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Trademark Image Retrieval System

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요 약

An image retrieval system is a piece of software that searches identical or similar images based on various image-specific features. This paper proposes a trademark image retrieval system that uses image colors and forms. In the proposed system, input images are segmented into several other regions, and color distribution histograms for different regions are extracted for use as color information. The proposed system uses form information through the preprocessing process such as boundary surface extraction, centroid extraction, angular sampling and, and through calculating the sums of the distances between the centroid and the boundary surfaces, standard deviations, and the ratios between long and short axes. Like this, the color and form information extracted is used to perform retrieval through measuring similarity

▸ Keyword : Trademark Image Retrieval System, Boundary Surface Extraction, Centroid Extraction, Angular Samplin

Ⅰ. Introduction

Generally, there has been much research on technologies involved in storing text data in the database and searching text data. On the contrary, effective query and retrieval techniques regarding multimedia data such as image, video, and sound still fall short, although a lot of research into those fields is currently underway. Images, the most widely used multimedia data, have many limitations in terms of time and space due to diverse storage and output methods, large capacity, and non-linearity with respect to the expression of spatial relations.

There are basically two methods of searching images that have a number of inherent limitations in terms of time and space. The one is a text-based retrieval method and the other is a content-based retrieval method[1,2].

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In the case of the former, text information such as file name, caption, keyword, etc. is used as a retrieval index, and such text information is used in performing retrieval. However, the text-based retrieval method has the disadvantages that it has difficulty in automatically creating keywords for different images as well as in extracting features that are used to distinguish among various types of images.

Practical image retrieval systems that enable you to store large-capacity image data in databases and allow for effective retrieval aren't yet widely deployed. As such, continued research into the implementation of more effective image retrieval systems needs to be conducted.

Retrieval of images from a large-capacity image database is subject to a number of limitations. Therefore, a more effective method for extracting visual features such as color, texture and form needs to be in place.

In this paper, a trademark image retrieval system that chooses color and form information among various types of image feature information is described. Chapter 2 describes the features of current trademark image retrieval systems. In Chapter 3, the proposed trademark image retrieval system is described. Chapter 4 shows experiment results, and Chapter 5 concludes this paper.

2. Related Research

A lot of research and development into image retrieval systems has been conducted thus far and is currently underway. The following are some of the most widely deployed image retrieval systems.

First, STAR[3] has four types of trademark images: text image; image trademark; text- and image-based trademark; and text-, image-, and background-based trademark. These trademark images are processed in the following order: image editing ? normalization ? segmentation ?feature extraction. In this paper, the Fourier conversion of boundary surfaces and the moment invariability of original images are used as form information, which feature invariability with respect to image movement, changes in image size, and image rotations. However, such methods require a lot of processing time and have the disadvantage of being recorded in the upper position despite the difference in form[4].

Second, EXCALIBUR[5] provides the image retrieval demo version on the Web. As feature information, this image retrieval system uses five features such as color, form, texture, brightness, and aspect ratio, and allows weights between 0 and 5 for different feature items to be applied.

Finally, QBIC(Query By Image Content)[5] provides the stamp retrieval demo version on the Web. This retrieval system uses color information, histogram, and texture as image feature information on color locations within an image as well as ratio information containing colors is used as color information. It also offers the opportunity for users to enter color information when they make queries. While the iris-pupil center detection technique [6], one of the most urgent outstanding issues that need to be addressed immediately for the purpose of iris recognition, is available with varying degrees on the Web, studies on the detection and tracing of feature spots of an object [7] are being conducted in order to improve the quality of communication services.

3. Trademark Image Retrieval System

As a means of implementing an effective trademark image retrieval system, the following restraints are allowed in this paper:

(1) No image movement, change in image size, and image rotation are taken into account.
(2) Experimental images are limited to 256-color images and only cover closed curve type images.
(3) In the case of images consisting of two or more objects, the image with a larger object is processed as the representative image.

(4) It is assumed that each image is saved in the database.

As illustrated in Fig. 1, the trademark image retrieval system is largely divided into the following: the process of extracting the color information on original images; and the process of extracting form information. The form information extraction process is divided into the preprocessing process for feature extraction and the process for extracting feature information from pretreated images.

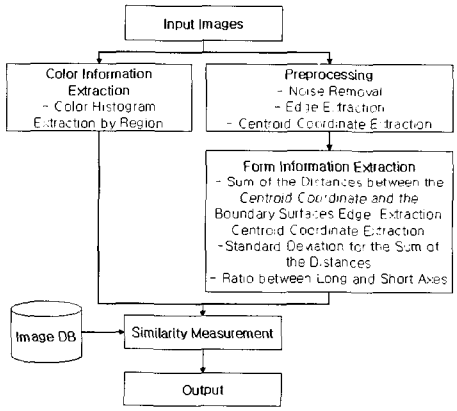


Fig. 1 Trademark Image Retrieval System Configuration

As a means of extracting color information, the method based on color distribution by region is used. As shown in Fig. 2, the input images are segmented into five regions of the same size. Based on the fact that the eyes of human beings are sensitive especially to the distribution of relatively large colored organs, and are focused on the center of an image, the region S5 is positioned in the central region, as shown in Fig. 2. The region S5 overlaps with other four regions for the purpose of selecting a color which takes a greater part of the central region of the images [8]. Histograms for five different regions are used as color information.

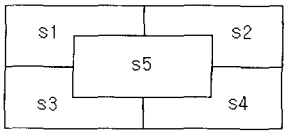


Fig. 2 Five Image Regions

As a preprocessing process for form information extraction, input images are converted into gray images and then into binary images using the threshold value. Boundary surfaces are then extracted using the 3 x 3 mask and the outermost boundary surfaces are extracted. The centroid of an object forming the boundary surfaces is obtained using Expression (1)[9].

$$M = \left(\frac{\sum_{i=0}^{n} x_i}{n}, \frac{\sum_{i=0}^{n} y_i}{n} \right) \quad \cdots\cdots (1)$$

In Expression (1), 'M' refers to the centroid, 'n' to the number of pixels forming the boundary surfaces, and 'xi, yi' to the position coordinate of the pixels forming the boundary surfaces.

What comes next is the process of extracting limited information amounting to 360 by means of angular sampling [9,10,11] for the boundary surfaces, as stated in Expression (2).

$$\theta_i = i \times 2\pi / N \quad for \ i = 1,...,N \quad \cdots\cdots (2)$$

Here, 'N' refers to 360 degrees. To identify pixel information on the boundary surfaces, a very limited amount of pixel information (amounting to 360) is extracted. Whereas this method has the advantage of shortening calculation time, it has the drawback of providing low accuracy in terms of form information.

What follows is the process of finding the sums of the distances between the centroid and the boundary surfaces among sampled pixels through the use of Expression (3).

$$I = \sum_{i=1}^{N} F(i) \quad \cdots\cdots (3)$$

Here, 'N' refers to the number of pixels on the sampled boundary surfaces amounting to 360, and 'F(i)' refers to the distance between the centroid and each pixel. What follows is the process of calculating the standard deviation for the sum of the distances through the use of Expression (4).

$$V = \frac{\sum_{i=1}^{N} (F(i) - D)^2}{n} \quad \cdots\cdots (4)$$

Here, 'D' refers to the sum of the distances from the images saved in the database. Finally, the ratio between the long and short axes of the image is calculated using Expression (5).

$$R = \min[F(i)] / \max[F(i)] \quad \cdots\cdots (5)$$

Here, 'min{F(i)}' refers to the smallest among the sums of the distances among the sampled pixels amounting to 360 and 'max{F(i)}' to the largest.

4. Experiments

For the purpose of this paper, experiments were performed using Pentium 4 1.3GHz CPU and Visual C++6.0 running on Windows XP. We experimented on 200 closed curve type images to obtain required data.

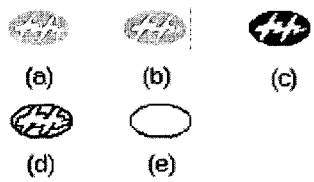
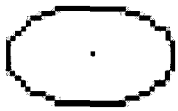


Fig. 3 Preprocessing Process

Fig. 3 shows the preprocessing process in which 'a' refers to the input images; 'b' to the 256 gray images converted from the 256 color images; 'c' to the binary images converted from the 256 gray images by means of the threshold value; 'd' to the boundary surfaces of the binary images extracted using the 3 x 3 mask; and 'e' to the outermost boundary surfaces extracted from the boundary surfaces of the image.



I=48.034, V=0.018, R=0.511
Fig. 4 Centroid

Fig. 4 shows the dot extracted from the coordinate position of the centroid (See 'e' in Fig. 3). The figure also shows the result of calculating the sums of the distances between the centroid and different outer lines, standard deviation, and the ratio between long/short axes.

In Fig. 5, each color histogram represents the features of different local color distributions (See Fig. 1) in the image 'a' (See Fig. 3).

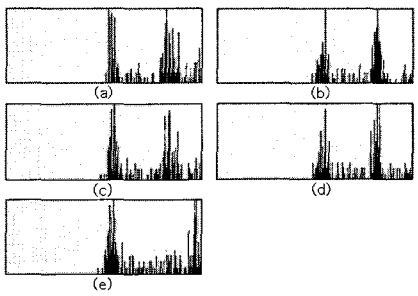


Fig. 5 Five Color Histograms by Region

The screen, as shown in Fig. 6, is used as a query wherein the weights for color and form between 0 and 5 are applied to perform color-based retrieval as well as content-based retrieval.

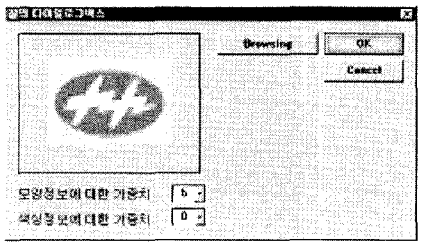


Fig. 6 Image Retrieval Query Box

Fig. 7 shows the arrangement of images in decreasing order of similarity, from left to right, top to bottom, as a result of making queries, as illustrated in Fig. 6. In this case, the weight applied to form information is 5 and the weight applied to color information is 0.

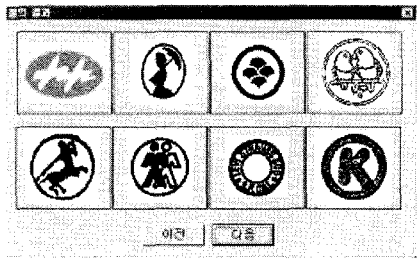


Fig. 7 Image Retrieval Query Result

As the proof for the effectiveness of the experiment result, the calculation result to which the following expression is applied is provided:

$$Recall = \frac{\text{Number of Accurately Retrieved Images}}{\text{Total Number of Relevant Images}} \quad (6)$$

$$\Pr ecision = \frac{\text{Number of Accurately Retrieved Images}}{\text{Number of Retrieved Images}} \quad (7)$$

As a result of performing experiments, the proposed system showed an average recall and precision of 0.67 and 0.81, respectively, proving effective. In Fig. 8 show the distribution of recall and precision on the basis of 20 images out of 200 closed curve type images.

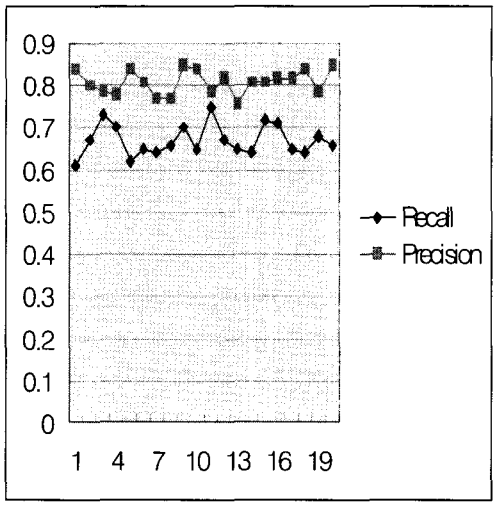


Fig. 8 Distribution of Recall and Precision

5. Conclusion

This paper proposed a trademark image retrieval system based on color and form information. As a means of extracting color information, color distribution histograms by region were used wherein images were segmented into several regions. As a means of extracting form information, the preprocessing process such as boundary surface extraction, centroid extraction and angular sampling, as well as the sum of the distances between the centroid and the boundary surfaces, standard deviation, and the ratio between long/short axes was used. In particular, centroid-based angular sampling contributed to shortening feature extraction and processing time. In addition, the proposed system allowed for performing both color-based and form-based retrieval through application of weights.

In the future, more focus needs to be placed on developing effective image feature extraction and retrieval techniques that enable proactive handling of not only the movement and rotation of images but also changes in image.

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