CDFIR:Cummulative Distribution Function based Image Retrieval

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***Abstract*—Content Based Image Retrieval is a well-known retrieval process in the field of Image processing. CBIR is a special way of finding similar images from huge database. CBIR utilizes three rudimentary features like color, texture and shape which plays an essential role in image retrieval. The effective image retrieval process is the need and number of computations along with the rate of retrieval should be less and high respectively. Thus a simple function using cumulative distribution function is involved in the retrieval process. In this work, we propose a new method to determine similar images from large database with the use of shape feature. The Morphological processing is applied to an image to get shape feature i.e. boundary of the image. For the boundary extracted image a simple basic cumulative distribution function is applied and it results in similar intensity distribution for an image. The similarity measurement is performed using Euclidean distance. The retrieval process is compared with shape extracted feature, CDF applied feature and with edge detection algorithms. The outcome would be a less computation and good accuracy in finding the similar images.**

***Keywords*—CDF;CBIR;shape;Morphology; Euclidean distance**

I. INTRODUCTION

Digital Image processing refers to processing of two dimensional picture by a digital computer. A digital image is an arrangement of real numbers described in the form finite number bits [7]. Due to lot of technical advancement in the field of digital image processing and multimedia systems there is a need for efficient image retrieval system because in the many areas like academia, hospital, crime prevention and digital library are creating a massive collection of images. Content based image retrieval exists when automatic retrieval of images from the database based on image color and shape. So CBIR refers to retrieval of images from the massive set of database based on the image features like color, shape and texture. The main challenge involves in content based image retrieval is to bridge the semantic gap between human perception and computer vision. To achieve this the shape feature extracted using morphological operations.

Morphology is a term which is widely used in the field of biology and it discuss about the structure and shape of different animals, plants and so on. In Image processing morphology is a topic which deals with shape structure and also it is a tool for extracting image components that are useful for representation and description of region shape, boundary, skeleton, convex hull etc., this is nothing but the application of mathematical morphology in image processing. Application of this morphology includes:

- Pre-processing
  - Filtering
  - Shape simplification
- Segmentation using object shape
- Object quantification
  - Area, perimeter, etc.
- Enhancing object structure
  - Skeletonization, thinning, thickening, convex hull, object marking etc.

There are two fundamental operations in morphology namely Erosion and Dilation from which other morphological operations are based. These two are basically operated on binary images and now it is extended to grayscale images. [8]

II. RELATED WORK

The performance of different CBIR systems using color, texture and shape are discussed [1] as a combined feature by applying wavelet transform. The performance evaluation is done using wavelet decomposition using threshold, wavelet decomposition using morphology operators and wavelet decomposition using local binary patterns. The wavelet decomposition of local binary patterns exhibits better performance than wavelet decomposition using threshold and morphological operations.

The color and texture information are used to retrieve the images from database. The color and texture features are extracted using color moment and Gabor filter transform. The author concludes that retrieval process can be improved by combining the color and texture features [2].

Various shape descriptors are discussed in [3]. The descriptors include 11 moment variants and area ratios and simple shape descriptors like eccentricity, compactness, convexity, rectangularity and solidity. By combining shape descriptors and area ratios the results are improved.

Three image features are extracted for retrieval process. Color auto-correlogram is used to extract color feature and Gabor wavelet is used for texture information and wavelet transform is linked to shape feature in the extraction of edge in an image. The Manhattan distance used for similarity measurement [4].

Image retrieval is tested using Edge orientation co-occurrence matrix. This matrix represents the spatial correlation of texture orientation. This operation is performed on gradient of gray level image. It is operated on WANG database [5].

Color and texture information are used to retrieve the similar images. Shape feature is not considered for the retrieval process. RGB color histogram, tamura texture and Gabor texture features are used. The Gabor texture feature gives better results compare to other two feature [6].

III. PROPOSED METHOD

The content based image retrieval mainly focuses on reducing the semantic gap. This can be achieved by retrieving the similar images from large database**.** To improve the performance of the CBIR system two image features are used namely shape feature and CDF applied shape. The performance of the proposed system is examined on Corel database and it achieves the propitious results on CBIR system. The block diagram of the proposed system is as shown in the figure 1. The Query image and database images are trained using morphological processing.

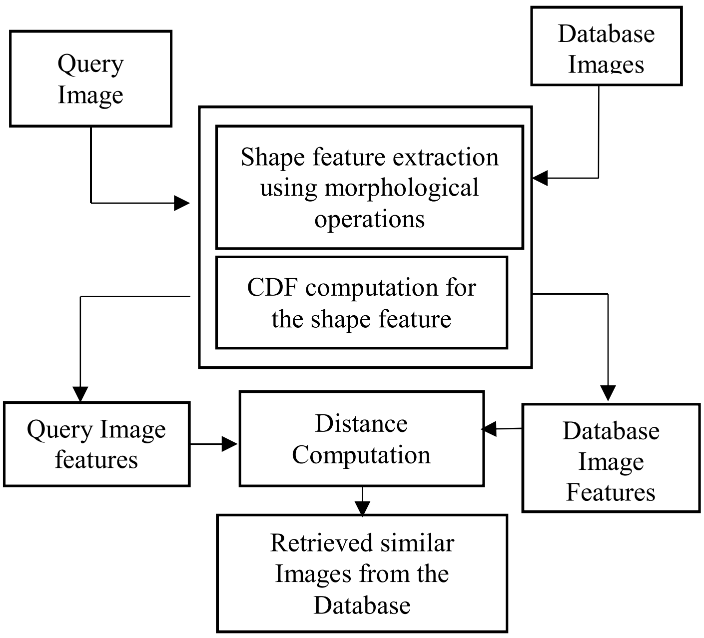

Fig 1. Block Diagram of the proposed System.

The features are extracted and stored. The distance computation i.e. similarity measurement is performed using Euclidean distance between query image feature vector and database image feature vector.

A. Morphological Erosion operation

Let us assume an image x, x is in the form of point set and along with x structuring element B is also given x eroded with structuring element is represented by the symbol as circle and within that circle negative sign like ɵ. So x eroded with B can be defined as x and B as sets in Z, the erosion of x by B is the set of all points in z such that B, translated by z, is contained in x. The mathematical representation of the erosion is given by,

$$X \ominus B = \{z | (B)_z \subseteq X\}$$

The aim of the erosion operation is to reduce the foreground (part of the scene) and extend the back part of the scene. (background). Erosion is used to make an image smaller by removing is outer layer of pixels. After applying the erosion operator on the image, the image becomes darker. This operator takes the image and structuring element as inputs and thins the object. The structuring element is a set or sub image used to examine an image in accordance with the study of properties of interest. In this work the disk structuring element is used to study the properties of image. The structuring elements required for an image to be a rectangular array. This is achieved by adding smallest number of background elements to form a rectangular array.

0	1	0
1	1	1
0	1	0

Fig 2. Structuring Element

B. Shape and Boundary Extraction

The shape of the image refers to its physical structure and profile. These characteristics can be represented by the boundary, moment, region, and structural representations and these are referred as regenerative features with respect to shape of an image. In this proposed work the boundary of an image is extracted using morphological erosion operation [9].

Morphological operations can be used to discriminate the boundaries of binary object. This function is very essential, because the border is an object part that completes, and at the same time very succinct description of the object. It is noticeable that the boundary points in its neighborhood will be having at least one background pixel. Thus, applying the operator of erosion with a structural element that contains all possible neighboring elements, we will remove all the boundary points. Then the boundary obtained by the operation of the difference between the sets of the original image and obtained as a result of erosion.
The example for eroded image and boundary extracted image.

Fig 2 .Original Image

Fig 3. Black and White Image.

Fig 3.Eroded Image

Fig 4. Boundary extracted image

The extraction of boundary of an image is a simpler and an easy task using XOR operation. The eroded image and boundary extracted image is as shown in the figure 2 and figure 3 respectively. The steps involved extracting a boundary of a images is shown in table 1.1. The retrieval process is done with the use of shape feature. The algorithm given in the Table 1.2 briefly describes the operation to perform a retrieval process using shape.

C. Cumulative distribution function

Cumulative distribution function for an image that associates larger range of pixel intensities with smaller range of interval and thus resultant image has lesser number of distinct intensities. This results in image will have similar pixel values so it increases the chance of finding similar images from large database. The important property of CDF is a continuously increasing quantity. For content based image retrieval CDF is equivalent intensity distribution for an image. For image retrieval CDF gives cumulative sum of all the probabilities lying in its selected window size and it gives almost same values for similar images. Consider an image I and let h_i be the number of occurrence of pixel values in a window. The probability of occurrence of pixel of intensity level i in the image is as given in equation (1)

$$P_x(i) = P(x = i) = \frac{h_i}{h}, 0 \le i \le L \qquad (1)$$

Where L is the number of pixel in the window.

Let us define CDF corresponding to P_x as,

$$CDF_x(i) = \sum_{j=0}^{i} P_x(j) \qquad (2)$$

The output image after computation of CDF is as shown in the figure 6. The steps involved in computing the CDF of an image is briefly described in the table 1.2.

Table 1.1: Algorithm for extraction of boundary of an Image and Image retrieval using shape feature

Step 1:	Read the input image A.
Step 2:	Convert original image into black and white image. A1
Step 3:	Perform erosion operation A2.
Step 4:	Perform XOR operation on A1 and A2.
Step 5:	Pixel to pixel comparison of eroded image and boundary extracted image.
Step 6:	If same exists in the pixel position increase the count.
Step 7:	Calculate the count for each test database image and each image database.
Step 8:	Store the count values.
Step 9:	Euclidean distance used for similarity measurement.
Step 10:	Retrieve the similar images from database.

Table 1.2: Algorithm for cumulative distribution function computation.

Step 1:	Read the input image
Step 2:	Pad Zero for the image matrix
Step 3:	Consider a window of size 3X3
Step 4:	For that window of elements start tracing from position (1,1)
Step 5:	Find out the probability
Step 6:	Compute cumulative distribution function
Step 7:	Find out middle element of that window
Step 8:	Replace that middle element by CDF value
Step 9:	Repeat all the steps for the entire matrix.


Fig 5.Original Image


Fig 6.Image after CDF computation

D. Image Retrieval Using CDF

The retrieval process is performed using the cumulative distribution function. The table 1.3 briefly describes the steps to find the similar images from large database using CDF function.

Table 1.3: Image retrieval using CDF

Step 1:	Read the input image A
Step 2:	Convert original image into black and white image. A1
Step 3:	Perform erosion operation A2.
Step 4:	Perform XOR operation on A1 and A2.
Step 5:	Compute the CDF for boundary extracted image
Step 6:	Store CDF values for query image database and image database.
Step 7:	Compute the similarity distance for query and database
Step 8:	Retrieve the similar images.

IV. EDGE DETECTION

Edge detection is used in image processing technique for locating the boundaries of the object present within images. This can be used for data extraction and image segmentation in the areas such as machine vision, image processing and computer vision. The edges identify the object boundaries for that reason used for segmentation, identification of objects and segmentation.

Edge point can be considered as a pixel location of sudden change in the gray level. Edge point can be defined as a pixel location in binary image at which black pixel with at least one white nearest neighbor, that is, pixel location (x, y) such that a (x, y) = 0 and b (x, y) = 1, where

$$b(x, y) \triangleq [\, a(x,y) \oplus a\,(x \pm 1, y)]\; OR\; [\, a\,(x,y) \oplus a(x, y \pm 1)]$$

$\oplus$ denotes XOR operation.

Edge detection is used for extracting the boundaries of the image for the process of retrieval of similar images. The common existing algorithms are used to for the retrieval process and results are tabulated as shown in the table below. The CDF method gives acceptable results compared with edge detection algorithms.

V. RESULTS AND DISCUSSION

All test image and database images of ten classes are trained and compared with various methods. The retrieval process is tested on the Corel database. The Corel database contains 1000 images. This is divided as test database and trained database. This test database comprised of 300 different images of thirty images from each class. Another set of database is trained database contains 700 images of ten classes. The ten classes consist of African people, Sea, Building, Bus, Dinosaurs, Elephant, Rose, Horse, Mountain and Food.
Initially all the test database and trained database features are extracted and stored. The values of query image and database image are compared to retrieve the similar images from the database. The retrieval results for Dinosaurs image of various methods is as shown in the figure 7, figure 8 and figure 9. The top ten Dinosaur's images are retrieved from the database.

A. Retrieval Efficiency

The performance analysis of the various methods is carried out using precision and recall. The precision is the ratio of relevant images to the total number of images retrieved.

$$\text{Precision} = \frac{Number\ of\ relevent\ images\ retrieved}{Total\ number\ of\ images\ retrieved}$$

$$\text{Recall} = \frac{Number\ of\ relevent\ images\ retrievd}{Total\ number\ of\ images\ in\ the\ database}$$

Precision and recall is calculated for the ten class of image from various methods. The system was tested and the results are shown in the table 4.1. The table 4.2 shows the total number of relevant images retrieved out of ten for each class of image and precision and recall values are tabulated.

Table 4.1. Precision and recall using various method

Sl. No.	Method	Average Precision	Average Recall
1	Shape(by taking pixel count)	0.46	0.06
2	Count mean	0.39	0.04
3	CDF mean	0.49	0.06
4	**CDF (proposed method)**	**0.55**	**0.07**
5	Canny edge detection	0.28	0.03
6	Sobel edge detection	0.29	0.03
7	Prewitt edge detection	0.31	0.04

V. CONCLUSION

A simple Cumulative distribution function and shape extracted features are compared with the various methods. The CDF applied feature gives acceptable results compared to other methods. The CDF method is simpler and less complex for the retrieval process. The good content based image retrieval is achieved using a cumulative distribution function.

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query image

Fig.7 Retrieval using CDF

query image

Fig.8 Rertrieval using shape count mean

query image

Fig.9 Retrieval using Shape pixel count

Table 4.3 The class of images are shown and results are tabulated.

Class of Image	**Retrieved Image out of 10**	**CDF mean**		**Retrieved Image out of 10**	**CDF**		**Retrieved Image out of 10**	**Shape Pixel count**		**Retrieved Image out of 10**	**Shape count mean**	
		Presicion	**Reacall**		**Precision**	**Recall**		**Pricision**	**Recall**		**Precision**	**Recall**
African People	4	0.4	0.057	4	0.4	0.057	3	0.3	0.042	4	0.4	0.057
Sea	7	0.7	0.1	6	0.6	0.085	2	0.2	0.028	2	0.2	0.028
Building	3	0.3	0.042	3	0.3	0.042	2	0.2	0.028	3	0.3	0.042
Bus	1	0.1	0.014	3	0.3	0.042	4	0.4	0.057	2	0.2	0.028
Dinosaurs	10	1	0.142	10	1	0.1	10	1	0.1428	6	0.6	0.085
Elephant	7	0.7	0.1	5	0.5	0.071	5	0.5	0.028	1	0.1	0.014
Rose	7	0.7	0.1	7	0.7	0.1	9	0.9	0.1285	1	0.1	0.014
Horse	9	0.9	0.128	4	0.4	0.057	5	0.5	0.071	1	0.1	0.014
Mountain	2	0.2	0.028	3	0.3	0.042	3	0.3	0.042	1	0.1	0.014
Food	5	0.5	0.0714	4	0.4	0.057	2	0.3	0.042	2	0.2	0.028
Average		**0.55**	**0.078**		**0.49**	**0.0695**		**4.6**	**0.6093**		**0.23**	**0.0324**