A Development of the Building *Kansei* Information Retrieval System

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Summary

The purpose of this research is to develop the method to retrieve a building name from the impression of the building. First, the images of the building are registered as database by the questionnaire. Next, the images of the objective building are compared with the degree of matching in image databases, and the building with high synthetic matching degree is retrieved. This system could get a good retrieval result. Moreover, image processing was done, and image databases are trained by neural network from the amount of characteristics of the image, and the retrieval system by image processing was examined.

1 Introduction

Imagine the situation that you find an interesting building when you are on a train. What do you do when you want to get information on that building immediately? If you know a building name, you can find out the information about the building easily through the Internet. But, it is not easy to look it up when you do not know the building name. Building names were necessary for the existent retrieval system. But now, you have the image of that building because you are looking at that building though you don't know a building name. The purpose of this paper is to develop a building sensitivity information retrieval system from the image of the building, and to verify that validity.

2 Abstracts

The flow of the whole system is shown in Fig.1.

2.1 Building of the image data base

It is necessary to build an image database in every building for sensitivity information retrieval. First, the adjective which show the image of the building is chosen. Next, the questionnaires are done about the objective buildings, and the data on the image degree by SD method are collected.

2.2 Development and verification of the sensitivity information retrieval system

First, the images of the building which you want to look for are inputted in this system by SD method. Then, the buildings which match the inputted images are searched from the image database. The verification of the retrieval precision uses the questionnaire data. In other words, the image values which a testee answered about a certain building in the questionnaire are inputted into this system as an image of the retrieval building. Then, when a retrieve is done, the precision verification of this system is examined by the retrieval order of that building.

2.3 Rebuilding of the image database by the image processing

It is necessary to build an image data base by the questionnaire but it is not practical to do a questionnaire every time the number of objective buildings increases. If an image data base can be built directly from the building photograph, it is not necessary to do a questionnaire. Now, the amounts of characteristics of the building are calculated from the building photograph by the image treatment. The image database will be able to be rebuilt by neural network through training the relations between these amounts of characteristics and matching degree.

2.4 Rebuilding of sensitivity information retrieval system by the image treatment

The sensitivity information retrieval system is conducted by using the image database, which is rebuilt by the image treatment. As Sect. 2.2, the image values, which a testee answered about a certain building in the questionnaire, are inputted into this system as an image of the retrieval building. Then, when a retrieve is done, the precision verification of this system is done by the retrieval order of that building.

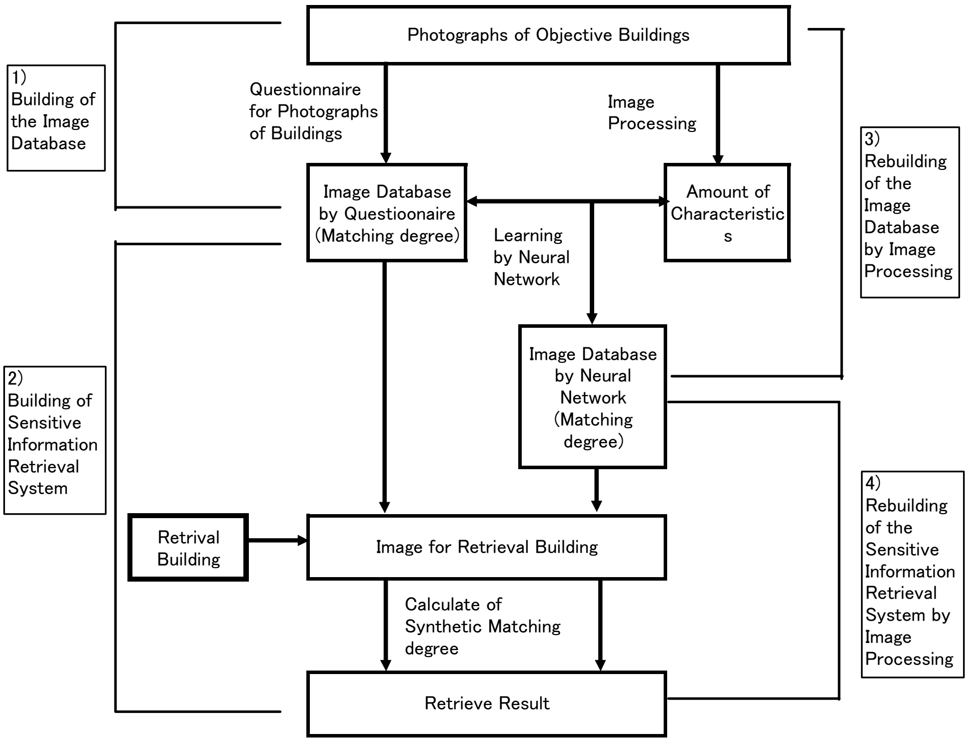


Fig.1. Flow Diagram of This System

3 Building of the Image Database

It is important to choose the adjectives which express the building image correctly, in order to evaluate a building image. The adjectives were chosen from the result of the pre-questionnaire. At first, the photographs of some buildings were presented, and the images for those photographs were listed. The adjectives which were answered abundantly in pre-questionnaire were used for the evaluation adjectives. The selected adjectives are seven as the following

1) Large scale - small scale 2) vertical oblong - horizontal oblong
3) straight line - curve line 4) simple – complex 5) modern – traditional
6) fresh - common 7) warm – cold

Next, when the questionnaires were conducted, the image degree of the above adjective pairs was expressed by seven steps to each building. The total number of buildings is 28 cases. The questionnaires were collected, the degrees of matching were calculated in every building, and the image database was built. The degree of matching is the value that the number of choice people of that degree was divided by the number of contestants.
The image database of the building of the Fig. 2 is shown in the Table 1.

Fig.2. Photograph of Objective Building (Tokyo Dome)

Table 1 Image database for Fig. 2

adjective	superior (0)	much (1)	rather (2)	same (3)	rather (4)	much (5)	superior (6)	adjective
Large scale	0.682	0.273	0	0.045	0	0	0	small scale
vertical oblong	0	0	0	0.727	0.091	0.182	0	horizontal oblong
straight line	0	0	0	0.136	0.227	0.227	0.409	curve line
simple	0.136	0.409	0.182	0.136	0.091	0.045	0	complex
modern	0.318	0.136	0.409	0.091	0.045	0	0	traditional
fresh	0.182	0.182	0.136	0.409	0.091	0	0	common
warm	0.045	0.091	0.045	0.455	0.136	0.091	0.136	cold

4 *Kansei* Information Retrieval System

A retrieval process is shown in the following.
1) Input the degree of adjective of image of the building for retrival.
2) Read the degree of matching about all buildings for the inputted degree of adjective from the database.
3) Calculate synthetic matching degree about all buildings by multiplying seven matching degrees of adjective read in 2).
4)Compare the value of degree of synthetic matching, and display the retrieval buildings in big order.

The input screen of the system is shown to a Fig. 3, and the output screen of the system is shown in Fig. 4.

The verification process of this system is shown in the following:

1) Take out at random ten buildings from the questionnaire in Sect. 3.
2) Retrieve a building by inputting image degree which was given to the building by the questionnaire.
3) Examine the order of synthetic matching degree of the building inputted image.
75% of the objective buildings were retrieved at first order, and 98% were within 5th order. This system will be efficient, although there is a problem that the number of objective buildings is a few.

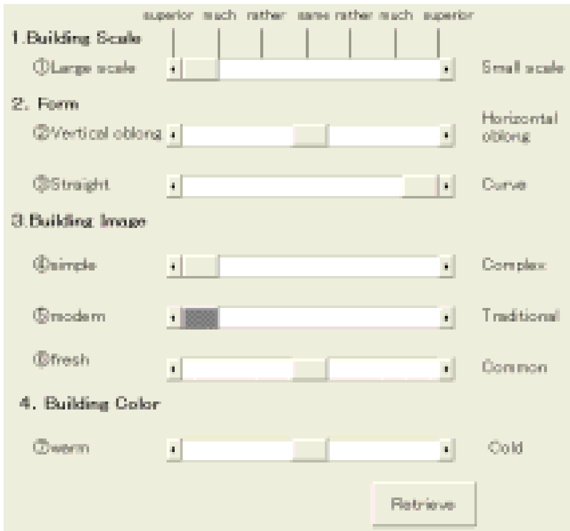
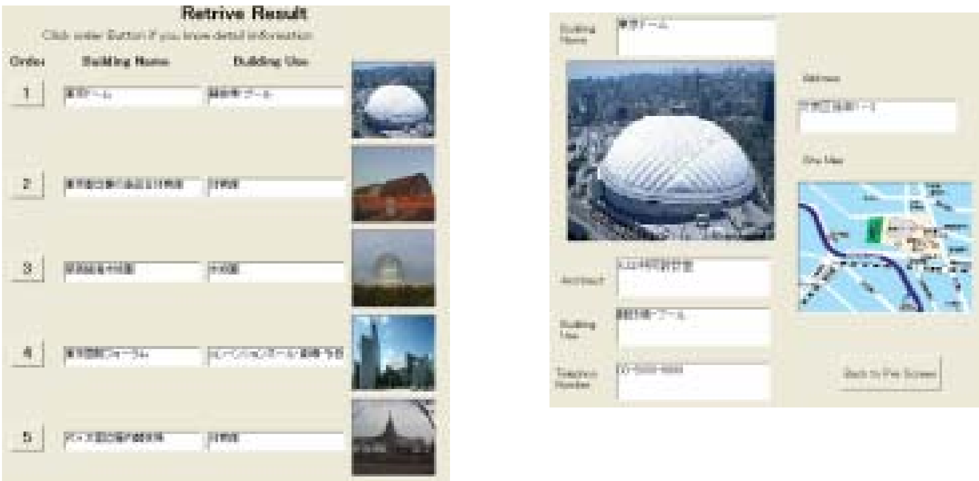


Fig. 3 Input Screen



(a) (b)

Fig. 4 Output Screen: (a) shows retrieval building lists, (b) shows detailed information of objective building.

5 Restructuring of the Image Database by the Image Processing

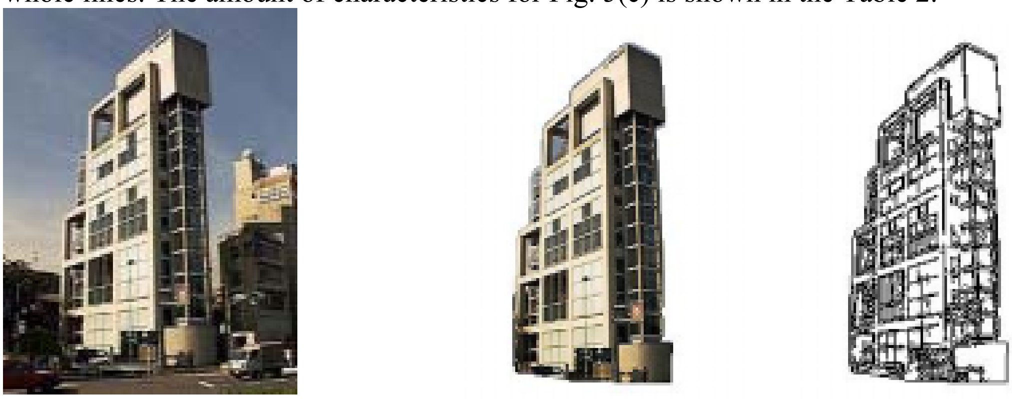
The restructuring process of the image database is shown in the following.

5.1 Pre-processing of the Image

It is not efficient for this system to deal with an original image, because the original image (see Fig.5 (a)) has many extra data. It is therefore important to reduce image data without spoiling the image of the building. At first, an image outside the retrieval object is deleted. (see Fig. 5 (b)) Next, the extraction of the outline line and a noise removal are done. (see Fig. 5 (c))

5.2 Feature Extraction

First, the number of adjectives was reexamined.
Through the cluster analysis, the adjective pairs with high independency were selected from seven adjective pairs used in Sect. 3. Selected adjective pairs are four, that is, "Large-scale vs small-scale", "vertical oblong vs horizontal oblong", "fresh vs common" and "warm color vs cold color". In order to evaluate these adjectives, important characteristics are extracted from the image. For example, these are in such cases as the slenderness ratio of the building, the straight line rate of the circumference part, the center of gravity and the distribution of the color. The image of the Fig. 5(c) is changed into pixel information to extract characteristics. Next, the amount of characteristics is extracted by using pixel information and the algorithms. A slenderness ratio is calculated in the ratio of the height (the maximum value - minimum value of a position of pixel in the y direction) to the width (the maximum value - minimum value of a position of pixel of the x direction) of the building.
On the other hand, a straight line rate is found as follows.
It is counted with the straight line when the direction of pixel which adjoins is the same. It is counted with the curve when the direction of pixel which adjoins changes.
A straight line rate is calculated by dividing the number of straight lines by the number of the whole lines. The amount of characteristics for Fig. 5(c) is shown in the Table 2.



(a) (b) (c)

Fig. 5 Flow of Pre-Processing of the Image: (a) shows original photograph, (b) shows an image deleted outside objective building, (c) shows an image after image pre-processing.

Table 2 Amount of characteristics

Straight Line Ratio	74.082	Slender Ratio	2.009	Area Ratio	0.716	Complexity	0.288
Curve Line Ratio	18.98	Distance Ratio	0.861	Color Average Blue	16.955	Color Difference Red	15.245
Straight Line Degree	0.613	Center of Grabity X	1.011	Color Average Red	22.894	Color Difference Green	15.252
Straight Line Degree 2	0.621	Center of Grabity Y	1.196	Color Average Green	20.862	Color Difference Blue	14.689

5.3 Rebuilding of the Image Database

5.3.1 Learning of the degree of matching

By the cluster analysis, the five amounts of characteristics with high independency were selected from the amount of characteristics of the image in Sect. 5.2. The input items in learning are the five amounts of characteristics, that is, a curve rate, straightness, a distance ratio, the center of gravity of the x shaft and complexity. On the other hand, the teacher signals for each adjective are two of the mean and the standard deviation found from the matching database built by questionnaires. As for a reason to use a mean and standard deviation, it would be easier to evaluate in the normal distribution than matching degree because the questionnaire number is small. The rule (weight between unit's) of the input and the output is built as a neural network's training result. Four neural networks are built for four adjectives. The construction of the neural network is shown in Fig. 6.

5.3.2 The estimation of the degree of matching

The amount of image characteristics is inputted in the input layer. The rules (weight between unit's) built by learning are used, and outputs (mean and standard deviation) are computed. Normal distribution is calculated from these outputs, and a database is built.

5.3.3 The verification of the degree of matching

It is verified by the difference in value between the normal distribution found from the result of a questionnaire and the estimated value of the degree of matching.

A learning example is shown about the adjective (Large-scale vs small-scale.) A learning photograph is 14 pattern within all the applicable 28 patterns. The degree of matching of the photograph of the rest 14 pattern is estimated from the characteristics of that photograph, and compared with the normal distribution made from a result of a questionnaire. A good result is shown in Fig. 7(a) and a bad result is shown in Fig. 7(b). On the other hand, the number of estimated value, which is within the range of the normal distribution ±0.03 for seven steps in each adjective, is shown in Fig. 8. It is understood that there is some dispersion in the estimated precision.

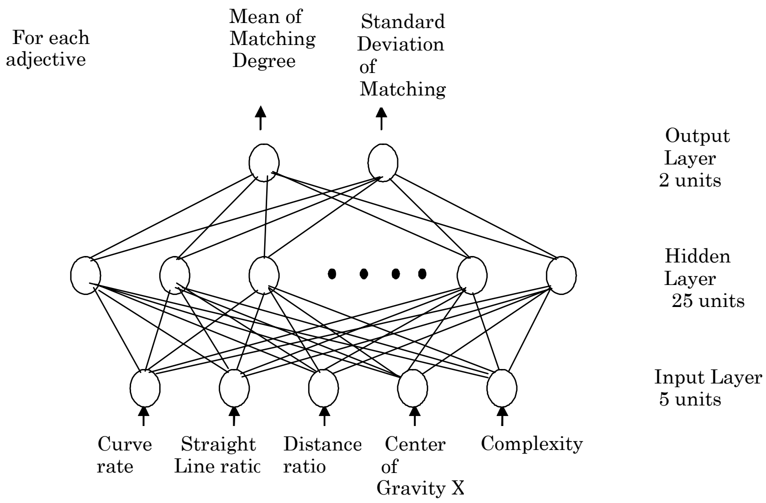


Fig. 6 Construction of Neural Network

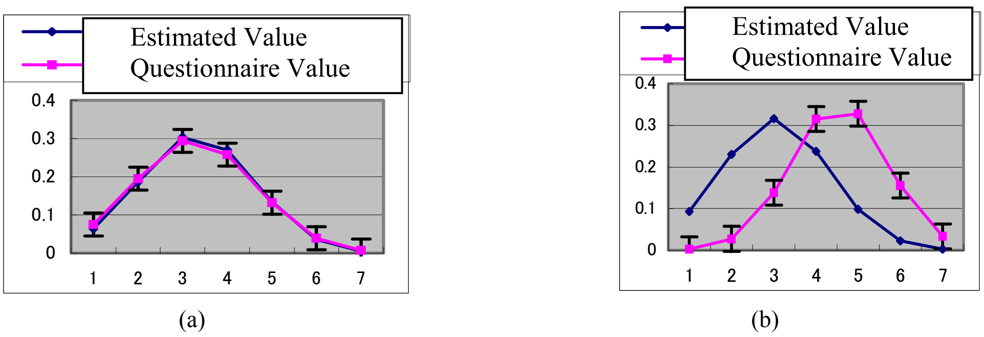


Fig. 7 Estimation Result: (a) shows good result, (b) shows bad result

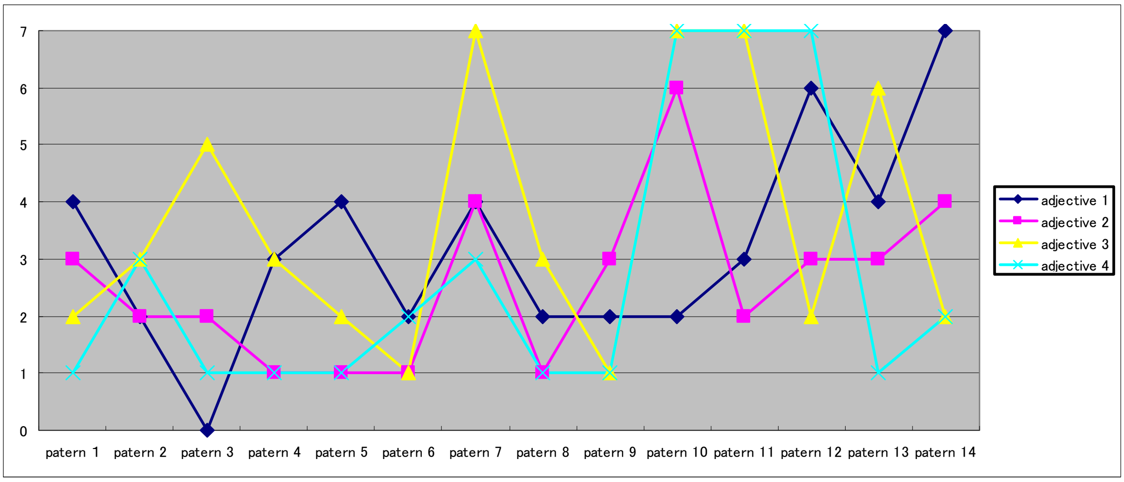


Fig. 8 Estimation Result: Vertical axis is the number of estimated value which are within the range of the normal distribution ±0.03 for seven steps in each adjective, horizontal axis is verification objects.

6 Rebuilding of the *Kansei* Information Retrieval System by the Image Processing

The image database of the sensitivity information retrieval system of 4 was replaced by the image database estimated by the image processing. The results of questionnaires for 5 people were inputted, and this system's efficiency was verified by the retrieved order for an objective building within 28 buildings. The retrieval result, whose estimated order is good, is shown in the Table 3. The average retrieval order of 14 verification buildings is the 13th. As for the reason why average retrieval order is low, neural network can not reproduce accurately the matching degree of all the retrieval objects. It can not estimate the matching degree of all the photographs precisely under the present condition. (See Fig. 8) In this system, when an order is chosen, the matching degrees are calculated to 28 retrieval objects, and the object whose matching degree is relatively high is chosen. Therefore, it is necessary to estimate accurately for matching degrees of all retrieval objects.

Table 3 Amount of characteristics

Building's Pattern		Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5
Adjective	Large Scale – Small Scale	2	4	5	4	5
	Vertical Oblong – Horizontal Oblong	3	2	3	3	3
	Fresh – Common	2	2	5	3	4
	Warm – Cold	4	4	1	3	3
Retrieval Order	Use Questionnaire	3	2	6	3	1
	Use Estimated Value	16	7	9	4	7

7 Conclusion

The conclusion of this research is expressed in the following.

1) Even if the building name is not known, the retrieval of the building can be searched from the building image. Even if the number of objective buildings was a few, this system could retrieve the object building within almost the fifth order.
2) The technique to build an image database from a building image is more important, because it is not practical to do a questionnaire every time retrieval objects are increased.
3) This paper proposed the technique to learn relations between the amount of image characteristics found by the image processing and the image of the building by a neural network. However, this paper could not get precision fully. Hence, more research is necessary.

8 Acknowledgement

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9 References

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