Trademark Image Retrieval using Angular Radial Histogram Approach on Object Region

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Abstract

Trademarks are valuable things for companies and organizations around the world. Trademarks can represent standard, quality, service and background image of the companies or the organization. Due to the increasing number of business companies and also trademarks, it is important to have a computerized system that can detect and extract the similarity of trademarks because a new trademark must be different from other registered trademarks. Content-Based Trademark Retrieval (CBTR) can deal with matching and detection of similar and infringement trademarks. In this paper, we propose a region-based shape descriptor that combined Angular Radial Approach (ARA) and histogram of object region of trademark image. To confirm the proposed method, the retrieval results are shown according to the rank values and by using the popular dataset.

Keywords: Content-Based Trademark Retrieval, Information Retrieval, Shape descriptor, Angular Radial Approach

1. INTRODUCTION

Trademark registration is an important factor for business companies and organization around the world. A trademark can represent 'symbol of quality' and can distinguish which goods or services come from. All of the companies and organizations appreciate their trademarks because it is priceless for them. Due to the increased number of companies in business world, having a unique trademark for them is important matter.

A trademark is simply, that may be composed of text, graphic or may be a combination of both. Figure 1 shows the types of trademark. The important thing is that a new trademark must be distinct from other registered trademarks. Nowadays, the trend in TIR system tends to check not only for similarity measurement but also for detecting trademark infringement case[1].

A lot of research have made many kinds of algorithms and applications that address to help Trademark Image Retrieval (TIR). All of the system goal is to have better retrieval performance.

Fig. 1. Real world trademarks of text, design and both types

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A good TIR system has the ability of detecting similar trademarks and also infringement trademarks. Content-Based Image Retrieval (CBIR) also known as Query by Image Content[2] (QBIC) trying to find an image according to image contents rather than metadata such as keywords or tags that are associated with the image. CBIR system mainly extract content features such as color, texture and shape. Each feature has their unique properties and combining these features can result in better performance. Figure 2 shows the architecture of CBIR system.

In our system, we concentrate only on the shape feature dealing with region based approach. Shape can give nature essence of image and therefore can capture image appearance. We propose a shape method that can be used in TIR system. The rest of the paper is organized as follows. In section 2, we review related works on TIR system and shape image retrieval. Section 3 provides methods and manner applied in our system. In section 4, experiment results are presented. Conclusion and discussion are presented in the section 5.

2. RELATED WORKS

Several research have addressed and improved on the trademarks retrieval. According to the advance of CBIR system, many have attempted to apply on the area of Content-Based Trademark Retrieval (CBTR).

Some researchers attempted by using Zernike moments for shape feature and introducing the technique of visual salient feature for CBTR system[3]. This approach was very promising and indicated the researchers who would like to apply and modify Zernike moments in later research.

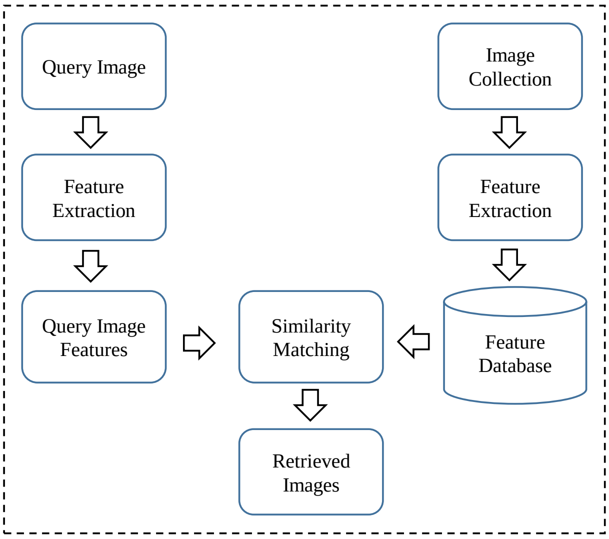


Fig. 2. An Architecture of CBIR System

For a shape descriptor, it must have the properties of translation, rotation and scale invariant. Many shape descriptors tested on MPEG-7 CE Shape-1 dataset and retrieval results are presented[4]. Shape descriptor can be divided into contour-based approach and region-based approach. For contour-based approach, it take operation on the boundary of the image and features are extracted. One of the contour-based approach that applied Angular Radial Partition (ARN) and then using Fourier transform on the extracted features to have invariant features[5].

A TIR system proposed with combining global and local features approach[6]. Zernike moments are extracted for global features and local features represented by calculating curvature feature and distance to centroid feature. For feature matching, matching process is separately processed on global and local and then employed on new propose measure, two-component feature matching.

Another approach also applied the integration of global and local features[7]. For global features, Zernike moments are extracted and SIFT[8] descriptors are extracted for local features. A modified histogram approach for TIR is presented in[9]. For feature vector, a combination of angle histogram and distance histogram are used.

To improve the TIR system, one of the important thing is to have the publicity available datasets for researchers. Some datasets are not publicity unavailable. So, providing a benchmark trademarks dataset and tested with existing approached that are focused on TIR retrieval system[1] and showing that existing methods are not well performed on that dataset. Tested feature descriptors are color histogram, gradient orientation histogram, local binary pattern, shape context, SIFT and triangular SIFT. The experimental results are shown with precision-recall graph of each descriptors.

3. PROPOSED METHOD

We propose a method by using Angular Radial Approached and horizontal and vertical histogram count of the object region in the image are employed. Figure 3 describes the proposed system architecture. First, the features are extracted from all images in the dataset, forming feature vectors and stored in a database. When an input query is applied, features are extracted from the query and then similarity measures between query image and all images in the dataset to be done. The result are shown to user according to the rank value.

3.1 Preprocessing

Before processing on images, it is important to make preprocessing step. Image preprocessing step is important for later operation such as feature extraction and matching. We experimented our system on MPEG-7 CE Shape-1 Part B dataset. The dataset contains 1400 shape silhouette images. It is divided into 70 classes and each class contains 20 images with similar structure. There are strong variations and some inconsistent within each class. This made difficult for every shape descriptor to have 100% accuracy[4].

The preprocessing step on the dataset is following: 1) Cropping the object region in image, and 2) Resizing the crop image into *n* x *n* equal size for having uniform structure on the dataset. When resizing image, some of the image are not fitted in *n* x *n* pixel range. This is because of width or height are not equal and some of size may be too large or small. For that kind of image, we padded with zero values for the require space and put the image in center position. Figure 4 show the preprocessing step.

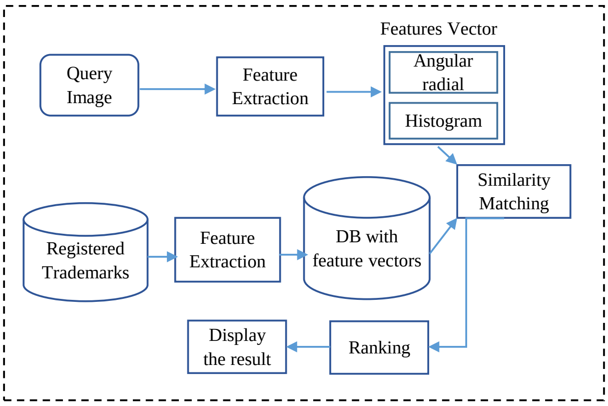


Fig. 3. Proposed System Architecture

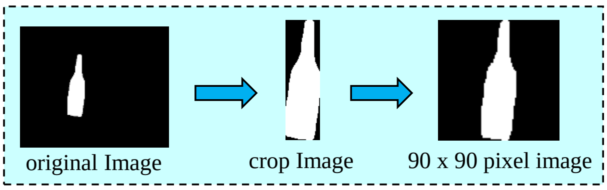


Fig. 4. Image Preprocessing Step

3.2 Feature extraction

The feature extraction stage is important and crucial that can impact retrieval performance of the system. In our proposed system, we extracted mainly two feature:

(i) Angular Radial histogram feature, and
(ii) Horizontal and vertical histogram of the image.

(i) Angular radial feature

In preprocessing step, we manage each image of size n x n. Let $(c_x, c_y) = (n/2, n/2)$ be the center point for image. First, we create a binary mask for each sector according with arbitrary radius. In experiment, we apply image size to 90 x 90 pixels size and there are k radius: $r_1, r_2, ..., r_k$. Figure 5 shows sector masks according with the radius. And then, we make a mask operation on an image to extract pixel count of each angular sector region and stored as feature vector. Let $H_{A,\theta}$ represent the histogram bin of each sector according with each radius:

$$H_{A,\theta}(R) = H_{A,\theta}(R) + 1 \quad (1)$$

where r and i are the radius and the number of object pixel in i^{th} radius. The angle θ is range between sectors of 45° each. Figure 6 shows the example of mask operation. When query image is applied, we also considered for flip image. We extract features for both query and horizontally flip image. The cyclic shifting for 45° rotation invariant method[10)] is applied in our system. This method is applied on original query image and flip image.

(ii) Horizontal and vertical histogram

For the second feature, we extract horizontal and vertical histogram from the image. For horizontal histogram, we count the object pixel row by row and for vertical histogram, counting column by column and store result pixel count in each respective bin.

Let $H_H(I)$ and $H_V(I)$ denote the horizontal and vertical histogram of image I, it can be expressed as:

$$H_H(I) = [h(i,1), h(i,2), ..., h(i,n)] \quad (2)$$

$$H_V(I) = [h(j,1), h(j,2), ..., h(j,n)] \quad (3)$$

where n, i and j are the number of n rows and n columns and the number of pixels in the i^{th} row and j^{th} column of the image.

When query image is applied, we extracted the horizontal and vertical histogram features for original image. And then, we compute for rotated version of 90, 180 and 270 degrees of query image. As like in angular radial approach, we also consider flip image and features are extracted. Cyclic shifting is also applied on extracted features. By doing this, having some rotational invariant can approved in matching process.

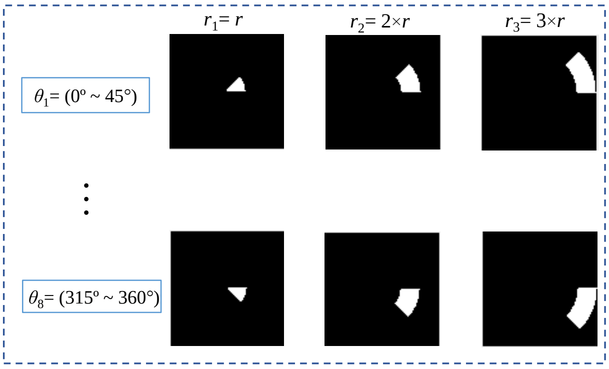


Fig. 5. Sector Mask According with Radius (here r = 15 pixel)

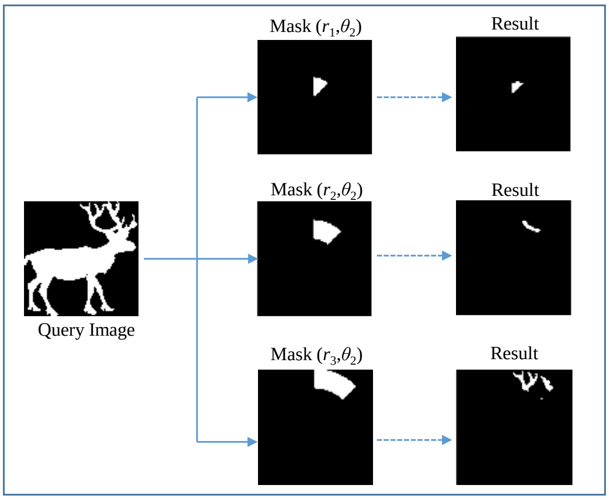


Fig. 6. An Example of Mask Operation within $\theta_2 = (45° \sim 90°)$ with r_1=15, r_2=30, r_3=45

3.3 Similarity Matching

For the similarity measure, we apply Euclidian distance between query feature vector and database feature vector. This method is employed on both extracted features of original image and flip image. Let d be the Euclidean distance between query image and database image:

$$d(x_q, y_t) = \sqrt{(x_q - y_{t1})^2 + (x_q - y_{t2})^2 + ... + (x_q - y_{tn})^2} \quad (4)$$

where
x_q= query features vector and
y_t = database features vector, t = 1, 2,….., n (total number of images in the database).

When we compute Euclidean distance, we take minimum value resulted from query and database image or flip image and database image. We compute distance measure separately for each features. Let E_D represent the total value of all features Euclidean distance values:

$$E_D = E_A + E_H + E_V \quad (5)$$

where E_A, E_H, E_V represents Euclidean distance values for angular radial features, horizontal histogram and vertical histogram, respectively. Finally, the result are shown with rank value that are sorted Euclidean values in ascending order.

4. EXPERIMENTAL RESULTS

We test our system on MPEG-7 CE Shape-1 Part-B dataset. The dataset has a lot of strong variation within each class. Figure 7 shows some variation images in the dataset. In order to know the system performance, we used bulls-eye test[11]. All the images in the dataset are used as a query and the top rank of 40 images are returned.

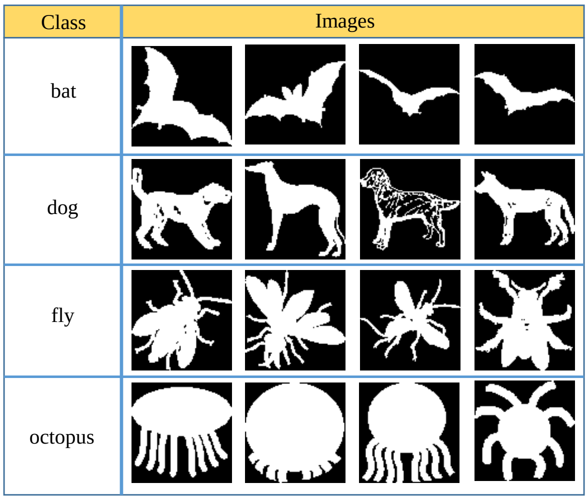
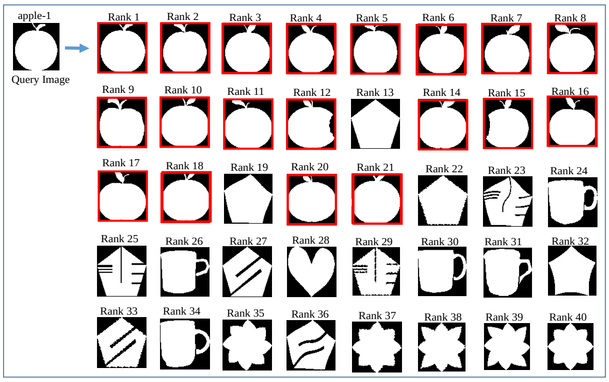


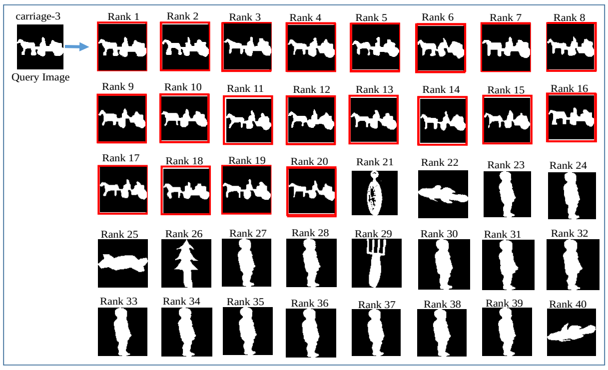
Fig. 7. Some Variations in MPEG-7 CE Shape-1 Part-B Dataset

Figure 8 (a), (b), (c), (d) show the some retrieval results (red rectangle are the correct matches). The maximum number of correct matches for each query is 20, so, the number of correct matches for whole dataset is 28000 (1400 x 20). Table. 1 illustrates the number of matches that are derived from all classes in the dataset.

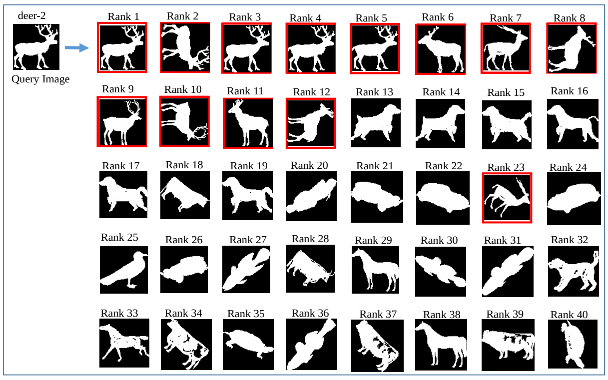
We found that some classes in the dataset are sensitive to the system performance evaluation. Some of these classes are describe in Figure 9 and 10. When querying these kind of image, the performance is decreased and the distance between query and database images are too far. So, the images in the same class are left behind than the images that are not in the same class. In Figure 9 of beetle class, some image has more pixel than others. These fact can impact our system performance. Also in Figure 9 of dog class and guitar class, the absence of some pixel in the image has also made greater distance between query and database images. In Figure 10(b), although the system can retrieve the similar images, other images belonging to same class are far from the list. For improvement, we will continue to deal with such classes in our future works. The number of correct matches for each class is shown in Figure. 11. Overall, our system get a bulls-eye scores of **63.91** %.



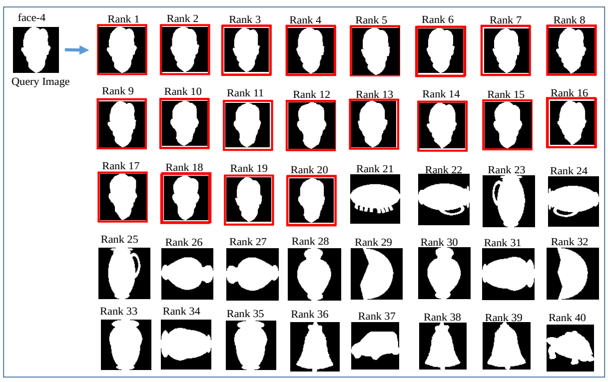
(a) apple-1 query, #(relevant images) = 19



(b) carriage-3 query, #(relevant images) = 20



(c) deer-2 query, #(relevant images) = 13



(d) face-4 query, relevant images = 20

Fig. 8. Some Experimental Results

Table 1. Number of matches (Among all classes)

Accuracy Rate	No. of Classes
100%	7
99% ~ 90%	7
89% ~ 70%	15
69% ~ 50%	23
49% ~ 10%	18

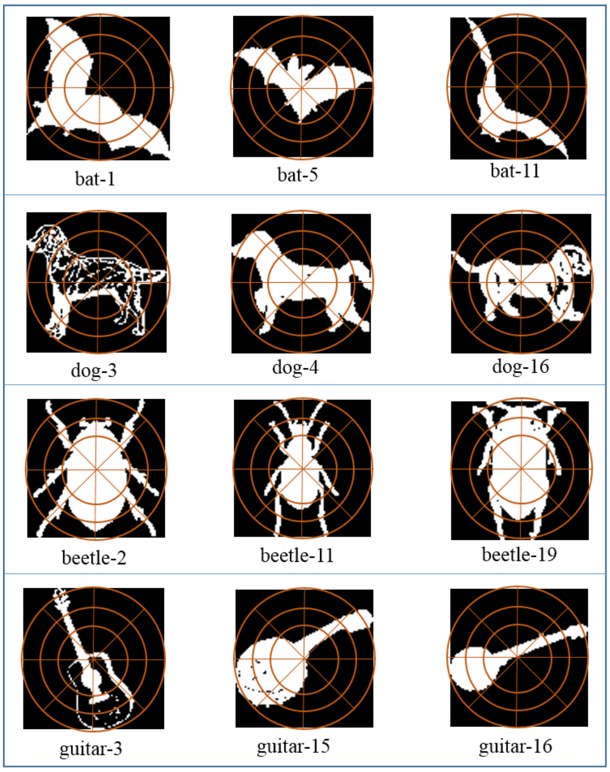
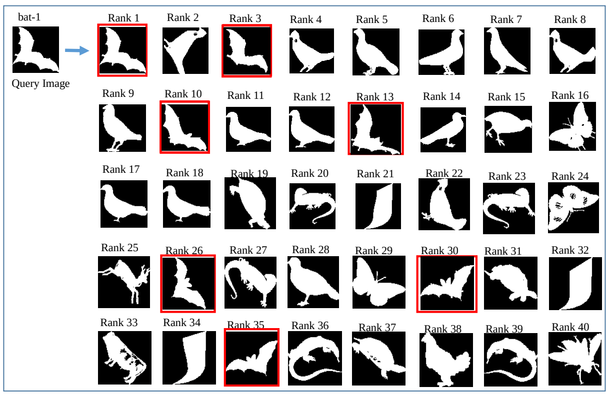
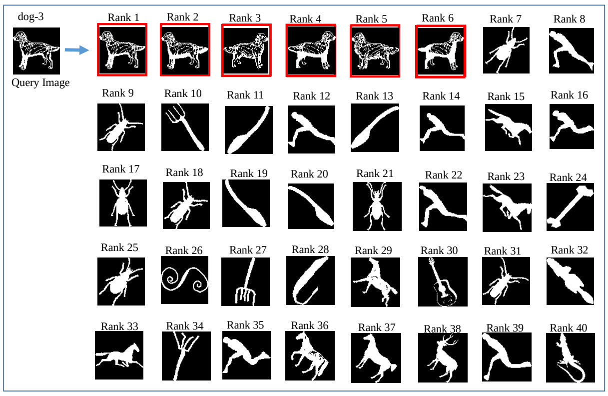


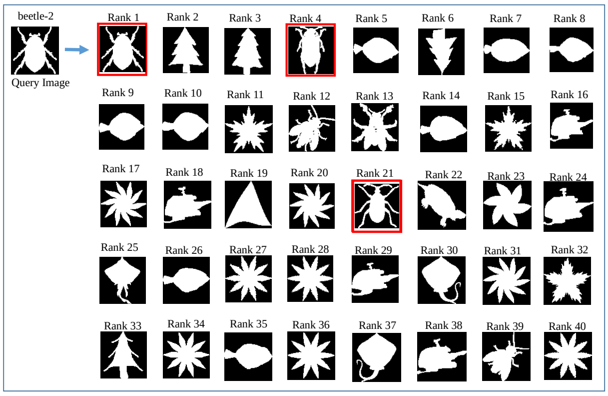
Fig. 9. Example of Some Class that Decrease System Performance



(a) bat-1 query, #(relevant images) = 7



(b) dog-3 query, #(relevant images) = 6



(c) beetle-2 query, #(relevant images) = 3

Fig. 10. Some retrieval results

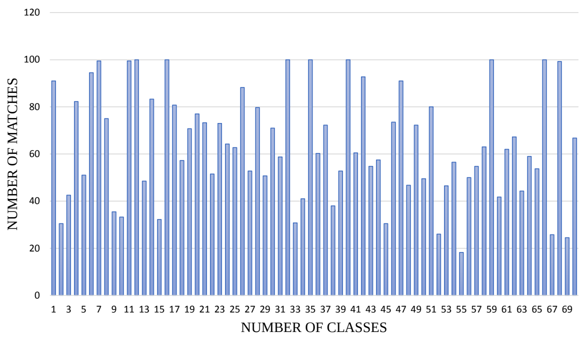


Fig. 11. Retrieval Accuracy on Each Class

5. CONCLUSION AND DISCUSSION

In this paper, we proposed a region-based shape descriptor to apply in TIR system. Angular radial and histogram of horizontal and vertical features are extracted from the image for feature vectors. After calculating similarity, image are shown according to the rank values. The region-based shape descriptor can describe interior details of the image while contour-based shape descriptor can give the outline details of the image. In our proposed system, angular radial features and also horizontal and vertical features work well when query image and database image are in appropriate position.

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