A *KANSEI* ANALYSIS OF THE STREETSCAPE IN KYOTO
- AN APPLICATION OF THE *KANSEI* STRUCTURE VISUALIZATION TECHNIQUE

Takumi NAKAMA* **and Yuichiro KINOSHITA**

Department of Computer Science and Media Engineering, University of Yamanashi, Japan

ABSTRACT

In city planning, a clear and comprehensive image or impressions of the entire region is a fundamental requirement. It is therefore required to consider not only the impression of a city but the impressions of regions and streets constituting the city. Considering these impressions at the same time is however difficult using the conventional *Kansei* engineering approaches. For this problem, the present authors have proposed the *Kansei* structure visualization technique. This study applies the technique to the city of Kyoto, Japan's old capital. The visualization clarifies the distribution and intensity of the impressions existing in the city. It also illustrates the difference between the impression of Kyoto and the impressions of each location in Kyoto. First, *Kansei* evaluation experiments are conducted to investigate the impressions of streetscapes in Kyoto. Based on the results of the evaluation, *Kansei* scores are allocated for each location in the city. The visualization process illustrates the scores using colours and their brightness. The visualization results are overlaid onto Google Maps. The results demonstrate that the visualizations enable users to understand the features of the impressions existing in the city easily. Also, it would be a useful tool to determine the locations where streetscapes need to be repaired.

Keywords: *visualization*, *Kansei evaluation*, *impression of city*, *Kyoto*, *streetscape*

1. INTRODUCTION

Streetscapes reflecting the history or regionality of a city may evoke certain impressions. Lynch suggested that a clear and comprehensive image or impression of the entire region is a fundamental requirement for a city [1]. It is however hard to say that most cities meet this requirement. Some streetscapes in a region even evoke the opposite impression from the impression of the whole region.

***Corresponding author:** 4-3-11 Takeda, Kofu, Yamanashi 400-8511, Japan, g09mk027@yamanashi.ac.jp

Kansei engineering [2] is a widely applied technique in the field of product design. The technique helps us to generate a product with a clear and comprehensive impression. *Kansei* engineering has also been applied to the impression of a city. Kinoshita et al. applied it for the problem of townscape colour planning [3]. The size of the target townscapes in the study was however small. Since *Kansei* engineering usually considers the impression of a whole target and translates this impression into perceptual design elements, it is actually difficult to be applied to the target consisting of a large number of design elements. It is almost impossible to apply the conventional *Kansei* engineering technique to an entire city. To apply *Kansei* engineering, it is required to narrow down the target area in the city.

The present authors have proposed a new visualization technique, called *Kansei* structure visualization technique [4]. Although several studies regarding the visualization of *Kansei* have been conducted [5, 6], these visualizations are based on the impressions of multiple targets and visualize the relationship between the targets. On the other hand, the proposed technique is based on the impressions of the small elements constituting in a single target and facilitates the process of understanding the existence of local impressions and their distribution in the single target. In this paper, the proposed visualization technique is applied to the impression of the city of Kyoto, Japan's old capital. The visualization clarifies the distribution and intensity of impressions existing in Kyoto as well as the difference between the impression of Kyoto and the impression of each streetscape. Using the visualization results, the features of the impressions of streetscapes in Kyoto are discussed.

2. PRELIMINARY *KANSEI* EVALUATION EXPERIMENTS

2.1. Methods

To investigate the impressions existing in Kyoto, *Kansei* evaluation experiments [7] were conducted using SD (Semantic Differential) method [8]. The subjects evaluated the impression of the city as well as the impressions of streetscapes. At first, 116 *Kansei* words were collected from travel magazines, dictionaries and former studies to express the impressions of a city and streetscapes. After collection, the *Kansei* words were classified into fifteen groups in term of their meaning using KJ method. A typical *Kansei* word was selected from each group. The *Kansei* words were paired with opposite meanings and the fifteen pairs shown in Table 1 were finally obtained. For each *Kansei* word, subjects selected a score suitable for the impression of Kyoto or a streetscape from a five-point SD scale. The left side of *Kansei* word corresponds to the score '1' while the right side corresponds to '5.' The experiments were conducted for eight male and two female subjects. Since this study focused on the impressions of tourists and visitors from outside Kyoto, persons without any advance knowledge about Kyoto were selected as the subjects.

2.2. Experiment 1: Impression of Kyoto

The first experiments were conducted to evaluate the impression of the city of Kyoto. Each subject evaluated the impression when he/she heard the name of the city "Kyoto" using the fifteen pairs of *Kansei* words.

Table 1: *Kansei* words used in the preliminary experiments.

No.	Pair of *Kansei* words		
1	fantastic	–	realistic
2	traditional	–	modern
3	typical	–	individualistic
4	unrefined	–	refined
5	dark	–	bright
6	noisy	–	quiet
7	simple	–	complicated
8	cheap	–	luxurious
9	awkward	–	elegant
10	ugly	–	beautiful
11	restless	–	calm
12	uncomfortable	–	comfortable
13	small-scale	–	large-scale
14	tasteless	–	tasteful
15	artificial	–	natural

Figure 1: Screen appearance of the experiments.

2.3. Experiment 2: Impressions of streetscapes in Kyoto

The second experiments were conducted to evaluate the impressions of streetscapes in Kyoto. Each subject evaluated the impressions of 25 sample streetscape pictures using the fifteen pairs of *Kansei* words. These sample pictures were taken from pedestrian's perspective in the area surrounded by Karasuma St., Oike St., Shijo St. and Kawabata St. as well as the Gion district. The streetscapes at the 25 locations were dissimilar each other. The green circles and arrows in Figure 2 indicate these locations and directions. The experiments were conducted using a 65-inch LCD display (SHARP AQUOS LC-65RX1W). A pair of *Kansei* words and one of the sample pictures were placed on the display as shown in Figure 1. Since the subjects evaluated all the 25 sample pictures using fifteen pairs of *Kansei* words, the total number of the evaluations became 375 per subject. The samples were shown at random to reduce influence from the order of the presentation.
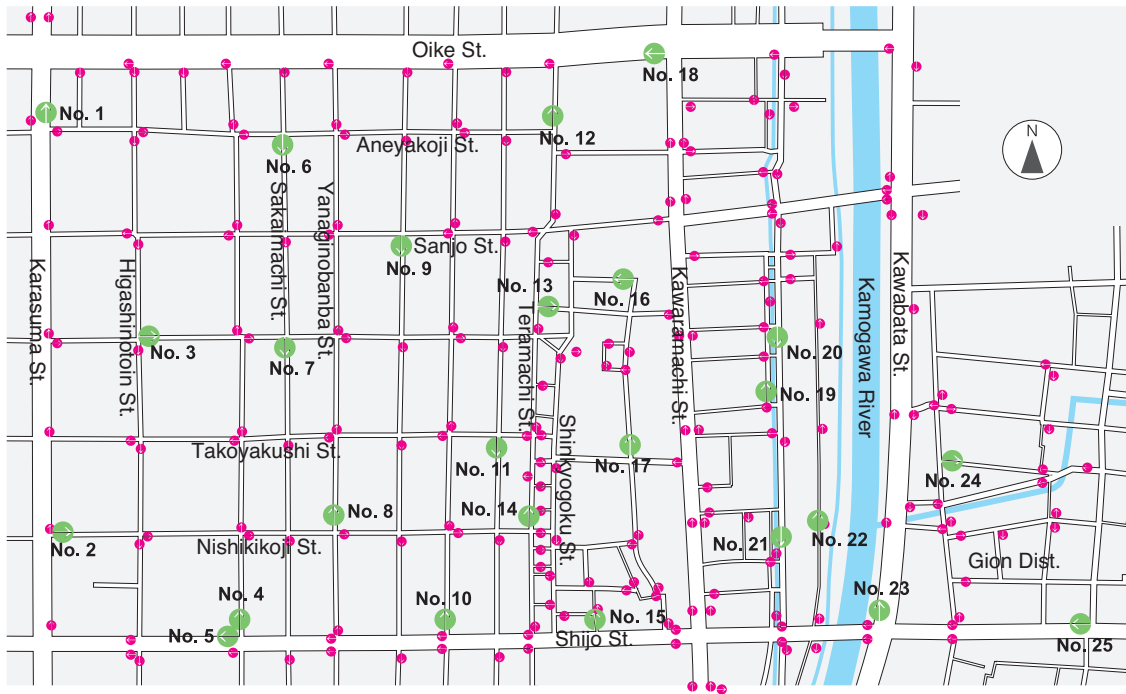
Figure 2: Locations selected for the streetscape samples in the experiments.

2.4. Results and remarks

Figure 3 shows the results of Experiments 1 and 2. The name of the city "Kyoto" mainly evoked the *traditional*, *elegant*, *calm* and *tasteful* impressions. Concurrently with the city of Kyoto, the location Nos. 22 and 24 in the city also evoked the same kinds of impressions as shown in Figure 3(a). The results showed those locations have similar impressions to those of Kyoto. Although the location Nos. 22 and 24 has a similar *Kansei* profile, the two locations are not in a same district and separated by Kamogawa River. In contrast, other locations such as the location Nos. 2, 6, 14 and 15 did not evoke the *traditional*, *elegant*, *calm* or *tasteful* impression at all as shown in Figure 3(b). The impressions of the four locations are different from those of Kyoto, and also dissimilar each other.

From these results, it was confirmed that each location in Kyoto had specific characteristics. Although several locations evoked the same impressions as the city of Kyoto, the number of the locations was few. Also, the locations were not in the same district. The number of locations evaluated in the preliminary experiments was only 25, and those locations evoked dissimilar impressions. To visualize the impressions of streetscapes in Kyoto accurately, detailed experiments therefore need to be conducted.

3. VISUALIZATION OF THE IMPRESSIONS IN KYOTO

3.1. Detailed *Kansei* evaluation experiments

To apply the proposed visualization technique [4] to the impression of the city of Kyoto, detailed *Kansei* evaluation experiments were conducted to investigate the impressions of the streetscapes
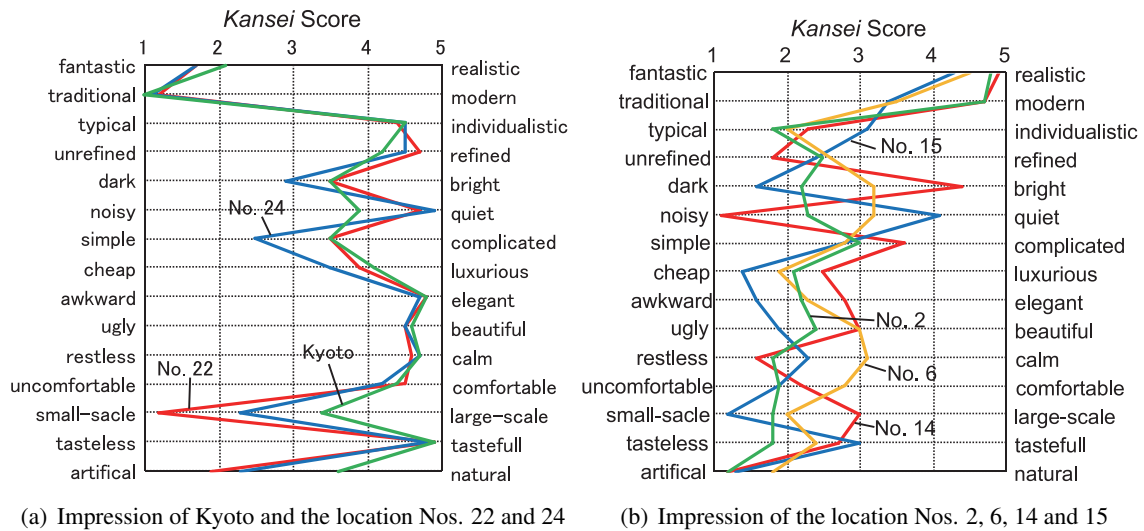
(a) Impression of Kyoto and the location Nos. 22 and 24   (b) Impression of the location Nos. 2, 6, 14 and 15

Figure 3: Example results of the preliminary *Kansei* evaluation experiments.

in Kyoto. The 213 streetscapes indicated by the red circles in Figure 2 were selected evenly from the area of Kyoto city centre. The locations were selected at intervals of 60–120 meters on each street. A sample picture for the experiments was taken at each location from pedestrian's perspective. Although the impressions evoked from streetscapes may differ depending on time, weather, days and seasons, this study fixed the condition of the pictures as daytime, fair/cloudy weather, weekdays and early summer. In terms of the *Kansei* words, similar meaning *Kansei* words were excluded to reduce subjects' physical and mental fatigue. Factor analysis with the principal factor method was performed using the results of the preliminary evaluation experiments. Since the factor loadings of the five pairs of *Kansei* words, *typical—individualistic*, *dark—bright*, *awkward—elegant*, *restless—calm* and *tasteless—tasteful*, were similar to one of the others, those words were excluded for the detailed experiments.

The experiments were conducted for the same subjects as those in the preliminary experiments. The experiment environment including the LCD display and the screen appearance were also the same. Since the subjects evaluated all the 213 sample pictures using ten pairs of *Kansei* words, the total number of the evaluations became 2130 per subject. In consideration of the reduction of subjects' fatigue, the evaluations were divided into five sets. The subjects were also allowed to take thorough breaks anytime they want during the sets. In addition to the *Kansei* scores for the 213 locations acquired in this experiments, the scores for the 25 locations in the preliminary experiments were used for the visualization of the impressions in Kyoto.

3.2. Allocation of *Kansei* scores

Based on the *Kansei* scores for the 238 sample pictures, the average *Kansei* scores for all the subjects were allocated for all locations in the target area. The scores for each sample picture express the evaluation for the streetscape existing inside the picture. The *Kansei* score with respect to each pair of *Kansei* words was therefore allocated to all the locations corresponding to the streetscape inside the picture. Since the sample pictures were taken with the same perspective, which was approximately with 63-degree expanse, 60-meter length and 30-meter width from the
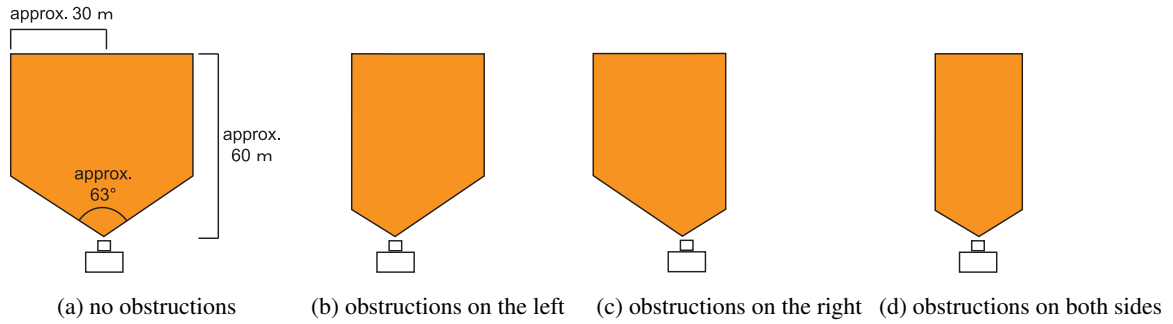
Figure 4: Areas where *Kansei* scores are allocated.

points of photography as shown in Figure 4(a), the *Kansei* scores were allocated to the area corresponding to this perspective. In the case that there are obstructions such as buildings existing in the streetscape, the area for the score allocation is decreased. When buildings obstruct the view on the left, for example, the *Kansei* scores are allocated to the locations in the area shown in Figure 4(b). Figures 4(c) and 4(d) also indicate the cases that obstructions are on the right and obstructions are on both sides, respectively.

Since the *Kansei* evaluation experiments used pictures taken at various locations, certain locations may be included in two or more pictures. These pictures could be evaluated with different *Kansei* scores even though the pictures commonly include the same location. The fact that one location has multiple different *Kansei* scores is however not desired to conduct the visualization process. It is required to integrate those scores and assign a single *Kansei* score for each location with respect to each pair of *Kansei* words. For this problem, this study defined a parameter of the *degree of confidence*, which expresses the probability that a certain location in a picture adopts the *Kansei* scores for the picture. The parameter was assigned with the range of [0, 1] for each location in a picture. It was considered that subjects paid attention to stand out locations in a picture throughout the *Kansei* evaluation processes. In this study, the degree of confidence was therefore assigned such that locations near the points of photography become higher values. Based on the assigned degree of confidence, the *Kansei* score for each location was finally determined as the weighted average of all the *Kansei* scores for the pictures including the location.

3.3. Interpolations of *Kansei* scores

After the score allocation process, locations in the sample pictures had a single *Kansei* score for each pair of *Kansei* words. In contrast, *Kansei* score was not allocated for the locations which were not included in the sample pictures used in the experiments. It was however considered that this kind of locations evokes specific impressions as well. This phase therefore allocated *Kansei* scores for those locations. Using all locations with *Kansei* scores, a two-dimensional plane (i.e., a map of the target area) was firstly divided into many triangles by means of Delaunay triangulation. Since three vertexes of the triangles already have *Kansei* scores, the scores inside the triangles were linearly interpolated.

Kansei score

Figure 5: Colour mapping for the *Kansei* scores.

Euclidean distance

Figure 6: Colour mapping for the Euclidean distance.

3.4. Visualization of *Kansei* scores

3.4.1. Method A: Distribution and intensity of the impression in Kyoto

The first visualization clarifies the distribution and intensity of the impression which is expressed by a single pair of *Kansei* words. After the processes of score allocation and interpolation, all the locations in the target area have a *Kansei* score with the range of [1, 5]. The score at each location was simply mapped to a colour, one by one. Figure 5 shows the colour mapping example for the pair of *Kansei* words *dark—bright*. Red and blue colours were assigned for the locations where the *Kansei* scores are '1' and '5,' respectively. For the locations with the *Kansei* score '3,' transparent color was assigned. The assigned colours were finally overlaid on Google Maps [9].

3.4.2. Method B: Difference between the impression of Kyoto and streetscape impressions

The second visualization clarifies the differences between the impression of each location and the impression of the city of Kyoto. Since the experiments were conducted using ten pairs of adjectives, the impression of Kyoto as well as the impressions of locations can be plotted in a ten-dimensional space. Here, the Euclidean distance in the space expresses the difference between these two impressions. The distance was directly mapped to the brightness of a colour. The distance between the impression of Kyoto and the impression of a location was calculated for all the locations in the target area. From those values, the maximal value was defined as $D_{\max}$. In this visualization, red colour was mapped for the distance $D_{\max}$ while transparent color was mapped for the distance '0' as shown in Figure 6.

4. RESULTS AND DISCUSSIONS

4.1. Method A: Visualization of intensity and distribution

The example results of the visualization for each pair of *Kansei* words are illustrated in Figure 7. Figure 7(a) shows the result for the impressions of *noisy—quiet*. The red colours correspond to the impression of *noisy* while the blue colours indicate the impression of *quiet*. This figure illustrates that the *noisy* impression exists along wide streets, such as Karasuma St., Shijo St. and Kawaramachi St., as well as in commercial districts, such as Shinkyogoku St., Teramachi St.

(a) *noisy—quiet*

(b) *small-scale—large-scale*

(c) *uncomfortable—comfortable*

(d) *ugly—beautiful*

Figure 7: Example visualization results of Method A.

and Nishikikoji St. Figure 7(b) shows the result for *small-scale—large-scale*. The blue colours indicate the impression of *large-scale*. The result explained the impression of *large-scale* is mainly distributing along the wide streets, such as Oike St., Shijo St. and Kawaramachi St., as well as along Kamogawa River. It can be said that the proposed technique allows users to visually reconfirm the impressions which are acquired from their daily experiences. Figures 7(c) and 7(d) show the results of visualization for the impressions of *uncomfortable—comfortable* and *ugly—beautiful*, respectively. In these two results, the areas coloured in red and coloured in blue are almost the same. This means the distributions of those impressions are very similar. It implies that there is some connection between the factors of *comfortable* and *beautiful*.

On the left side of the maps, many narrow streets exist and they cross at right angle each other. Although most locations in the area evoke the impression of *quiet*, strong impression of *noisy* is observed along Shinkyogoku St., Teramachi St. and Nishikikoji St. Also the area slightly evokes the *uncomfortable* and *ugly* impressions. Concurrently with those impressions, the *comfortable* and *beautiful* impressions are partiality existing along Sanjo St. and Sakaimachi St. This visualization results also enable users to find the impressions which are usually difficult to be found from geographical information or maps.

In the Gion district, on the right side of the maps, most locations evoke the impressions of *comfortable* and *beautiful*. However the impressions of *uncomfortable* and *ugly* are fragmentarily existing at certain locations in the district. This suggests that the streetscapes at these locations include some elements that evoke the *uncomfortable* and *ugly* impressions. In city planning, they
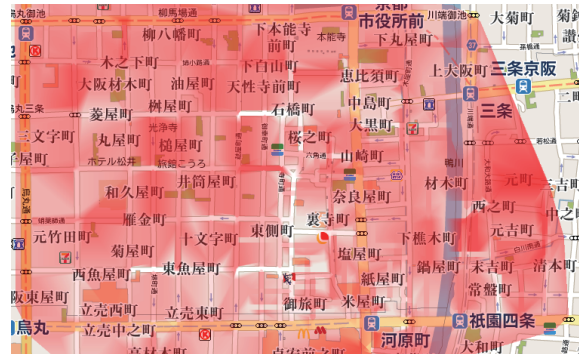
Figure 8: Visualization result of Method B.

usually need to be repaired to realize a clear and comprehensive impression of the entire region. This visualization results enable users to find the locations where streetscapes need to be repaired.

4.2. Method B: Visualization of the difference between the impression of Kyoto and streetscape impressions

Figure 8 illustrates the visualization result of the difference between the impression of Kyoto and streetscape impressions. The areas with translucent colours have the impressions similar to the impression of Kyoto while dense red colours express the impressions far from the impression of Kyoto. In the figure, colours in the Gion district, located on the right side of the map, are relatively translucent. This implies that the impressions of the streetscapes in this district is almost the same as the impression evoked from the name of the city "Kyoto." In addition to the Gion district, this kind of streetscapes were also observed in several locations, such as the parts of Higashinotoin St., Sakaimachi St., Yanaginobanba St., Aneyakoji St. and Takoyakushi St. These locations however exist fragmentarily. In contrast, several locations, especially along Shinkyogoku St., Teramachi St. and Nishikikoji St., are coloured in dense red. Although these locations are actually in the city of Kyoto, tourists and visitors from outside Kyoto recognize that the impressions of those streetscapes are somewhat different from the impression on Kyoto. Using this visualization result, the tourists and visitors are able to find and explore another aspect of Kyoto, which they have not imagined. The visualization results are also used for tourist applications such as *Kansei*-based sightseeing maps.

5. CONCLUSIONS

In this paper, the *Kansei* structure visualization technique [4] was applied to the impressions in the city of Kyoto, Japan's old capital. The *Kansei* evaluation experiments were conducted using ten pairs of *Kansei* words in order to investigate the impressions of 238 streetscapes existing in Kyoto. Based on the results of the experiments, *Kansei* scores were allocated for each location in the city. The visualization process illustrated the scores using colours and their brightness. The visualization results were finally overlaid onto Google Maps.

The first visualization clarified the distribution and intensity of the impressions existing in the city. The results demonstrated that the impression of *noisy* existed along wide streets, such as

Karasuma St., Shijo St. and Kawaramachi St., as well as in commercial districts. Also, the *comfortable* and *beautiful* impressions were partiality observed along Sanjo St. and Sakaimachi St. even though the surrounding area slightly evoked the *uncomfortable* and *ugly* impressions. The visualization enabled users to reconfirm the features of the impressions existing in the city. Also, this can be used as a useful tool to determine the locations where streetscapes need to be repaired. The second visualization illustrated the difference between the impression of Kyoto and the impressions of each location in Kyoto. The result showed that the impression existing along Shinkyogoku St., Teramachi St. and Nishikikoji St are different from the impression imagined from the name of the city "Kyoto." This visualization result enables tourists and visitors to find and explore another aspect of Kyoto.

As the future studies, the present authors will focus on possibilities for the application of these visualized impressions of Kyoto, which may include novel interfaces such as *Kansei*-based interactive sightseeing maps and their automatic generation.

ACKNOWREDGEMENT

REFERENCES

[1] Lynch, K., *The Image of the City*, MIT Press, Cambridge, MA, 1960.

[2] Nagamachi, M., *Kansei* Engineering: A new ergonomic consumer-oriented technology for product development, *International Journal of Industrial Ergonomics*, 15(1): 3–11, 1995.

[3] Kinoshita, Y., Sakakura, Y., Cooper, E. W. and Kamei, K., IroKage: A townscape colour planning support system using *Kansei* and colour harmony evaluations, *Kansei Engineering International*, 6(4): 31–40, 2006.

[4] Kinoshita, Y. and Nakama, T., A proposal of the *Kansei* structure visualization technique for product design, *In Proceedings of the International Conference on Kansei Engineering and Emotion Research 2010*, To be published.

[5] Ryoke, M. and Nakamori, Y., Kansei visualization system using fuzzy correspondence analysis, *In Proceedings of the 8th International Symposium on Knowledge and Systems Sciences*, 140–147, 2007.

[6] Nakakoji, K., Yamamoto, Y., Sugiyama, K. and Takada, S., Finding the "right" image: Nisualizing relationships among persons, images and impressions, *In Proceedings of the IFIP Conference on Designing Effective and Usable Multimedia Systems*, 91–102, 1998.

[7] Nakama, T. and Kinoshita, Y., An analysis of the image structure in Kyoto - Evaluating townscape impression from pedestrians' perspective, *In Proceedings of the 10th Annual Conference of Japan Society of Kansei Engineering*, 13D-05 (5 pages), 2008. (in Japanese).

[8] Osgood, C. E., Suci, G. J. and Tannenbaum, P. H., *The Measurement of Meaning*, University of Illinois Press, Urbana, IL, 1957.

[9] Google Maps, http://maps.google.com/.