Angular Histograms for Shape Retrieval

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Abstract. Distance histograms have been used for Shape Representation and Retrieval [1][2]. In this paper, we have proposed the use of angular histograms for shape representation. We have implemented a system for conducting experiments and evaluating the effectiveness of the proposed method. The proposed method is compared with the distance histograms method. It is found that the proposed method is effective.

1. Introduction

Retrieval of images based on the shape of objects in images is an important part of Content based image retrieval (CBIR). Recently, a contour based method for shape representation and retrieval was used by Fan [1]. The method used by Fan is based on distance histograms. We propose a method based on angular histograms. We also modify the basic method to incorporate coherence. We provide experimental results for the effectiveness of the proposed method. We compare the effectiveness of the proposed method with and without using coherence.

In Section 2, we describe the traditional histogram method for shape representation and retrieval. In Section 3, we describe the proposed method. The Experimental Setup and Results are presented in Section 4. We provide the conclusion in Section 5.

2. Histogram Method

Fan [1] has proposed a method of using distance histograms for shape representation and retrieval. In this method, points are sampled along the shape boundary and their distances are computed from the centroid. The centroidal distances obtained are discretised into buckets. The resulting histograms are used for shape representation and retrieval. A histogram is represented as below.

$$D : (d_0, d_1 \ldots d_{N-1}) \quad \textbf{(1)}$$

where N is the number of buckets in the histograms and d_i is the number of centroidal distances, which were discretised into bucket i.

The distance between two shapes is measured as the Euclidean distance below.

$$Dist(D_1, D_2) = \sqrt{\sum_{i=0}^{N-1} \left(d_{1i} - d_{2i}\right)^2} \quad \textbf{(2)}$$

Each shape has N buckets, from 0 to N-1, d_{1i} is the count in bucket i for histogram D_1 and d_{2i} is the count in bucket i for histogram D_2.

3. Proposed Method

We propose to use angular histograms for shape representation. Points are sampled along the shape boundary. The centroid is computed from the sample points as shown below.

$$x_c = \frac{\sum_{i=0}^{N-1} x_i}{N} \quad y_c = \frac{\sum_{i=0}^{N-1} y_i}{N} \tag{3}$$

We define the major-axis as the line obtained by joining the centroid to the sample point on the shape boundary which is farthest from the centroid.

Angle for each sample point is computed as the angle between the x-axis and the line joining the centroid and the sample point. The angles thus obtained are invariant to scale and translation. However, the angles need to be normalised for rotation. To normalise the angles for rotation, we rotate the shape by angle θ so that the major-axis aligns with the x-axis, where, θ is computed as below.

$$\theta = \arctan\left[\frac{y_m - y_c}{x_m - x_c}\right] \tag{4}$$

where, (x_m, y_m) is an extremity of the major axis on the shape boundary and (x_c, y_c) is the centroid. Normalisation of a shape for rotation is illustrated in the figure below.

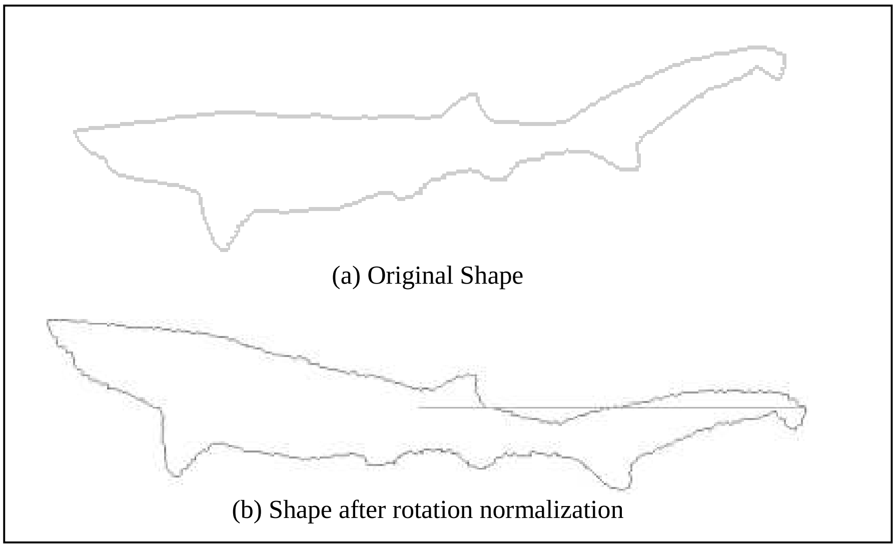

Fig. 1. Rotation normalization

The angles made by sample points on the normalized shape boundary are discretised into buckets. Rotating the shape by angle θ about the centroid will move all points (x, y) on the shape boundary to (x′, y′) as shown below.

$$x' = x\cos\theta - y\sin\theta \tag{5}$$

$$y' = x\sin\theta + y\cos\theta \tag{6}$$

4. Experimental Setup and Results

The SQUID database [4] is used to perform experiments and test the proposed method. This database consists of 1100 fish shapes and has been extensively used by researchers for testing. Indexing and Retrieval experiments are performed on the database for the traditional method and the proposed method. We use 150 sample points along the shape boundary. The shapes are normalized for rotation. After rotation normalisation, angle for each sample point is computed as the angle between the x-axis and the line joining the centroid and the sample point. The angles are discretised into 20 buckets. Indexing is also performed for the distance histograms by discretising the normalized centroidal distances of the sample points into 20 buckets.

Queries are performed using the traditional method and the proposed method. The shapes in the database, which are perceptually similar to the query shapes are noted. We obtain the rank of the relevant shapes for each query, using both methods. The change in the rank of the relevant shapes retrieved is used to compare the effectiveness of the proposed method with the traditional method. We make six queries for both the methods. The six query shapes are shown in Fig. 2 below. The results obtained for the six queries are shown in Fig. 3.

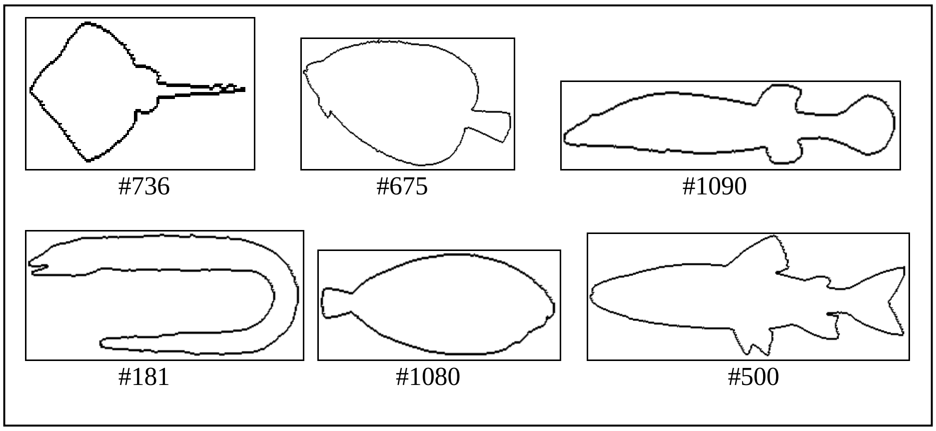

Fig. 2. Query Shapes

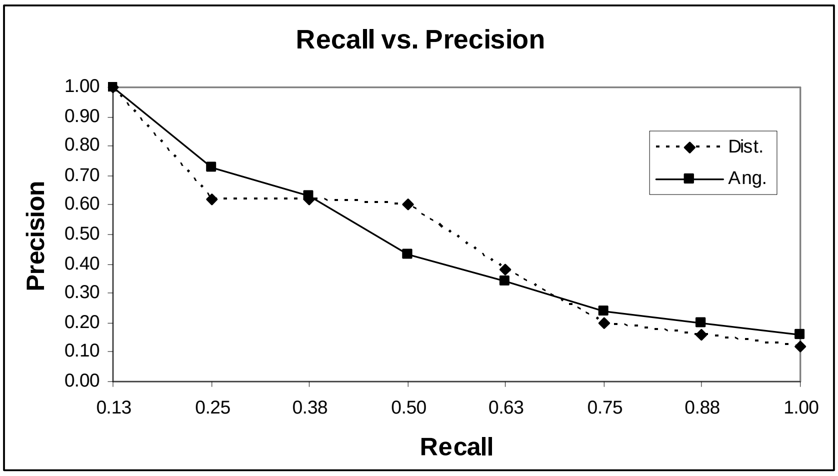

Fig. 3. Average Recall and Precision

5. Conclusion

From the experimental results we see the effectiveness of the proposed method. We note that the effectiveness of the distance histogram method and the angular histogram method is similar. In the future, we will conduct more experiments to see how the performance is affected by discretisation of the angles into more and fewer buckets.

References

1. Fan, S.: Shape Representation and Retrieval using Distance Histograms, Technical Report – University of Alberta (2001)
2. Sajjanhar, A., Lu, G.: Effect of Spatial Coherence on Shape Retrieval, CISST'03, Las Vegas, 23-26 June 2003.
3. Pass, G., Zabih, R.: Histogram refinement for content-based image retrieval, IEEE Workshop on Applications of Computer Vision (1996) 96-102
4. SQUID: http://www.ee.surrey.ac.uk/Research/VSSP/imagedb