A Feature Vector for CBIR Based on DLEP and Gabor Features

L. Koteswara Rao[1], Dr. D.Venkata Rao[2]

[1]Asst.Professor, Dept of ECE, Faculty of Science and Technology, IFHE University, Hyderabad, India

[2] Principal , Narasarao Pet Institute of Technology ,Guntur District, Andhra Pradesh , India

***Abstract*-The properties of texture present in an image can be derived in different ways. Local Binary Pattern(LBP) operator is one among them in which a centre pixel is compared with the neighboring pixels to obtain a feature vector. However, the directions are not obtained in this method. The Directional Local Extrema Patterns(DLEP) are used to encode the relationship between the reference pixel and its neighbors by computing the edge information in four directions .In this paper, we propose a new feature vector which is a combination of DLEP and Gabor filter to derive the feature which can be used in the process of Image retrieval**.

***Keywords*- Gabor filters, LBP, image retrieval, precision, recall**

I. INTRODUCTION

Nowadays, due to the rapid growth in the Internet and related fields, large number of images are being created and stored across the globe foe every moment. Hence there is a dire need for a system which can search and index these images in various applications. The traditional text based annotation method of image retrieval becomes inefficient if the database size is too large. Content based image retrieval(CBIR), has drawn the attention of many researchers as an alternative to the existing methods in which, the visual contents such as color, texture, shape etc., are extracted to form a feature vector .Similarity between set of features of query image and data base image is measured to retrieve more relevant images from the database. However, the efficiency of any CBIR system depends on the extraction of features such as color, texture, shape etc., to index and retrieve the images [1]-[3].

Among those features, texture provides more discriminating information .It is a visual feature that refers to the innate surface properties of an object and their relationship to the surrounding environment. Many techniques to classify and segment the texture were proposed in the past based on statistical analysis, signal processing techniques .In [4],use of texture feature for classification of images was discussed. Arivazhagan et al[5] proposed texture classification using wavelet transform. In [6] texture classification and segmentation was proposed using wavelet packet frames and Gaussian mixture model. Gabor wavelets were used in texture classification for rotation invariant features[7].

Gabor filters have been used in the field of Image processing and texture analysis[10] .It is a linear, band pass filter which is similar to human visual system. It provides the spatial frequency information.

A. Contribution

The directional local extrema pattern (DLEP) extracts the directional edge information based on local extrema in 0°, 45°, 90°, and 135° directions of an image. In this paper, we propose combination of features such as DLEP and Gabor to improve the performance of the existing Directional Local Extrema Pattern. The organization of this paper is as follows. Section II reviews about different types of local patterns .Section III covers gabor feature. Section IV explains the proposed work for retrieval system. Section V contains the results. The conclusions are given in section VI .

B. Related work

An approach based on Local Binary Pattern was introduced by Ojala et. al [8],the concept of LBP was extended to face recognition in [9].However, LBP has the limitation of rotational invariance in classifying the structures of an image. Local Derivative pattern by considering the n^{th} order Local Binary Pattern was proposed by Zhang et. al[11]. Subramanyam et al[12] proposed Directional Local Extrema Pattern as a feature vector for texture analysis of an image. An improvement to DLEP was proposed by Koteswararao et al [13]. DLEP differs from the existing LBP and other extensions in terms of directional information.

II. LOCAL PATTERNS AND VARIATIONS

Local Binary Pattern (LBP)

Local binary pattern was proposed by T Ojala [8] .In this, the value of the centre pixel is considered as threshold and the difference between centre pixel and its neighbor is taken into account to assign a binary 0 or 1. The method is repeated until all the neighbors surrounding the centre pixel are covered in the computation.

$$LBP_{P,R} = \sum_{p=0}^{p-1} k(g_p - g_c)2^p, k(x) = \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases}$$

where g_c represents the gray value of the center pixel and g_p is the gray value of P equally spaced pixels on circumference of the circle with radius R.

Local Directional Pattern (LDP)

Local Directional Pattern[14] is based on LBP that uses the edge response values of neighborhood pixels in order to encode the texture in an image. It assigns an eight bit binary code to each pixel of an input image.

A binary value of 1 or 0 is assigned depending on the presence of an edge.

$$LDP_n = \sum_{i=1}^{8} f_i(m_i - m_k) * 2^i, f_i(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

Directional Local Extrema patterns (DLEP)

DLEP was introduced by Subrahmanyam et al [12].It describes the spatial structure of the local texture using the local extrema of center gray pixel g_c. The local extrema in four directions are obtained by calculating the difference between the centre pixel and all its neighbors.

In DLEP, the local extrema in 0^0,45^0, 90^0 and 135^0 directions are calculated by calculating the local difference between the center pixel and its neighbors as shown below.

$$I'(g_i) = I(g_c) - I(g_i); i = 1,2,....8$$

The local extremas are based on the equations given below.

$$\hat{I}_\alpha(gc) = f_3(I'(g_i) * I'(g_{j+4})); j = (1 + \alpha / 45)$$

$$\forall_\alpha = 0^0, 45^0, 90^0, 135^0$$

Here f is the central frequency of sinusoidal plane and θ is the orientation of x y plane.

$$\begin{bmatrix} x\theta_n \\ y\theta_n \end{bmatrix} = \begin{bmatrix} \sin\theta_n & \cos\theta_n \\ -\cos\theta_n & \sin\theta_n \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} (n-1)$$

θ_n is the rotation of xy plane by θ_n angle results gabor filter at the orientation θ_n.

$$f_3(I'(g_j), I'(g_{j+4})) = \begin{cases} 1 & I'(g_j) * I'(g_{j+4}) \geq 0 \\ 0 & \text{else} \end{cases}$$

The DLEP is defined ($\alpha = 0^0, 45^0, 90^0$ and 135^0) as follows:

$$DLEP(I(g_c))|_\alpha = \{\hat{I}_\alpha(g_c); \hat{I}_\alpha(g_i); \hat{I}_\alpha(g_z); ....\hat{I}_\alpha(g_8)\}$$

The detailed representation of DLEP can be seen in figure1.In the next step, the given image is converted to DLEP images with values ranging from 0 to 511. After calculation of DLEP, the whole image is represented by building a histogram based on the equation mentioned below.

$$H_{DLEP|\alpha}(i) = \sum_{j=1}^{N_1} \sum_{k=1}^{N_2} f_2(DLEP(j,k)|_\alpha, \ell);$$

$$\ell \in [0,511]$$

where the size of input image is N_1 x N_2 . The procedure for calculation of DLEP for center pixel marked in green color is presented in fig.1.The directions are evaluated using the local difference between the center pixel and its neighbors.

As an example, the DLEP in 90^0 direction for a center pixel marked in green color is shown in the figure2. For the center pixel value 27, it can be observed that two neighboring pixels are leaving. Therefore, this pattern is represented as 1. In the same way the rest of the bits of DLEP pattern are calculated and the result is 110011110. Similarly, the DLEP's are computed for 0^0,45^0 and 135^0 directions. The improved DLEP is given in [13].

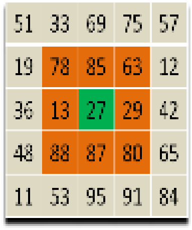
III.GABOR FEATURE

The Gabor filter is found efficient for text representation and discrimination. The representation of 2-D Gabor filter is as specified below.

$$\psi_{f,\theta}(x,y) = \exp\left[-\frac{1}{2}\left\{\frac{x^2\theta_n}{\sigma^2 x} + \frac{y^2\theta_n}{\sigma^2 y}\right\}\right]\exp(2\pi f x\theta_n)$$

$$\text{angle}\,\theta_n = \frac{\pi}{p}$$

where n=1,2,…p ,p€n and p is the orientation.



	$0_{(27)}$	$1_{(29)}$	$2_{(80)}$	$3_{(87)}$	$4_{(88)}$	$5_{(13)}$	$6_{(78)}$	$7_{(85)}$	$8_{(63)}$	DLEP
P (0^0)	0	0	0	0	1	1	0	1	0	26
Q(45^0)	1	0	0	1	1	1	1	0	1	317
R(90^0)	1	1	0	0	1	1	1	1	0	415
S(135^0)	1	1	0	0	0	1	1	1	0	398

Fig. 1 Illustration of DLEP for 3 x 3 pattern

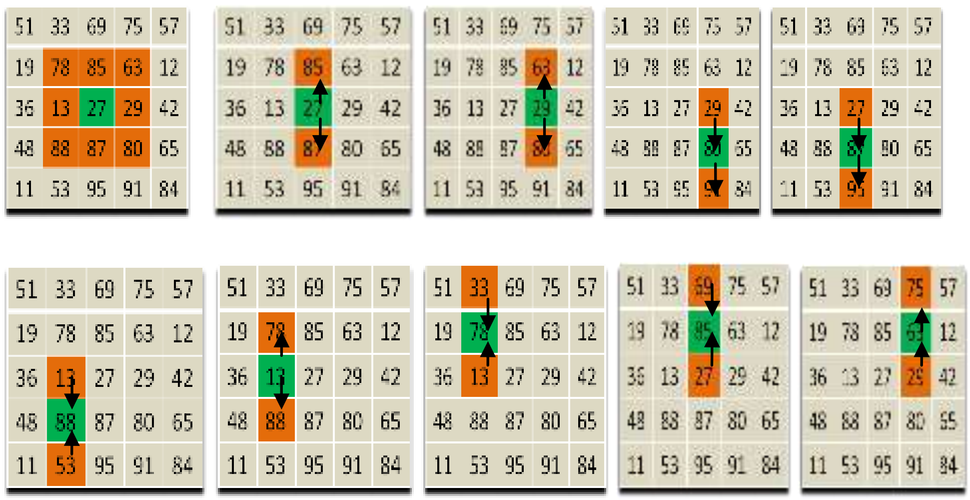


Fig. 2 Example to compute DLEP in 90^0 direction (110011110)

(a)

(b) (c) (d) (e)

Figure3: Example of DLEP maps; (a) Sample Image (b) 0^0 (c) 45^0 (d)90^0 (e) 135^0

IV. PROPOSED GDLEP SYSTEM

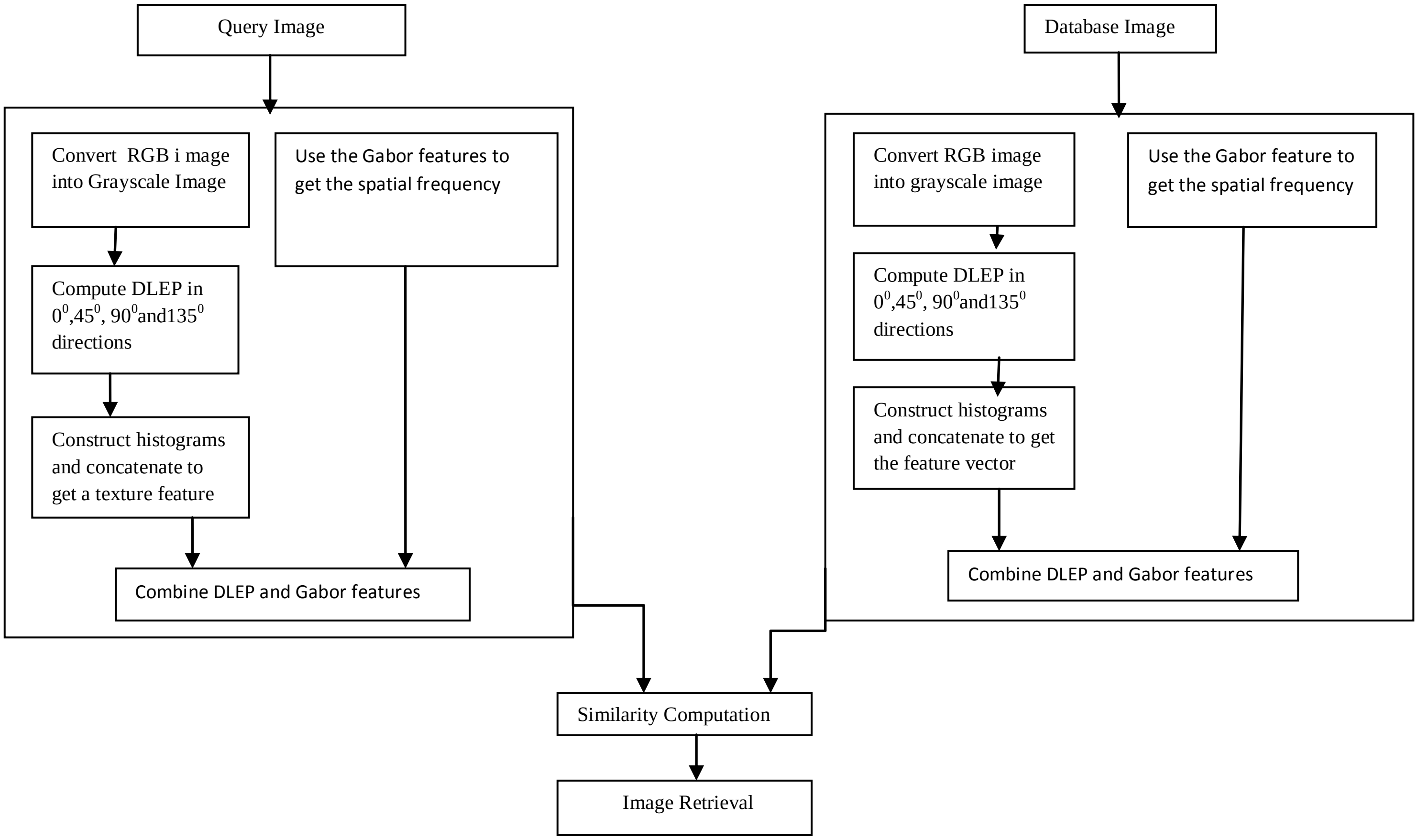


Fig.4 Proposed framework for content based Image retrieval

Algorithm

1. Convert the RGB image into gray scale image.
2. Use the Gabor filter to get the spatial frequency.
3. Compute the local extrema in 0^0,45^0, 90^0and135^0 directions.
4. Calculate the DLEP patterns in four directions mentioned in step 2.
5. Make a histogram for the DLEP patterns obtained in step 3 and concatenate to get the texture feature vector.
6. Combine these two features to get a feature vector that can be used in image retrieval

Query Matching

After extracting the features, the feature vector for query image is obtained. In the similar way, feature vectors for all images in the database are also calculated. In order to select the more relevant image to the query image, the distance between query image and database images is computed .

V. EXPERIMENTAL RESULTS

The Performance of any CBIR can be measured in terms of Precision and Recall.In our work, the GDLEP is evaluated on benchmark corel-1k database[15]. The precision(P) is calculated as per the relationship mentioned here under.

$$P = \frac{\text{No. of relevant images retrieved}}{\text{No. of images retrieved}}$$

The results for top ten categories of the data base are specified in the table 1.

Category	Existing DLEP	DLEP+ Gabor feature
Africans	69.3	75.5
Beach	60.5	67.5
Building	72.0	78.9
Buses	97.9	90
Dinosaur	98.5	98.7
Elephant	55.9	67.5
Flower	91.9	96
Horse	76.9	79.4
Mountain	42.7	60.8
Food	82.0	90
Average Precision (%)	**74.8**	**80.4**

Table 1: Comparison of precision values for DLEP and GDLEP

The comparison in terms of average precision is given in the graphs in figure 5 .

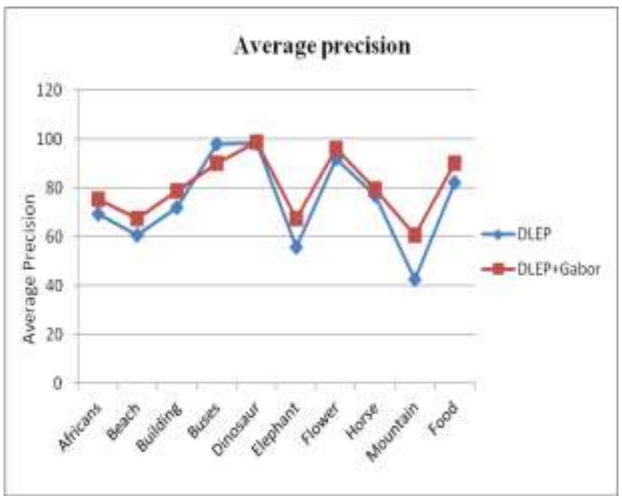


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Figure 5. category- wise performance in terms of precision

VI. CONCLUSION

It is proved from the results that the precision values of the proposed method are better than the existing directional patterns.

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