Content Based Image Retrieval using Collaborative Color, Texture and Shape Features

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Abstract: ***Selection of feature extraction method is incredibly recondite task in Content Based Image Retrieval (CBIR). In this paper, CBIR is implemented using collaboration of color; texture and shape attribute to improve the feature discriminating property. The implementation is divided in to three steps such as preprocessing, features extraction, classification. We have proposed color histogram features for color feature extraction, Local Binary Pattern (LBP) for texture feature extraction, and Histogram of oriented gradients (HOG) for shape attribute extraction. For the classification support vector machine classifier is applied. Experimental results show that combination of all three features outperforms the individual feature or combination of two feature extraction techniques.***

Keywords: Color Histogram, Image Retrieval, LBP, HOG, Support Vector Machine.

I. INTRODUCTION

CBIR is exigent task in multimedia field. “Content” of the image can be color, texture, or shape of the image. “Content based” means that image search technique analyzes the content of image data rather than keyword, tags, or description associated with the images [1]. Large collection of multimedia data such as images and video are available on different platforms such as social media photo collections, community website images, scientific image data, news media, consumer media data and surveillance archives. Therefore it is challenging to retrieve the data based on the content of the data.

CBIR can be performed using particular combination of the color, texture and shape of the image object, the presence or arrangement of specific types of objects, the view of particular type of event, and the presence of named individual, events, or locations [2][3].

Previously common color feature extraction techniques used for CBIR are color histogram [4], HSV color histogram [5]. Color based descriptors are the weak descriptors for the images and performance of the color based retrieval is subject to the noise, blur, shadow and illumination variation in the image. Further, texture features techniques such as Local Binary Pattern [6][7], Grey Level Co-occurrence matrix [8], Wavelet Transform[9], Dual Cross Pattern features (DCP) [7] have been used for image retrieval. Texture has better descriptive nature than color of the image objects and can be used to model the temporal variations in the image. Shape of the image object is change in the intensity at the edges of the image object plays an important role in retrieval process. Popular shape extraction method used previously are Scale Invariant Fourier Transform (SIFT)[10] and HOG [11][12], Regionlet transform [13].

In this paper, combination of color, texture and shape features is used for the image retrieval. Color histogram, LBP and HOG methods are used for color, texture and shape feature extraction respectively. Feature level fusion is performed which maintain the information of respective features. For the classification SVM algorithm is used. The flow diagram of proposed method is shown in figure 1.

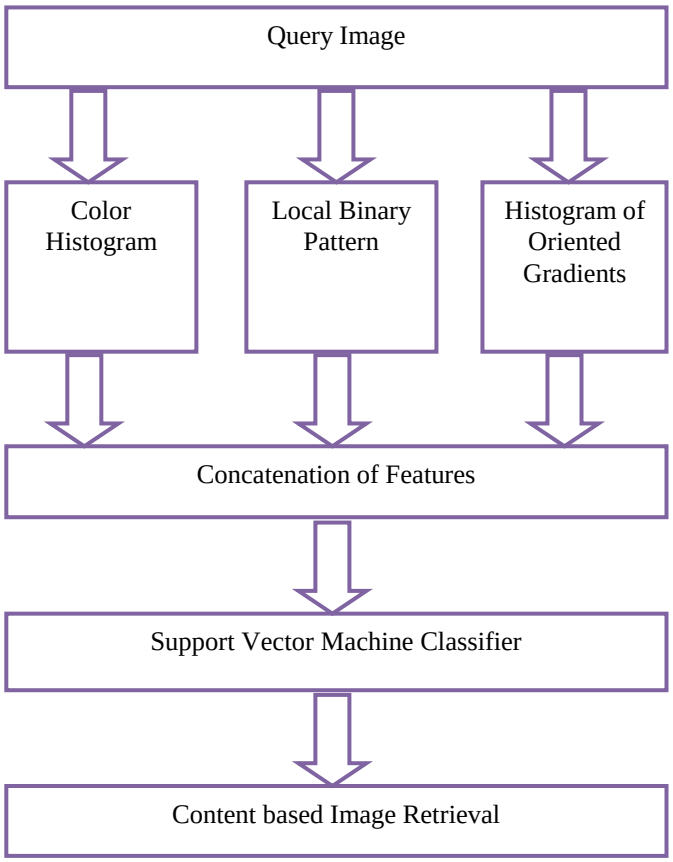

Fig. 1 Flow diagram of proposed system

The paper begins with the detailed introduction of CBIR and previous techniques used in CBIR. Further, section II gives description of feature extraction methods. Section III offers the experimental results and discussion. The ultimate section presents conclusion.

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II. PROPOSED METHODOLOGY

This section provides the detailed description of color histogram, LBP and HOG feature extraction techniques.

A) Color Histogram features

Color histogram of image is used to describe the distribution of color intensity in the image. Color histogram is graph of color intensity or color intensity range verses number of pixels in the image. Normally for all three basic color components of RGB image, all components have value from 0 to 255. Therefore it becomes very difficult to obtain histogram which is time consuming, due to this color images are normally converted in to the L*a*b or HSV color spaces[6,7]. In this paper, color image is transformed in to the L*a*b color space. Where L stands for luminance of image, a and b stands for croma components of image. 10 Bin histogram is calculated for the images as color feature as shown in fig. 2.

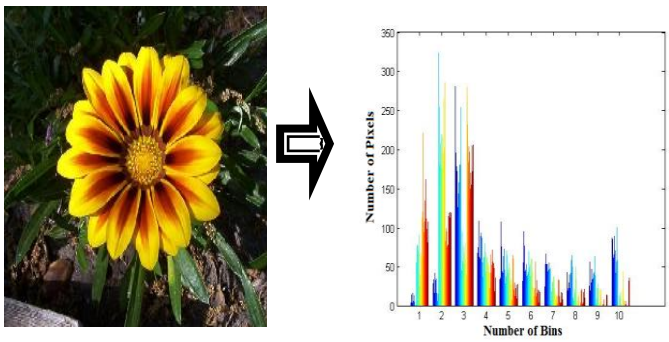

Fig. 2 Sample image and its color histogram

Only color information is not sufficient for content base image retrieval, because color of two or more images can be same but the texture or shape may differ.

B) Local Binary Pattern (LBP)

LBP is used for the texture feature extraction of the images. For the implementation of LBP 3×3 window is selected. For the LBP feature extraction local 3×3 window is considered which slides over the all rows and columns of image. In the local 3×3 window all pixel values are compared with centered pixel intensity. If the value is greater than centered value then it is taken as 1 otherwise 0. Later decimal equivalent value is computed as shown in fig. 3.

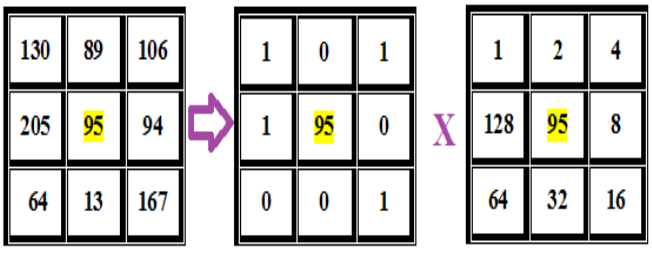

Fig. 3 LBP operation example

Normally window size is selected as odd, because it is easy to find centered element in odd sized window rather than even sized window.

C) Histogram of Oriented Gradients

Local intensity gradient at the edges of the image gives better characterization of the image which can be computed by taking the histogram of intensity orientation of the edges in the local region of the image. The HOG features are computed for the detection window of 128×128 pixel. The detection window is divided in to 15×15 block with 50% overlapping whereas each block consists of 2×2 cells and each cell has size of 8×8 pixel. The edges are obtained using horizontal derivative filter and vertical derivative filter mask as given in equation (1) and (2) respectively. The horizontal gradient image is obtained by convolving input image with horizontal filter as given in equation (3) and vertical gradient image is obtained by convolving the input image with vertical derivative filter as shown in equation (4).

$$H_x = [-1 \quad 0 \quad 1] \tag{1}$$

$$H_y = [-1 \quad 0 \quad 1]^T \tag{2}$$

$$I_x = \text{conv2}(I_m, H_x) \tag{3}$$

$$I_y = \text{conv2}(I_m, H_y) \tag{4}$$

The gradient magnitude and orientation of the gradient (Θ) is computed using equation (5) and (6):

$$\text{Magnitude} = \sqrt{I_x^2 + I_y^2} \tag{5}$$

$$\Theta = \begin{cases} \tan^{-1}\left(\frac{I_x}{I_y}\right) - \pi & IF\ I_x < 0\ and\ I_y < 0 \\ \tan^{-1}\left(\frac{I_x}{I_y}\right) + \pi & IF\ I_x < 0\ and\ I_y > 0 \\ \tan^{-1}\left(\frac{I_x}{I_y}\right) & Otherwise \end{cases} \tag{6}$$

The orientation of edge gradients are computed for 9 bins in between [-180°,180°]. The negative orientations are summed up with 180° to get the unsigned representation. Feature level fusion of all three types of features is done using concatenation based feature level fusion [14].

III. RESULT & DISCUSSION

We have used 102 category dataset for the implementation which consists of 102 flower categories. The flower images of database are commonly found in the United Kingdom. Each flower class consists of minimum 40 to maximum 258 images. The database images have very high resolution, multicolored, pose and light variations. In addition, some flower images are taken in different condition of day, environment and season. The dataset images are having different sizes, for simplicity the images are resized to the size of 128 × 128. The sample images of dataset are shown in Fig. 4

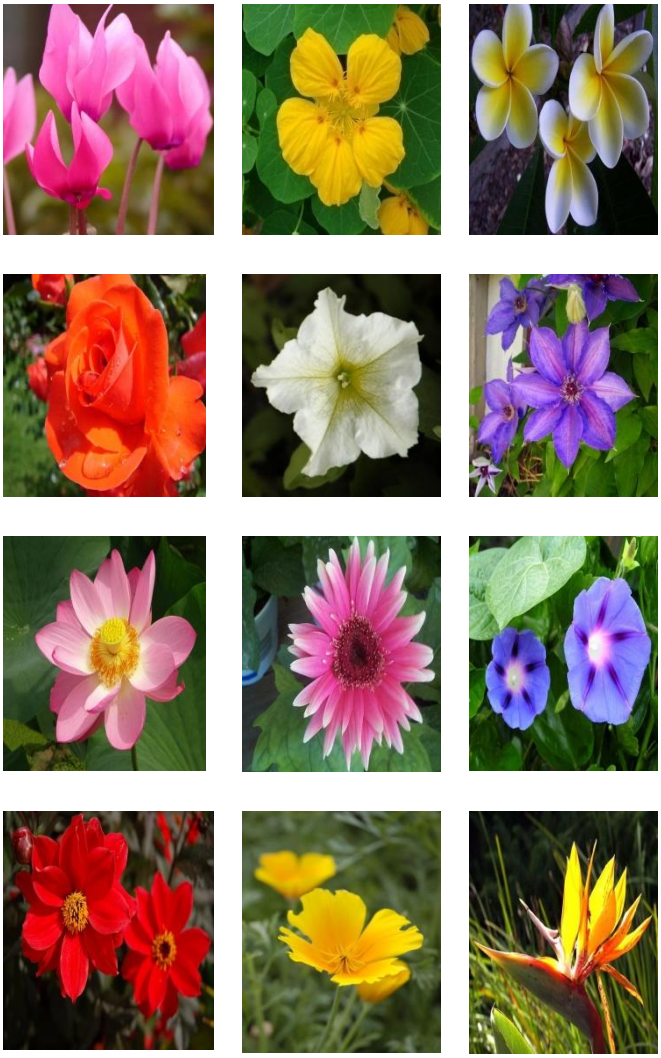

Fig.4. Sample images of dataset

The individual feature vector length and concatenated feature vector length for color histogram, LBP histogram for one block and HOG descriptor are shown in Table I.

Table-I: Feature vector length for different methods

Method	Parameters	Feature Length
Color Histogram	Number of Bins=10	10
LBP	Window Size = 3× 3 Number of Block = 1	256
HOG	Detection Window =128 × 128 Number of Block =15 × 15 Number of Bins = 9 Cell Size = 8 × 8 pixels Block Size = 2 × 2 cells Block Overlapping = 50 %	8100
Color Histogram + LBP + HOG		**8366**

The experimental results for color histogram, LBP and HOG are shown in Fig 5.

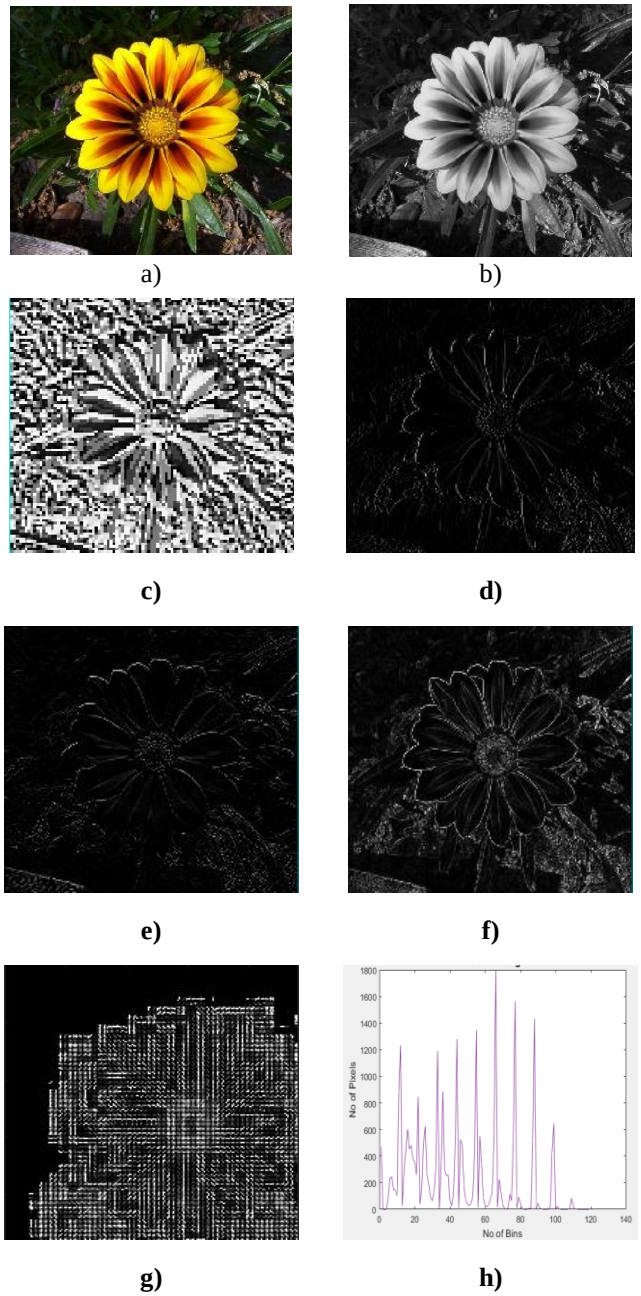

Fig. 5 a) Original Image b) Gray Image c) LBP image d) Horizontal Gradient e) Vertical Gradient f) Magnitude of Gradients g) HOG features h) Color Histogram

For the classification liner SVM classifier is used. Multiclass SVM architecture is formed using one vs all classification technique. Performance of proposed algorithm and linear SVM classification algorithm is evaluated on the basis of percentage accuracy as Table II. Percentage retrieval accuracy is calculated as equation 5,

$$Retrieval\ Accuracy\ (\%) = \frac{Total\ Number\ of\ images\ correctly\ retrieved}{Total\ images} \quad (5)$$

Table-II. Retrieval Accuracy (%)

Features Extraction Techniques	Retrieval Accuracy (%)
Color Histogram	38.50 %
LBP	52.40 %
HOG	54.80 %
Color Histogram + LBP	63.00 %
Color Histogram + HOG	65.30 %
LBP + HOG	73.80 %
Color Histogram + LBP + HOG	82.00 %

IV. CONCLUSION

In this paper, we have presented CBIR using color histogram, LBP texture features and histogram off oriented gradients shape features. LBP added scale invariance, better representation of the local texture of region and robustness against the illumination changes. The linear SVM classifier is used for image retrieval and the performance of the collaborative technique is compared with all individual and amalgamation of two features extraction techniques. For the performance analysis percentage retrieval accuracy is evaluated. It has been observed that collaboration of three types of features extraction techniques along with linear SVM classifier performs better than individual feature extraction method and combination of two feature extraction techniques. Future scope of our work consists of minimization of feature vector length with the help of proper fusion algorithm.

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