An Integrated Approach to Content Based Image Retrieval

Roshi Choudhary, Nikita Raina, Neeshu Chaudhary, Rashmi Chauhan, Dr. R H Goudar
Graphic Era University, Dehradun, 248001, India
Email-roshichoudhary01@gmail.com

Abstract—**Content based image retrieval, in the last few years has received a wide attention. Content Based Image Retrieval (CBIR) basically is a technique to perform retrieval of the images from a large database which are similar to image given as query. CBIR is closer to human semantics, in the context of image retrieval process. CBIR technique has its application in different domains such as crime prevention, medical images, weather forecasting, surveillance, historical research and remote sensing. Here content refers to the visual information of images such as texture, shape and color. Contents of image are richer in information for an efficient retrieval in comparison to text based image retrieval. In this paper, we have proposed a content based image retrieval integrated technique which extracts both the color and texture feature. To extract the color feature, color moment (CM) is used on color images and to extract the texture feature, local binary pattern (LBP) is performed on the grayscale image. Then both color and texture feature of image are combined to form a single feature vector. In the end similarity matching is performed by Euclidian distance which compares feature vector of database images with query images. LBP mainly used for face recognition. But we are going to use LBP for natural images. This combined approach provides accurate, efficient, less complex retrieval system.**

Keywords: Content based image retrieval (CBIR), Local Binary Pattern (LBP), Color moment (CM), Euclidian Distance.

I. INTRODUCTION

Due to the development of the Internet at large scale and the availability of various image capturing devices such as digital cameras, smart mobile phones, image scanners, digital image collection is increasing rapidly. With the popularity of the computer based smart system, content based image retrieval has grown in different areas to research [8].

Efficient image browsing, image retrieval and searching tools are needed to users in various domains including remote sensing, crime prevention, fashion, medicine, publishing, architecture, etc. To achieve content based image retrieval, many retrieval systems have been developed. Two frameworks are accessible to perform the information retrieval which are content based retrieval and text based retrieval. Text based framework was introduced in 1970s. In this approach, text descriptors are used to annotate the image. These descriptors are used in database to perform information retrieval. But Text based approach has several disadvantage, firstly, more human work is required to annotate the images and second is annotation inaccuracy.

Two overcome the problems in text based framework, in 1980s content based image retrieval (CBIR) was introduced. In CBIR, contents of image are used to annotate to perform retrieval. The term "CONTENT" might refer to low level feature such as shape, color, texture, or any other important information derived from the image. "Content-based" means analyzing the image contents not the text descriptors such as tags, descriptions or keywords correlated with image. Basic function of CBIR is to extract the contents or features of image. The crucial difference between text-based and content-based retrieval systems is that interaction of human is an necessary part of the latter system [14]. Humans mostly had used keywords, text, descriptors (high level features), to get information of images and to find out their similarity. The features of image are mostly low-level features which can be extracted automatically using available computer vision techniques. By extracting these features, searching, browsing from a database and similarity matching between the images is performed. Main advantage of CBIR system is that it uses image features rather than image itself.

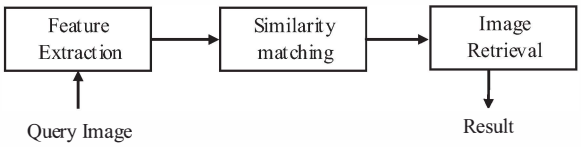

Figure 1. CBIR Block Diagram

As Figure 1 shows, first step is to extract the feature of image. Extraction process adopts the available various feature extraction technique to extract the features of images. Next step is to perform similarity matching of images. In next step, results are stored in database and are displayed on graphical user interface.

So, CBIR is effective and fast to perform retrieval of the images. Research in CBIR has focused on image preprocessing, feature extraction, similarity measurement etc [14]. Most of the past studies on CBIR has used a single content such as shape or texture or color to describe the image. The drawback of this method is that only one feature is not sufficient to describe the image because the image can have more visual characteristics.

The paper is organized as follows: Section 2 describes the related work in content based image retrieval. Section 3 focuses on the background concepts and proposed approach which is used in this paper. In Section 4, algorithm of overall

methodology is discussed. Section 5 discussed the conclusion and future work of our paper.

II. LITERATURE SURVEY

Query by image content (QBIC) also referred as content based image retrieval (CBIR) was developed by IBM. QBIC performs the image retrieval by passing the content of query image like shape, color, texture, spatial location. There are various techniques available to extract the image content and to perform the image retrieval. CBIR has its application in various fields like digital libraries, medical field, military, facial recognition to prevent crime etc. An image has three types of contents as texture, color, shape which is used in content based image retrieval. Among all the three features for color image retrieval, color feature is used. It is not variable to complex background and independent of image orientation and size [8].

Color is invariant to complexity and very much sensitive to humans than the grayscale images [1].There are various techniques available to extract the color from images. Color coherence vector, color histogram, color correlogram are the main techniques which are used to extract the color feature. Basically color histogram finds the color distribution in image. When two different images have the same histogram then histogram techniques gets fail [1]. Color Moment extracts these color distribution efficiently. So color moment is better than histogram because it also finds the spatial information of pixels [6]. Color distribution in an image is characterized by color moment so we have to find out the three order color moment- first order (mean), second order (standard deviation), third order (skewness). Further techniques which used in extracting the color feature are color coherence vector and color correlogram. Color Moment [7] is much better then all color techniques.

Various color models are also available to perform retrieval which are RGB, HSV, L*a*b*, CMY etc. The RGB color space is well supported on image processing programs. Main disadvantage of RGB is that the RGB color space is not uniform and all three components (R, G, B) have equal importance and so those values have to be quantized with the same precision [9]. So over RGB color space, HSV is preferred. The L*a*b* (Brightness, red-green and yellow-blue content) system gives quantitative expression to the Munsell system of color classification [6]. Now L*a*b* color space is mostly used.

Texture is another one widely used feature in content based image retrieval. Various methods are available which are used to describe texture feature such as gray-level co-occurrence matrix [4], Ranklet texture feature [3], Haar discrete wavelet transform [12] and Gabor filter texture feature [5] etc.

Shape is also a feature of image which is used in feature extraction. Various methods to extract shape feature are edge histogram descriptor (EHD) [6], Sobel descriptor, SIFT, Fourier descriptor of PFT [10] etc.

After feature extraction, various algorithms for clustering, classification, similarity matching are used. Clustering [2] makes the cluster of similar data in image database. K-means clustering algorithm is used to perform clustering. Classification uses the PNN classifier [7]. Similarity matching is mainly performed using Euclidian distance, Manhattan distance, histogram matching etc.

III. BACKGROUND CONCEPTS AND PROPOSED WORK

In this section, an approach is proposed which retrieves similar images from the database using image as a query. This approach uses low level features of image for content based image retrieval. The objective of this work is to make the image retrieval efficient, fast and less complex. To achieve this objective, two methods are used to extract the color feature and the texture feature.

Basic idea of the proposed work in this paper is to extract the texture and color features of images. The extraction of color feature from the images is based on the understanding of the theory of color and the distribution of color in images. Texture is an attribute that represents the spatial arrangement of the pixels gray level in a region or image.

A. Architecture

This section describes architecture of proposed approach as shown in figure 2.

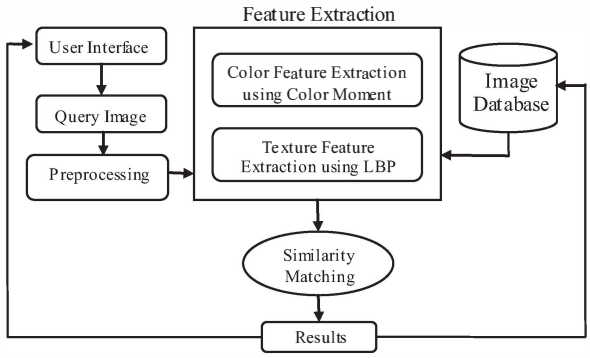

Figure 2.Architecture

Figure 2 describes the architecture of proposed work in which, firstly the image is preprocessed so that feature can be extracted. After preprocessing, a combined texture and color feature technique is applied for feature extraction. After feature extraction and similarity matching is performed to retrieve the results. Description of architecture is discussed below:

- *Preprocessing*

Preprocessing is a process which is applied on the image before feature extraction. Preprocessing includes image enhancement, image segmentation, image conversion etc. Image enhancement is used to improve the image contrast so that things can become clear. Image segmentation is used to create the segments of image based on color or to segment into

blocks. Image conversion is the process to convert the image from one color space to another required color space.

- *Feature Extraction*

Feature Extraction is crucial part in content based image retrieval. It includes the extraction of image features. Techniques used in this paper are defined below:

1. Local Binary Pattern (LBP)

A local binary pattern was introduced by Ojala et al [13] for texture analysis. In simplest form, a basic LBP descriptor [10] is created by setting a threshold as the values of the 3 X 3 neighborhood of the pixel against the central pixel. In comparison to other available texture analysis algorithm, LBP descriptor is not computationally expensive. To create LBP representation, first we have to convert the color (RGB color space) image into grayscale image. Then we sub-block the image into 3x3 blocks. From the block, we have to find out gray level pixel values. Then we calculate LBP value. By using these LBP values we get a LBP image and calculate the histogram of calculated LBP codes as shown in figure 3.

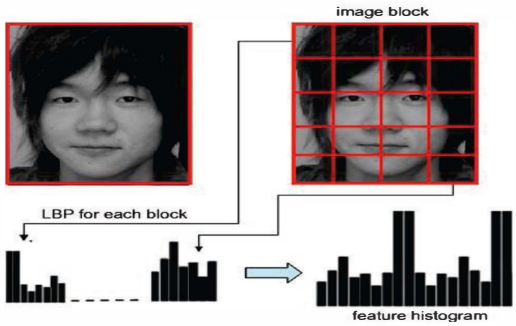

Figure 3. Basic LBP Descriptor [19]

Below figure 4 shows, a sub-block of size 3X3 gray scale value.

180	168	149
175	150	120
157	100	133

Figure 4.A 3X3 sub-block of image

bp_0	bp_1	bp_2
bp_7	cp	bp_3
bp_6	bp_5	bp_4

Figure 5.A 3X3 sub-block bit Position of image

Figure 5 shows different bit position with central pixel on the sub-block. All the pixel values are used to compare with central pixel 'cp' to calculate the LBP codes.

Now we will compare all the bit position bp0, bp1, bp2 …etc with the central pixel cp and follow the following formula:

$$bp_i = f(x) = \begin{cases} 1: \sum_{i=0}^{7} bp_i \geq cp \\ 0: \sum_{i=0}^{7} bp_i < cp \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

After applying above formula, we get the figure 6 below as a binary pattern form the figure 3.1.1 and figure 7 we shows the weighted value of the bit position bp0,bp1,bp2… etc.

1	1	0
1	p	0
1	0	0

Figure 6.A 3X3 sub block showing binary value

1	2	4
128		8
64	32	16

Figure 7.A 3X3 sub block weighted value of the bit position

Finally, we have to find the binary string which represents a pattern using the following formula:

$$cp = \sum_{i=0}^{7} 2^i * bp_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Here b^i is a bit in the figure 6. Now each bit position of Figure 6 and Figure 7 are multiplied by using above formula and we get a LBP feature value which acts as a signature of the texture in Figure 8.

1	2	0
128		0
64	0	0

Figure 8.A 3X3 sub block of LBP Feature Value

Then we add all the bit position and get the value of cp=1+2+128+64=195.

The histogram of LBP pattern of all central pixel cp is then created to describe the texture of the image. The histogram of LBP features extracted from each sub-region are concatenated into a single, spatially enhanced feature histogram defined as

$$H_{ij} = \sum_{x,y} I\{f_i(x,y) = i\} I\{(x,y) \epsilon R_j\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The extracted feature histogram represents the local texture of image.

Local binary pattern has its application in medical field [16], facial recognition [15] [11], to detect forged images [18], to classify gender [10] etc.

2. *Color Moment*

Color moment is a technique that is used to extract color from image. It is used to differentiate the images based on color of image. Color moment is used to check the color similarity between images. The basis of color moments is to calculate distribution of color in an image that can be understand as a probability distribution.. Stricker and Orengo proposed the method of color moment [5]. They used to calculate the first order, second-order and third-order moment of each color component.

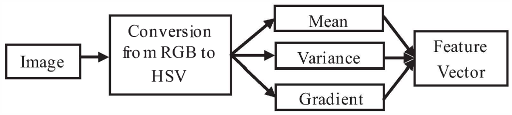

Figure 9. Color Moment Feature Extraction

The color moment is an efficient and simple method to extract color. These color moments are as first-order (mean) and second (variance) and third-order (gradient). If the value of the a^{th} color channel at the b^{th} image pixel is p_{ab}, then the three colors moments are defined as below:

Moment 1(Mean)

$$E_a = \frac{1}{N}\sum_{b=1}^{N} p_{ab} \quad \ldots\ldots(4)$$

Mean is the average color value in the image.

Moment 2(Standard deviation)

$$\sigma_a = \sqrt{\left(\frac{1}{N}\sum_{b=1}^{N}(p_{ab} - E_a)^2\right)} \quad \ldots\ldots (5)$$

The standard deviation is the square root of the variance of the distribution.

Moment 3(Gradient or Skewness)

$$S_a = \sqrt[3]{\left(\frac{1}{N}\sum_{b=1}^{N}(p_{ab} - E_b)^3\right)} \quad \ldots\ldots (6)$$

Skewness is a measure of the degree of asymmetry in the distri bution.

N is total number of pixels in image. In content based image retrieval, color moment of an image can find by using above equation 4, 5 and 6. So to calculate the color distribution of an image we have to calculate three color moments by using above formulas.

3. Similarity Measurement

Distance measurement is the measurement of a certain distance between two images which are compared [8]. Euclidean distance given by following formula-

$$D\left(F\_V_q, F\_V_{DB_{Im}}\right) = \left\{\sum_{i=0}^{L-1}\left(F\_V_q(i) - F\_V_{DB_{Im}}(i)\right)^2\right\}^{1/2} \quad ..(4)$$

Where

$F\_V_q(i) = (F\_V_q(0), F\_V_q(1) \ldots\ldots\ldots F\_V_q(L-1))$

is the query image feature vector.

$F\_V_{DBim}(i) = (F\_V_{DBim}(0), F\_V_{DBim}(1) \ldots F\_V_{DBim}(L-1))$

is database images feature vector and L is the dimension of image feature vector.

So Euclidian Distance is the difference between two feature vectors of image. Here we create two feature vectors, one is texture feature vector and one is for color feature vector. After combining these two vectors we get the final vector of an image. So here to calculate similarity difference between the feature vector of query image and database images is measured. Images in database which have Euclidian distance equal to zero will be the same image as query image. Here we have to find the similar images so we have to set a threshold of Euclidian distance.

IV. ALGORITHM

Input: Image given as query image supplied by user through user interface.

Output: Similar images to query image will retrieved after applying following process.

CM – Color Moment

LBP – Local Binary Pattern

F_V_q – Feature Vector of Query image

F_V_{DBim} - Feature Vector of Database Images

DB_{Im} – Database of images.

E_d – Euclidian Distance

R_s - Result set of retrieved images from the database which would have similar to query image.

For image IM_q do

i. Preprocess the image.

ii. Apply Color Moment algorithm to extract the Color feature of query image. i.e.

$$F1 = CM\ (IM_q)$$

iii. Apply Local Binary Pattern algorithm to extract the Texture feature of query image. i.e.

$$F2 = LBP\ (IM_q)$$

iv. Create a final feature vector of query image which contains color feature and texture feature vector of an image. i.e.

$$F\_V_q = \{F1, F2\}$$

v. For each image in database DM_{Im} repeat II to IV step to get the feature vectors (F_V_{DBim}) of database images, Where DM_{Im}= { IM_{DB1}, IM_{DB2} ..... IM_{DBn}}, where n is number of images present in database.

vi. Use Euclidian Distance algorithm to perform similarity matching.

$$D(F\_V_q, F\_V_{DB_{Im}}) = \{\sum_{i=0}^{L-1}(F\_V_q(i) - F\_V_{DB_{Im}}(i))^2\}^{1/2}$$

vii. Retrieved topmost images having similarity specified by a given threshold Th so that

R_s (Image) = {Irs1 ..... Irsk}

Where Ed (Irsk) > Th.

Algorithm starts when user supplies the query image through user interface. First of all query image is preprocessed to increase the contrast of image and then feature extraction is applied. Color moment is used as a color descriptor and local binary pattern is used as a texture descriptor. After applying these techniques, a feature vector of color and texture is created. A final feature vector is created by combining the color feature vector and texture feature vector. By using this feature vector, histogram is generated and then similarity matching is performed to retrieve the result from database.

V. EXPERIMENTAL RESULTS

James S. Wang et al. [17] has provided a database which is known as wang database. This wang database is used to test the proposed method. This database consist 1,000 images of 10 classes. Each class has 100 images. These 10 classes are composed of African people, sea, building, dinosaur, bus, elephant, flower, horse, mountain, and food.

Here we are comparing color moment and local binary pattern. We can see figure 10 which shows the results using query image shown in figure 9 using color moment.

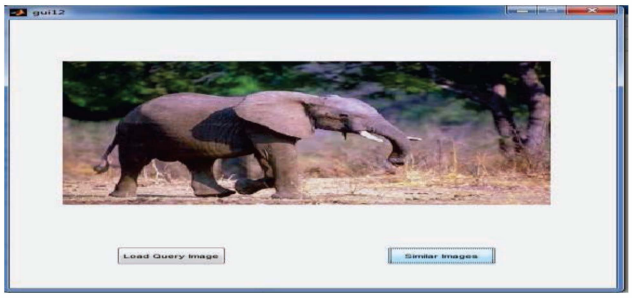

Figure 9: Query image to perform content based image retrieval

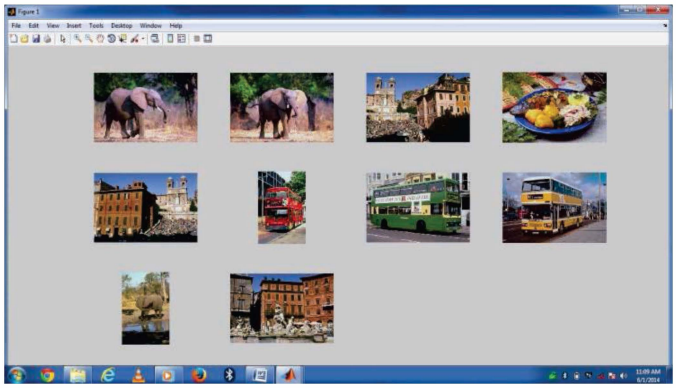

Figure 10.Retrieved results using Color Moment

Query image shown in figure 9 is used to retrieve the result using local binary pattern and results using this method are shown in figure 11. Here we can analyze if we use only one feature to perform retrieval then retrieval is not accurate as shown in figure 10 and 11.

So we have combined two techniques to get the images similar to query image. Results using this integrated approach are shown in figure 12.

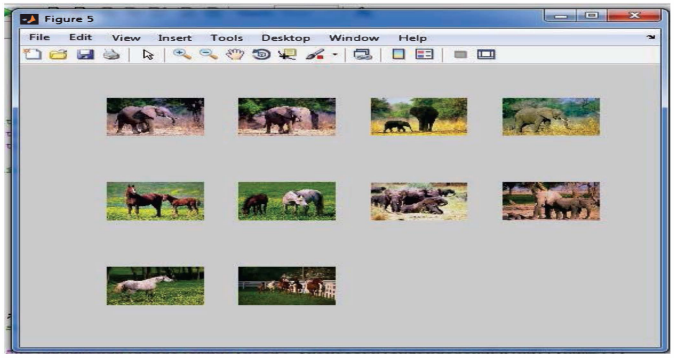

Figure 11: Retrieved results using Local Binary Pattern

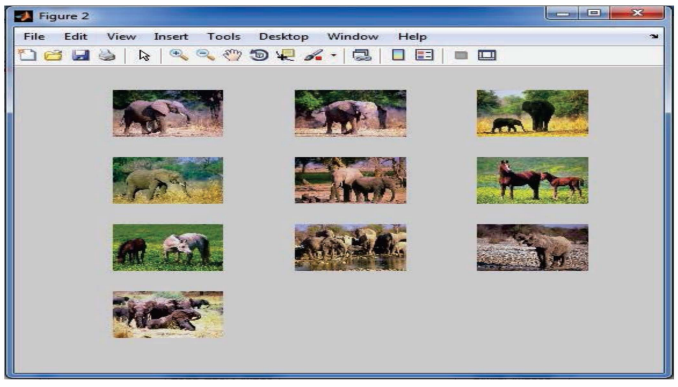

Figure 12.Retrieved results using proposed integrated approach

TABLE I. AVERAGE PRECISION BASED ON DIFFERENT METHOD

Images Category	CM	LBP	Integrated Approach
Beaches	0.31	0.35	0.5
Buildings	0.285	0.3	0.7
Buses	0.314	0.8	0.98
Dinosaurs	0.93	0.97	1.0
Elephant	0.44	0.19	0.6
Flowers	0.61	0.79	0.89
Horse	0.28	0.32	0.8
Mountain	0.49	0.12	0.7
Food	0.28	0.34	0.6
Overall Accuracy	0.43	0.46	0.75

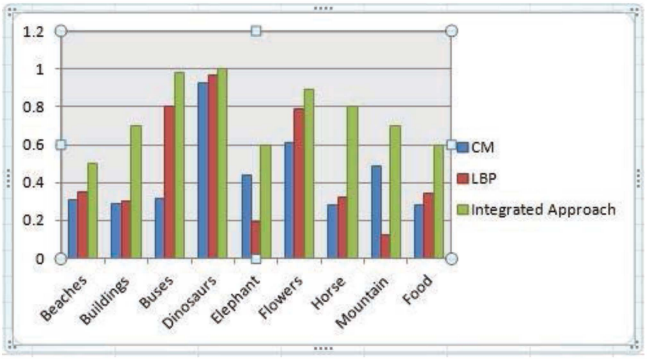

Figure 14.Precision results of CM, LBP and Proposed Integrated approach

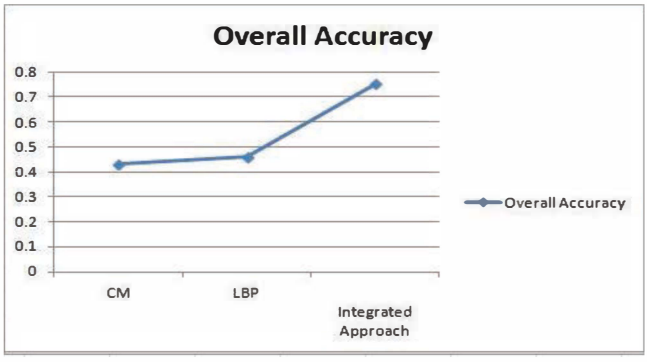

Figure 15.Comparison of Accuracy of System

To perform quantitive analysis, we perform the operation on some random images to find the recall and precision to check system effectiveness. Quantitive analysis is performed in three phase. In first phase, first step is to find recall and precision using retrieved result of color moment only, second step is to find out recall and precision using retrieved results of local binary pattern only and third step is to get recall and precision using retrieved results of integrated approach. In the second phase, system will perform the similarity measurement using color feature and the texture feature separately. In the third phase, the system will retrieve similar images to the input image by using both the texture feature and the color feature. Table I shows the experimental results for each category of image by computing the precision for each experiment performed.

Table I has cleared that when we use texture and color feature to retrieve images from database then we get the good results rather than using single color feature. Proposed method has more accuracy as compared to the texture only or the color only as shown in figure 15. Figure 14 shows a graphical representation of system accuracy to show which method has produced more accurate results. The proposed method has lesser computational complexity as compare to other methods.

VI. CONCLUSION AND FUTURE WORK

In this paper we have proposed an approach to perform content based image retrieval. It is an integrated approach used to extract color and texture feature from images. By using single feature, correct results can never produced. So multi feature extraction is more beneficial to perform image retrieval. To extract the color feature, higher order of color moment is used which is the descriptor of color. To extract texture, LBP is used which is the descriptor of texture. Local binary pattern is mainly used to face recognition. Here we used LBP on the natural images to extract texture. In future, we will improve this proposed work by using other methods. We will try to propose a new technique which will give more sufficient results. Clustering approach will applied to reduce the searching time. Classification will perform to improve the system performance so that results can be more better.

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