CONSTRUCTION OF A FLOWER IMAGE DATABASE WITH FEATURE AND INDEX-BASED SEARCHING MECHANISM

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ABSTRACT

In this paper we propose an image-database system, which takes an image as a query key and retrieves similar images with their characteristics from its collection. For this database we introduce a new similarity measure based not only on the images' physical features but also on some interpretation of the images as flowers. The proposed image database could be used for varieties of images, but in this study our focus is to build a flower-image database, in which the query key is a flower image taken in a natural environment and the extraction result, is flower images which are similar to the key image and the related information like the name of the flower, the generic name, blooming season and so on. The effectiveness of the retrieval could be improved by also adding some textual keywords associated with the characteristics of flowers as the number of sepals, the size of petals and so on.

1. INTRODUCTION

Due to rapid progress of computer and Internet technologies, multimedia contents could be easily obtained, hence their number grows very rapidly. In such situations, efficient tools for managing multimedia contents are strongly required. Efficient methods for storing, searching, retrieving, and classifying data are becoming very important.

As an actual example of information retrieval, a text-based query system has already been put into practical use in WWW such as Yahoo! and Google. In this case, textual keywords are given by the users to the search engine which then extracts a number of links to the information that match the given keywords. However, for some contents like images and sounds, textual keywords are not suitable, because it is not always easy to express the characteristics of images or sounds using textual keywords. It is very important to build a database system that could take not only textual keywords but also other data expressions like images or sounds. In this study we propose an image-database system that is able to accept images as the query key and retrieve images which have some similarities with the given query. We introduce a new similarity measure that considers not only the images' features such colors and shape but also the interpretation of the images. The search and retrieval efficiency could also be enhanced by also adding some textual keywords associated with the characteristics of the image that could be understood easily by the users. In this research we build a flower image database. The query key for searching this database is a flower images taken in the natural environment with no constraints regarding lighting condition, background and postures. The images collection stored in the database are flower images in which each image is associated with some textual information regarding characteristics of the flower included in that image, such as the name of the flower, the generic name, blooming season, etc. Because the query and stored images could be taken in arbitrary environments, we propose an efficient method for extracting the flowers' regions from their backgrounds, and used the extracted flower image for similarity matching in the searching process. The proposed database could be used by any user with no specific knowledge on the database system nor special knowledge on flowers. For example a person strolling in some garden can use the database when he/she wants to know the name of the flower that he/she finds in that garden.

2. OUTLINE OF THE SYSTEM

We mainly focus on flower images for retrieval target, because flower images taken in natural environment usually include complex backgrounds and appearance changes caused by the sunlight and the orientation, so that accurate retrieval is difficult when based only on image's attributes. Retrieval from text information is also a difficult task if the user does not have any special knowledge about flowers. From these points, we choose flower images as a typical example of image retrieval system that requires both of textual and visual information.

Image searching methods using only image attributes have been previously presented [2,3,4]. The method of using both the image and text information was also proposed in the previous research [5]. In this research we proposed a method for image-similarity measure to improve the image matching efficiency by introducing a new parameter to each pixel included in the image as an addition to the color information of that pixel. This parameter can be considered as a measure of the likeliness of that color as the color of flowers. The value of the parameter is calculated by a neural network trained to classify colors that are common for flowers positively, while to classify colors that are not common for flowers negatively.

The flower database is named "HANAMARU", which can be accessed through Internet [6].

Figure 1 illustrates the outline of the proposed image database and the image retrieval procedure. The database has two kinds of stored data, one is the image collection and the other is a collection of textual information of each image. In the retrieval procedure, the proposed system retrieves a number of images as candidates for the desired image with regard to the query key. The user can then reduce the number of candidates by inputting the textual information associated with the query key until the user is satisfied with the retrieval result.

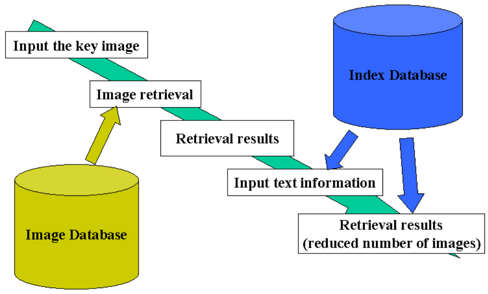

Fig.1 Outline of the Database

3. EXTRACTING THE FLOWER FROM THE BACKGROUND

Because the query image and the stored images are images of flower taken in natural environment, we need to distinguish the flower region from their backgrounds. The similarity matching is then executed only between the flower regions. As we assume that the image contains only one kind of flower. It is not necessary to separate a flower from another flower. In the existing system [5], the flower area separation is done with the color of each pixel independently. Therefore the results contain miss-classifications because of noises especially in the bright region. In the proposal system, a rough segmentation is performed first and the each region is classified whether it is included in the flower region or not.

3.1 Color histogram and flower-likeliness

In our proposed database system, images are expressed with the L*a*b* color expression, which is based on the human perception of colors.

First, we manually extracted the flower regions of 6 images containing flowers to make the training data. Figure 2 shows an example of an image of a flower taken in a natural environment and manually extracted flower region. We introduce a Multi Layer Perceptron (MLP) to discrete the flower colors from the background colors. The MLP is trained by using 90000 color samples extracted from the 6 images by Backpropagation learning method[7]. Figure 3 shows the classification map generated by the MLP in the L*a*b* color space when L* is fixed to 50. The white area shows an area that is classified as flower (which means that colors laying in this area are likely to be colors that are common for flowers), and the gray area is colors that are classified as background. Our idea is not to use the trained MLP to classify individual pixel but to use for pixel characterization in the image segmentation to develop the reliability of the flower region extraction.

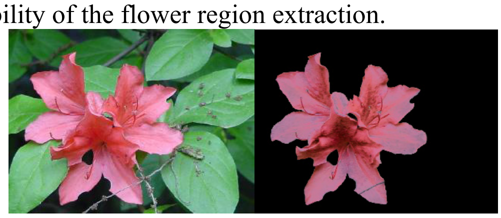

Fig.2 flower image and the flower region

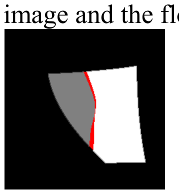

Fig.3 flower-likeliness distinction curved surface

3.2 Segmentation and labeling

To extract the flower area from its background the given image is scanned from top left and each pixel is labeled. A group of pixel having the same label will be grouped into a segment. After the labeling and segmentation procedure are executed, the segment considered to be flower's area could be extracted. The labeling and segmentation procedure is executed as follows,

1. Scan the given image from top left pixel by pixel in rightward direction.
2. Judge whether a pixel belongs to the same label as its adjacent upper segment, its adjacent left side or should be given a new label.
3. If the pixel belongs to both segments, then the two segments are merged.

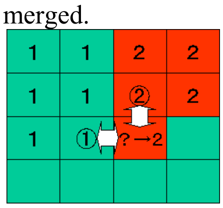

Fig.4 labeling method

The decision on the label of a pixel is based on the difference of the pixel with its adjacent upper segment or left side segment defined in Eq. 1.

$$S=\sqrt{(L_{av}-l)^2+(A_{av}-a)^2+(B_{av}-b)^2+\alpha\times(N_{av}-n)^2} \quad (1)$$

$$L_{av}=\frac{1}{M}\sum_{i=1}^{M}L_i \quad A_{av}=\frac{1}{M}\sum_{i=1}^{M}A_i \quad B_{av}=\frac{1}{M}\sum_{i=1}^{M}B_i$$

$$N_{av}=\frac{1}{M}\sum_{i=1}^{M}F(L_i,A_i,B_i) \quad n=F(l,a,b) \quad (0\le F\le 1)$$

$$\alpha=100$$

S is the difference between a pixel and its adjacent segment. L_i, A_i and B_i, are the L*a*b* values of the i-th pixel in the adjacent segment, while M is the number of the pixels included in that segment. The value of l, a and b, are the L*a*b* values of the pixel. F is a function that is learned by MLP, which outputs the flower likeliness of a pixel. The difference S is compared to an empirically decided threshold value St, in which if S does not exceed St then it will be included in the segment, and if it exceeds St it will be given a new label. St is set to 40.

3.3 Flower area extraction

The average color of each segment is calculated and given to the neural network to be classified as flower or background. Fig. 5 shows an example of segmented image and flower extraction.

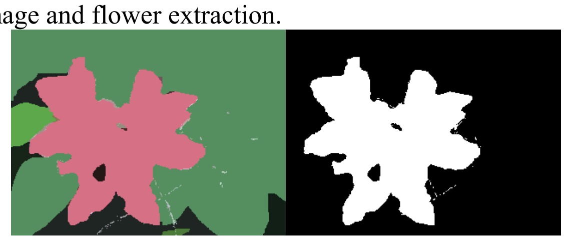

Fig.5 the segmented image and extracted image

4. EXTRACTION EXPERIMENT

We test the extraction algorithm with respect to the 100 sets of images. The result is shown in Table 1. From table 1 we can show the improvement of flower extraction efficiency compared with the previous method.

Precision=(number of pixels classified correctly in the flower area of an extraction image)/(number of pixels of the flower area in the input image)

Recall=(number of pixels classified correctly in the flower area of an extraction image)/(total number of pixels classified as flower)

Table.1 result of extraction experiment

	Precision [%]	Recall [%]
Method of the paper of [5]	62.0338	71.2931
Method in this paper	87.8853	75.3740

5. FLOWER DATABASE

The proposed system consists of two databases, one is the flower image database and the other is the textual information (index) database.

The interface of the flower database "HANAMARU" is shown in Fig. 6.

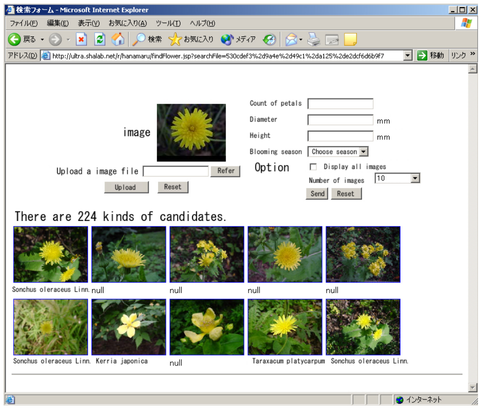

Fig.6 Flower image database sever "HANAMARU"

5.1 Image Database

After the extraction of the flower region from the query image, a similarity matching procedure based on color and shape information of the extracted flower region will be executed to search from the database collection for images' with similar features. The proposed system is powered by an image search engine developed by Ricoh Co. Ltd.

The number of flower images stored in the database is 1300, all of which are taken in the natural park of the National Institute of Nature Study in Tokyo in the span of 1 year consisting all seasons. This database contains 224 kinds of flowers. All of the images were taken under various conditions (view angle or sunlight).

5.2 Index Database

The index database has several text items that explain the properties of each flower. The main role of this database is to explain the characteristics of the flower to the user. The information stored in this database are,

1.Flower name, 2.Generic name, 3.Family name, 4.Count of flower petals, 5.Diameter of flower, 6.Height, 7.Blooming season, 8.Other information

The user could also narrow down or reduce the number of candidates that will help to make the final choice by inputting the information of blooming season, diameter, height and count of petals.

6. RETRIEVAL EXPERIMENT

The experiment result of retrieving flower information given a query image is presented in Figs 7 – 9. The query image is an image that is not included in the database, although the database has the same kind flower in its collection. Fig. 7 shows the query image, Fig. 8 shows the image matching result, in which 15 images with the highest similarities are presented. The user then, could narrow down the number of candidates by inputting some textual information about the query image. Fig. 9 shows the retrieval result, in which the database presented 4 types of flowers to the user. This is the result of inputting the information of the diameter of flower, height and blooming season. The user could make the final choice from these candidates and extract the information about the flower.

Fig.7 Query image

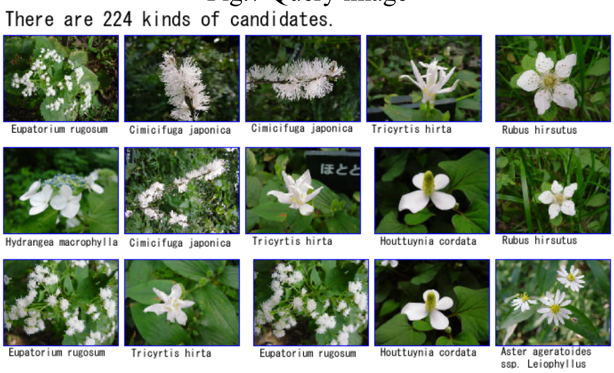

Fig.8 the image of top 15 of similarity ranking

Fig.9 retrieval results reduced kinds of flower

7. CONCLUSION

In this paper, we introduced a flower image database and its retrieval system based on the indexed color, shape, and the text information. The addition of the measure of the likeliness of a color as flowers' color generated by a neural network improves the accuracy of flower labeling, thus contributing to the accuracy of the database retrieval. If the feature is in the color of the target object and a background, it will be thought that it is applicable also to the retrieval of those other than a flower. In the near future we plan to enrich the database with many more flowers and evaluate the efficiency of the database by testing it though its usage in the internet. The proposed method can be applied to a variety image database where the color of target object is essential in the identification.

8. ACNKOWLEDGEMENTS

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9. REFERENCES

[1] J.Yamane, M.Sakauchi, "A Construction of a New Image Database System which Realizes Fully Automated Image Keyword Extraction," IEICE Trans. on Information and systems, E76D: (10), pp.1216-1223 Oct. 1993.

[2] W.Niblack et al., "The QBIC Project: Querying Images by Content Using Color, Texture and Shape," Proc. SPIE Conf. Storage and Retrieval for Still Image and Video Databases, Soc. of Photo-Optical Instrumentation Engineers, Bellingham, Wash., 1993, pp.173-187.

[3] S.Belongie et al., "Color- and Texture-Based Segmentation Using EM and Its Application to Content-Based Image Retrieval," Proc. Sixth IEEE Int'l Conf. Computer Vision and Pattern Recognition, IEEE Computer Soc. Press, Los Alamitos, Calif., 1998, pp.675-682.

[4] P.Kelly, M.Cannon, and D.Hush, "Query by Image Example: The CANDID Approach," Proc. SPIE Conf. Storage and Retrieval for Still Image and Video databases, Vol.2420, Soc. of Photo-Optical Instrumentation Engineers, Bellingham, Wash., 1995, pp.238-248.

[5] S.Nakamura, M. Sawada, Y. Aoki, P.Hartono, S.Hashimoto, "Flower image database construction and its retrieval," Proceedings of the 7th Korea-Japan joint Workshop On Computer Vision, pp. 37-42, 2001.

[6] The Flower Image Database Server *"HANAMARU"*
URL: http://hanamaru.shalab.phys.waseda.ac.jp/

[7] D. Rumelhart and J. McClelland 1986, "Learning internal representation by error propagation," Parallel Distributed Processing 1, 318-362, MIT Press.