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Shape Feature Extraction technique for Content-Based Image Retrieval in Multimedia Databases

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Abstract

Although many content-based image retrieval systems using shape feature have tried to cover rotation-, position- and scale-invariance between images, there have been problems to cover three kinds of variance at the same time. In this paper, we introduce new approach to extract shape feature from image using MBR(Minimum Bounding Rectangle). The proposed method scans image for extracting MBR information and, based on MBR information, compute contour information that consists of 16 points. The extracted information is converted to specific values by normalization and rotation. The proposed method can cover three kinds of invariance at the same time. We implemented our method and carried out experiments. We constructed R*-tree indexing structure, perform k-nearest neighbor search from query image, and demonstrate the capability and usefulness of our method.

1. Introduction

Recently, the character-images have been widely used in many parts of industry. The explosion of using various character-images needs new content-based retrieval technique that can search similar image efficiently. Although the character image is less complex on color, shape and texture than others like nature image, it is not free from high dimensionality. The problem of indexing multimedia database is a high dimensionality. It contains many overlaps in the index structure that decreases search performance. To avoid overlap, most of content-based image retrieval system is using lower dimensional features extracted from images. The color and texture are usually used as a feature to express an image. Another feature, that is shape, is essential as it can efficiently reveal the characteristic of an image. Although many of systems that use shape feature tried to cover rotation-, position- and scale-invariance between images, there are problems to cover three kinds of invariance at the same time.

In this paper, we introduce a new approach to extract shape feature from images using MBR(Minimum Bounding Rectangle) which can cover 3 kinds of invariance. In section 2, we present the existing several techniques and propose new technique in section 3. In section 4, we present the experimental result that we conducted that quantitatively show the efficiency of the method. Finally, we conclude in section 5.

2. Related Work

Many attempts to extract shape feature from images have been made. The QBIC(Query By Image Content) system[3] uses 3-dimensional Average RGB color values as a color feature and 'shrink-wrap' ,which is an initial coarse outline around an object by the user and, is used by system to compute a final outline around the object boundaries as a shape feature.

In [4], Chua, Lim, and Pung use a technique of extracting a set of distinct color pairs from an image to express the shape of an object in the image which model the adjacency relationships between regions and objects in that image. However, this technique, using color information to express shape feature, has limitation to express the shape characteristics of an image precisely.

PAMIS(Parallel Multimedia Index Server)[5] project uses specifically polygonal contours. It uses the *turning function* to extract tangent value from points on the boundary with respect to a reference axis of arbitrary orientation. This technique, though covering rotation-, position-, scale-invariance, didn't mention the method to extract the contour information from image.

VisualSEEk[6] is a hybrid system in that it integrates feature-based image indexing with spatial query method. The integration relies on the representation of color regions by color-sets. For one, color sets provide for a convenient system of automated region extraction through color set back-projection. Second, the color sets are easily indexed for retrieval of similar color sets. However, when the system selects color set in order to extract regions, color set can be obtained by thresholding color histograms. In this step, the small color set that includes an important object can be deleted.

While color and texture have been used successfully in general and fully automated retrieval systems, the use of shape has been limited. The main purpose of using extracted shape feature is covering 3 kinds of invariance. But, most systems do not cover full invariance and do not extract shape feature from image automatically.

3. Shape Feature Extraction using MBR

We propose new approach to extract shape feature from image. This approach is focused on character image and is a simple method to represent a contour of object in image. The extracted shape feature covers position-, scale- and rotate-invariance between objects in character image.

The first stage (Figure1) performs scanning to find a MBR which cover object in an image. While scanning character image vertically and horizontally, the method compares RGB value between adjacent pixels and chooses the 4 points (top, bottom, right and left point). Based on acquired 4 points, MBR and a center point of rectangle are acquired.

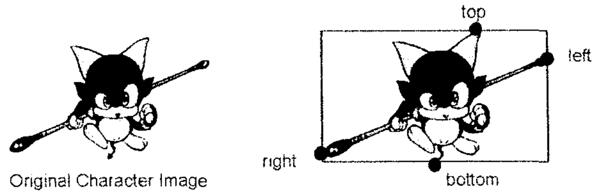

Figure 1. Extract Minimum Rectangle

Moreover, wherever object is positioned in an image, MBR is free from position-error. That's why it covers only object in an image. If the object is positioned in center and the other same size one is positioned in right bottom, MBR information between them is same. Because the distance from center to points is same.

The second stage (Figure 2) extracts 16 points from object boundary based on MBR information. The proposed method scans rectangle region on image to the 8 directions that depend on the MBR. While scanning, 16 points are extracted from object boundary.

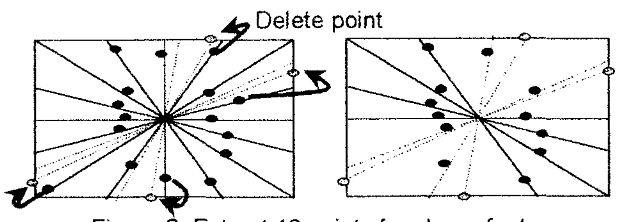

Figure 2. Extract 16 points for shape feature

Totally, we get 20 points (4 points on 1st stage, 16 points on 2nd stage) for shape feature. For all 20 points, we compute distance from center to their location. The 4 points of 1st stage include the longest distance from center point and it can be more meaningful than points of 2nd stage. With a little loss of shape information, for decreasing the number of points, among 16 points extracted from 2nd stage, we delete 4 points which have a similar distance value and position with the 4 points from 1st stage. Finally, we use 16 points for computing shape feature.

The 3rd stage (Figure 3) normalizes object size to cover scale-invariance. We choose the smallest distance and divide all distance value by it and store the rate of distance. Using the rate of distance, we can compare different sized character images. If the object is positioned in center and the different size one is positioned in right bottom, MBR information is extracted one by one on first stage. But this information is different from each other, because the distance from center to points is not same. To overcome this scale-invariance we convert original distance value into rate value

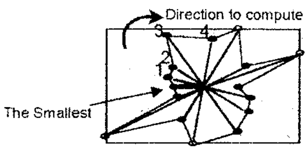

Figure 3. Distance normalization

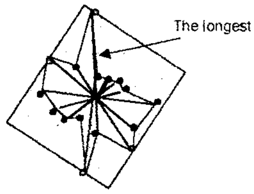

Figure 4. Object rotation

The 4th stage (Figure 4) rotates the stored rate to cover partially rotate-invariance. The longest among 16 rates of distance is selected as a first dimension to be compared between images. From the selected rate value to the right direction, the 16 rate values are stored. The 16 rate values are used as dimension in multi-dimensional indexing structure. With the 4th stage, rotated two objects in different angle can be recognized as a same object

4. Performance

4.1 Experiment Environments

For experiments, we searched and collected 5,000character images from internet. We implemented our method in C++ language, extracted shape features from images and carried out experiments. We constructed R*-tree[1] indexing structure, perform k-nearest neighbor search[2] from query image, and demonstrate the capability and usefulness of our method.

4.2 Performance Test

To test that the extracted shape feature using the proposed method covers position-, scale- and rotate-invariance between objects in character image, we modify query image into 6 different images (2 different sized images, 2 different positioned images and 2 rotated images) and store them into DB. Nearest neighbor query are performed until find 6 modified images. As shown in Figure 5, images of different size and position are searched with high ranking.

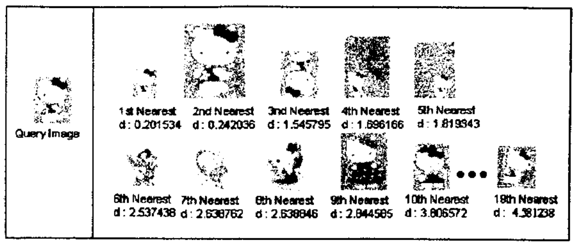

Figure 5 Result of Nearest Neighbor Query

However, the rotated image is searched in 19^{th} nearest neighbor. That's why the proposed method cannot cover perfectly whole degree of object rotation. That means that the proposed method covers partially rotate-invariance. In Figure 6, we present the recall percentage of query result for evaluating search performance. We performed 6-nearest neighbor query using 20 different query images. And we checked how many modified images are searched in the 6 nearest result. As shown in table, average 79.6% of the modified images are searched which is very encouraging.

Query Image	Recall	Query Image	Recall
Query01.bmp	83%	Query11.bmp	83%
Query02.bmp	83%	Query12.bmp	83%
Quer03.bmp	83%	Query13.bmp	66%
Query04.bmp	66%	Query14.bmp	83%
Query05.bmp	83%	Query15.bmp	66%
Query06.bmp	83%	Query16.bmp	83%
Query07.bmp	83%	Query17.bmp	83%
Query08.bmp	66%	Query18.bmp	83%
Query09.bmp	83%	Query19.bmp	83%
Query10.bmp	83%	Query20.bmp	83%
The average of Recall (20 Queries)			79.6%

Figure 6 Performance result of recall

5. Conclusions

The shape feature is essential as a part of interest in image data. Many approach have been tried to handle shape feature of an image, but there have been problems to cover three kinds of variance at the same time. We introduce new approach to extract shape feature for character image which covers position-, scale- and partially rotate-invariance. On performance test, we showed that the usefulness and accuracy of the proposed method. Because the shape feature does not represent image information perfectly, the other features like color and texture should be combined with proposed shape feature extraction method.

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