Efficient CBIR Using Color Histogram Processing

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ABSTRACT

The need for efficient content-based image retrieval system has increased hugely. Efficient and effective retrieval techniques of images are desired because of the explosive growth of digital images. content based image retrieval (CBIR) is a promising approach because of its automatic indexing retrieval based on their semantic features and visual appearance. The similarity of images depends on the feature representation.However users have difficulties in representing their information needs in queries to content based image retrieval systems. In this paper we investigate two methods for describing the contents of images. The first one characterizes images by global descriptor attributes, while the second is based on color histogram approach.To compute feature vectors for Global descriptor, required time is much less as compared to color histogram. Hence cross correlation value & image descriptor attributes are calculated prior histogram implementation to make CBIR system more efficient.The performance of this approach is measured and results are shown. The aim of this paper is to compare various global descriptor attributes and to make CBIR system more efficient. It is found that further modifications are needed to produce better performance in searching images.

KEYWORDS

CBIR, Image Retrieval, Feature extraction, Global descriptor.

I. INTRODUCTION

Advances in computer and network technologies coupled with relatively cheap high volume data storage devices have brought tremendous growth in the amount of digital images. The digit contents are being generated with an exponential speed. Businesses, the media, government agencies and even individuals all need to organize their images somehow. As the amount of collections of digital images increases, the problem finding a desired image in the web becomes a hard task. There is a need to develop an efficient method to retrieve digital images.

Nowadays, CBIR is a hotspot of digital image processing techniques. CBIR research started in the early 1990's and is likely to continue during the first two decades of the 21st century. Many research groups in leading universities and companies are actively working in this area and a fairly large number of prototypes and commercial products are already available. However, the current solutions are still far from reaching the ultimate goal.

DOI : 10.5121/sipij.2011.2108

There are two approaches to image retrieval: Text-Based approach and Content- Based approach Today, the most common way of doing this is by textual descriptions and categorizing of images. This approach has some obvious shortcomings. Different people might categorize or describe the same image differently, leading to problems retrieving it again. It is also time consuming when dealing with very large databases. Content based image retrieval (CBIR) is a way to get around these problems.

CBIR systems search collection of images based on features that can be extracted from the image files themselves without manual descriptive.In past decades many CBIR systems have been developed ,the common ground for them is to extract a desired image. Comparing two images and deciding if they are similar or not is a relatively easy thingto do for a human. Getting a computer to do the same thing effectively is however a different matter. Many different approaches to CBIR have been tried and many of these have one thing in common, the use of color histograms.

Researchers working on CBIR claim that TBIR(Text Based Image Retrieval) has limitations. For example, Brahmi et al. mentioned the following two drawbacks in text-based image retrieval First , manual image annotation is time-consuming and therefore costly. Second, human annotation is subjective. In addition, Sclaroff et al. indicated that some images could not be annotated because it is difficult to describe their content with words . This may be one of the main causes of above two problems. We agree that the above two problems of annotation seem valid; however, we do not think that we should support CBIR instead of TBIR. There are two reasons to support TBIR. First, CBIR has its own problems, which are probably more crucial. Second, the negative effects due to the above problems in ABIR may be mitigated. First, let us start with the analysis of the problems in CBIR. It is obvious that there are many applications where the use of CBIR is advantageous. As examples, CBIR is suitable for medical diagnoses based on the comparison of X-ray pictures with past cases, and for finding the faces of criminals from video shots of a crowd. These examples can be categorized as “find-similar” tasks; the images to be searched may not differ significantly in their appearances, and so the superficial similarities of the images are more important than the semantic contents. Other applications that involve more semantic relationships cannot be dealt with by CBIR, even if extensive image processing procedures are applied. For instance, in the gathering of the photos regarding the ’Iraq war’, it is not clear what kind of images should be used for the querying. This is simply because visual features cannot fully represent concepts. Only texts or words can do that. Also, it should be noted that in a QbE setting, which is usually the premise of CBIR, users must have an example image at hand. In contrast, in a QbT setting, users simply need to have their search requests in mind because they can compose queries freely using their natural language. Now that we have clarified the advantages and disadvantages of CBIR.

CBIR systems use visual content such as color, texture, and simple shape properties to search images from large scale image databases (Del Bimbo, 1999). Although they improve text-based image retrieval systems, these systems are not yet a commercial success. One of the major reasons for this limited success is that CBIR rely upon a global view of the image, sometimes leading to a lot of irrelevant image content that is used in the search process. A solution for the global view problem can be found in localized CBIR. These systems only focus on the portion of the image the user is interested in.

In this paper ,three dimensional color space RGB is investigated & histogram based image retrieval method is used. Another issue in this work is to evaluate the performance measurement parameters of all global descriptor attributes including cross correlation function and make comparision.

II. LITERATURE SURVEY

In 2004 , Issam El-Naqa, Yongyi Yang , Nikolas P. Galatsanos , Robert M. Nishikawa , and Miles N. Wernick ,in his paper “A Similarity Learning Approach to Content-Based Image Retrieval: Application to Digital Mammography ” published in Ieee Transactions On Medical Imaging, Vol. 23, No. 10, October 2004 1233 proposed a learning machine-based framework for modeling human perceptual similarity for content-based image retrieval. In 2006 , Zhe-Ming Lu, Su-Zhi Li and Hans Burkhardt , in his paper “ A Content-Based Image Retrieval Scheme In JPEG Compressed Domain ” published in International Journal of Innovative Computing, Information and Control ICIC International °c 2006 ISSN 1349-4198 Volume 2, Number 4 proposed an image retrieval scheme in the DCT domain that is suitable for retrieval of color JPEG images of different sizes. In 2007 , Ryszard S. Chora´s , in his paper “Image Feature Extraction Techniques and Their Applications for CBIR and Biometrics Systems” identifies the problems existing in CBIR and Biometrics systems - describing image content and image feature extraction. He has described a possible approach to mapping image content onto low-level features. This paper investigated the use of a number of different color, texture and shape features for image retrieval in CBIR and Biometrics systems. In 2007 , from “ Content Based Image Retrieval using Contourlet Transform” by Ch.Srinivasa rao , S. Srinivas kumar & B.N.Chatterji describes the CBIR system with rotational invariance. In 2008 , S. Nandagopalan, Dr. B. S. Adiga, and N. Deepak in his paper “A Universal Model for Content-Based Image Retrieval” proposed a universal model for the Content Based Image Retrieval System by combining the color, texture, and edge density features or individually. In 2009 , Hichem Bannour_Lobna Hlaoua_Bechir Ayeb, in his paper “Survey Of The Adequate Descriptor For Content Based Image Retrieval On The Web:Global Versus Local Features “ proposed two methods of content based image retrieval according to visual similarity. The first method consists in indexing the images automatically through global features calculated on the whole image, while the second consists in indexing the image using features calculated on the regions of the image. In 2010 , H. B. Kekre & Dhirendra Mishra , in his paper ”CBIR using Upper Six FFT Sectors of Color Images for Feature Vector Generation” presented a new algorithm for digital image search and retrieval. in this paper, they have used Fast Fourier Transform of each R,G and B component of images separately. In 2010 , “CBIR Using Kekre’s Transform over Row column Mean and Variance Vector ” published in (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 05, 1609-1614 presented two algorithms with the application of Kekre’s transform and conclude that even though the database is having variety of images still the system is performing better in terms of precision for both the approaches. In 2010 , Jalil Abbas, Salman Qadri, Muhammad Idrees, Sarfraz Awan and Naeem Akhtar Khan, in his paper “Frame Work For Content Based Image Retrieval (Textual Based) System” published in Journal of American Science 6(9) focuses on both the content based image retrieval and Text Based image retrieval (TBIR). In 2010 , Ramesh Babu Durai C in his paper “A Generic Approach To Content Based Image Retrieval Using Dct And Classification Techniques” published in (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 06, 2022-2024 shows that the outcome of the results using DCT for feature extraction is pretty promising.

III. THEORY RELATED TO WORK

Content-based image retrieval, also known as query by image content and content-based visual information retrieval is the application of computer vision to the image retrieval problem, that is, the problem of searching for digital images in large databases. Content-based means that the search makes use of the contents of the images themselves, rather than relying on human-input metadata such as captions or keywords. A content-based image retrieval system (CBIR) is a piece of software that implements CBIR. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. It involves two steps.

A. Feature Extraction

The first step in this process is to extract the image features to a distinguishable extent. In this paper ,global features are extracted to make system system more efficient. In this section, we introduce the image features used by our methods for images description. We classify the various features as follows-

Texture Features
Color Features

The used color descriptor is composed by the following attributes

Colors expectancy: $\mathrm{Ei} = \frac{1}{N}\sum_{j=1}^{N} \mathrm{Pij}$ (1)

Colors variance: $\delta\mathrm{i} = (\frac{1}{N}\sum_{j=1}^{N}(\mathrm{Pij}\ \ \mathrm{Ei})^{2})^{1/2}$ (2)

Skewness: $\sigma\mathrm{i} = (\frac{1}{N}\sum_{j=1}^{N}(\mathrm{Pij}\ \ \mathrm{Ei})^{3})^{1/3}$ (3)

Where Pij is the (i; j) pixelcolor, N is the total number of pixels in the image.
These values allow to estimate the average color, the dispersion of color values from the average and the symmetry of their distribution on the whole image.

B. Matching

The second step involves matching these features to yield a result that is visually similar.
Basic idea behind CBIR is that, when building an image database, feature vectors from images (the features can be color, shape, texture, region or spatial features, features in some compressed domain, etc.) are to be extracted and then store the vectors in another database for future use. When given a query image its feature vectors are computed. If the distance between feature vectors of the query image and image in the database is small enough, the corresponding image in the database is to be considered as a match to the query. The search is usually based on similarity rather than on exact match and the retrieval results are then ranked accordingly to a similarity index.

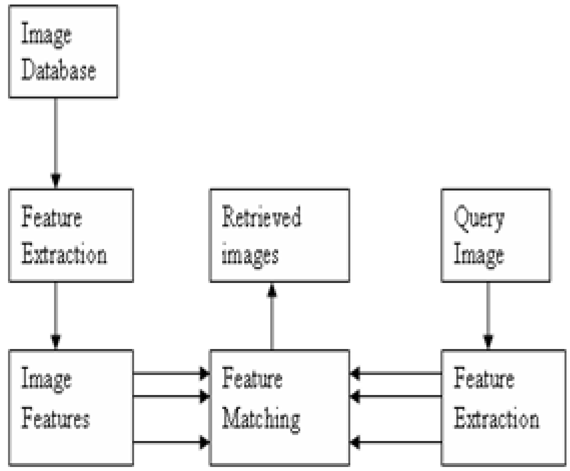


Figure 1: Block diagram of CBIR system

IV. COLOR SPACE

A color space is defined as a model for representing color in terms of intensity values.Typically,a color space defines a one-to-four dimensional space.A color component or a color channel is one of the dimensions. A color dimensional space(i.e. one dimension per pixel) represents the gray scale space.

A. The RGB colour model

The RGB model uses three primary colors, red, green and blue, in an additive fashion to be able to reproduce other colors. As this is the basis of most computer displays today, this model has the advantage of being easy to extract. In a true-color image each pixel will have has a red, green and blue value ranging from 0 to 255 giving a total of 16777216 different colors.

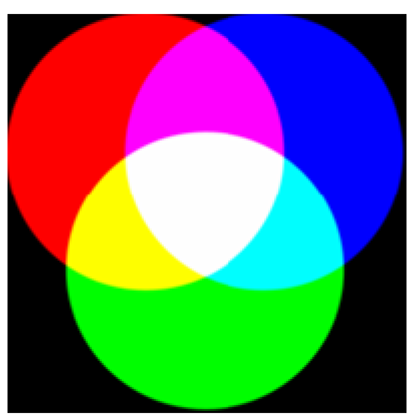


Figure 2: Additive mixing of red, green and blue[6]

One disadvantage with the RGB model is its behaviour when the illumination in an image changes. The distribution of rgb-values will change proportionally with the illumination, thus giving a very different histogram.

V. HISTOGRAM BASED IMAGE SEARCH

The color histogram for an image is constructed by counting the number of pixels of each color.In these studies the development of the extraction algorithms follow a similar progression (1) selection of a color space (2) quantization of the color space (3)computation of histograms.

A. Color Histogram

The approach more frequently adopted for CBIR systems is based on the conventional color histogram (CCH), which contains occurrences of each color obtained counting all image pixels having that color. Each pixel is associated to a specific histogram bin only on the basis of its own color, and color similarity across different bins or color dissimilarity in the same bin are not taken into account. Since any pixel in the image can be described by three components in a certain colour space(for instance, red, green and blue components in RGB space or hue, saturation and v alue in HSV space), a histogram, i.e., the distribution of the number of pixels for each quantized bin, can be defined for each component.
By default the maximum number of bins one can obtain using the histogram function in MatLab is 256. The conventional color histogram (CCH) of an image indicates the frequency of occurrence of every color in an image. The appealing aspect of the CCH is its simplicity and ease of computation.

VI. IMPLEMENTED METHOD

A. Overall Scheme

The flow chart of experiment in fig. follows the procedure of general image retrieval system.

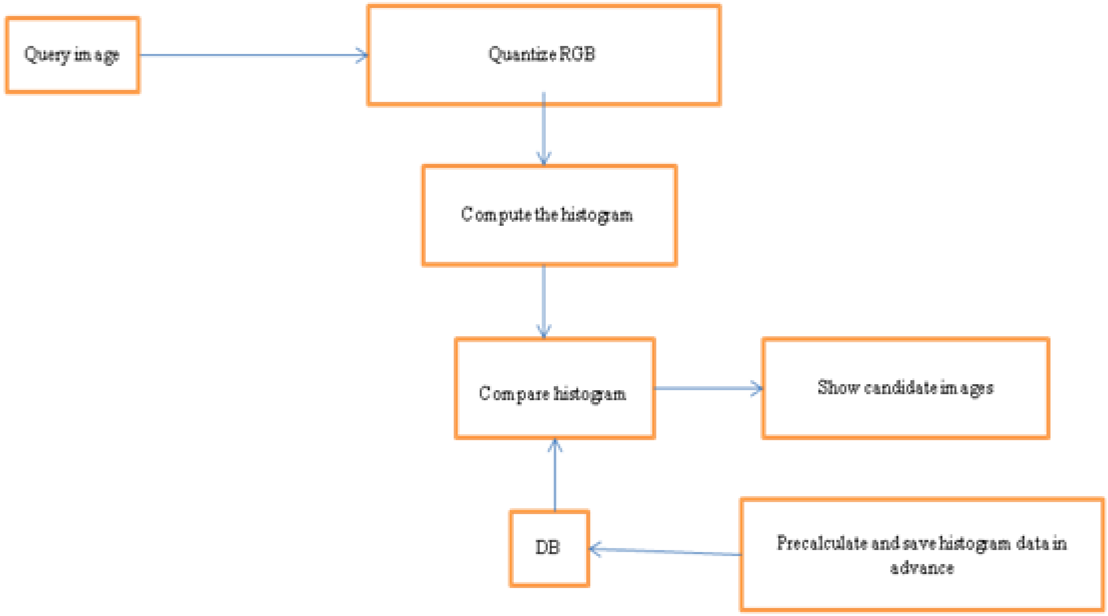


Figure 3: Flow of implemented image retrieval system

In the fig. above, once a query image & a retrieval method is chosen by users, the rest of whose process is done automatically.However,the histogram data for all images in database are computed and saved in DB in advance so that only the image indexes and histogram data can be used to compare the query image with images in DB.All processes were realized using MATLAB. The following sections explain the experiment in detail.

B. Generation of image DB

The image data used in the experiment were taken from digital camera & few of the images were downloaded from a web site to create large database..However in order to reduce the computation time of the whole process,image sizes were reduced to 8×8 pixels.

C. Quatization

Comparing all the colours in two images would however be very time consuming andcomplex, and so a method of reducing the amount of information must be used. Oneway of doing this is by quantizing the colour distribution into colour histograms. this is probably one of the more popular approaches to image retrieval today.
When computing a colour histogram for an image, the different colour axes are dividedinto a number of so-called bins. A three dimensional 256x256x256 RGB histogram would therefore contain a total of 16777216 such bins. When indexing the image, the colourof each pixel is found, and the corresponding bin's count is incremented by one.

Figure 4(a) :Orignal RGB Image

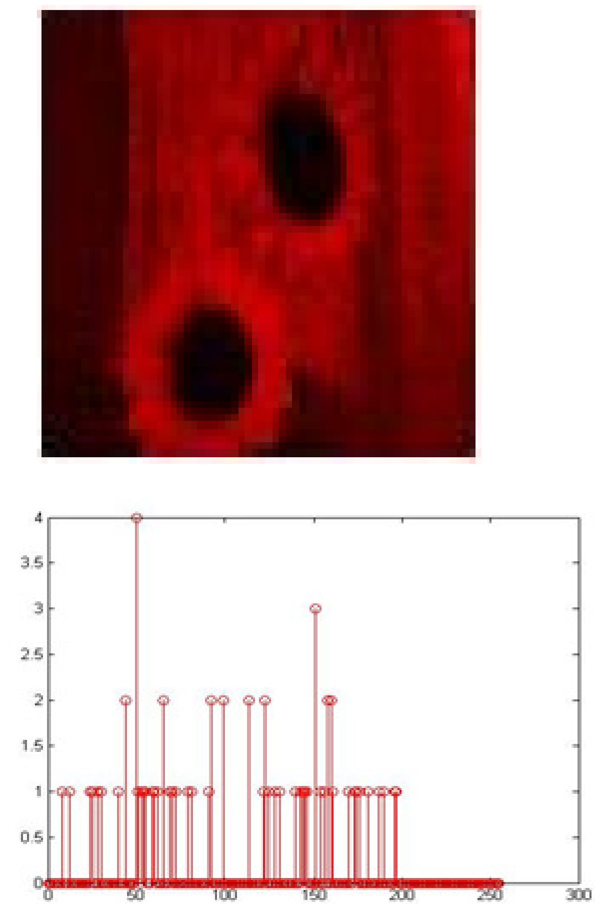
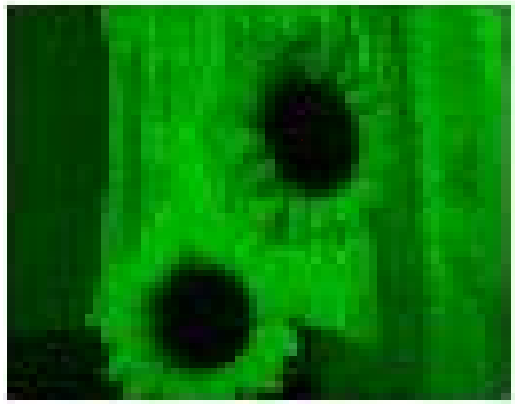


Figure 4(b): R Color Model Of Orignal Image With Respective Histograms



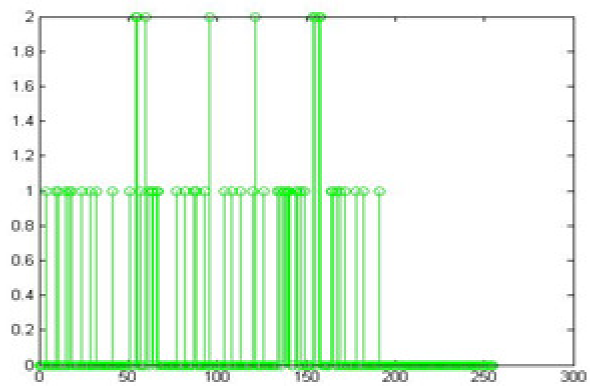
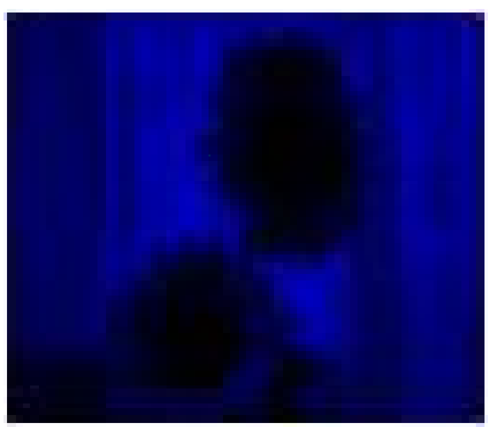


Figure 4(c): G Color Model Of Orignal Image With Respective Histograms



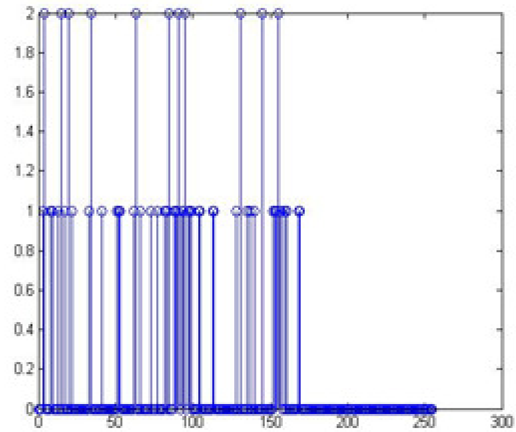


Figure 4(d): B Color Model Of Orignal Image With Respective Histograms

VII. COMPARISION OF HISTOGRAM

Computation of histogram is simple.All we have to do is just to count number of pixels that correspond to a specific color in quantized color space whether it is the RGB color space or HSV space. In order to compare histograms of two images,we first need to generate specific codes for all histogram bins. In thi experiment,(r:0-255, g:0-255, b:0-255) codes were generated for RGB histogram bins.

When the images have been quantized into histograms, a method of comparing these is needed. One of the most popular histogram comparison metric is the L1 (4) defined as:

$$L1 = \sum_{i=1}^{n}(Q_i - I_i) \quad (4)$$

Where Qi is the value of bin i in the query image and Ii is the corresponding bin in the database image. Based on experience from earlier projects ,the L1-norm is the metric of choice for this paper

VIII. PROBLEM WITH COLOR HISTOGRAM.

There are however, several difficulties associated with the color histogram (CH)viz a) CH is sensitive to noisy interferences such as illumination changes and quantization errors; b) large dimension of CH involves large computation on indexing, c)It does not take into consideration color similarity across different bins, d)It cannot handle rotation and translation.It means that information about object location,shape,, and texture is discarded.e) Two perceptually very different images with similar colour distribution will be deemed similar by a colour histogram-based retrieval system as illustrated in figure 5. Hence image retrieved by using global color histogram may not be semantically related even though they share similar color distribution.

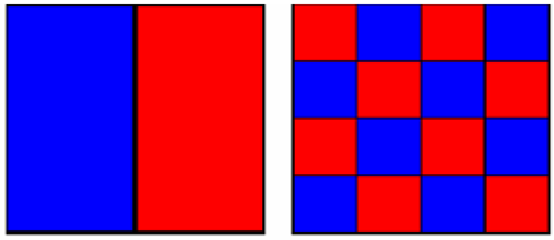


Figure 5: Two Perceptually Different Images with Equal Color Distribution

IX. EXPERIMENTS

Our methods has been implemented with a general-purpose image database including about 20 pictures , which are stored in JPEG format with size 8x8. To make more efficient color histogram based CBIR method, firstly texture feature attribute i.e. cross correlation & color feature attributes are calculated for all 20 database images against query image.

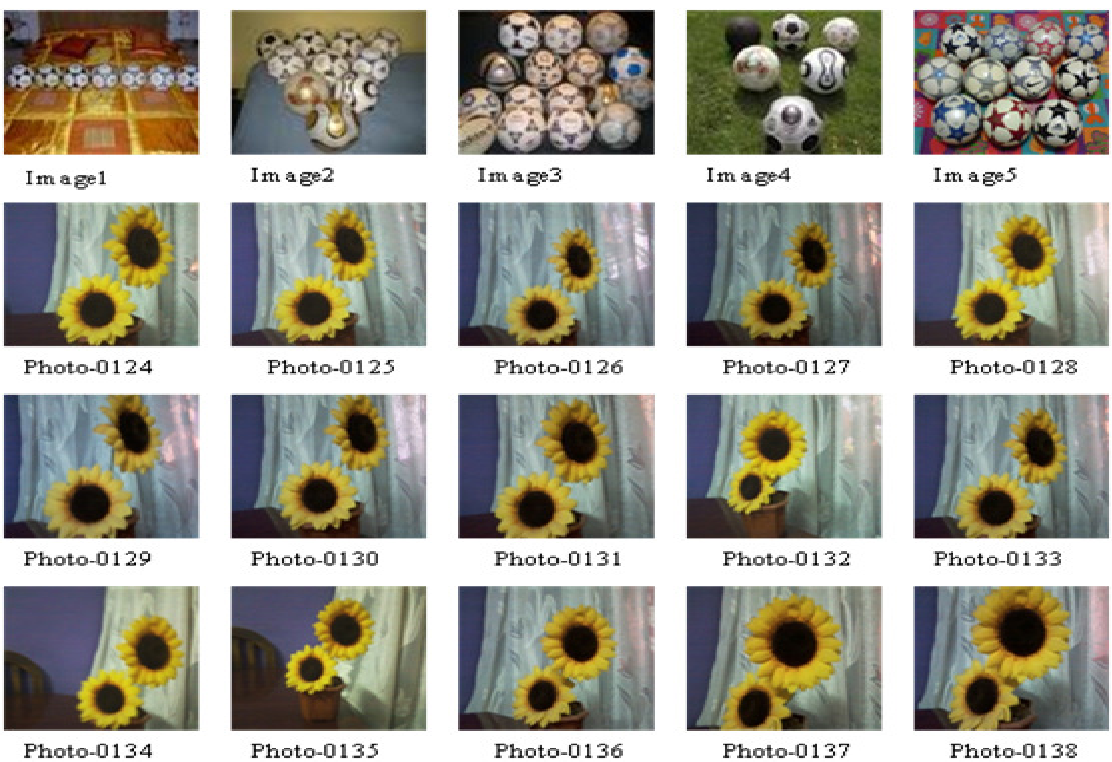


Figure 6: Image database

Figure 7: Query Image

Image Category	Image Name	Color Expectancy	Color Variance	Color Skewness	Cross correlation
Footballs	Image1	12	1.19	1.16	0.64
	Image2	8.84	4.47	2.5	0.4
	Image3	1.14	9.33	2.08	.33
	Image4	18	1.856	1.58	0.36
	Image5	7.9	1.15	1.9	0.24
Flowers	Photo0123(Query image)				
	Photo-0124	10.	1.47	2.41	0.51
	Photo-0125	24	3.14	4.53	0.6
	Photo-0126	18.7	2.27	3.08	0.59
	Photo-0127	7.25	1.174	1.84	0.54
	Photo-0128	19.9	2.91	4.74	0.72
	Photo-0129	11	1.36	1.74	0.5
	Photo-0130	5	8.93	1.57	0.49
	Photo-0131	0	0	0	1.00
	Photo-0132	17	2.41	3.75	0.52
	Photo-0133	7.4	7.5	8.12	0.73
	Photo-0134	1.26	4.36	5.07	0.41
	Photo-0135	10.56	1..4	8.615	0.42
	Photo-0136	10.3	1.14	1.35	0.61
	Photo-0137	2	3.01	3.84	0.74
	Photo-0138	.55	7	1.64	0.731

Table 1: : Showing Distance Between Global Feature Attributes of Query Image & Database Images

A. AMP-measurements

The match percentile MP of a given image is defined as:

$$MP = (N - R)/(N - 1) \qquad (5)$$

Where N is the number of images in the database and R is the rank of the returned image. This is calculated for each image and the results averaged. A score of 100% indicates a perfect match.

Image Category	Image Name	Color Expectancy	Color Variance	Color Skewness	Cross correlation	Total AMP
Footballs	Image1	30%	80%	95%	75%	70%
	Image2	55%	25%	45%	20%	36.25%
	Image3	90%	5%	55%	10%	40%
	Image4	20%	60%	80%	15%	43.75%
	Image5	60%	90%	60%	5%	53.75%
Flowers	Photo0123(Query image)					
	Photo-0124	50%	65%	50%	45%	52.5%
	Photo-0125	5%	35%	25%	65%	32.5%
	Photo-0126	15%	55%	40%	60%	42.5%
	Photo-0127	70%	85%	65%	55%	68.75%
	Photo-0128	10%	45%	20%	80%	38.75%
	Photo-0129	35%	75%	70%	40%	55%
	Photo-0130	75%	10%	85%	35%	51.25%
	Photo-0131	100%	100%	100%	100%	100%
	Photo-0132	25%	50%	35%	50%	40%
	Photo-0133	65%	15%	10%	85%	43.75%
	Photo-0134	85%	30%	15%	25%	38.75%
	Photo-0135	40%	70%	5%	30%	36.25%
	Photo-0136	45%	95%	90%	70%	75%
	Photo-0137	80%	40%	30%	95%	61.25%
	Photo-0138	95%	20%	75%	90%	70%

Table2 : Showing Result of AMP Measurement

Those images for which obtained AMP result is above 60%are considered to be matched. Secondly,histogram comparision metrics using RGB color model is applied to the matched databases.

The top six best images according to AMP measurement are returned as result.Now histogram comparision metrics using RGB color model is applied to the matched databases .

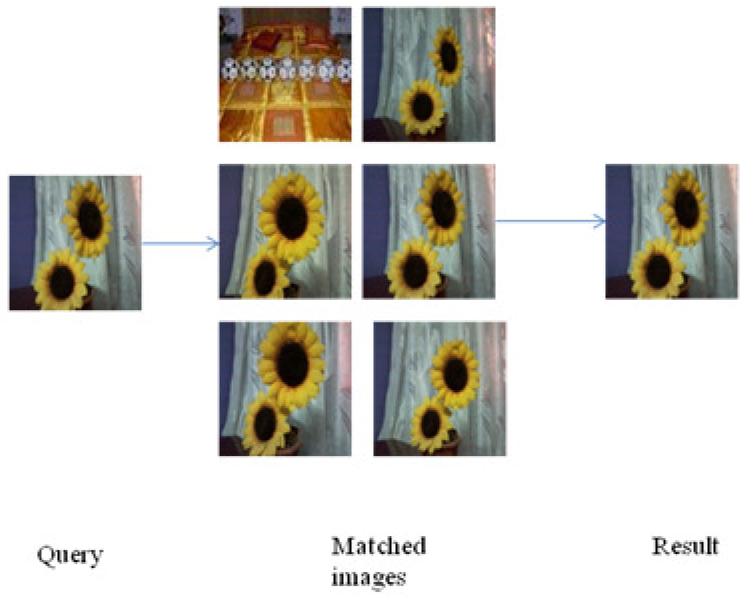


Figure 8: A CBIR system showing result of AMP measurement.

No. of matching database cases	Mean difference obtained by Comparision
Image1	1.13
Photo0127	1.09
Photo0131	0.00
Photo0136	1.11
Photo0137	1.05
Photo0138	1.07

Table 3 : Result of histogram comparision metrics

Hence the desired image is successfully retrieved i.e. photo0131.

B. Retrieval Efficiency

The retrieval efficiency, namely recall precision and accuracy were calculated for 20 color images from image database. Standard formulas have been used to compute these parameters.

$$\text{precision} = \frac{\text{No of relevant images retrieved}}{\text{Total No of images retrieved}}$$

$$\text{recall} = \frac{\text{No. of relevant images retrieved}}{\text{Total No of relevant images in the Database}}$$

$$\text{Accuracy} = \text{precision} + \text{recall}/2$$

Total no. of images in the database	No. of relevant images in the database	Total no.of images retrieved	No. of relevant images retrieved	Precision rate	Recall rate	Accuracy rate
20	10	8	6	75%	60%	67.5%

Table 4: Precision And Recall Values In % For Color Expectancy(E)

Total no. of images in the database	No. of relevant images in the database	Total no.of images retrieved	No. of relevant images retrieved	Precision rate	Recall rate	Accuracy rate
20	10	9	6	66.6%	60%	63.2%

Table 5 : Precision And Recall Values In % For Color Variance(□)

Total no. of images in the database	No. of relevant images in the database	Total no.of images retrieved	No. of relevant images retrieved	Precision rate	Recall rate	Accuracy rate
20	10	8	5	62.5%	50%	56.25%

Table 6 : Precision And Recall Values In % For Skewness(σ)

Total no. of images in the database	No. of relevant images in the database	Total no.of images retrieved	No. of relevant images retrieved	Precision rate	Recall rate	Accuracy rate
20	10	8	7	87.5%	70%	78.75%

Table 7 : Precision And Recall Values In % For Cross Correlation

Total no. of images in the database	No. of relevant images in the database	Total no.of images retrieved	No. of relevant images retrieved	Precision rate	Recall rate	Accuracy rate
20	10	6	5	83.3%	50%	66.6%

Table 8 : Precision And Recall Values In % For Average Value Of Image Descriptor Attributes

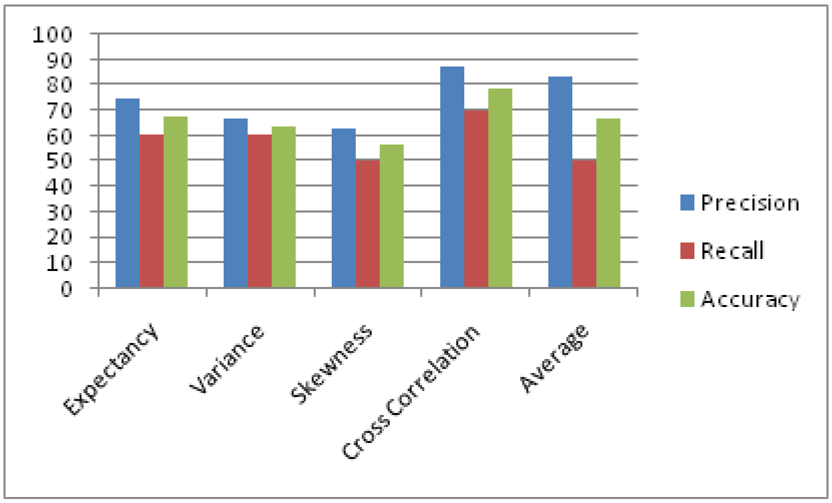


Figure 8: Comparative global descriptor attributes of the proposed CBIR system for various retrieval efficiency measurement parameters.

A comparision result between global descriptor attributes shows that , cross correlation function achieve better retrieval results than all color descriptor attributes for all retrieval efficiency measurement parameters.However recall rate is same for both E and □ global descriptor attributes. Precision and recall rate of both E and □ is also better than σ one.It has found that cross correlation function also works better than result obtained by taking the average of all image descriptor attributes. Precision rate of average value is greater than that for all color descriptor attributes but recall rate is same as for σ.From these comparision results, we can see that cross correlation function achieves a highest retrieval efficiency.

X. CONCLUSION

To compute feature vectors for Global descriptor, required time is much less as compared to color histogram.Hence to enhance the efficiency of retrieval system , a new CBIR technique is developed in which global descriptor attributes of all database images are measured first and then histogram-based search method is investigated in RGB color space only on matched databases.A higher successful rate in retrieving a target image is obtained.

The performance of various image feature attributes are measured and compared. A comparision result between global descriptor attributes containing texture feature attribute “cross correlation” and color feature attributes “ color expectancy, color variance, skewness” shows that cross correlation function achieves better retrieval results than all color descriptor attributes for all retrieval efficiency measurement parameters.
Histogram search characterizes an image by its color distribution, or histogram but the drawback of a global histogram representation is that information about object location, shape, and texture is discarded. Thus this paper showed that images retrieved by using the global color histogram may not be semantically related even though they share similar color distribution in some results.This drawback is also minimized upto some limit by calculating color feature attributes along with efficient implementation.

XI. FUTURE SCOPE

On the approaches proposed in this paper, further work and testing is needed for them to be effective.For future work, Finding good parameters could be another subject to improve histogram-based search algorithm. There are several difficulties associated with the color histogram (CH) as mentioned above. To address the problem of rotation and translation an invariant color histograms based on the color gradients can be used makes which use of gradients in different channels that weight the influence of a pixel on the histogram to cancel out the changes induced by deformations.To address the problem of spatial relationship and large variations between neighboring bins of conventional color histograms ,fuzzy color histogram (FCH) can be used, by considering the color similarity of each pixel’s color associated to all the histogram bins through fuzzy-set membership function. In comparison with the conventional color histogram (CCH), which assigns each pixel into one of the bins only, FCH spreads each pixel’s total membership value to all the histogram bins.
Another area in the field of CBIR where more work is needed is creating consumer applications that use the technology already available.

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