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Efficient Method of CBIR Using Combination of Shape, Color and Texture Feature with Fuzzy Technique

Rajni Bala[1], Reecha Sharma[2]

M. Tech Student, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India[1]

Assistant Professor, Department of Electronics and CommunicationEngineering, Punjabi University, Patiala, India[2]

Abstract: **content based image retrieval process is used to retrieve the most similar images from large data base of image on the basis of feature that can be color, texture, shape or combination of features by combining two or more feature. Images are retrieved on the basis of distance matrices. In this paper combination of features color, texture and shape with fuzzy logic is used to retrieve the most similar images. Fuzzy logic is imported into image retrieval system to deal with the existing problems. As fuzzy logic is better tool to overcome the problem of semantic gap and user's subjective intentions. Fuzzy logic adds the rules and based on the rules it computes the attribute ranges and features of the image.An experimental result shows the better performance of the system.**

Keywords: **CBIR, Gabor filter,color moments, feature extraction.**

I. INTRODUCTION

Content based image retrieval has become a popular research topic due to increase in availability of digital cameras, video recorders and use of them. Due to the satellite technology, digital image sensor technology and availability of large bandwidth to access the internet allows the user to browse through the image database present at remote sites. There are two main requirements of retrieval systems that are high efficiency and low computational complexity.In the conventional image retrieval system that is based on the keyword based searching has some main problems:

1) Image contents cannot be described in fixed set of words.
2) Subjectivity of human perception. Different users have different perception of same images.
3) Large volume database and responsibility on the end user [1].

To overcome these problems the content based image retrieval (CBIR) techniques is used. That is based on the extraction of visual features like color, texture and shape.On the basis of feature extraction, the similar images are retrieved. But the images retrieved are not always according to human requirement because there lays a gap between the human thinking and mathematical modeling on the basis of which images are retrieved [10]. So the main requirement of the system is to fill the gap between low level features and high level semantic gap [10]. An image is considered as same although its color and shape are not same.Different systems have used different techniques but all the CBIR system work in same Way. The objective of this paper is to use the color, texture and shape feature with the fuzzy logic to improve the system performance. Color is the most widely used feature as it is easy to extract as compared to shape and texture. Texture contains the information about structural arrangement of surface and their relationship with surrounding and Shape feature is the visual feature used in CBIR. For the color feature extraction color moments is used. For texture and shape feature extraction Gaborfilters and moments invariant is used. The block diagram of CBIR system is as shown:

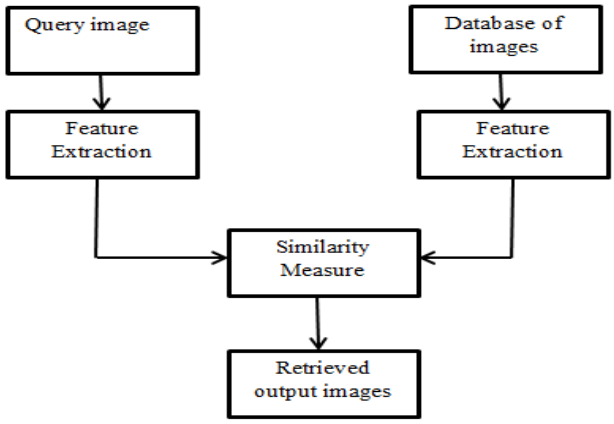

Fig 1: Block Diagram of CBIR

The rest of paper is organized as follows: section 2 gives the details about retrieval techniques with fuzzy logic and proposed retrieval system is described in section 3. Section 4 describes the performance evaluation parameters and experimental result is shown in section 5. Finally, Paper is concluded and future work is given in section 6.

II. CBIR TECHNIQUES

The contents of image comprise the low level features like texture, shape, color etc. and high level semantic features. The low level features can be extracted directly from an image but the high level features not only required mathematical modeling but required uncertainty and natural language descriptor also.

A. Color Based Retrieval

Color feature is the most widely used feature because it is easy to extract, insensitive to orientation and size of image and also it requires less memory space.One required characteristic of color space for image retrieval is its uniformity. Color space can be RGB, HSV etc. RGB color is not uniform so HSV color space is most widely used [4].For the color representation color moment is widely used because it is more robust and runs faster than histogram based methods. The first order (mean), the second (variance) and the third order (skewness) color moments have been proved to be efficient in many retrieval systems. The three moments are defined mathematically as:

$$E_{r,i} = \frac{1}{N}\sum_{j=1}^{n} I_{ij} \quad (1)$$

$$\sigma_{r.i} = \left(\frac{1}{N}\sum_{j=1}^{n}(I_{ij} - E_{r,i})^2\right)^{1/2} \quad (2)$$

$$S_{r,i} = \left(\frac{1}{N}\sum_{j=1}^{N}(I_{IJ} - E_{r,i})^3\right)^{\frac{1}{3}} \quad (3)$$

Where I_{ij} is the value of ith color channel at the jth image pixel, N is the number of pixels and r is the region.$E_{r,I}$ is the average color or region r ,$\sigma_{r,I}$ is the variance and $S_{r,i}$is the skewness of each color channel.

B. Texture Based Retrieval

Texture is an important feature that plays an important role in pattern recognition, biomedical modalities and in computer vision. It consists of uniformity, directionality and regularity, periodicity, randomness, contrast and coarseness [6].From the recent literature, Gabor filter is widely used in retrieval system to extract texture from the image. Gabor filter is a linear filter used for edge detection. These are group of wavelets and each wavelet captures energy at particular orientation and frequency. Orientation and Frequency representations of Gabor filters are similar to those of the human visual system so they have been found to be appropriate for texture representation [7]-[9]. The design of Gabor filter is as done:
For a given image I(x, y) with size P x Q, its discrete Gabor wavelet transform is given by [1]:

$$G_{mn}(x,y) = \sum_s \sum_t I(x-s, y-t)\varphi^*_{mn}(s,t) \quad (4)$$

Where s and t are filter mask size variable, and φ^*_{mn} is a complex conjugate of φ_{mn} which is function generated from dialation and rotation of mother wavelet:

$$\varphi_{mn}(x,y) = \frac{1}{2\pi\sigma_x\sigma_y}\exp\left[-\frac{1}{2}\left(\frac{x^2}{y^2} + \frac{y^2}{\sigma_y{}^2}\right)\right].\exp(j2\pi Wx) \quad (5)$$

Where W is called the modulation frequency.
After applying the gabor filter on the image with different scale and orienataion, we obtain an array of magnitudes:

$$E(m,n) = |G_{mn}(x,y)| \quad (6)$$

m= 0,1,….. M-1; n=0,1,…..N-1.
These magnitudes represent the energy content at different scale and orientation of the image. The mean μ_{mn} and standard deviation σ_{mn} of the magnitude of the transformed coefficients is used to represent the homogenous texture feature of the region:

$$\mu_{mn} = \frac{E(m,n)}{P\ X\ Q} \quad (7)$$

$$\sigma_{mn} = \frac{\sqrt{\sum_x \sum_y (|G_{mn}(x,y)| - \mu_{mn})^2}}{P\ X\ Q} \quad (8)$$

Gabor filters in medicine, textural features have gained more importance.Texture information can hardly provide semantic information so usually it is combined with other features.

C. Shape Based Image Retrieval

Shape feature is the visual feature used in CBIR. Shape is related to the specific object in the image, so semantic feature of shape is stronger than that of texture. There are main two categories for shape representations: boundary-based or region-based representation. The former uses only the outer boundary characteristics of the shape while the latter uses the entire region. Fourier descriptors and the moment invariants are the representation of these two methods. [3], [10].. In this paper we used moment invariants and distance between the symmetry of texture to describe the shape feature [9].

$$\mu_{pq} = \sum\sum (x-\mu_x)^p (y-\mu_y)^q f(x,y) \quad (9)$$

Where

$$\mu_x = \frac{\sum\sum x f(x,y)}{\sum\sum f(x,y)}$$

$$\mu_y = \frac{\sum\sum y f(x,y)}{\sum\sum f(x,y)}$$

D. Fuzzy Logic Based Image Retrieval

There are some key issues involved in CBIR that are: semantic gap, user's subjective intentions. Semantic gap is a gap that lies between human insight of an idea and its machine level illustration. The semantic of the image has features of fuzziness and complicacy [3] .Image retrieval system should have the property to retrieve the image according to human thinking, should not only depends on the distance metrics. Fuzzy logic is helpful tool to realize this goal. Fuzzy logic based system consists of mainly four parts that are [10]:

1. Feature extraction
2. Fuzzifier
3. Fuzzy inference
4. Defuzzifier

III. PROPOSED METHOD

Content based image retrieval is a process to retrieve images on the basis of features color, texture, shape or combination of these.If morefeatures are combined, better performance of the system can be achieved. If the fuzzy logic is used with these

features then system performance can be improved.For this an method is proposed in which color, texture, shape features are combined with the fuzzy logic.Fuzzy logic deals with vagueness and ambiguity of human judgment of image similarity. Fuzzy logic adds the rules and based on the rules it computes the attribute ranges on the basis of range we compute the features in the image. The flow chart for proposed method is shown in fig 2.

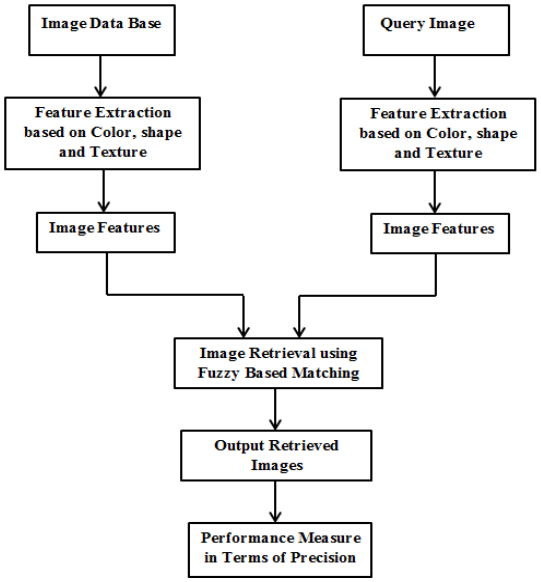

Fig 2: Flow Chart for Proposed Method

In proposed method, first a query image is taken and its features color, texture and shape are extracted. Similarly features of images present in data base are extracted and by using fuzzy logic it is matched with query image features. If it gets matched with it then images are retrieved according to similarity measure. Performance of system is measured in terms of precision.

IV. PERFORMANCE EVALUATION

Both objective and subjective performance evaluation has been a crucial part of image retrieval process. Hence for the performance evaluation, precision and recall can be used.

A. *Precision*

Precision is the fraction of retrieved image that are truly relevant. It is the probability that a retrieved image is relevant [9].

$$\text{Precision} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of images retrieved}} = \frac{A}{A+B}$$

B. *Recall*

Recall is the fraction of retrieved images that are actually retrieved [9], [1]. It is the probability that a relevant document is retrieved in a search. Inbinary classification, recall is also called sensitivity.

$$\text{Recall} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of relevant images}} = \frac{A}{A+C}$$

Where A represents the total number of relevant images that are retrieved,B represents the number of irrelevant items and C the number of relevant items those were not retrieved.

V. EXPERIMENTS AND RESULTS

The experiment is carried out with the data base of different images to evaluate the performance of proposed method on the basis of precision and recall. Query image is taken and features are extracted by using color moments, distance and texture Gabor filter.Similarly features are extracted from images in data base and on the basis image are retrieved and performance is evaluated in terms of precision and recall. Higher the value of precision and recall indicates the better performance of system.

The experiment is carried out with the number of retrieved images set to compute the average precision. In proposed technique, the experiment is carried out on the basis of color moments, Gabor filter and distance and texture involve in the image. Table 1 shows the precision value for different data sets using different methods.

Table I
Precision Values of Retrieval Images for different methods. Color + Texture; Color + Texture + Shape; Color + Texture + Shape + Fuzzy Logic.

Data sets	**Average precision value**		
	Color + Texture (A)	**Color + Texture + Shape(B)**	**Color + Texture+ Shape +Fuzzy Logic (C)**
African	7.4	9.00	9.78
Building	3.6	8.94	9.86
Buses	7.7	8.78	9.86
Dinosaurs	9.5	8.88	10.00
Beach	3.8	8.73	9.10
Average Precision (%)	64	88.66	97.20

Table II
Average Precision Value of Color +Texture; Color + Texture + Shape

Average precision (%)	**Color + Texture (A)**	**Color + Texture + Shape (B)**
	64	88.66

Table III
Average Precision Value of; Color + Texture + Shape; Color +Texture+ Shape + Fuzzy Logic

Average precision (%)	Color + Texture + Shape (B)	Color + Texture + Shape + Fuzzy Logic (C)
	88.66	97.20

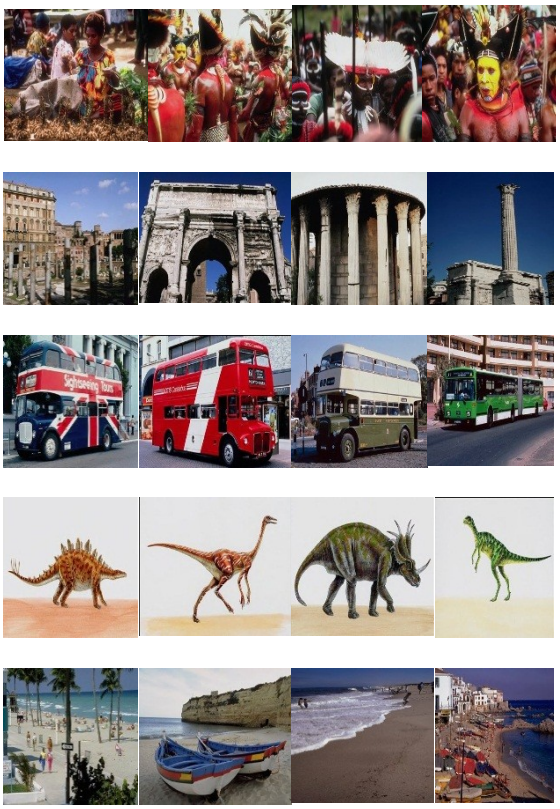

Fig 3: Sample of Image Database

Fig 3 shows the database used for the image retrieval. From table 2, it is seen that the average precision value for the method using only color and texture feature is 64 % [1] and it is 88.66 %by using color, texture and shape features. Thus the performance is improved by using more features. From table 3 it is seen that the average precision value for method using color, shape and texture is 88.66 % while it is 97.20 % with using fuzzy logic.Thus by using fuzzy logic system performance is improved by approx. 9 %.

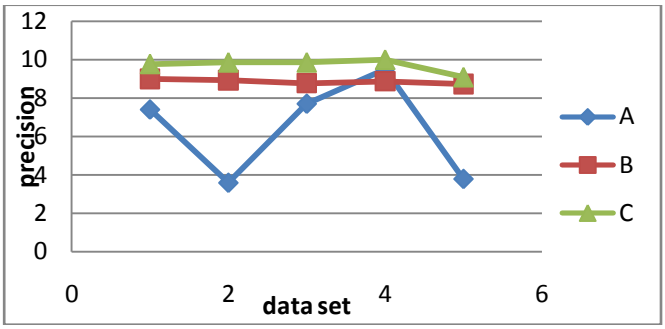

Fig 4: Precision value of different data sets for different methods.

It is also seen that value of average precision is increased for more number of features. Thus retrieval efficiency is improved when more features are combined.

VI. CONCLUSION AND FUTURE WORK

In this paper, a method based on combination of all the three features color, shape and texture is proposed. To increase the efficiency of system fuzzy logic is used. Experimental results show that proposed method has higher retrieval efficiency than existing methods using one or more features. Only one feature cannot describe image content properly. When all features are combined better results are obtained.Fuzzy logic helps in decreasing the semantic gap problem that is main problem in CBIR. However this method can be applied in content based video retrieval and neuro fuzzy concept can be used for further improvement of system.

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