An Analysis on Color Characteristics of Website Images of Restaurants According to Price Range

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Abstract: In this study, we propose a method of Kansei analysis of aspects such as preference or impression using a large amount of automatically processed data. We focused on representative colors which are low colors representing many colors in an image because colors affect people’s feeling and impression and are easily quantify and express features. Our method consisted of automatic data acquisition by web crawling and automatic feature extraction through an algorithm of image processing. Data collected from restaurant websites were analyzed in order to verify the following hypothesis: expensive restaurants have more achromatic photographs on their websites. As a result, the hypothesis has been proven in several restaurant genres.

Keywords: Color, Data-analysis, Marketing

1. INTRODUCTION

Understanding how people feel about products is necessary to analyze consumer preference and apply that analysis to marketing research and product design. However, it is difficult to acquire large amounts of data for Kansei analysis, such as consumer preferences, because it requires some expert knowledge and manual labeling. An analysis using a large amount of data is very important considering the unsettled aspect of Kansei. An analysis that uses a large amount of data requires a system that can collect data and extract features that people selectively recognize.

In this paper, the representative colors of photographs automatically extracted from websites were analyzed so that relations between representative colors and photograph impressions could be found. The researchers collected advertising photographs of restaurant websites and extracted representative colors from them to be analyzed through an algorithm [1]. This study focused on colors because they are known to affect preferences and impression [2-4] and easily quantify and express features of large amounts of data.

2. Methods

The photographs analyzed in this study were downloaded from many restaurant websites. They included photographs not only of the food but also of the exterior and interior of the restaurants, as the photos of the websites were used not only to advertise the food but also atmosphere of the restaurant. They were also helpful to analyze Kansei characteristics, such as how high-class the restaurant is. Such photographs that deliver Kansei value are defined as “image photographs.” The upper row of Figure 1 shows examples of pictures analyzed in this study.

The websites’ URLs were collected from Gurunavi, which is a Japanese foodspotting site. The analyzed websites were not created by Gurunavi, but by the restaurants themselves. The following restaurant genres were chosen: Izakaya (Japanese style bar), dining bar, Japanese, Western, Italian & French, Chinese, Korean, ramen, and café. All restaurants are located in Tokyo.

The analysis process consisted of three steps. In the first step, restaurant URLs, price averages, and images were collected from the Gurunavi API. A price average is defined as a nine-point scale on the Gurunavi page (see Table 1). Moreover, images whose height or width was less than 32 pixels were removed in order to exclude images that do not directly affect the impression on a restaurant, such as backgrounds, button interfaces, and white pixels for layout adjustment.

In the second step, representative colors from collected images were automatically extracted. Representative colors are defined as low colors that people perceive as representing many colors in an image. The algorithm determined the number of representative colors of each image while other means, such as k-means color reduction, extracted a predetermined fixed number of colors from all
images. This algorithm consists of segmentation and clustering and requires segment-segment and cluster-cluster distance thresholds as parameters if clusters or segments are merged. The lower row of Figure 1 shows examples of representative colors extracted from the source images.

![Image 1: Examples of representative colors](image)

In the third step, the distribution trends of the representative colors extracted from restaurant photos and the relations between the representative colors and the average prices of these restaurants were analyzed. We formed the hypothesis that high-class restaurants use more achromatic colors because of our previous study. Therefore, the relation between the average prices and the chroma of the representative colors extracted from the images of restaurants was analyzed.

3. Results

Through a web crawler, 13,424 pictures from 401 websites were collected. The average number of representative colors extracted per image was 5.55. Table 1 shows the number of images by price range and genre of their restaurants. Most of the images were in price range of ¥1501 to 7,000, and the price range depended on genres.

### 3.1. Statistics on extracted representative colors

The tendency of the representative colors extracted to grasp features of colors used in restaurant photographs was examined. Figure 2 shows histograms of saturation (the upper row) and hue (the lower row). A saturation s and a hue h are calculated by formula (1); a and b are CIELab values of the color. The bin widths of saturation and hue histograms are 5 and 10 respectively. The colors of the bins of the hue histogram indicate the correspondent hue values. The hue frequency was calculated excluding representative colors whose saturation was less than 20.

\[
s = \sqrt{a^2 + b^2}, \quad h = \frac{360}{\pi} \tan^{-1} \frac{a}{b} \quad a \geq 0 \]

\[
= \frac{360}{\pi} \left(\tan^{-1} \frac{a}{b} + \pi\right) \quad a < 0
\]

The saturation had a frequency peak in 0≤s≤5 and tends to be generally low. Colors that satisfy 0≤s≤5, which are almost achromatic, were extracted from the white backgrounds of retouched pictures rather than from photographs taken with natural backgrounds. The reason why the saturation of many colors used in photographs was low may be that low saturation colors are useful to maintain the balance of color theme for composition of pictures.

The hue had a frequency peak in around h=60° (from orange to green). These colors were extracted from food or interiors of restaurants. The colors of food are red and green; particularly, red has the effect of promoting appetite and green has the effect of making food more vivid in contrast to red. Moreover, the colors of the interiors were chosen considering their effect of promoting appetite, their harmony with food colors and their harmony with the design of the webpages.

### Table 1: Quantity of images by price range and genre of restaurants

<table>
<thead>
<tr>
<th>Price range</th>
<th>Izakaya</th>
<th>Dining bar</th>
<th>Japanese</th>
<th>Western</th>
<th>Italian &amp; French</th>
<th>Chinese</th>
<th>Korean</th>
<th>Ramen</th>
<th>Café</th>
</tr>
</thead>
<tbody>
<tr>
<td>¥501~1,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>¥1,001~1,500</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>¥1,501~2,000</td>
<td>37</td>
<td>58</td>
<td>27</td>
<td>167</td>
<td>59</td>
<td>50</td>
<td>415</td>
<td>494</td>
<td>0</td>
</tr>
<tr>
<td>¥2,001~3,000</td>
<td>689</td>
<td>554</td>
<td>338</td>
<td>266</td>
<td>331</td>
<td>245</td>
<td>221</td>
<td>40</td>
<td>252</td>
</tr>
<tr>
<td>¥3,001~4,000</td>
<td>512</td>
<td>629</td>
<td>471</td>
<td>403</td>
<td>660</td>
<td>454</td>
<td>354</td>
<td>0</td>
<td>151</td>
</tr>
<tr>
<td>¥4,001~5,000</td>
<td>8</td>
<td>15</td>
<td>42</td>
<td>76</td>
<td>20</td>
<td>31</td>
<td>60</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>¥5,001~7,000</td>
<td>22</td>
<td>0</td>
<td>30</td>
<td>78</td>
<td>0</td>
<td>10</td>
<td>43</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>¥7,001~10,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>¥10,001~15,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
3.2. Correlation between saturation and average prices

Average saturation per average prices were calculated in order to verify the hypothesis that achromatic color tends to be used in high-class restaurants photographs rather than chromatic colors. Since price ranges depend on genre, saturations were compared in each genre.

As an example, Figure 3 shows the saturation averages of representative colors from photographs of dining bars for each average price. As seen in the figure, the lower the saturation, the higher the price. Therefore, Kendall’s tau correlation between prices and saturation of colors was calculated. In Table 2, “N” indicates the number of representative colors and “τ” indicates the Kendall rank correlation coefficient. A negative correlation was significant in the dining bar, Italian & French, Korean, Ramen, and café genres.

![Figure 2: Histograms of saturation (upper row) and hue (lower row)](image)

**Table 2:** Kendall rank correlation coefficients

<table>
<thead>
<tr>
<th>Genre</th>
<th>N</th>
<th>τ</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Izakaya</td>
<td>6751</td>
<td>-0.014</td>
<td>0.14</td>
</tr>
<tr>
<td>Dining bar</td>
<td>6960</td>
<td>-0.045</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Japanese</td>
<td>4847</td>
<td>0.014</td>
<td>0.21</td>
</tr>
<tr>
<td>Western</td>
<td>5183</td>
<td>-0.031</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Italian &amp; French</td>
<td>5855</td>
<td>-0.043</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Chinese</td>
<td>4530</td>
<td>-0.013</td>
<td>0.25</td>
</tr>
<tr>
<td>Korean</td>
<td>3927</td>
<td>-0.076</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Ramen</td>
<td>2548</td>
<td>-0.005</td>
<td>0.75</td>
</tr>
<tr>
<td>Café</td>
<td>4861</td>
<td>-0.085</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

4. Discussion

4.1. Analysis of statistics on the extracted representative colors

Most of the representative colors extracted showed low saturation or ranged from red to green. The role of low saturation color is to be the base-color of color coordination; colors ranging from red to yellow serve to promote appetite, while green emphasizes the liveliness of red.

In our previous research, a similar analysis was made with a home interior brand instead of restaurants. There were similar tendencies, such as a frequency peak at low saturation and orange. White and brown (dark orange) were extracted as base-colors mostly because they come from construction materials, such as wood. Orange is a natural color and makes people feel warm. Such effect can be expected regardless of the domain, be it a restaurant or a home.

4.2. Analysis of saturation and average prices

As a result of Kendall’s test of correlation, significant negative correlations were obtained in 5 genres. High-class restaurants can be considered to use achromatic colors to create a sophisticated and extraordinary mood, while popular restaurants use warm colors to express relaxation and familiarity.

In 4 genres, no significant correlation was found between saturation and prices. This fact implies that the use of colors to direct high-class atmospheres is different among the genres of restaurants. For example, ramen restaurants tend to use food photographs, not interior photographs. In other cases, the difference may be a matter of national culture. For example, Chinese high-class restaurants prefer red while Western, Italian, French, and Korean high-class restaurants tend to use achromatic colors to direct high-class atmosphere. The use of achromatic color makes people feel warm. Such effect can be expected regardless of the domain, be it a restaurant or a home.
colors.
In this study, we focused on restaurant price ranges. However, an expensive restaurant does not always make people feel high class. Although the subjective feeling of whether subjects feel expensive or cheap is considered to be related to the price range of the restaurant, it is necessary to assess the subjective feeling of when photographs are given. If a significant correlation is obtained, the results can be applied to marketing research and product design.

4.3. Efficiency of the proposed analysis method
The analysis method can deal with a large amount of data easily, since it can collect data and extract quantitative features automatically. Moreover, it can be used for Kansei temporal analysis of preference and impression, which vary by season or fashion.
In this study, the numbers of samples are quite variable among the price ranges. The numbers were not standardized because the variability seems to reflect the characters of the parental population. In addition, automatic collection reduces data quality. Data was removed by simple filtering using the size of an image but some noise data has not yet been filtered. The detection of objects on the picture or on a white background will be required to obtain high quality data.

The proposed method focuses on the color of images. Although preference and impression can be undoubtedly affected by colors, they can also be affected by factors external to colors. However, the analysis was not extended to other factors because complicated features make it difficult to understand and to apply this method to another domain. We believe that developing an analysis method for understanding Kansei using only color features is challenging but useful for many analysts.

5. Conclusion
In this study, the tendency of color distribution in the restaurant domain and the relations between price ranges and features of representative colors were analyzed. Our future works will compare subjective feelings, price ranges, and features of representative colors. Moreover, this method needs a system to remove noise data automatically because the pictures used in this study included those that do not relate to Kansei.

This analysis can be applied to marketing research and product design. Moreover, it can apply to other domains without any changing a method and is used for modeling Kansei across some domains and analysis of temporal changing of features.

REFERENCES