# Plural Object Recognition using Image Similarity and Word-Concept Association

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***Abstract*** *- Object-recognition capabilities will be indispensable for any intelligent robot that will serve as a human partner. In this research, we combined existing image-processing and word-concept association techniques to perform object recognition based human style common-sense judgments.*

**Keywords:** object recognition, image similarity, degree of association, Concept-Base

## 1 Object recognition based on common-sense judgments

Our goal in this research was object recognition based on comprehensive judgments that mimic the human object-recognition mechanism using an image database and a word-concept association system. The procedural flow is as follows:

(1) Image input (background image + foreground image)
(2) Object extraction by background subtraction
(3) Candidate acquisition via size judgment
(4) Filter by image similarity
(5) Filter by degree of association
(6) Output object names

## 2 Candidate acquisition via size judgment

We used an image database to acquire candidates using size judgments. Then, we obtained the area of the region cut away by object extraction, normalized that, and compared the result with each object in the image database in terms of size to acquire object candidates.

The image database stores multiple sets of images of objects with their names. For a single object, it will store multiple images, and the current database of 50 objects includes a total of 200 images, each with size information (Figure 1).

## 3 Filter by image similarity

After adjusting direction of principal axes and center of gravities of two object domains $I_1$ and $I_2$, for color and binary images, the correlation values $S_1$ and $S_2$ are calculated each and the image similarity $S$ is derived by equation 1. Because there are two ways of the direction of principal axes, the bigger one is adopted. In addition, It is used L*a*b* color system for the correlation value calculation of a color image.

$$S\left(I_1, I_2\right) = w_1 S_1 + w_2 S_2 \quad (1)$$

We then filtered candidates using image similarity $S$ between the input image and images in the image database.

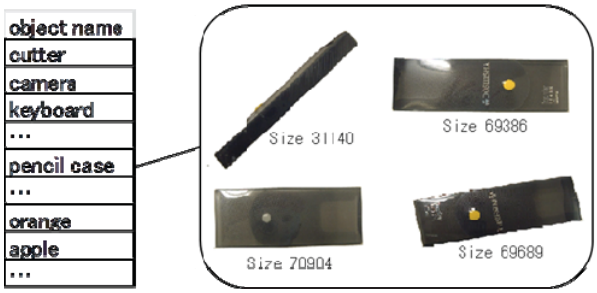


**Fig.1: The image database**

## 4 Word Concept Association System

### 4.1 Concept-Base

A concept-base (CB) is a knowledge base comprised of terms (concepts) mechanically constructed from multiple sources such as Japanese-language dictionaries and newspapers, along with terms (attributes) that express their semantic features. Concepts have been given attributes along with a weighting that expresses their importance. Approximately 90,000 concept notations have been compiled in the CB, with an average of 30 attributes for one concept. A certain concept $A$ has a pair of sets of attribute $a_i$ and weighting $w_i$, as appear below.

$$A = \{(a_1, w_1), (a_2, w_2), \cdots, (a_m, w_m)\}$$

Any primary attribute $a_i$ is composed of the terms contained in the set of concept notations in its CB. Therefore, to ensure that a primary attribute matches a certain concept notation, that primary attribute can be further extracted. This is called a secondary attribute. In a CB, a concept is defined by a chained set of attributes to the $n$-th order.

### 4.2 Degree of Association

The Degree of Association(DoA)[(1)] is a value ranging from 0.0 to 1.0 that quantifies the strength of the relationship between words and words registered to the CB. There are three types of DoA [(2)]:

1) DoA concerned with meaning of words (DoA-M)
2) DoA concerned with coincidental word information (DoA-C)
3) DoA concerned with above both (DoA-MC)

Using the degree of association with combinations of two object names in the image database, the candidates are filtered.

## 5 Evaluation

### 5.1 Object extraction

We observed considerable residual noise when performing input image object extraction by background subtraction. We regard this as being a result of using a simple difference method to discern the input image from the background. Because this degradation and noise will affect subsequent image-similarity calculations and other processes, it will be necessary to consider better extraction techniques using other image-processing technologies.

### 5.2 Filter by size judgments

Size filtering eliminated a mean of 24 candidate objects, and did not erroneously eliminate the correct answer as a candidate. Based on this, we regard our current size filtering technique to be appropriate.

### 5.3 Filter by image similarity

The image similarity is calculated by the correlation value of the color image and that of the binary image with weightings $w_1$, $w_2$. (Equation 1)

We inspected these weightings $w_1$, $w_2$ using the image which came out of 40 objects same as an object stored away within image database. As shown in the figure 2, at the time of weightings ($w_1$,$w_2$)=(0.4,0.6), the precision became approximately 60%. When only the binary image is used, the precision became 42%, and when only the color image is used, the precision became 31%. It may be said that compositely using both binary image and color image is effective.

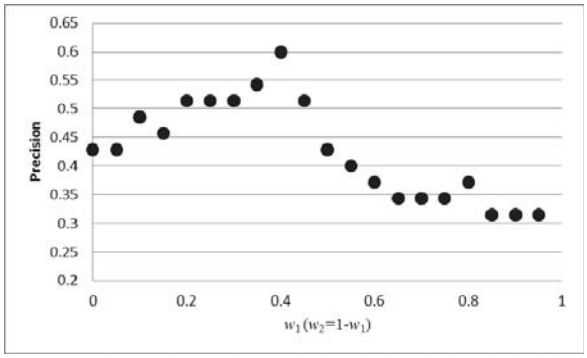


**Fig.2: Image similarity**

### 5.4 Filter by DoA

To filter by DoA, it is used the image similarity ($S$) and DoA ($R$) by combining them to obtain an assessed value (Equation 2).

$$E = W_S S + W_R R \quad (2)$$

Using 80 images (160 objects) including each two objects which may not be objects in the image database shown like figure 3, the experiment is performed with changing weightings $W_S$ and $W_R$ . As the degree of association, three types of those, DoA-M, DoA-C and DoA-MC are examined.

Figure 4 shows the results of this experiment. By this result, in the case using DoA concerned with coincidental word information (DoA-C) and weightings ($W_S$,$W_R$)=(0.6,0.4), the precision is the best 45%.

Therefore, it may be said that compositely using both image similarity and the word concept association is effective.

**Fig.3: Part of input images**

## 6 Conclusion

In this study, using an image similarity by the technique of the conventional image processing and the association between the plural number object, it is aimed at the realization of the object recognition based on the general judgment such as the human object recognition mechanism. The precision of the object recognition became approximately 45% by using the value of the degree of association. It was approximately 40% when the degree of association was not used, and approximately 5% of precision improvement was achieved. It is thought that it was able to show the usefulness of using a word concept association system as one technique of the object recognition.

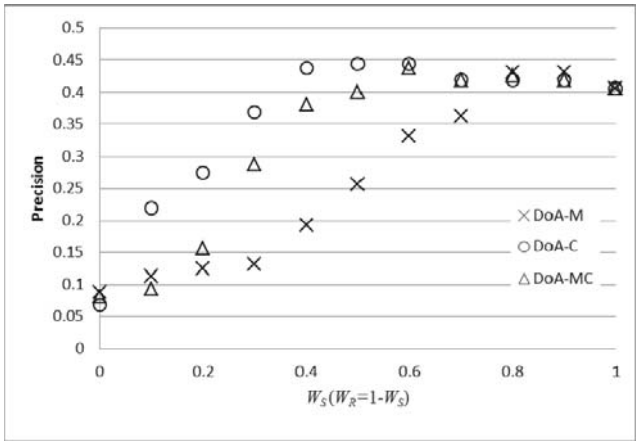


**Fig.4: Experimental results**

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## References

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