional simulation. It is possible for it to be extended to higher dimensional cases. Extensions to other areas of application are also possible.

REFERENCES

Strassmann S (1986) Hairy Brushes. Computer Graphics 20(4):225-232

Ziman JM (1979) Models of Disorder - The theoretical physics of homogeneously disordered systems. Cambridge University Press

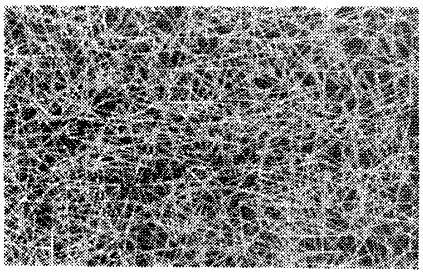

Fig. 1 A mesh generated by a computer

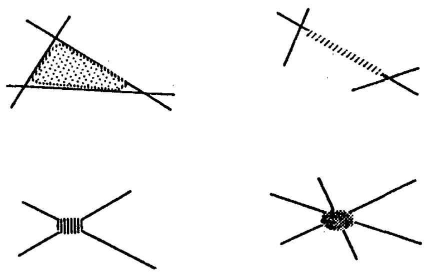

Fig. 2 The classification of the pixels in the meshes

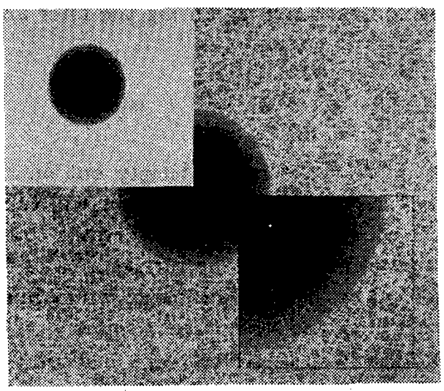

Fig. 3 Generation of the nijimi image

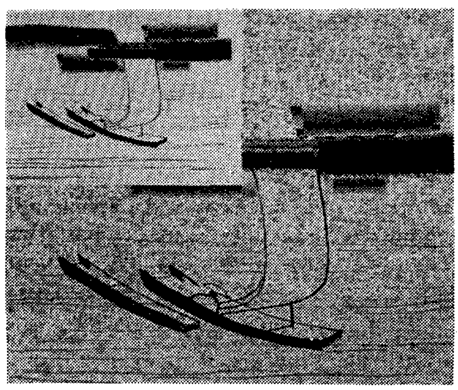

Fig. 4 A computer-generated sumie