

TRADEMARK RETRIEVAL USING CONTOUR-SKELETON STROKE CLASSIFICATION

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ABSTRACT

In this paper we propose a method to retrieve trademarks using query by sketches. The trademark images are first filtered to remove noise. Then each filtered image is segmented into regions based on pixel connectivity. For each region, a decision is made about whether thinning or edge extraction should be applied. Afterwards stroke tracing is performed to extract the sketch of the trademark. The user can then provide a query sketch that will be compared with those extracted sketches from the database trademark images in order to retrieve similar trademarks. Query by sketch is useful in the trademark retrieval application since the user can search for similar trademarks by providing a rough sketch instead of keywords. Our approach saves a lot of labor because it does not require the trademark database to be manually annotated with keywords.

1. INTRODUCTION

In traditional trademark retrieval systems, the trademarks are first annotated with keywords that are then used for retrieval. However, this process requires a lot of manual labor in order to assign keywords. Also, the annotation for the same trademark may not be consistent with different users. As a result, it is more desirable to allow the user to input a query by providing a rough sketch and then the system is smart enough to automatically extract features from this query sketch and use them for comparison in order to search for similar trademarks in the database.

Query by sketch falls into the category of content-based image retrieval (CBIR). QBIC [1] was the first CBIR system and it also supports query by sketch. Global features such as area, circularity, eccentricity, etc., are used in shape matching. Matusiak et al. [2] proposed another approach to sketch-based images database retrieval by using Curvature Scale Space (CSS) to match contours. In Sciascio and Mongiello's system [3], the Fourier descriptors are used for shape comparison and they use relevance feedback to improve the retrieval performance for content-based image retrieval over the web. All the above systems assume that the query consists of a single shape.

Some trademark retrieval systems have been proposed. The Query by Visual Example (QVE) reported by Kato et al. [4] used correlation of the corresponding blocks between the query image and database image for evaluating similarity. In the TRADEMARK system [5] the graphic features (GF) consist of spatial distribution, spatial frequency, local correlation and local contrast measure are used. In Ciocca and Schettini's work [6] on trademark retrieval, moments, histogram of edge directions and wavelet coefficients are used as the features. The Zernike and Pseudo-Zernike Moments are used in Kim and Kim's content-

based trademark retrieval system [7]. Ravela and Mammatha used curvature and phase histogram for trademark retrieval [8]. These systems typically compute the *global* similarity between the query and the database trademark. Therefore, the retrieval system will not be robust if the query is merely a rough sketch or if the query consists of multiple components.

In the ARTISAN project [9], the boundaries of the components of a trademark are extracted and analyzed. The similarity is based both on shape matching for each component as well as the distance between the centroids of the corresponding components. The content-based retrieval system of trademark images in Alwis' thesis [10] also performs multiple component matching by categorizing each component into a line, an arc or a closed figure. The component features include end-point proximity, parallelism, co-linearity and co-curvilinearity. The difference between their approaches and our proposed approach is that we categorize the components (strokes) into primitives such as circle, polygons and lines, each with a confidence measure. The primitive and the associated confidence are used for matching two corresponding strokes. For computing the final similarity between two sketches, both the matching score between each corresponding strokes as well as the spatial order between the strokes are considered.

In this paper we propose a method to retrieve trademarks using query by sketches. The trademark images are first filtered to remove noise. Then the filtered image is segmented into regions based on pixel connectivity. For each region, a decision is made about whether thinning or edge extraction is applied since one method is preferred to the other under different situations. For example, if edge extraction alone is used to extract the contour, then both the trademarks in Figure 1(b) and Figure 1(c) are considered to be the same as the trademark in Figure 1(a) although they have different solid regions. If thinning alone is used to extract the skeleton, then the trademark in Figure 1(d) is considered to be very similar to the trademark in Figure 1(a). This gives us the motivation of classifying a region with contour vs skeleton representation. Afterwards the contour-skeleton classification, stroke tracing is performed to extract the sketch. The user can provide a query sketch that will be compared with those extracted sketches from the database trademark images in order to retrieve similar trademarks.

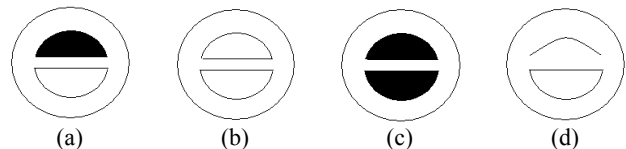


Figure 1 Example trademarks

This paper is organized as follows. In Section 2 we provide the system description of our approach. In Section 3 we describe the user interface. In Section 4 we describe the experiment and presents the results. The conclusions and future work are in Section 5.

2. SYSTEM DESCRIPTION

Figure 2 shows the diagram of our system. The input query can be either a sketch drawn by the user or a trademark image. For the trademark image in the database or in the query, it is first filtered to remove the noise. The sketch is then extracted from the filtered image. Afterwards, the features are extracted from the sketch and used to compute the similarity between the query and the database trademarks. The similarity scores are ranked and the database trademarks with the highest ranks are retrieved. Each module will be explained in further details in the following subsections.

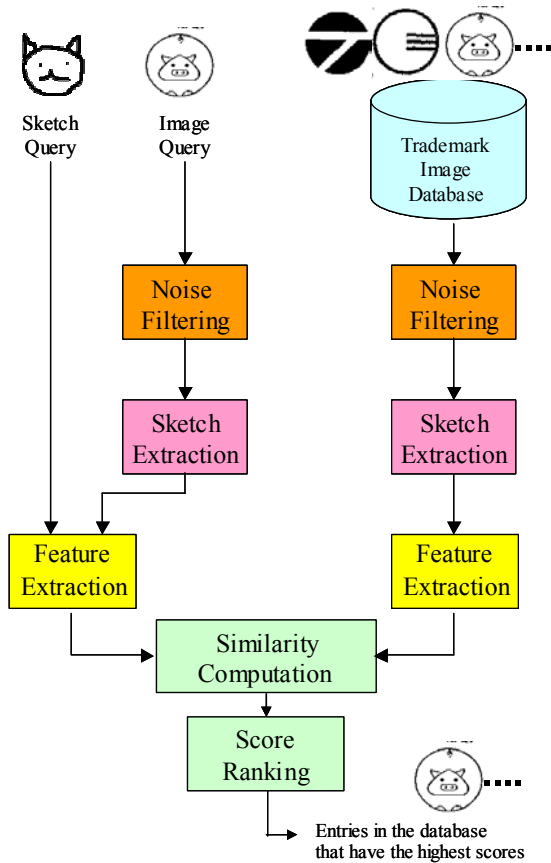


Figure 2 System diagram of our approach

2.1 Noise Filtering

The trademarks are scanned binary images in which holes and spots may be presented as noise. Some filtering is applied in order to reduce such noise. We apply four 3×3 masks separately and the resulting image is obtained by combining the filtered output. Figure 3 shows an example of the images before filtering and after filtering, together with the resulting extracted sketch. It can be seen that the extracted sketch is much better with noise filtering.

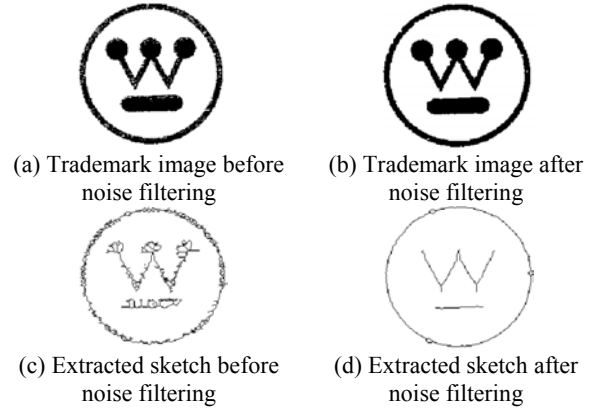


Figure 3 Effect of noise filtering

2.2 Sketch Extraction

The filtered image is first segmented into regions according to the pixel connectivity. For each region, either edge extraction is performed to extract the contour or thinning is performed to extract the skeleton. It is advantageous to use different methods under different situations. For example, for a solid region in which the shape conveys a lot of visual information, it is better to perform edge extraction to that region to extract the contour. On the other hand, for a region that contain curves, thinning should be performed to that region to extract the skeleton that is a better representation. To determine whether contour or skeleton is a better representation for a region, we look at the distribution of the distance between each pixel of the skeleton and the nearest pixel of the contour. For example, we would like to perform thinning for a region if the distance from the skeleton to the nearest boundary pixel is small and if this distance does not vary too much for different skeleton pixel values as shown in Figure 4(b). On the other hand, if there is a large variation in the distance from the skeleton pixel to the nearest boundary pixels, then edge extraction is preferred to extract the contour as shown in Figure 4(a). Therefore, the mean and variance of that distance distribution is used for classifying a region into skeleton-best or contour-best representation. After performing edge extraction or thinning for all the regions, the strokes are traced by examining the pixel connectivity starting from the end points. This results in two types of strokes: contour strokes which are obtained by edge extraction and skeleton strokes which are obtained by thinning.

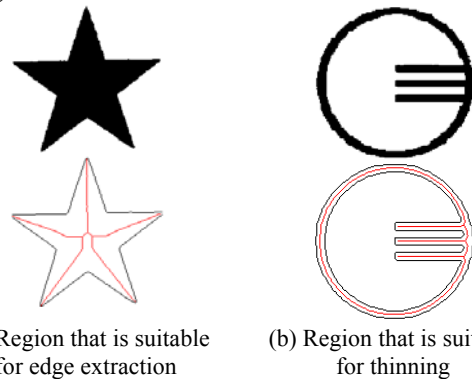


Figure 4 Example regions that are suitable for edge extraction and for thinning, and their corresponding skeleton superimposed on the contour

2.3 Feature Extraction

Once the strokes are identified, features are extracted from each stroke based on the scheme we proposed in [11]. These features are used for shape estimation to determine the likelihood that each stroke falls in each primitive shape type: line, circle and polygon as shown in Figure 5. A confidence measure that takes the value between 0 and 1 is assigned for each stroke with respect to each shape type.

Shape Type	Features
Line	<ul style="list-style-type: none"> - height of triangle formed by the two end points and each sample point - ratio between the sum of distances of each pair of neighboring points and the distance between end points
Circle	<ul style="list-style-type: none"> - perimeter efficiency - area between the number of points of the convex hull and the number of point of the original stroke samples - angle that the stroke samples go around the center of the stroke
Polygon	<ul style="list-style-type: none"> - ratio between area formed by stroke samples and area of its convex hull - area between the number of points of the convex hull and the number of point of the original stroke samples - angle that the stroke samples go around the center of the stroke

Figure 5 Shape types and the corresponding features

2.4 Similarity Computation

The matching (similarity) score between the strokes is calculated after finding the correspondence between the query strokes and the database strokes based on both the spatial order of the strokes in each direction and the feature distance of the strokes. Two strokes will not be considered similar if they are of different types. For example, a contour stroke (obtained by edge extraction during the sketch extraction) is considered to be dissimilar to a skeleton stroke (obtained by thinning in the sketch extraction). The overall similarity score between two sketches is the sum of the similarity between the corresponding matched strokes and the similarity between the spatial relation for each pair of the matched strokes, subtracted by the cost for the unmatched strokes. A more detailed description of the similarity computation module can be found in [11].

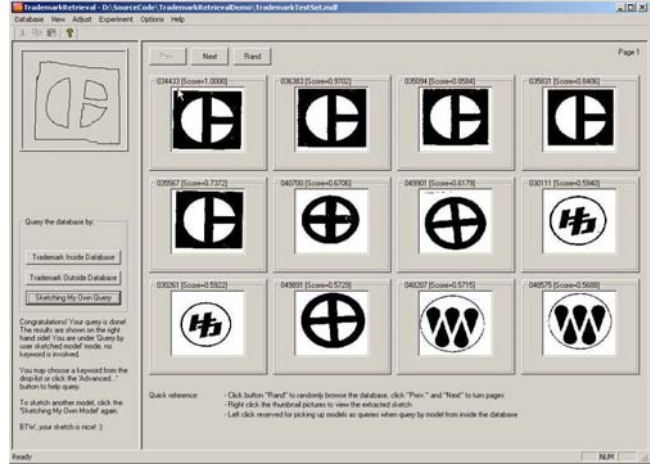


Figure 6 The user interface with t query by sketch

3. USER INTERFACE

Our trademark retrieval interface is shown in Figure 6. After the user selects a database a trademarks, he/she can browse through the trademarks. A window will pop up after the user right clicks on the trademark image and the corresponding sketch extracted for that trademark will be shown. Moreover, he/she can click on the trademark to select that trademark to be the query and then trademarks in the database that are similar to the query will be retrieved. The query is shown on the frame in the left hand side. The twelve trademarks that have the highest ranks according to the similarity score are shown on the frame in the right hand side. In addition to trademark image, the user is also able to provide a sketch as a query, and the trademarks whose corresponding extracted sketches similar to the query sketch are retrieved and ranked as shown in Figure 6. Note that the query is merely a rough sketch yet the system is able to retrieve all the relevant trademarks with the highest similarity scores.

Method	Query	Rank 1	Rank 2	Rank 3	Rank 4
Contour-Skeleton Stroke Classification					
Contour Strokes Alone					
Skeleton Strokes Alone					

Figure 7 Retrieval result under 3 different methods

4. EXPERIMENTS AND RESULTS

Our database consists of close to two thousand trademarks. The ground truth of the database is obtained by classifying the trademarks in groups. Under each group the trademarks are similar to each other and one may be a transformed version of the other such as translation, rotation and scaling or may contain a different noise level. We first analyze the performance of our classifier for deciding whether an edge or skeleton should be extracted for each region. We pick 154 trademarks out of 43 classes as queries and then examine the rankings of the trademarks from the same classes. The same queries were used under 3 different conditions for the sketch extraction: 1) when thinning alone is applied to each region to extract the skeleton strokes; 2) when edge extraction alone is applied to extract the contour strokes; 3) when a classifier is used to decide whether thinning or edge extraction should be performed for each region so that a sketch may consist of both the skeleton strokes and the contour strokes. Some examples of the retrieval result using these three methods are shown in Figure 7. It can be seen that when contour strokes are used alone, solid regions and non-solids regions with similar shapes are treated the same way thus the retrieved trademark of rank 2 is considered to be more similar to the query than the retrieved trademark of rank 3. When skeleton strokes are used alone, solid regions shrink to the skeleton thus the retrieved trademark of rank 3 is considered to be more similar to the query than the retrieved trademark of rank 4. On the other hand, when contour-skeleton stroke classification is used, the system is able to distinguish between solid and non-solid regions even if they have similar shapes. The overall retrieval performance is shown in Figure 8 and is presented as the precision-recall graph [12]. The precision-recall curve with higher precision at the same recall values means better retrieval performance. It can be seen that by classifying the sketch into skeleton strokes and edge strokes, the retrieval performance is better than the other two cases: 1) when thinning alone is performed for all regions to divide the sketch into all skeleton strokes; and 2) when edge extraction alone is performed for all the regions to divide the sketch into all contour strokes.

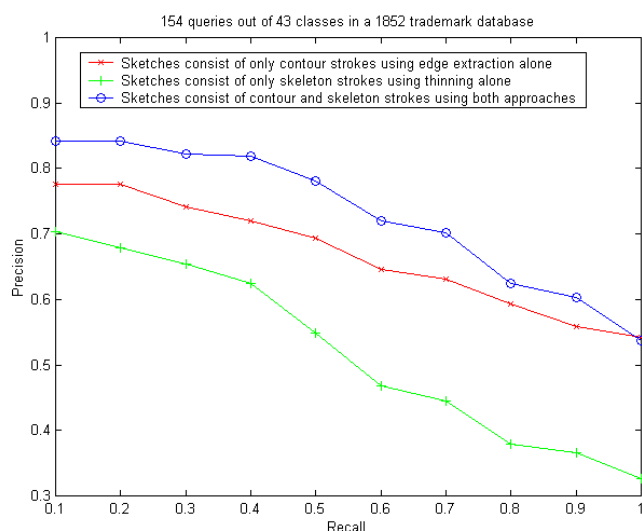


Figure 8 Comparison of retrieval performance

5. CONCLUSIONS AND FUTURE WORK

This paper presents our trademark retrieval system using query by sketch. The retrieval performance is improved when a classifier is used to decide whether edge extraction or thinning should be applied to each region during the sketch extraction such that both skeleton strokes and contour strokes may be present in a sketch and the stroke type is considered in computing similarity between two strokes. Trademark retrieval using query by sketch is useful for people to search for the desired trademark by providing a rough sketch as the query. For future work, we would like to add more functions to our trademark retrieval system to allow users to provide a more complex query.

6. ACKNOWLEDGEMENT

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