Artistic Patterns Creating Support System by User's "Kansei" Estimation

Junko Ichino*, Ayako Chikawa**, and Shun'ichi Tano**

*Information Systems Div., DaiNippon Printing Co. Ltd.,
3-87-4 Haramachi, Shinjuku, Tokyo, 162-0053 Japan
E-mail: Ichino-J@mail.dnp.co.jp

**Graduate School of Information Systems, University of Electro-Communications,
1-5-1 Chofugaoka, Chofu, Tokyo, 182-8585 Japan
E-mail: ayako@tlab.is.uec.ac.jp, tano@is.uec.ac.jp

ABSTRACT

Design-related software is becoming widespread due to the rapid growth in the use of personal computers and workstations. However, this software is primarily utilized as a convenient tool and does not actually contribute to the creative process itself. Here we attempt to create a system that supports artistic pattern drawings. By analyzing the creative process we have developed a user interface that supports and expands the user's creative activities. In addition, we have proposed an algorithm that can estimate the images a user wants to draw.

1. INTRODUCTION

Using computers for design-related work has become increasingly widespread and many design software programs have been developed. In order to increase creative possibilities these programs use features such as feeling-based operation with GUI, 3-D images, paint-like images. Yet these programs often heavily rely on the user's own knowledge and intuition.

Most drawing software allows us to draw by selecting basic patterns such as circles, rectangles, free lines, etc., laying them out, and choosing color and other attributes. However, the software completely entrusts these decisions to the user. This is a heavy burden for a user that does not have design sense or knowledge.

If the system can grasp the user's "kansei" (feeling or sensitivity in English) and support their creative work, we believe this system will further the creative design process, [1], [2], [3], and [4].

The purpose of our system is to support the user's creative activities by analyzing the user's images during user-system interaction.

In the following section, we analyze design skills and the design knowledge that is needed to implement this type of system. In Section 3, we study the user interface of the design support system and demonstrate the user interface. In Section 4, we explain an algorithm that can estimate the design images that a user may draw. In Section 5, we demonstrate the effectiveness of the interface method during the actual design process. In the last section we provide a summary of our work.

2. KNOWLEDGE TO DESIGN IMAGES

We analyzed the specialized knowledge needed for design. Our study focused on colored artistic geometrical patterns. We first asked the following questions:

- What are the main elements found in design images?
- How images are related to these elements and expressed with a combination of these elements?

We used the literature of [5], [6], and [7] to answer these questions.

The main basic elements of design

We first clarified which elements are related to "kansei" since design contains many components – such as color, shape, material, pictorial composition, time, space, and light.

Most works on analyzing the relationship between image and "kansei" have tended to focus only on the one or two components such as color or pictorial composition. [8], [9], [10], and [11]. However, these elements alone are unable to represent an entire design.

In the case of two-dimensional geometric patterns, many more elements need to be taken into consideration – color, shape, and pictorial composition. Furthermore, the these components – individually and in combination – influence the user's "kansei".

Designing vague images

Based on the analysis of that color, shape, and pictorial composition must synthetically be treated to design vague image, we have studied the process of designing vague images.

When people imagine and image, they think about concrete scenes or images. In Fig. 1 we show the design process for *happy*. First, we imagine a *happy* scene. And we describe our feelings in words. In the case of *happy*, we come up with words such as, a *smiling face*, *fast heart-beat*, *jumping*, *openhearted*, *exaggerated behavior*, and *blushing*. Next, we pick out the features of each component – color, shape, and pictorial composition— from these words. For example:

- From the words: *a smiling face* and *blushing*, we extract the colors *light*, *yellow*, and *red*.
- From the words: *jumping*, *openhearted*, and *exaggerated behavior*, we extract the features of shape, *energetic shape*, *openhearted shape*, *dynamic shape*, and *rounded shape*.
- From the words: *fast heart-beat*, we extract the features of pictorial composition, *repeating composition* and *rhythmical composition*.

Finally, by combining these elements we can transform an unclear image into an actual drawing.

The knowledge to design images

The knowledge to design images is summarized as follows.

- The main elements of design are color, shape, and pictorial composition and their interaction.
- In order to design something, it is necessary to have a certain image of what is going to be drawn and to specify and combine the characteristics of color, shape and, composition.

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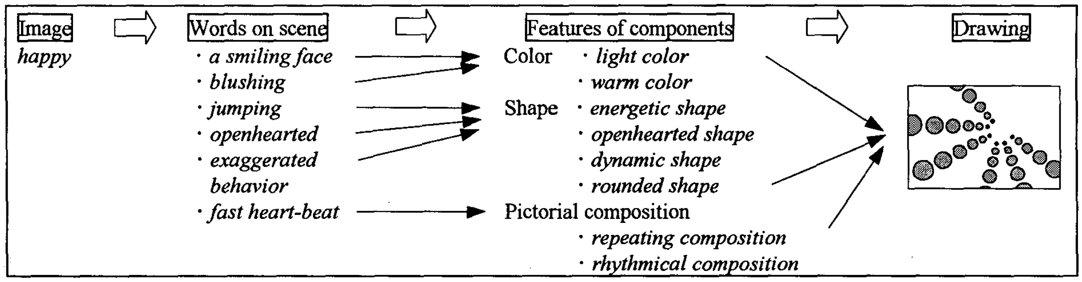

Fig. 1. An example for image materialization

3. DESIGN OF A USER INTERFACE

Necessary requirements of the user interface

"Kansei" is unclear and ambiguous and therefore in this section we focus on how the user and system are able to communicate "kansei".

Since "kansei" by its very abstract nature it is difficult to represent it concretely we classify "kansei" into verbal and non-verbal expressions in Table 1. In the verbal case, there are both abstract expressions – "I want to draw refreshing feelings", and perceptual expressions – "I want to draw with the color blue". In the non-verbal case, there are both showing examples and directly drawing or modifying painting.

Table 1 Media of "kansei"

Verbal
• Abstract words
• Perceptual words
Non-verbal
• Show examples
• Directly draw or modify

It is important to understand that people can not completely grasp their "kansei" in advance. It means that they can not represent their "kansei" at once. Usually their "kansei" is stimulated as they go along by outside sounds, ideas, or images.

Therefore, the user interface for a design system should have the function that stimulates and fosters the user's "kansei."

The necessary requirements of user interface are summarized in Table 2.

Table 2 Requirements

· Basic elements of design:	
Color, Shape, and Pictorial composition	…①
· Design process:	
"Kansei"⇒Scenes⇒Fundamental features⇒Drawings (Abstract) (Perceptual)	… ②
· Representation of "kansei":	
· No unique representation	
Verbal: Abstract/Perceptual	… ③
Non-verbal: Show examples	… ④
Directly draw and modify	… ⑤
· No complete representation in advance	… ⑥

Design of user interface

Based on the analysis of the previous section, we designed the system's user interface.

To meet the requirements ①, ②, and ③, we designed the 3-layered *List Box* shown in Fig. 2. The three layers correspond to the abstract "kansei" (the left column in Fig. 2), the concrete scene (the center column in Fig.2), and the fundamental features (the right column in Fig.2). Each layer has word lists from which the user can select the suitable words as shown in the upper part of Fig. 2 or can modify the strength of the words in an absolute or relative way as shown in the lower part of Fig. 2.

The layer of the fundamental features is divided into three types of word lists (color, shape, and pictorial composition), which are the basic elements used to define the drawings.

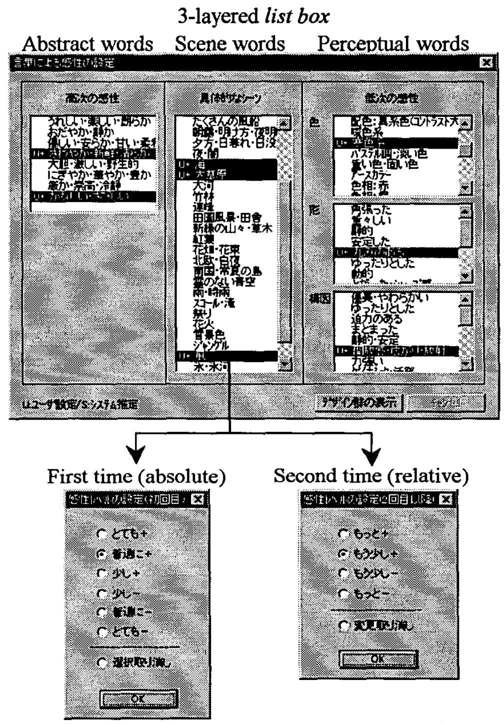

Fig. 2. "Kansei" indication by words.

To meet requirement ④, we added the user interface function to select the desired drawings from the design candidates (shown in Fig. 3).

For ⑤, the user can directly draw and modify the drawings through mouse and the pen operation (shown in Fig. 4).

For ⑥, the user can indicate the words to show the "kansei" and select the most preferable candidates as many times as they want. Through this interaction, they gradually come to understand what they really want to draw.

4. ALGORITHM FOR USER'S "KANSEI" ESTIMATION

System architecture

To tell the system about the "kansei" of the design that the user wants to draw, they select the words from the 3-layered *List Box*, select the preferable drawings from the drawings that the

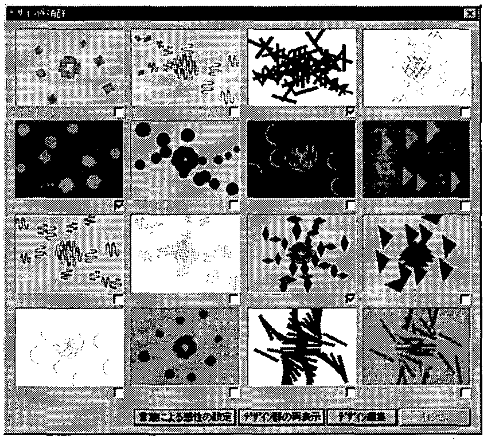

Fig. 3. Selection from design candidates.

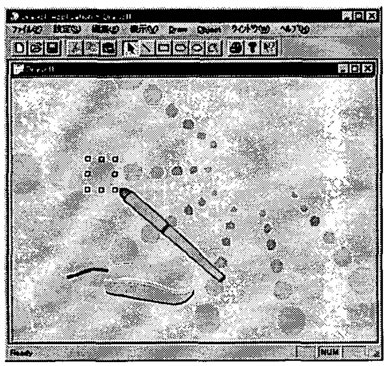

Fig. 4. Direct manipulation by a pen or a mouse.

system produced, and modify them by hand. If the user's instruction is partial and imprecise, the interaction continues until the preferred drawing is produced. The system must produce the design candidates based on the user's partial and imprecise instruction.

Our system is created by the software architecture shown in Fig. 5. The three left blocks correspond to the 3-layered *List Box* in Fig. 2.

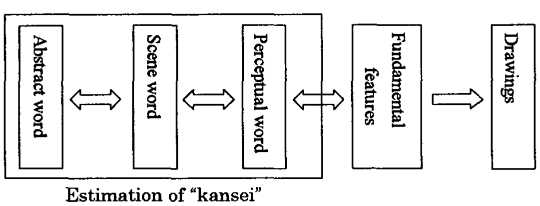

Fig. 5. System architecture.

For example, if a user selects the words, *happy* (abstract word) and *spring* (scene word), the system associates the user's unconscious "kansei" words, *calm* (abstract), *light color* (perceptual), *rounded shape* (perceptual), and *openhearted composition* (perceptual). And the system gets fundamental features using the associated perceptual words. Finally, the system creates the drawings combining the fundamental features.

In the following subsection, the algorithm to estimate the user's unconscious abstract words, scene words, and perceptual words is explained.

Algorithm to estimate the user's "kansei"

We use a fuzzy theory because the system uses drawing images with vague information [12], [13], [14], [15], and [16]. The word selected by a user in the 3-layered *List Box* is represented as a real number. The rules to associate the user's partial and imprecise instruction with the user's unconscious "kansei" are given with a fuzzy rule. The rules are described using a fuzzy set (membership function).

In this system, each word instructed by a user corresponds to the if-part or then-part given by fuzzy rules. Since users instruct the plural words in the 3-layered *List Box* at the same time, the if-part or then-part is set by the user-defined activity level at the same time. And since the instructed words are partial, the system needs the function to estimate the degree of preference with non- instructed words. To satisfy the requirements analyzed above, we have developed a new associative inference algorithm based on the well-known Hopfield neural network. Because the network needs to memorize the fuzzy rules directly, one condition of fuzzy rules described by fuzzy set is represented in one node in the network. We estimate user's "kansei" using the network.

Network structure: The fuzzy rule represents the relation among the 3-layer *List Box*. Let's use the variables X, Y, and Z for the abstract word, the scene word, and the perceptual word. We need two types of rules. One shows the relation between the Xs and Ys, the other shows the relation between the Ys and Zs. The examples are given below.

Rule1 : If x_1 is P, x_2 is N then y_1 is P, y_2 is Z.
Rule2 : If x_1 is Z, x_2 is P then y_2 is P, y_3 is N.
Rule3 : If y_1 is P, y_2 is P then z_1 is N, z_3 is P.
x_i ,y_i ,z_i : some word in the 3-layer *List Box*
P : Positive
N : Negative : trapezoidal membership function
Z : Zero

Then the fuzzy associative neural network is composed of the two fully connected neural networks. Each fully connected neural network can be seen as a fuzzily extended Hopfield neural network.

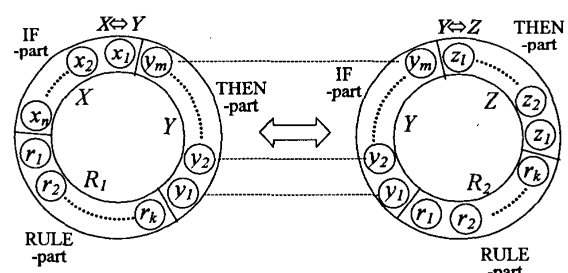

Fig. 6. Multistage fuzzy associative network.

Note that r_i is the node that represents each rule. They are useful to check the active rules and to improve the capacity of the associative memory.

Node updating: First, each node in the network is allocated a default value ($n \in [-1,1]$). In case that the node is instructed by a user, the default value is the value with which the user specifies the degree their preference. In other cases, the default value is a random value.

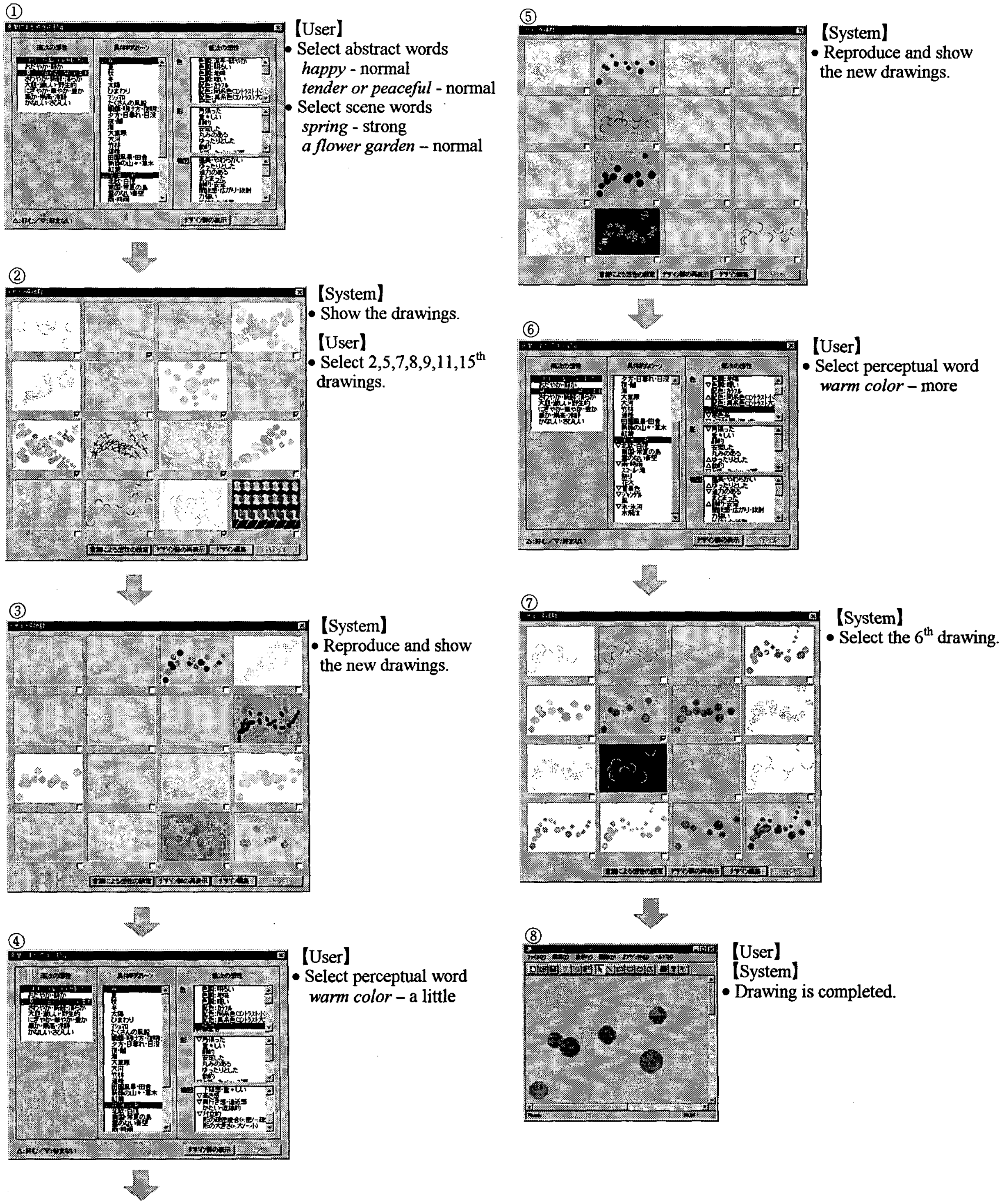

Fig. 7. Example of Design Process.

Here we introduce the parameter α ($\alpha \in [0,1]$) to show the modification of the node. The parameter α =1.0 means that the modification is zero and α =0.0 means that the modification is full. So the status of each node is updated as follows.

$$n = \alpha n_{old} + (1.0 - \alpha) n_{net}$$

n_{old} : node before updating

n_{net} : node after updating with n_{old}

In case α =1.0, actually, no update occurs. When α =0.0, the status is completely updated, independent of the past status.

Each node has its own parameter α and the value itself is also updated through the iteration of the interaction with the user.

Network convergence: Our neural network is composed of two networks, *X*⇔*Y* and *Y*⇔*Z*, in which the *Y*s are the common nodes (Fig. 6). We update each neural network at each cycle repeatedly. This is because that *X*s, *Y*s, and *Z*s are closely related to each other.

First, the network *X*⇔*Y* updates each node by using the above updated equation. These updated *Y*'s nodes are set up as *Y*'s nodes in the network *Y*⇔*Z*. Next, the network *Y*⇔*Z* updates each node by using the above equation. These updated *Y*'s nodes are set up as *Y*'s nodes in the network *X*⇔*Y*. When both networks converge continuously with iteration of the above procedures, we define this state as convergence of the networks.

For the estimation algorithm mentioned above, the degree of user's preference to each word in the 3-layer *List Box* is found.

5. EXPERIMENT FOR EVALUATION

We have evaluated the effectiveness of the inference method by studying actual design processes. Here one typical design flow is demonstrated in Fig. 7. In this example, the design image that the users want to draw is *soft and comfortable feelings*.

First, words close to "soft and comfortable feelings", the following words were preferred (Fig. 7 ①).

[abstract words] (the left column in ①)

- *happy* – normal (degree of preference)
- *tender or peaceful* - normal

[scene words] (the center column in ①)

- *spring* – strong
- *a flower garden* - normal

Perceptual words (the right column in ①) were not selected.

From these preferences, The system created 16 design candidates (Fig. 7 ②). They generally gave soft impression and were suited to the indicated words. Furthermore, these drawings were not uniform but contain various images.

Next, the 2,5,7,8,9,11,15th desired drawings from the candidates were selected (Fig. 7 ②). The features of preferred candidates were the colors light yellow, yellow-green, beige, and a rounded shape.

According to these preferences, the system then created 16 design candidates (Fig. 7 ③). They all had features of light color, yellow-green, and rounded shape.

Next, the following word was preferred for these candidates and there was little variety (Fig. 7 ⑤).

[perceptual word] (the right column in ④)

- *warm color* – a little

Through the iteration of the operation mentioned above, the system could finally create the drawing that had a warm color and rounded shape – similar to the initial design image (Fig. 7 ⑧).

6. CONCLUSION

We analyzed the process of the creative work and designed a user interface that supports and expands the user's creative activities. Based on the analysis, we proposed the interface method for our "kansei "design support system.

Based on the experiment, we confirmed the validity of the user interface and the algorithm for Kansei estimation.

In the future we plan to further study:

- the mechanism for learning a user's "kansei", which varies from person to person
- the method for understanding the user's preference from electric-pen operation

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