Kansei Retrieval Method using Visual Pattern Image Coding for Virtual Reality Space Presentation

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Abstract

In this paper, we propose a Kansei Retrieval method based on the design pattern of traditional Japanese crafting object to provide a user with the desired presentation space in digital traditional Japanese crafting system. The visual quantitative feature values are extracted by using Visual Pattern Image Coding (VPIC). These values include the total number, the frequency, the dispersion rate and the deviation rate for different edges. The quantitative feature values for traditional Japanese crafting objects are registered in the multimedia database and the relation between Kansei words and the visual feature of traditional Japanese crafting objects are analyzed by using the questionnaire. Then, the visual features are compared with the quantitative feature values. Through the above process, we want to find the relation between the design pattern components and edge types using VPIC. By finding this relation, the Kansei retrieval method can be realized.

1. Introduction

In Japan, there are many traditional Japanese crafting such as fittings, furniture, textile, etc., which are closely related to Japanese culture and life. However, these industries are on the decline in recent years. In order to keep traditional Japanese crafting in the future, it is necessary to attract people and educate many successors. From 1980 to 1990 some database systems for traditional Japanese crafting are proposed to introduce information technology in traditional Japanese crafting or local industry. This data are shown on World Wide Web (WWW) [1] and include shoji, fusuma, ranma and so on. However, it is difficult to represent the impression and functions for most of the crafting objects by existing hypermedia composed of text, images and movies. Most of the crafting objects are very important elements for living space and the fittings should be fit in the Japanese rooms. So, it is necessary to represent the impression of the room by open/close the fitting from different places. In order to overcome such problems, it is required to realize the virtual reality presentation system including presentation space and crafting objects by 3D Computer Graphics (CG) for traditional Japanese crafting.

We have proposed a Digital Traditional Japanese Crafting System (DTJCS) [2] providing a presentation space for traditional Japanese crafting. We also introduced a Kansei Retrieval Method (KRM) [3, 4] to provide the presentation space reflected by people’s feelings. In this paper, we propose Kansei Retrieval Method using Visual Pattern Image Coding for virtual reality space presentation to provide the users with the desired presentation space.

The organization of this paper is as follows. In the next Section, we will introduce the related works. We describe the DTJCS in Section 3. We explain KRM in Section 4. The extraction method using Visual Pattern Image Coding (VPIC) [5] is treated in Section 5. We show the experimental results of extraction by using VPIC in Section 6. Finally, some conclusions are given in Section 7.

2. Related works

A Kansei retrieval method for textile design image database system was proposed by Fukuda et al. [7, 8]. The proposed image retrieval method uses the relation between Kansei word and the feature of the image which may be the color or the pattern shape. This method was applied to retrieve the textile images, but it can not be applied to the traditional Japanese crafting object.

The shape future space constructing method for retrieving image database was proposed by Harada et al. [9]. This method uses for retrieving the relevance between Kansei word and the shape features.

A retrieval method on the image database using sensitive word reflecting user’s subjectivity was proposed by Kurita et al. [10]. These methods did not consider the affinity of the design pattern with the traditional Japanese crafting object.

3. DTJCS

In order to learn the existing products, the craftsmen and the successors should see the products during the design process. Also, the customers and craftsmen should see the products during the design process too. Especially, products such as fittings are important elements of the designed products. For this reason, the designed products should be very close to the desired ones. But using the conventional design methods, it is very difficult to achieve this goal. On the other hand, by using computers, the presentation of traditional Japanese crafting products is possible in a digital way by CG and Virtual Reality (VR) technologies. In this way, it is possible to see the virtual products during the design process. For this reason, we developed the DTJCS which is shown in Fig.1. The DTJCS can realize a 3D CG presentation of traditional Japanese crafting for both classic and modern fittings. Also, the proposed system can be used by the craftsmen and the
successors to study traditional Japanese crafting which include the existing products and their impressions. On the other hand, the proposed system can be used by architects and designers to plan and construct creative and original Japanese-style hotels, houses, event halls, etc. Furthermore, using this system, the users can construct their own space reflecting their feelings and can walk through the space and exchange the interior fittings using PCs or WSs connected to the Internet.

4. KRM

It is difficult to attain the desired design or data based on user’s feeling or Kansei by using the key-word retrieving and index retrieving methods. This is because the keywords and the indexing processes are carried out by persons who register the database and they are influenced by their subjectivity. In traditional Japanese crafting not only the key-words and indexes but also the feeling process is very important. For this reason, we developed a Knowledge Agent (KA) to retrieve suitable designs based on each user feeling.

For retrieving information, the KA uses a knowledge-base which is based on the relation between people feeling, the presentation space, and the objects. In order to realize this retrieval method, we need to find the relation between Kansei word and the quantitative feature values. However, it is difficult to find this relation directly. So, in this study, we classified the feature as the sensitive feature and the quantitative feature value. Then, we consider the sensitive feature as the design pattern of traditional Japanese crafting object and the quantitative feature values are processing parameters extracted by VPIC.

We show the flow of Kansei retrieval method using the feature of traditional Japanese crafting object in Fig. 2. When user requests a presentation space by using a Kansei word, the CA sends a Kansei word to KA. When the KA receives a Kansei word, the KA converts it to a sensitive feature. The KA retrieves MDBs by using the quantitative feature values corresponding to a sensitive feature and sends the retrieved objects to the CA. Finally, retrieved objects are put on the presentation space by CA. For instance, when a user wants a “Calm” space, he sends a request to its CA. The CA sends the “Calm” to KA. The KA converts “Calm” to sensitive features such as “Brightness is low”, “Density is rough”, and “Periodicity is high”. After that, the KA transforms sensitive features into parameters in order to be processed by the KA. Based on the parameter values, the KA sends its query to multimedia database and the required objects are retrieved. The retrieved objects are represented in the presentation space by the CA. Thus, a “Calm” space is presented to the user.

We select Kansei words, which are adjective words used often in the interior design and the fitting design. We use the relation between the Kansei word and the sensitive feature of the fitting getting by the questionnaire [3]. The relation between the Kansei word and the sensitive feature of the fitting are shown in Table 1. The “Black” or “Brown” in the sensitive feature corresponds to the color and “Straight” or “Curve” to the line. The pattern includes the density, the geometric pattern, the periodicity and the size of pattern. These relations between the Kansei word and the quantitative feature values are stored in the knowledge base of KA.

5. Extraction method for quantitative feature values

In order to record the traditional Japanese crafting object in MDB, the sensitive features are converted to the quantitative parameter. To extract the quantitative feature value including the pattern, we use VPIC [5]. To find relation between the visual feature and the quantitative feature values, we use the type and number of edge patterns in the object.

The design of traditional Japanese crafting includes the general pattern which recognizes the design from far sight.
and the exquisite pattern which recognizes the design from near sight. However, VPIC can encode not only the general pattern but also the exquisite pattern by changing the encoded block size. Furthermore, this method can extract the quantitative feature values quickly by converting from the VPIC edge to several edge patterns and expressing the edge pattern as a vector with size and direction.

5.1. VPIC

The edge pattern is extracted by dividing the encoded block of an image as shown in Fig.3. There are two types of pattern: the edge pattern and uniform pattern without the edge. In the visual pattern the average of positive element and negative element with encoded block becomes zero. We use 8 types of edge patterns to represent 8 directions. In the process of the edge pattern, we divide the encoded block into 4 sub-blocks as shown in the left side of Fig.4. Then, we calculate an average intensity in the encoded sub-blocks. Next, we calculate the difference of intensity in the diagonal encoded sub-blocks $v_0, v_1$ based on the equations (5.1) and (5.2). After that, we calculate the angle and the size of edges between $v_0$ and $v_2$ based on the equation (5.3) and (5.4). Finally, we convert the angle of edge to the edge pattern as shown in the center of Fig.4 and decide the edge pattern for the encoding block as shown in the right side of Fig.4.

$$\text{The difference of intensity for the diagonal encoding is calculated by following formula.}$$

$$|v_0| = \text{Ave}_3 - \text{Ave}_0 \quad (5.1)$$

$$|v_1| = \text{Ave}_1 - \text{Ave}_2 \quad (5.2)$$

The angle of edge $\angle v$ and M are represented by the following formula.

$$|v| = \sqrt{(|v_0|^2 + |v_1|^2)} \quad (5.3)$$

$$\angle V = \tan^{-1}\left(\frac{|v_1|}{|v_0|}\right) \quad (5.4)$$

5.2. Expression method for pattern components

In order to represent the pattern components in the design of traditional Japanese crafting, we try to find the relation between the pattern components and the edge types using VPIC as shown Table 2. The density is represented by total number of edges. The periodicity can be represented by frequency of edges because the regular pattern includes the equivalent intervals in the space and non-regular pattern includes different edge intervals in the same direction. The geometric pattern is represented by the equivalent number in each edge direction. When the geometric pattern consists of square and is equivalent to the number in each direction, the dispersion rate is high. But, the dispersion rate is low when the geometric pattern has only circles. The size of pattern is represented by the deviation rate of number of edges when the encoded block size is changed. When the encoded block size is small, a large size of edge pattern is lost from the noise. While, when the encoded block size is large, a small size of edge pattern is lost by averaging pixel intensity.

### Table 2: Pattern relations.

<table>
<thead>
<tr>
<th>Pattern Components</th>
<th>The Quantitative Feature Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Total Number</td>
</tr>
<tr>
<td>Periodicity</td>
<td>Frequency</td>
</tr>
<tr>
<td>Geometric Pattern</td>
<td>Dispersion Rate</td>
</tr>
<tr>
<td>Size of Pattern</td>
<td>Deviation Rate</td>
</tr>
</tbody>
</table>

6. Experimental results

In order to evaluate the relation between the pattern components and the VPIC quantitative feature, we extracted the VPIC quantitative feature from test images including triangles, squares or circles shapes and then analyzed the relation between the pattern components and the VPIC quantitative features. We analyzed the influence to the number of edges by changing geometric pattern. In Fig.5 is shown the relation between the number of square and the total number of edges. The horizontal axis shows the number of square and the vertical axis shows the number of edges. The result shows that there is a proportional relation between the number of geometric patterns and the number of edges. Therefore, the density can be derived from the total number of edges.
In Fig.6 is shown the dispersion rate extracted by each geometric pattern. The horizontal axis shows the block size and the vertical axis shows the dispersion rate. The dispersion rate makes difference for each geometric pattern. The dispersion rate is low when the geometric pattern is similar to the circle, because in the circle pattern the number of edges in each direction is the same. But, the dispersion rate is high when the geometric pattern is similar to the square, because in the square pattern the number of slant edges is small. While, the triangle has low dispersion rate because slant line is expressed by not only the slant edge but also the vertical edge in discrete coordinates. Therefore, it can be concluded that the dispersion rate corresponds to the geometric pattern.

We analyzed the influence of the edge frequency rate that was extracted from the regular geometric pattern and the irregular geometric pattern. In Fig.7 is shown the relation between the regularity and the frequency rate of the edges. The horizontal axis shows the block size and the vertical axis shows the frequency. The solid lines show the frequency rate extracted from the regular geometric pattern. The dotted lines show the frequency rate extracted from irregular geometric pattern. The frequency rate is high when the geometric pattern is regular. But, the frequency is low when the geometric pattern is irregular. By these results, it is clear that the frequency corresponds to the regularity of geometric pattern.

7. Conclusions

In this paper, we proposed a using VPIC for virtual reality space presentation. We described Kansei retrieval method and the quantitative feature values extraction method by using VPIC. Then, we showed the result of extraction using VPIC. The experimental results show that by finding the relation between the design pattern components and the edge types using the VPIC, the Kansei retrieval method can be realized. Now, we are analyzing the relation between Kansei words and quantitative feature values of traditional Japanese crafting objects.

References


