A Study on the Generation for Chinese ink painting

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摘要

近年來有許多中國元素被應用於設計上。對視覺設計師而言，中國水墨畫亦是其中一種藝術的表現手法，不僅代表了一種風格的呈現，藉由水墨畫的筆觸質感也可以呈現出其設計作品的風格。因此，使中國水墨畫於電腦輔助設計上的應用，具有更為靈活的可能性技術，來幫助設計問題 – 花費較多的時間與單調的變化，提供視覺設計師在從事中國水墨圖像設計過程中，可以藉由衍生式系統的輔助，將中國水墨畫的設計圖像，在筆觸與質感上的呈現能更具實用性、豐富性與便利性。植物生長之概念與 NPR〔Non-Photorealistic Rendering〕技術來提供系統更多元的呈現方式，使設計師在水墨圖像創作時的需求，能獲得更大且多面的可能性，藉此，讓中國水墨畫的應用範圍更廣泛也更提高其效果的價值。

關鍵詞：中國水墨畫，衍生式設計系統，視覺設計。

Abstract

Recently, many elements of Chinese graphics are used in design. Chinese ink painting is one of them – a skill applied by visual designers or graphic designers; as well as represents many kinds of styles. Visual designers or graphic designers often apply Chinese ink painting in design. Therefore, the application of Chinese ink painting has its potential to be a more flexible skill in the Computer Aided Design. That helps solve the problems of being time-consuming and changeless.

This study focus on manipulating the variables that construct on growth processes of plant - L-system concept and Non-Photorealistic. We should support visual designers or graphic designers in designing process which a generative design system to generate Chinese ink painting. By the generative design system, when designer is working the graphic of Chinese ink painting, it can make the textures of stroke represent more practicability, more plenty and more conveniently. The conception of plant growth and NPR (Non-Photorealistic Rendering) technique support the system with diversified way, it can gained wide possibility, when designer create Chinese ink painting. Finally, the application of Chinese ink painting will be extensive and enhance its value.

Keywords: Chinese ink painting, Generative design system, Visual or graphic design.

1. Introduction

In recent years, there are many elements of Chinese graphics are used in design. Chinese ink painting is one of them – a skill applied by visual designers or graphic designers; as well as represents many kinds of styles. Textures of stroke can define the styles of a design work. Chinese ink painting possesses very unique style, also possesses plentiful textures [18]. Although a lot of commercial graphic software have many different kinds of strokes and now they deal with some Chinese ink paintings, but the painting result by the software are not naturally vivid. They take designers much time in designing process. The Computer Aided Design's aim is tried to make thing faster, easier and better [19]. Therefore, some researchers start to develop new software in Chinese ink painting of visual effect as there subject.

Visual designers or graphic designers often apply Chinese ink painting in design. Their works of design are created in very unique styles. However the application of Chinese ink painting not only takes designers in working out their works but also fails to meet their need. This time-consuming way happens because the designers or by others finish Chinese brush writing on paper, then scan them into the

computer which is more effect way. Besides, the scanned pictures are changeless, providing no elements in design work. Fischer and Herr [5] generated the design which represents the design discipline's interest to apply natural inspiration not only in terms of the creation of products but this is also shows in term of the process of creation. Therefore, the application of Chinese ink painting has its potential to be a more flexible skill in the Computer Aided Design. That helps solve the mentioned problems of being time-consuming and changeless.

This study focus on manipulating the variables that construct on growth processes of plant - L-system concept and Non-Photorealistic. We should support visual designers or graphic designers in designing process which a generative design system to generate Chinese ink painting. By the generative design system, when designer is working the graphic of Chinese ink painting, it can make the textures of stroke represent more practicability, more plenty and more conveniently.

And in order to represent the accurately characteristic of Chinese ink panting, system will specifically generate to the 'Four gentlemen' - Plum Blossom, Orchid, Bamboo and Chrysanthemum; as further effect to solve the problem that designer can't present appropriately then have to confront with the basic skill of Chinese ink painting. The conception of plant growth and Non-Photorealistic technique support the system with diversified way, it can gained wide possibility, when designer create Chinese ink painting. Finally, the application of Chinese ink painting will be extensive and enhance its value.

In order to help designer had better present in Chinese ink painting, we develop a Generative Design System and the primary researches to be addressed in this paper are as follows:

1. To research the generation of Chinese ink painting that designer applies to stroke and textures.
2. Emphasize the characteristic of textures and stroke with Chinese ink painting, the color and artistic conception are not in the scope of this research.
3. Employ Generative Design System to generate the four type's graph of textures in Chinese ink painting- Plum Blossom, Orchid, Bamboo and Chrysanthemum.
4. Analyses the interface of Generative Design System witch has interaction with the designer.

2. Background

2.1 Introduction of Chinese ink painting

Chinese ink painting is a kind of form of Chinese traditional art that is over three thousand years old. Chinese ink painting stresses the notion of "implicit meaning" in which painters use a minimum amount of strokes to express their deepest feelings [10]. The Chinese ink painting basic methods have brush, ink, color, water, and paper. By using brush tip in different, can product different effects. From thick ink to thin ink, its special property is that it can depict the light and color of any subject. Color is used primarily after the basic ink outline is completed, and the effect is brought out with the aid of the varying degrees of color brightness. The ingenuity of ink use is in the use of water [1].

Since the ancient periods ink painting always is the most typical example of Chinese couture art [2]. Chinese ink painting has it own uniqueness not only in the technique, material and cultivation but also in the notion of esthetics. Even through the many years, it still has a considerable standing in Chinese art history, and turn into one of the main stream of Chinese painting that develop divers personal style and period style [18]. Chinese ink painting is really a rare skill in the world witch is historic, artistic and significant [14].

2.1.1 Textures of Stroke.

These are different characteristics with different textures and strokes represent in Chinese ink paintings. A Chinese painter, Li [15] said "The point of ink painting lies on the gradation of the ink and the manipulation of the brushwork. To paint is not to copy the outer form of the subject, but to represent the mental conception of the subject in the painter's mind." Therefore, ink and strokes can convey the spirit of a painting in an effective way [13].

Before we start to study Chinese ink painting, we have to establish some basic concepts at first, the following point are examples of: brushwork, ink style, copy, sketch [18]. It can help us to use ink painting correctly. The fundamental of any painting are point, line and plane, line has the large possession above all [2].

Chinese ink painting presents seriously in line that had remarkable accomplishment in brushwork then the style it show is not only lithe but also clumsy. Although the Chinese ink

painting different with the modern painting, but the line still had absolute worth in present. As we noted above, Chinese ink paining particular about the line present. And the present of line that we called is 'penwork' witch shows the different line and different texture in skill. The painter Bin-Hong Huang who from china classifying the brushwork to five categories (Figure 1): smooth, round, stay, heaviness and change [18]. Indeed to the basic implement imitating the characteristic, the most important thing is how people to use the implement to present it [12].

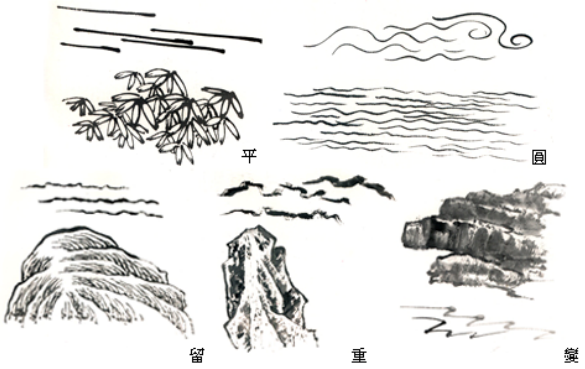

Figure 1 the brushwork to five categories.

2.1.2 Basic elements of graph – Four Gentlemen.

Plum Blossom (梅), Orchid (蘭), Bamboo (竹) and Chrysanthemum (菊) are the normal subject of Chinese ink painting. Theses four plant have their own trait; as Plum Blossom is hardy and easy to live in winter; Orchid have pure and fresh smell; Bamboo is straight and Chrysanthemum can growing abundantly. An old China scholar give a name to them called 'Four gentlemen' (Figure 2).

Figure 2 Four gentlemen.

Some savants propose that learning Chinese ink painting should begin from 'Four gentlemen'. That is because when you draw Plum Blossom you can understand the way to draw the branch; and when you draw Orchid you can easily to draw the other similar plant; drawing Bamboo can know the vary of brushwork; and drawing Chrysanthemum is the original painting way of other flowers. So that's why we offer the 'Four gentlemen' as choice [14].

2.2 Generative design system

Generative Design is a design method under the Problem Solving and Generative concept. The concept of Generative Design is applying Generative rule to produce some feasible substitute for designer decision. And classify human's thinking to the rational logic knowledge [16]. Eastman and Mitchell used Simon and Newell's information processing theory as basis; it assumed that design process is a procedure of recurring problem solving- specification, generation and evaluation [4].

Generative Design System is about rule basis and condition control. It use algorithm to generate new design graphic and possibility [17]. By the generative mechanism of Generative Design System, designer does not need to follow the traditional way in design, on the other hand, to regulate variable event for an ideal result [16]. No matter system or algorithm, they are both software witch can self generate and self organize. For this reason system considers the term witch had been input, then system will generate speedily to reappraise for the better term.

There is a new form of using Generative Design System to assist designer, and by the variable event there has an unknowable combination result for designer, undoubtedly these variation let the result won't be an inflexible style [17].

2.3 L-system and plant of generative

Lindenmayer system or L-system is a mathematical formalism proposed by the biologist Aristid Lindenmayer in 1968. L-system most famously used to model the growth processes of plant development [8]. More recently, L-systems have found several applications in computer graphics. Therefore, L-system has two principal areas. (1) Growth processes of plant and (2) Generation of fractals [11]. Originally the L-systems were devised to provide a formal description of the development of such simple multicellular organisms, and to illustrate the neighbourhood relationships between plant cells. Later on, this system was extended to describe higher plants and complex branching structures. Original L-system for modelling the growth of algae.

variables: A B
constants: none
start : A
rules: (A → AB), (B → A)

which produces:
n = 0 : A
n = 1 : AB
n = 2 : ABA
n = 3 : ABAAB
n = 4 : ABAABABA
n = 5 : ABAABABAABAAB
n = 6 : ABAABABAABAABABAABABA
n = 7 : ABAABABAABAABABAABABAABA
ABABAABAAB
This is an example for Fractal plant.
variables : X F
constants : + −
start : X
rules : (X → F-[[X]+X]+F[+FX]-X),(F → FF)
angle : 25°

F means "draw forward", - means "turn left 25º", and + means "turn right 25º". X does not correspond to any drawing action and is used to control the evolution of the curve. Fractal plant is shown in Figure 3.

Figure 3 Fractal plant for n = 6 [11].

2.4 Non Photo-Realistic

Non-photorealistic rendering (NPR) is a newly developed rendering technique, also injects aesthetic and stylized element into computer graphics in recent years. NPR is not rendering objects realistically, primarily aims to convey not only compressed information but also a certain painting spirit and more creatively, by simulating various painting styles such as pencil sketching(Figure 4), watercolor painting(Figure 5), oil painting, and Chinese ink painting [10].

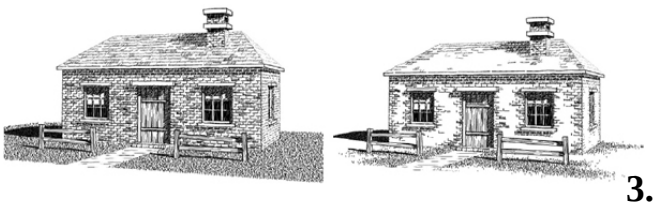

Figure 4 Pencil sketching [3].

Figure 5 Watercolor painting [3].

Strothotte and Schlechtweg proposed [9] Halftoning was a process by which each small resolution unit (called pixels) is imprinted a circle of black ink whose area is proportional to the intensity of the corresponding area. Concept of the halftoning(figure 6).

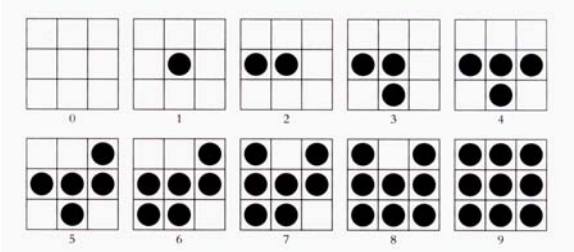

Figure 6 Example of patterns for representing ten intensity levels of a 3 × 3 pixel area [9].

The artistic qualities and textures of Chinese ink painting, watercolor or oil paintings, such images also are a challenge from a physicist's point of view. A simulation of the physical properties of the medium, namely, paper, brushes, and paints. A simulation of applying Chinese ink painting in computer graphics includes some models the following [9]:

1. The paper properties,
2. The peculiarities of different brushes,
3. The consistency of the paint resulting from the amount of water and paint particles.

And, a simulation of effects of the Chinese ink painting processes such as the following:

1. The flow of paint on the paper,
2. The adsorption of paint particles in paper,
3. The adsorption of water in the paper.
4. The interaction between different strokes of brush,

3. Approach

This study proposes to develop a Generative Design system to generative texture of Chinese

ink painting and to support designer apply in visual or graphic design. A two-phase models study was designed to explore:

1. Generation of plant skeleton model.
2. Simulating generation of texture of Chinese ink painting model.

3.1 Generation of plant skeleton model

The plant skeleton is important element in this system. L-system famously used to model the growth processes of plant development, And in this study, we used the concept to develop the skeleton of plant as production rule of plants by L-system. We using concept of L-systems alphabet is extended with five new symbols as show in TABLE 1.

TABLE 1 Extended with symbols interpreted

Symbols	Interpret
F	Draw line
[	Pop a state from the stack and make it the current state of the turtle.
]	Push the current state of the turtle onto a pushdown stack.
+	Rotate left draw line
-	Rotate right draw line

The procedure of the plant skeleton generation as follow:

1. Designer draws a simple line in the system.
2. The system will analyze the line from designer with production rule of plant.
3. Follow direction of the line and production rule of plants to generative the plant skeleton.

3.2 Simulating generation of texture of Chinese ink Painting model

Simulating generation of texture of Chinese ink Painting is a performance of texture model. A simulation of applying Chinese ink painting in computer graphics includes some elements, and we using the paper properties to generative texture of Chinese ink painting.

3.2.1 The paper properties.

All papers own characteristic. Papers have one of two types of fiber mesh. Constructing a mesh like Hsuan paper requires an appropriate data format in which to represent a mesh structure. Traditionally, a network format is used to represent paper with a random fiber network [6]. Therefore, the entire mesh in the paper is separated out into many layers, each of which are divided into 2D array of [X Y] cells called papels (paper elements) [7]. A papel (paper element) is a basic unit of paper structure and corresponds to a pixel on the screen. Some of the diffused ink is deposited in the holes or spaces between the fibers through which is passes; the remaining ink continuously flows along the fibers until it is completely absorbed. Let Absorbency (p) of papel p be defined as follows. When the moving ink passes through p with N fibers, the amount of water deposited in p is Q. The relationship between Q and N can be expressed as $\text{Absorbency}(p) \propto N \propto Q$. Based on this relationship, we define several kinds of paper model with different abillty of water absorbency with different absorption of paper fibers. The initial ability of absorbency of each papel can be described as:

$$\text{Absorbency}(p) = \text{Base} + \text{Var} \times \text{rand}() \quad (1)$$

3.2.2 The water particles.

Water is a liquid which can move to anywhere in the paper under the forces associated with capillary action. All water particles are defined as objects with the same volume, mass, color and respond to forces. They only differ in position, recorded as coordinates in the papel. The quantity of water accordingly governs the span of the diffusion image or the number of diffusion steps. When the water in a certain papel flows out, its quantity and direction must be determined. Based on above description, the approximate equation for K(p), the ratio of the quantity of out-flowing water to the quantity of water in the papel p is represented as [6],

$$K(p) = F_{base} + F_{diff} \times (1 - (1 - \text{Absorbency}(p)^2)) \quad (2)$$

where Fbase is a real number between zero and one that represents the basic flow rate p, and Fdiff is a real number between zero and one that represents the difference between the highest flow rate and the lowest.

3.2.3 The carbon particles.

A carbon particle is a black and solid grain. It cannot move by itself. When water particles move, carbon particles move with them. Carbon particles are suspended and move in this liquid since they collide with water particles. Suspended carbon particles undergo Brownian motion,

buffeted water particles.

The carbon particles can be most simply simulated like water particles. They have mass, position, diameter and color. These attributes all vary among particles. The diameter and mass of a carbon particle are determined by the fineness to which the ink is initially ground. If the ink is initially ground coarsely, it contains small and large particles that produce observably different color intensities at the border of the initially brushed area. However, most homogeneous, small and uniform carbon particles move in water unhindered by the fibers, such the intensity changes smoothly over across the diffusion area. Only carbon particles that are smaller than the space between the fibers can seep into the mesh in the water. Particles larger than the space remain in their initial positions, as shown in figure 7. This phenomenon is referred to as the "filtering effect" of the fiber mesh, and can be represented as follows, where p is the papel in which the carbon particle is located [6].

if (Carbon_Diameter > Hole_Diameter(p))
then Carbon_Position ← p
else
Carbon_Position Water_OutFlow_Direction(p)

In figure 7, two adjacent cubes represent two neighboring papels. Black grains in papels are carbon particles with different sizes. It is chaotic between two papels represent fibers. The arrow represents the direction in which the water flows; the carbon particles move in this direction. Larger carbon particles cannot pass through holes in the paper [6].

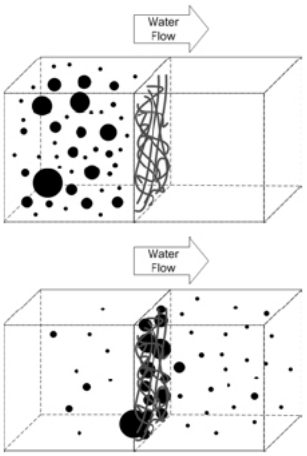

Figure 7 An illustration to explain the phenomenon called "filter effect" [6].

3.3 Motion of water

Water may flow from one papel to some of its neighboring eight papels. The directions of this motion are determined by considering the following factors that dominate the flow of water.

1. Gradient of water between neighboring papels, based on Brownian motion.
2. Absorbency of neighboring papels for water.
3. Paper texture of neighboring papels.
4. Inertia of water.

In Figure 8 shows that a papel C0 has eight neighboring cells pk defining eight directions, dk (k = 1, 2…8). The probabilities of motion in each direction are calculated according to the above four factors. The amount of water particles that flow into a neighboring papel is proportional to the calculated probability.

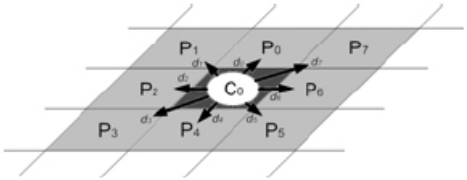

Figure 8 Determine directions of water flowing into neighboring papels, pk (k = 1, 2…8), according to the probabilities in eight directions calculated based on four factors.

4. System implementation

4.1 System architecture

The system architecture has three parts and the diagram of system architecture as show (figure 9).

1. User interface, designer can draw line in the interface.
2. Generation of plant skeleton model, the model can analyze line and generation of plant skeleton with production rule of plant.
3. Simulating generation of texture of Chinese ink Painting model, the model will follow the plant skeleton to generative texture of Chinese ink painting.

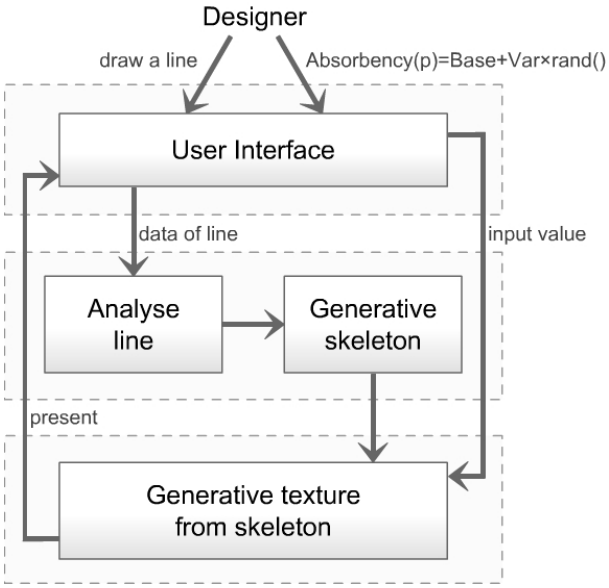

Figure 9 Diagram of system architecture.

4.2 Expected benefits

The Original problem that designer confronted with is time-consuming and fruitless present when they doing Chinese ink painting in graphic design. Through the generative design system designer can not only save working time but also have plenty expression. Furthermore, designer can alter the variable value to choose witch style he wants and immediately modify it. In the end we expect this study can inspired more and more designer to produce Chinese ink painting design.

5. Summary

When a visual designer or a graphic designer is working, they usually need some software to assist them with their creation. We establish a generative design system about Chinese ink painting to provide varied texture of stroke and convenient real time effect for designer in design process. By the interaction between designer and the system interface, the present of variable can support designer a totally different result. Finally, in this study, we can support designer to apply a flexible system of Chinese ink painting in graphic design process.

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