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A Novel Approach for Image Retrieval Using Color and Shape Features combined with IGA

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***Abstract*—Image Retrieval is a sub domain of Information Retrieval. A Content Based Image Retrieval (CBIR) system is a computerized system for browsing, searching and retrieving images from a large database of digital images. In this paper we present a novel approach for image retrieval by combining color and shape. Color feature is extracted using color moments in HSV color space and shape feature is extracted using zernilke moments. Interactive Genetic Algorithm is used to optimized the weight of different features. It also reduce the semantic gap between low level features and high level user abstraction about an image. Experiments shows that combination of above methods give better retrieval accuracy than existing methods.**

***Index Terms*— Image Retrieval, Content Based Image Retrieval, Low level feature, Semantic gap, Interactive Genetic Algorithm**

I. INTRODUCTION

In recent years the expressive growth in use of internet, computers, storage device, smart phones and digital camera that enable to collect a large number of digital information and store them in computer readable formats. To store and manage these huge amount of information is a challenging task. Image retrieval is process of retriving specific image from large amount og image database. Image processing has an enormous range of applications and almost every area of science and technology such as medicine, space program, agriculture, industry and law enforcement make use of these methods and one of the key issues with any kind of image processing is image retrieval which is the need to extract useful information from the raw data such as recognizing the presence of particular color or textures before any kind of reasoning about the image's contents is possible fields of image processing, multimedia, digital libraries, remote sensing, astronomy, database applications and other related area [4]. Fast retrieval of images has not always been easy, especially when you are working with thousands of images. An effective image retrieval system needs to operate on the collection of images to retrieve the relevant images based on the query image which conforms as closely as possible to human perception [4].

In text-based image retrieval, images are indexed using keywords, which means keywords are used as retrieval keys during search and retrieval. Text-based retrieval is non-standardized because different users employ different keywords for annotation. Text descriptions are sometimes subjective and incomplete because they cannot depict complicated image features very well [2].

The Content Based Image Retrieval uses image content (color, texture, shape) to search and retrieve digital images from huge database of images. Content-based image retrieval systems were introduced to solve the problems of text-based image retrieval. Content based image retrieval is a set of techniques for retrieving semantically-relevant images from an image database based on automatically-derived image features [3].

II. LITERATURE REVIEW

Researcher T.Kato used the term Content Based Image Retrieval very first to represent his experiments for retrieving image from a database using color and shape feature. After that this term (CBIR) has been used widely for the process of retrieving image from large collection of images based on features that is the signature of the image [2].

Researchers have proposed different methods to improve the system of image retrieval. Very first they have introduced keyword based image retrieval then they have introduced content based image retrieval. Both of these methods are explained here:

A. Keyword Based Image Retrieval

In keyword based image retrieval, images are indexed using keywords, which means keywords are used as retrieval keys during search and retrieval.

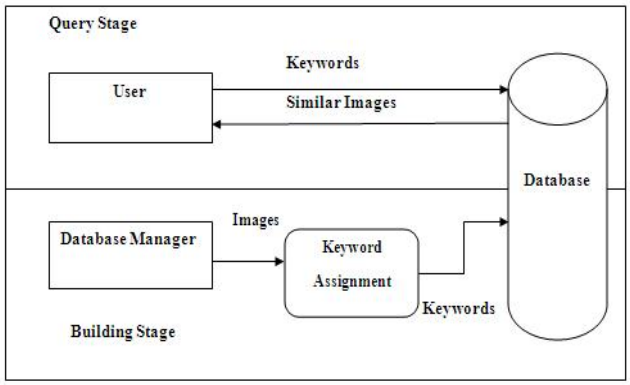

Fig1:General Framework of Keyword Based Image Retrieval [4]

General Framework of keyword based image retrieval is shown in Fig.1. Here images are examined manually and assigned keyword that are more significant to its contents [4]. Then these keywords or annotations are stored in database along with images. During query stage, user will input keyword or text which represents the search criteria. Then Images are retrieve on the basis of matching keyword [4].

B. Content Based Image Retrieval

In content based image retrieval, images are indexed using its features like color feature, texture feature and shape feature.

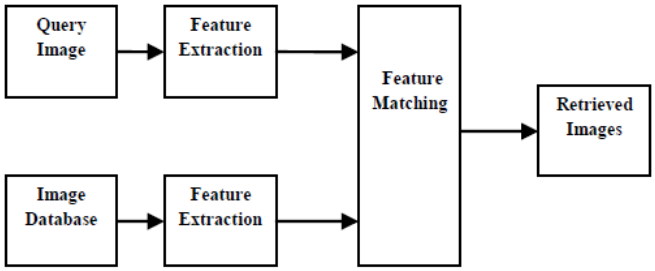

Fig 2:General Framework of Content Based Image Retrieval[10]

General Framework of content based image retrieval is shown in Fig.2. Before images are being stored in the database, they are examined and features are extracted from the images. Parameters of these features are stored in database. During query stage, user will input image which constitute the search criteria. Features matching process is then performed to retrieve images associated with the features that match the search criteria.

III. FEATURE EXTRACTION

Feature Extraction is very important process of any CBIR techniques. A "*feature*" means anything that is localized, meaningful and detectable. The object in the image, textures, lines, motions, corners, and shapes, color are features of an image. The extracted feature defines and describes the content of image. Extracted feature can be used as the signature of the image. Different images should have different signatures. Mainly three features color, texture and shape are extracted using various feature techniques. Color, texture and shape are refer as low level feature of an image

A. Color Feature Extraction

Color is the widely used descriptor in CBIR. Various techniques are available to describe or extract color from any image. Methods such as color histogram, color corrlogram, color moment, Average RGB, Dominant color and other are used for it[4]. In digital image processing, different color space are available like RGB color space, HSV color space, YIQ color space and CMYK color space. RGB color space is frequently used because of its simplicity , but it has main drawback that it does not include luminance component of color. So RGB color space is converted into HSV color space where H is Hue, S is for saturation and V stands for value.

Color Histogram: This method represents color distribution in a sequence of bins[12]. It is easy to calculate. There are different types of color histogram available but mainly divided into two categories global and local color histogram[5]. An image will be reprented with its color histogram, and the distance between two images will be calculated by the distance between their color histograms [10]. Local color histogram divides whole image into segments and gives color distribution of all segments so the color distribution of particular regions in image can be easily obtain. The main drawback of this method is if two images are having equal amount of color then both having same histogram and does not include any spatial information of image.

Color Moments : It is widely used technique to detect color feature of given image. Three parameters are measure in this technique : Mean, Standard deviation and Skewness. Mean is used to find average color of an image , standard deviation is used to find amount of variation in color of an image, and skewness measures asymmetry of the color distribution thus it gives information about the shape of the color distribution[12]. Efficient and effective in representing color distributions of images is represented by Color moments. . But it suffer from the problem that they fail to encode any of the spatial information surrounding the color within the image [8]. First Moment : Mean

$$E_i = \frac{1}{N}\sum_{j=1}^{N} p_{ij} \quad (1)$$

In (1) N represents total number of pixel in any image and i represents color channel.

Second Moment : Standard Deviation

$$\sigma_i = \sqrt{\left(\frac{1}{N} \sum_{j=1}^{N} \left(p_{ij} - E_i \right)^2 \right)}$$

(2)

Third moment : Skew-ness

$$s_i = \sqrt[s]{\left(\frac{1}{N} \sum_{j=1}^{N} \left(p_{ij} - E_i \right)^3 \right)} \quad (3)$$

By evaluating each moments we get 9 dimension vector for color feature in HSV color space.

Dominant Color : All pixels on database images are categorized into similar types of groups according to the similarity of their color. All images are quantized to these similar colors in RGB color space. A color will be selected from predefined colors which are very near to image pixel color and it will be stored as new color pixel in the image. Color distance is calculated using Euclidean distance. The color having highest percentage is determine as dominant color of the block.

Average RGB : The main intention of this technique is to remove images with higher distance at very early stage. Another strong reason of selection this method is that it requires a small amount of data to describe the feature vector and require low computation than other methods. However, if this feature is not combined with other features, the accuracies of query result could be significantly impact [10]. So performance of this method is not good with images having same color and different objects.

Shape Feature Extraction

Any object is easily describe and visualize by its shape so shape descriptors are selected for describing an object in image[15]. The shape descriptor has been classified into two major kinds, Boundary based and region based shape descriptors. Boundary based methods uses only shape boundary information and further classified into continuous approach and discrete approach. The region based shape representation technique takes the whole region under consideration, not only boundary information. The region based technique is further classified into two types namely structural and global and some of the global region based techniques are Area, Euler Number, Eccentricity, Geometric Moments, Zernike Moments, Pseudo-Zernike Moments, Legendre Moments, Generic Fourier Descriptor, Grid Method and Shape Matrix while the different structure based techniques are Convex Hull, Me,mdia Axis and Core [15].Many methods has been introduced by researchers to extract shape feature from the image. Here some of the methods to extract shape feature are explained.

Fourier Descriptors : They are calculated by applying Fourier transform on shape boundary of any object presented in any image. Two main property of FD are its ability to derive easily and robustness. With Fourier descriptors, coarse shape features or global shape features are captured by lower order coefficients and the finer shape features are captured by higher order coefficients [16]. Following equation (4) shows how it work.

$$r_i = \left(\left[x_i - x_c \right]^2 + \left[y_i - y_c \right]^2 \right)^{\frac{1}{2}}, i=1,2,\ldots,L$$

(4)

Where x_c, y_c are averages of *x* coordinates and *y* coordinates respectively. Due to the subtraction of centroid (which represent position of the shape) from the boundary coordinates, the centroid distance representation is become constant and it is invariant to translation [14]. For applying Fourier transform normalized the boundary points of all the shape in database. The Fourier transform of r_i , i=1,2,……N-1 is given by

$$u_n = \frac{1}{N} \sum_{i=0}^{N-1} r_i \exp\left(\frac{-j2\pi ni}{N} \right), n = 0,1,\ldots,N-1 \quad (5)$$

The coefficients (u_n, n = 0, 1… N-1,) are called Fourier descriptors (*FD*) for the shape, It denotes as FD_n, (n =0, 1… N-1)[14].

In Fourier Descriptor noise is not become major problem because at very high frequencies noise is automatically truncated out.

Zernike moments : This method allows independent moment invariants to be constructed to an arbitrarily high order. Zernike moments descriptor does not need to know boundary information so it is very suitable for more complex shape representation [16]. Like Fourier descriptor Zernike moments descriptors can be constructed in arbitrary order, this solve the limitation of geometric moments in which higher order moments are difficult to construct[16].

$$V_{nm}(x,y) = V_{nm}(\rho\cos\theta, \rho\sin\theta) = R_{nm}(\rho)\exp(jm\theta)$$

(6)

$$R_{nm}(\rho) = \sum_{s=0}^{(n-|m|)/2} (-1)^s \frac{(n-s)!}{s!\left(\frac{(n+|m|)}{2} - s \right)!\left(\frac{(n-|m|)}{2} - s \right)!} \rho^{n-2s} \quad (7)$$

Where *n* and *m* are subject to *n*-|*m*| = even, |*m*|≤*n*. Zernike polynomials are become complete when set of complex valued function added over the unit disk,
(i.e., *x*2 + *y*2 = 1). Then the complex Zernike moments of order *n* with repetition *m* are defined as follow [16]

$$A_{nm} = \frac{n+1}{\pi} \sum_{x} \sum_{y} f(x,y) V_{nm}^{*}(x,y), x^2 + y^2 \le 1 \quad (8)$$

The another use of it is to expand a signal into series of orthogonal basis. The different number of moments truncated from the expansion is called the precision of shape representation. Unit disk is taken as domain by basis functions of Zernike moments. This unite disk must be specified before calculating moments. For suitable complex shape representation Zernike moment's descriptor does not need to know boundary information [16].

Edge Histogram : Edges of any object are very important feature to recognize shape of object presented in any image. Edges in images constitutes an important feature to represent their content. Human eyes are sensitive to edge feature for image perception. Edge histogram represents each five edges of given image[13]. An edge histogram in the image space represents the frequency and the directionality of the brightness changes in the image [7].
Researchers are using Euclidian Distance to compare similarities between images and they are using WANG database. It is sample database, used for testing purpose in Content Based Image Retrieval. It is a subset of the Corel database which contain 1000 images in JPEG format. These images are grouped into various ten categories. Each category contains 100 images. Within this database, it is known whether any two images are of the same class. Image classification into 10 various categories makes the evaluation of the system easy. These categories include mountain, dinosaurs, African people, buses, horses, flowers, building, food, beaches[17]. Recently researchers are working on three parameters of CBIR: Precision, Recall and Retrieval Time. Precision is ratio of relevant retrieved images and total retrieved images. Recall is ratio of relevant retrieved images and total relevant images in database. Retrieval time is time taken to retrieve all images.

IV. INTERACTIVE GENETIC ALORITHM

A genetic algortithm is a huristic search algortithm that uses genetic as its model of problem solving. It mimics the process of natural selection. The basic steps for genetic algortihms are as follow[7].

1. **[Start]** Generate random population of *n* chromosomes (suitable solutions for the problem)
2. **[Fitness]** Evaluate the fitness *f(x)* of each Chromosome *x* in the population
3. **[New population]** Create a new population by repeating following steps until the new population is complete
    a. **[Selection]** Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to be selected)
    b. **[Crossover]** With a crossover probability cross over the parents to form a new offspring (children). If no crossover was performed, offspring is an exact copy of parents.
    c. **[Mutation]** With a mutation probability mutate new offspring at each position in chromosome.
    d. **[Accepting]** Place new offspring in a new population
4. **[Replace]** Use new generated population for a further run of algorithm
5. **[Test]** If the end condition is satisfied, **stop**, and return the best solution in current population
6. **[Loop]** Go to step **2**.

The main dissimilary between GA and IGA is calculation of fitness function in GA it is calculated using some mathematical formula and in IGA human judgement is added to calculate Fitness function[7]. A user can interactively determine which member of population will reproduce, and IGA autometically generates the next generation of content based images.

V. PROPOSED APPROACH

The proposed system consist of user oriented CBIR that uses the interactive genetic algorithm to identify which images in the datasset would be of most intert to the user. Two low level feature color and shape are extracted using color moments and zernike moments.

Initially feature extraction of all the images, stored in the database is performed and alll the extracted features are stored seperately. Now query image is loaded by user and matching images are displayed. Figure 3 shows the proposed system flow diagram.

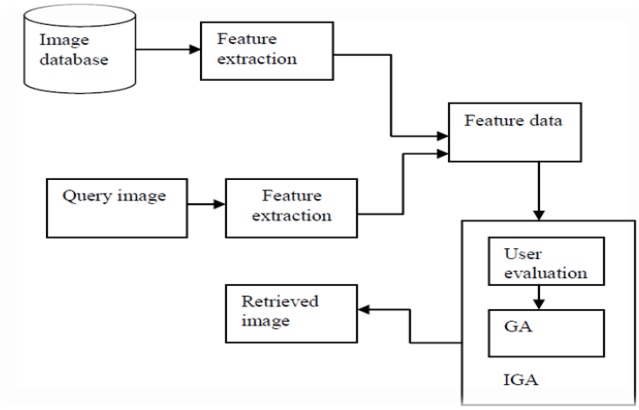

Fig 3 : Proposed System Flow Diagram

The proposed algorithm of the CBIR system is listed bellow.

Step 1: Start

Step 2: Convert RGB color space of all images into HSV.

Step 3: Feature extraction of all the images of database using Color moments and Zernike moments and stored into database.

Step 4: User inputs a query image (Query by example).

Step 5: The interactive genetic algorithm requires a population of potential solutions to be initialized at the beginning of the GA process

Step 6: User have to give number (like 20, It means first 20 images are relevant so we have secured that images and 2nd round will apply on further images)

Step 7: Now user will select 2 parent images(one for color and another for shape). They can select It from initial population.

Step 8: Color moments will apply on first parent and find distance d1 and Zernike moments will apply on second image and find distance d2.

Step 9: Final distance D = d1 + d2 is calculated.

Step 10: According to that distance D, another images are retrieved.

Step 11: All steps from Step 6 to 10 are repeated until we get required precision

Step 12: End

VI. RESULT ANALYSIS

We extract two types of features (color, and shape) using different extraction techniques with optimal weights to a subset of COREL database. In particular, a retrieved image is considered a match if and only if it is in the same category as the query. We use precision value to measure performance of our system. The system is tested for its significance against the existing method of CBIR. First user selects any query image here we illustrate example of flowere image as a query image as showm in figure 4.

Fig 4 : Query Image

The color and shape features of these query image is extracted and being complared with exixsting images features and similar images are displayed as a result as showm in figure 5.

Fig 5 : Result obtained for query image using combination of color moments and zernike moments (without IGA)

Following table shows the average precision value for retrieval of every image class . It clearly shows that combination of colr and shape feature gives better results as compared to seperately used.

Wang Database Categories	Color moments	Zernike moments	Combined
Africans	0.43	0.31	0.51
Beaches	0.32	0.33	0.39
Buildings	0.31	0.29	0.53
Buses	0.34	0.31	0.48
Dinosaurs	0.91	0.98	0.94
Elephants	0.57	0.52	0.71
Flowers	0.49	0.57	0.67
Horses	0.53	0.42	0.63
Mountains	0.41	0.38	0.52
Foods	0.39	0.31	0.48

Table 1 : Precision values(in percent) obtained for combined appeoach(color + shape)

Now after applying user interaction i.e. interactive genetic algorithm, user selects two parents one for color and one for shape follwoing results are being generated.

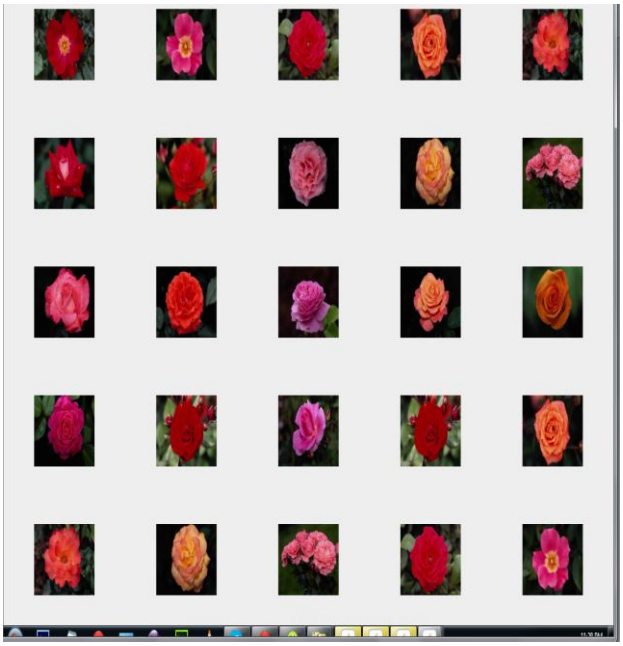

Fig 6 : Result obtain for query image After applying IGA to process

Wang Database Categories	Color Feature	Shape Feature	Color + Shape Feature	Color + Shape + IGA
Africans	0.43	0.31	0.51	0.78
Beaches	0.32	0.33	0.39	0.71
Buildings	0.31	0.29	0.53	0.79
Buses	0.34	0.31	0.48	0.76
Dinosaurs	0.91	0.98	0.94	1
Elephants	0.57	0.52	0.71	0.93
Flowers	0.49	0.57	0.67	0.92
Horses	0.53	0.42	0.63	0.91
Mountains	0.41	0.38	0.52	0.78
Foods	0.39	0.31	0.48	0.76

Table 2 shows the experimantal results of precision value for different image classes of database. Figure 7 shows the performance graph for the same. From the graph it is observe that the performance of the system is increse by using IGA.

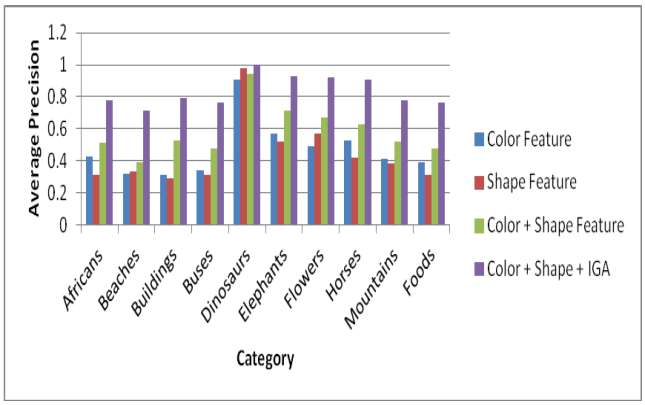

Fig 7 : Graph corresponding to table 2

As more and more iteration of IGA is performed, performance of the system is improved. It shows in table 3 that the seccesive generation gives better result than previous generation. Figure 8 shows the graph for the same.

Wang Database Categories	Generation 1	Generation 2	Generation 3	Generation 4
Africans	0.51	0.63	0.72	0.78
Beaches	0.39	0.45	0.56	0.71
Buildings	0.53	0.61	0.72	0.79
Buses	0.48	0.58	0.67	0.76
Dinosaurs	0.94	0.96	0.98	1
Elephants	0.71	0.79	0.87	0.93
Flowers	0.67	0.78	0.84	0.92
Horses	0.63	0.75	0.83	0.91
Mountains	0.52	0.63	0.72	0.78
Foods	0.48	0.57	0.68	0.76

Table 3 : Precision values(in percent) for different IGA generation

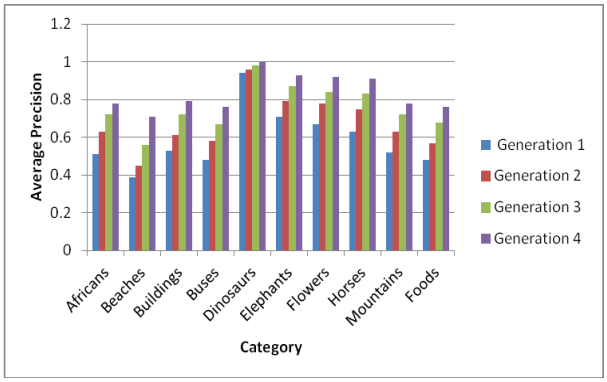

Fig 8 : Graph for table 3

VII. CONCLUSION AND FUTURE WORK

Content Based Image Retrieval (CBIR) has the potential to greatly improve KBIR systems. The proposed method uses two best techniques for low level feature extraction, on color

HSV Color moments and on shape Zernike moments. Interactive Genetic Algorithm is used to reduce semantic gap between low level feature and high level semantics . And it also optimized weight to each feature of given image. Experiment shows that proposed method combine all these features increase efficiency of CBIR than existing systems. Our future work will include texture feature and strong image indexing schema to improve accuracy and reduce retrieval time of the system.

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