



## Texton Based Image Retrieval Using Indexed LBP Transitions

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### ABSTRACT

The present paper derived a new model of texture image retrieval by integrating the transitions on Local Binary Pattern (LBP) with textons and Grey Level Co-occurrence Matrix (GLCM). The present paper initially derived transitions that occur from 0 to 1 or 1 to 0 in circular manner on LBP. The transitions reduce the 256 LBP codes into five texture features. This reduces the lot of complexity. The LBP codes are rotationally variant. The proposed circular transitions on LBP are rotationally invariant. Textons, which represents the local relationships, are detected on this. The GLCM features are evaluated on the texton based image for efficient image retrieval. The proposed method is experimented on a huge data base of textures collected from Google data base. The experimental result indicates the efficiency of the proposed model.

**Keywords:** Image retrieval; rotational invariant; textons; GLCM.



## Council for Innovative Research

Peer Review Research Publishing System

Journal: INTERNATIONAL JOURNAL OF COMPUTERS & TECHNOLOGY

Vol. 13, No.12

[www.ijctonline.com](http://www.ijctonline.com) , editorijctonline@gmail.com



## 1. INTRODUCTION

The twentieth century has witnessed unparalleled growth in the number, availability and importance of images in all walks of life. Images now play a crucial role in fields as diverse as medicine, journalism, advertising, design, education, entertainment, etc. Technology, in the form of inventions such as photography and television, has played a major role in facilitating the capture and communication of image data. Problems with traditional methods of image indexing [1] have led to the rise of interest in techniques for retrieving images on the basis of automatically derived features such as color, texture and shape in a technology now generally referred to as Content Based Image Retrieval (CBIR). The CBIR systems allow the user to iteratively search image databases looking for those images which are similar to a specified query image. Selection and ranking of relevant images from image collections remains a problem in CBIR. Image retrieval has been an active research topic in recent years due to its potentially large impact on both image understanding and Web image search.

### 1.2 Content Based Image Retrieval (CBIR) Systems

The earliest use of the term CBIR in the literature seems to have been by Kato [2], to describe his experiments into automatic retrieval of images from a database by color and shape feature. The features used for retrieval can be either primitive or semantic, but the extraction process must be predominantly automatic. CBIR draws many of its methods from the field of image processing and computer vision, and is regarded by scholars as a subset of that field. There has been a lot of interest in content-based image retrieval using visual features over the last decade. An overview of work in this area can be found in [3, 4, 5, 6, 7, 8, 9]. CBIR is like an information filter process and is expected to provide a high percentage of relevant images in response to user query [10]. The presence of large volumes of digital repositories leads to many schemes of indexing and retrieval of such data (e.g., QBIC [11, 12], Netra [13], VisualSeek [14], Chabot [15], Blobworld [16], photobook [17], etc). In all these cases, the user is interested in seeking the most similar images to his query.

Gudivada et al. [18] have identified many important applications of general purpose CBIR. The CBIR has been applied for many purposes [19] in law enforcement and crime prevention, such as fingerprint recognition [20], face recognition [21], DNA matching, shoe sole impressions [22], and surveillance systems [23]. Integrated tools in Web image retrieval can help considerably in identifying suspicious sites and thus in filtering them.

Color is one of the most important image indexing features employed in CBIR. Schettini et al. [24] and Del Bimbo [3] provide a comprehensive survey of various methods employed for color image indexing and retrieval in image databases. Some of the popular methods to characterize color information in images are color histograms [25, 26], color moments [27], and color correlograms [28]. Though all these methods provide good characterization of color, they have the problem of high-dimensionality. This leads to more computational time, inefficient indexing, and low performance. To overcome these problems, use of SVD [25], dominant color regions approach [29, 30], and color clustering [31, 32] have been proposed. Many authors have done a survey of various shape methods used for content-based image retrieval [3, 33, 9, 34]. Recently, techniques using shape measure as an important feature have been used for CBIR.

The texture features are one of the important features for an efficient and cost effective retrieval system. Many texture features derived from various approaches of texture analysis and classification are thus important and crucial to build an efficient retrieval system [10, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46].

The rest of the paper is organised as follows. Section 2 describes the proposed texton based transitions LBP. Experimental results are discussed in section 3 and conclusions are given in section 4.

## 2. METHODOLOGY

Proposed Texton based Transitioned LBP (TTLBP) model:

The proposed TTLBP model aims to overcome rotational variance problem and to reduce the large number of codes that are derived by LBP. The proposed TTLBP model consists of five steps as given below.

Step 1: Color Quantization of 7-bit Binary Code.

During the course of feature extraction, the original images are quantized into 128 colors of RGB color space and the color gradient is computed from the RGB color space and then the statistical information of textons is calculated to describe image features. In order to extract gray level features from color information, the proposed TTLBP model utilized the RGB color space which quantizes the color space into 7-bins to obtain 128 gray levels. The index matrix of 128 color image is denoted as  $C(x, y)$ . The RGB quantization process is done by using 7-bit binary code of 128 colors as given in Eqn.(1).

$$C(x,y)=16*I(R)+2*I(G)+I(B) \quad (1)$$

where

$$I(R)=0, 0 \leq R \leq 16, \quad I(R)=i, ((16*i)+1) \leq R \leq (16*(i+1)) \\ i= [1, 2, 3 \dots 7] \quad (2)$$

$$I(G)=0, 0 \leq G \leq 16, \quad I(G)=i, ((16*i)+1) \leq G \leq (16*(i+1))$$

$$i = [1, 2 \dots 6] \tag{3}$$

$$I(B) = 0, 0 \leq B \leq 32, \quad I(B) = i, ((32*i)+1) \leq B \leq (32*(i+1))$$

$$i = [1, 2, 3] \tag{4}$$

Therefore, each value of C(x, y) is a 7 bit binary code ranging from 0 to 127.

STEP 2: Representation of the Texture image by the number of circular transitions from 0 to 1 or 1 to 0 on LBP instead of LBP codes or numbers.

### 2.1 Representation of LBP

LBP is a gray-scale invariant texture measure computed from the analysis of a 3x3 local neighborhood over a central pixel. The LBP is based on a binary code describing the local texture pattern. LBP is a local texture operator with low computational complexity and low sensitivity to changes in illumination. LBP has the following advantages i) the local texture character can be described efficiently ii) it is easy to understand and compute iii) the whole image character description can be easily extended. LBP also suffers with following disadvantages i) in the course of analysis, its window size is fixed ii) It neglects the effect of the central pixel in local region iii) LBP code is rotationally variant.

In a square-raster digital image with a 3 x neighborhood, each pixel is surrounded by eight neighboring pixels and this represents the smallest complete unit (in the sense of having eight directions surrounding the pixel). A neighborhood of 3x3 pixels is denoted by a set containing nine elements:  $P = \{P_0, P_1 \dots P_8\}$ , here  $P_0$  represents the intensity value of the central pixel and  $P_i \{i=1, 2 \dots 8\}$ , is the intensity value of the neighboring pixel  $i$ . The eight neighbors are labeled using a binary code  $\{0, 1\}$  obtained by comparing their values to the central pixel value. If the tested gray value is below the gray value of the central pixel, then it is labeled 0, otherwise it is assigned the value 1 as described by the Equation 5

$$P_i = \begin{cases} 0 & P_0 < P_i \\ 1 & otherwise \end{cases} \tag{5}$$

$P_i$  is the obtained binary code,  $P_i$  is the original pixel value at position  $i$  and  $P_0$  is the central pixel value. The Fig.1 (a) shows the grey level values of a 3x3 neighborhood of an image. And the Fig.1 (d) shows its corresponding binary labelling based on Equation 6. The binary weights of the given 3x3 neighborhood are calculated by the Equation 5.2.

$$Weights_{LBP} = \sum_{i=0}^7 P_i * 2^{i-1} \tag{6}$$

As each element of LBP has one of the two possible values, the combination of all the eight elements results in  $2^8 = 256$  possible local binary patterns ranging from 0 to 255. There is no unique way to label and order the 255 LBP on a 3x3 neighborhood.

63	28	45
88	<b>40</b>	35
67	40	21

(a)

1	0	1
1		0
1	1	0

(b)

$2^0$	$2^1$	$2^2$
$2^7$		$2^3$
$2^6$	$2^5$	$2^4$

(c)

$$1*2^0 + 0*2^1 + 1*2^2 + 0*2^3 + 0*2^4 + 1*2^5 + 1*2^6 + 1*2^7 = 229$$

(d)

Fig. 1: (a) Sample Grey level Neighborhood (b) Conversion of Fig. 1 (a) into LBP (c) Representation of LBP-Weights (d) LBP code or LBP number.

Fig.1 shows an example on how to compute LBP. The original 3x3 neighborhood is given in Fig.1 (a). The central pixel value is used as a threshold in order to assign a binary value to its neighbors. Fig.1 (b) shows the result of thresholding the 3x3 neighborhood. The obtained values are multiplied by their corresponding weights as shown by Fig.1 (c). The LBP code is given in Fig.1 (d), which is 229 in this case the central pixel 40 is replaced by the obtained LBP value 229. In this way a new LBP image is constructed by processing each pixel and its 3x3 neighbors in the original image. The binary weights of Fig.1 (c) can be given in eight different ways as shown in Fig.2.

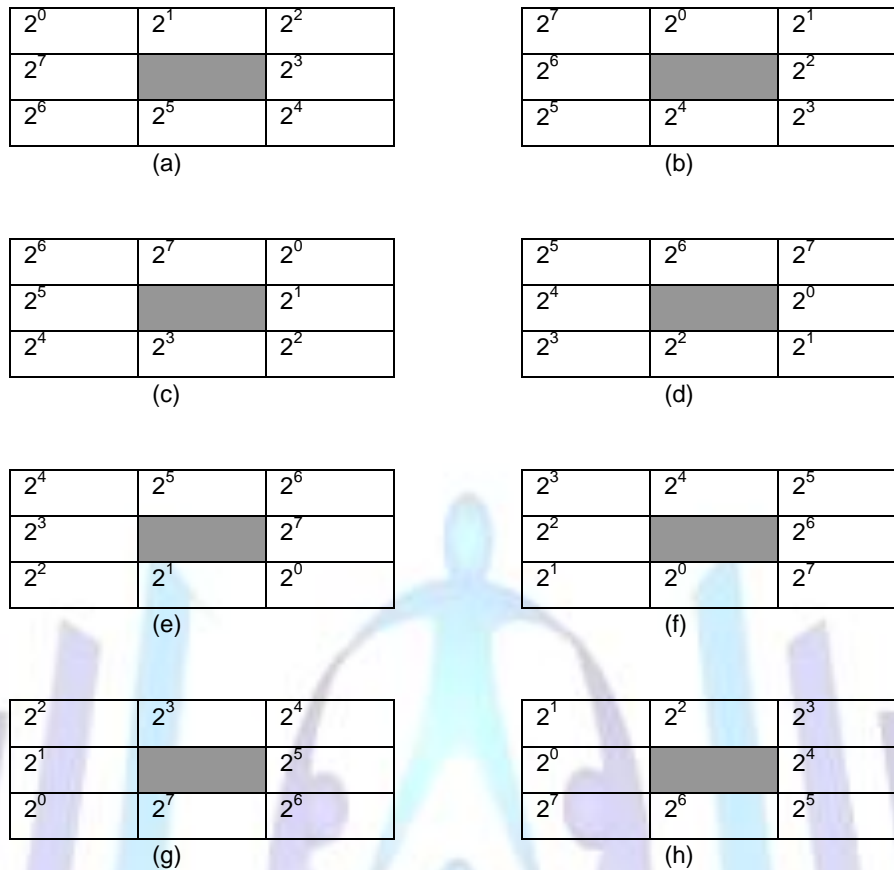


Fig.2: Eight Different Ways of measuring LBP weights on a 3x3 neighborhood.

The value of the LBP changes by the representation of the weights. The LBP can be calculated in 8 different ways for a 3x3 neighborhood as shown in Fig. 5.2. That is for any 3x3 neighborhood one can generate eight LBP values. The LBP value for the Fig.1 (a) in all eight directions as represented in Fig.2 is given as 227, 242, 121, 188, 94, 47, 151, and 203 respectively.

To overcome the rotational variant disadvantage of LBP the proposed method measures the number of transitions from 0 to 1 or 1 to 0 in a circular manner and replaces the central pixel with the number of transitions. That is the above LBP 10100111 of Fig.1 contains four transitions from 0 to 1 or 1 to 0. The central pixel is replaced by the obtained number of transitions value 4. In this way the second step derives a new LBP image by replacing each central pixel value of a 3x3 neighborhood with its circular transition number that occur from 0 to 1 or 1 to 0 as shown in Fig.3.

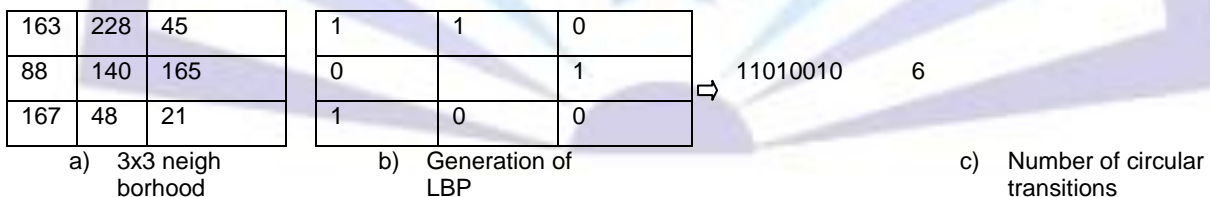


Fig.3: Derivation of circular transitions number on LBP.

The converted transitioned number LBP texture image pixels contain grey levels of 0, 2, 4, 6 and 8 only. This is because no circular LBP contains odd number of transitions and the number of circular transitions from 0 to 1 or 1 to 0 on 8-neighboring LBP can be 2, 4, 6 or 8 only. The present paper indexed the above transition numbers 0, 2, 4, 6 and 8 as 1,2,3,4 and 5 respectively.

Step-3: Texton detection on transitioned number LBP texture image

The transitioned number LBP texture image of step2 generates an image with 5- indexed greylevel values i.e. 1,2,3,4 and 5. The present research evaluates Textons on these 5-grey level image in step3.

Textons [47, 48] are considered as texture primitives, which are located with certain placement rules. A close relationship can be obtained with image features such as shape, pattern, local distribution orientation, spatial distribution, etc., using textons. Textons are effectively utilized to develop efficient models in the context of texture recognition or object recognition. Textons are considered as texture primitives which are positioned with certain placement rules. The textons are defined as a set of blobs or emergent patterns sharing a common property all over the image [47, 48]. The different



textons may form various image features. To have a precise and accurate texture classification, the present study strongly believes that one need to consider the significant textons. There are several issues related with i) texton size ii) tonal difference between the size of neighbouring pixels iii) texton categories iv) expansion of textons in one orientation v) elongated elements of textons with jittered in orientation . By this sometimes a fine or coarse or an obvious shape may results or a pre-attentive discrimination is reduced or texton gradients at the texture boundaries may be increased. To achieve the above, the present paper utilized four texton types on a 2x2 grid as shown in Fig.4.

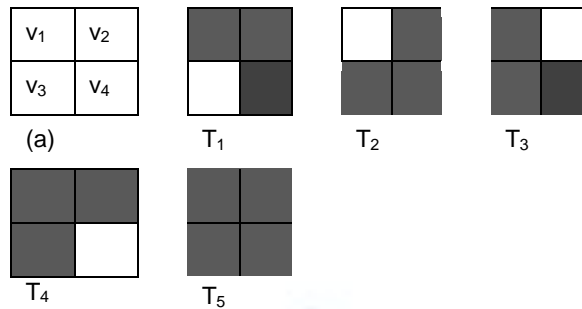


Fig. 4 Different Textons representation on 2x2 grid.

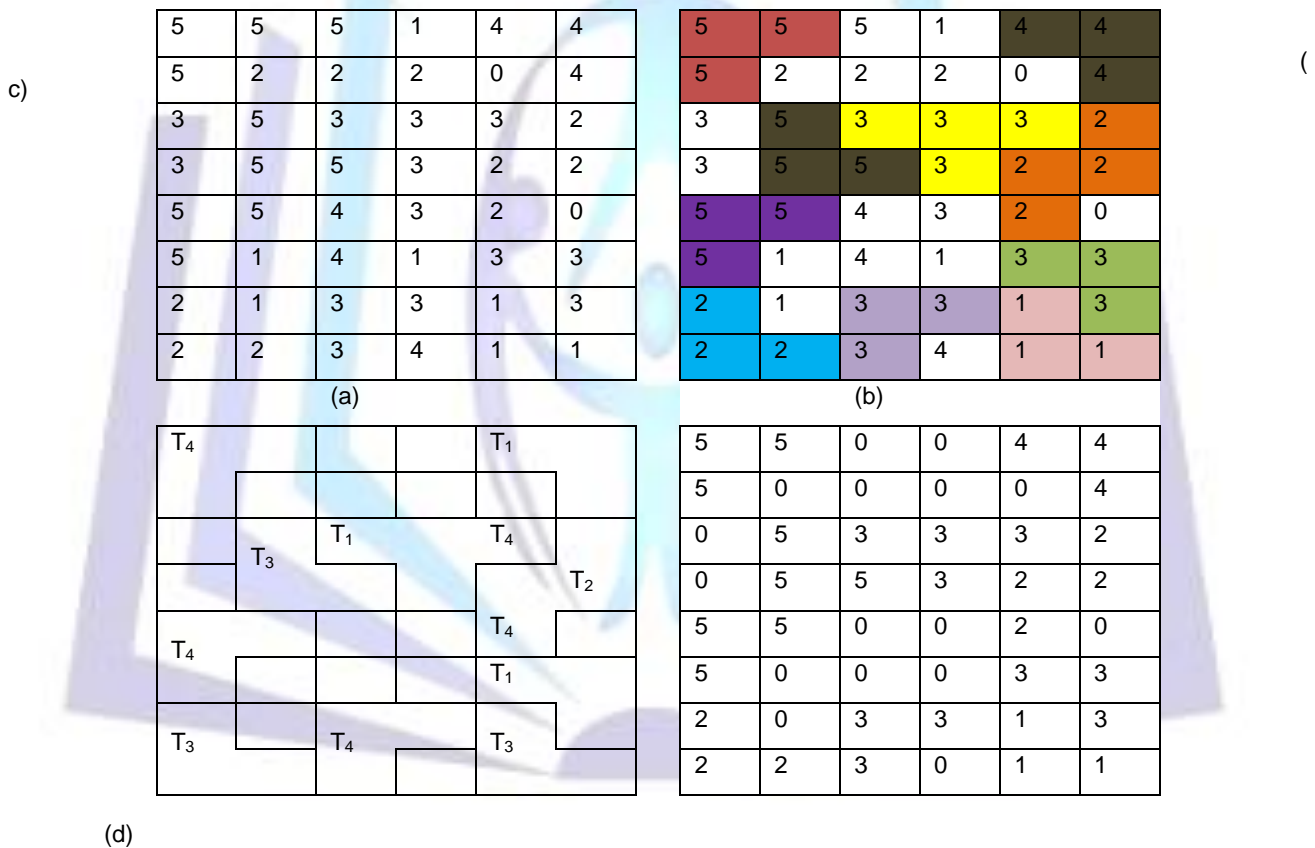


Fig. 5: Illustration of the texton detection process (a) Original texture image (b) Transitioned texture image (c) textons names identification (d) Final texton image.

In Fig.4 the four pixels of a 2x2 grid are denoted as  $V_1, V_2, V_3$  and  $V_4$ . Texton is detected is if three or more pixels contains the same grey level value. Once the texton  $T_1, T_2, T_3, T_4$  and  $T_5$  is detected the the proposed texton representation remains the 2 x 2 grid as it is without any change. If there are no textons then the 2 x 2 grid will be made as zeros. The working mechanism of texton detection is illustrated in Fig.5.

The Texton based transitioned LBP texture image is formed by remaining the 2 x 2 grid as it is whenever a texton is found otherwise the 2 x 2 grid pixels are assigned to zero. This process is repeated starting from top left corner by shifting one column right till it reaches the last column and then shifting bottom by one position till it reaches the last row and last column in a convolution manner.

Step4: In the step four the present paper evaluated the GLCM features on the Texton based transitioned LBP texture image.

One of the most popular statistical methods used to measure the textural information of images is the GLCM. The GLCM method gives reasonable texture information of an image that can be obtained only from two pixels. Grey level co-occurrence matrices introduced by Haralick [37] attempt to describe texture by statistically sampling how certain grey levels occur in relation to other grey levels. Suppose an image to be analyzed is rectangular and has  $N_x$  rows and  $N_y$  columns. Assume that the gray level appearing at each pixel is quantized to  $N_g$  levels. Let  $L_x = \{1, 2, \dots, N_x\}$  be the horizontal spatial domain,  $L_y = \{1, 2, \dots, N_y\}$  be the vertical spatial domain, and  $G = \{0, 1, 2, \dots, N_g - 1\}$  be the set of  $N_g$  quantized gray levels. The set  $L_x \times L_y$  is the set of pixels of the image ordered by their row-column designations. Then the image  $I$  can be represented as a function of co-occurrence matrix that assigns some gray level in  $L_x \times L_y$ ;  $I: L_x \times L_y \rightarrow G$ . The gray level transitions are calculated based on the parameters, displacement ( $d$ ) and angular orientation ( $\theta$ ). By using a distance of one pixel and angles quantized to  $45^\circ$  intervals, four matrices of horizontal, first diagonal, vertical, and second diagonal ( $0^\circ$ ,  $45^\circ$ ,  $90^\circ$  and  $135^\circ$  degrees) are used. Then the un-normalized frequency in the four principal directions is defined by Equation 7.

$$p(i, j, d, \theta) = \# \left\{ \begin{array}{l} ((k, l), (m, n)) \in (L_x \times L_y) \times (L_x \times L_y) \\ (k - m = 0, |l - n| = d) \text{ or } (k - m = d, l - n = -d) \\ \text{or } (k - m = -d, l - n = d) \text{ or } (|k - m| = d, l - n = 0), \\ \text{or } (k - m = d, l - n = d) \text{ or } (k - m = -d, l - n = -d), \\ I(k, l) = i, \quad I(m, n) = j \end{array} \right. \quad (7)$$

where # is the number of elements in the set,  $(k, l)$  the coordinates with gray level  $i$ ,  $(m, n)$  the coordinates with gray level  $j$ . The following Fig.6 illustrates the above definitions of a co-occurrence matrix ( $d=1, \theta=0^\circ$ ):

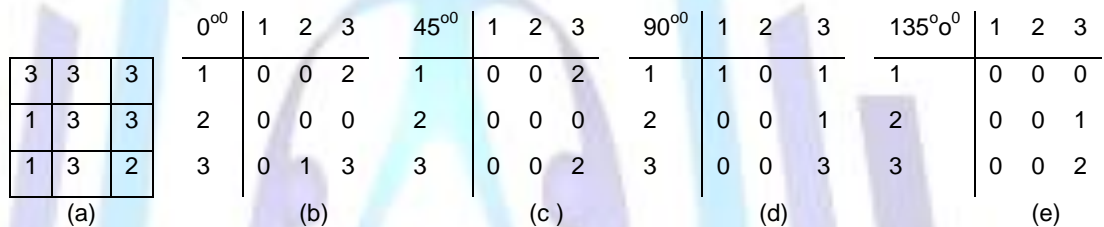


Fig.6: An example of Gray level co-occurrence matrix.

Even though Haralick [37] extracted 24 parameters from co-occurrence matrix, only four are commonly used such as contrast, correlation, energy, homogeneity as given in Equations (8) to (11) and is stored in feature database.

$$\text{Contrast} = \sum_{i,j=0}^{N-1} P_{ij} (i - j)^2 \quad (8)$$

The contrast feature is a difference moment of the P matrix and is a standard measurement of the amount of local variations present in an image. The higher the value of contrast are, the sharper the structural variations in the image.

$$\text{Correlation} = \sum_{i,j=0}^{N-1} P_{ij} \frac{(i - \mu)(j - \mu)}{\sigma^2} \quad (9)$$

where  $P_{ij}$  is the pixel value in position  $(i, j)$  of the texture image,  $N$  is the number of gray levels in the image,  $\mu$  is  $\mu = \sum_{i,j=0}^{N-1} i P_{ij}$  mean of the texture image and  $\sigma^2$  is  $\sigma^2 = \sum_{i,j=0}^{N-1} P_{ij} (i - \mu)^2$  variance of the texture image. Correlation is the measure of similarity between two images in comparison.

$$\text{Energy} = \sum_{i,j=0}^{N-1} -\ln (P_{ij})^2 \quad (10)$$

Energy measures the number of repeated pairs and also measures uniformity of the normalized matrix.

$$\text{Homogeneity} = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1 + (i - j)^2} \quad (11)$$

It measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. The converse of homogeneity results in the statement of contrast.

### 3. RESULTS AND DISCUSSIONS

The proposed TTLBP using GLCM features is experimented on the Tire, Animal fur, Car and Leaf textures collected from Google data base with a resolution of 256 x 256. Fig. 7, 8, 9 and 10 shows some of the texture images of Tire, Animal fur, Car and Leaf respectively with their numbers mentioned below the texture images.



Fig.7. Tire texture images.



Fig.8. Animal fur textures images.



Fig.9. Car texture images.

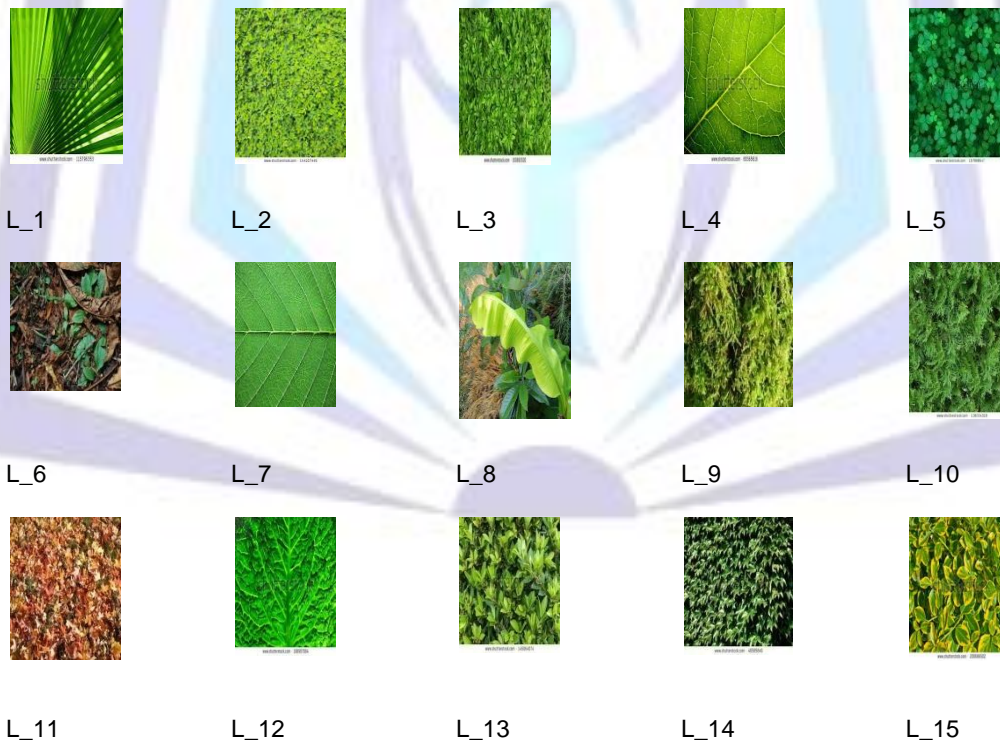


Fig.10: Leaf texture images.

The present paper evaluated the integrated texture features  $F_1$ ,  $F_2$ ,  $F_3$  and  $F_4$  using the GLCM features contrast, correlation, energy and homogeneity respectively on TTLBP. The Table 1, 2, 3 and 4 shows the integrated texture features  $F_1$ ,  $F_2$ ,  $F_3$  and  $F_4$  evaluated on each of the Animal fur, Tire, Car and Leaf textures respectively using the proposed TTLBP method and placed them in the training data base. Whenever a probe image is given then the integrated texture features  $F_1$ ,  $F_2$ ,  $F_3$  and  $F_4$  are evaluated on the probe image using TTLBP, the proposed TTLBP method. Based on the





nearest neighbourhood the texture features of probe image is compared with training images. The Euclidean minimum distance for image retrieval is calculated by the following equation 12.

for  $j=1$  to  $N$

$$d_j = \sum_1^4 \sqrt{(T_j F_i - P F_i)^2} \quad (12)$$

where  $N$  is the number of textures in the data set (training database), the  $T_j F_i$  refers to the integrated texture features value of  $F_i$  for the training texture  $T_j$ ,  $P F_i$  represents the histogram of the texture feature  $F_i$  for the probe texture  $P$  and  $d_j$  represents the summation of absolute difference between the corresponding texture features of the trained texture  $T_j$  and probe texture  $P$ .

The retrieved image  $R$  is obtained by the following equation 13

$$R = \min(d_j) \text{ where } j \text{ is } 1 \text{ to } N \quad (13)$$

Based on  $R$  the hit and miss are evaluated and represented in Table 5, 6, 7 and 8 for considered textures. A hit indicates a correct match is found and miss indicates there is miss match between the probe image and image retrieved. In the table 5, 6, 7 and 8 hit and miss are shown with binary value 1 and 0 respectively.

Table 1: The texture feature values by the proposed TTLBP method for animal fur images.

Texture No	Contrast ( $F_1$ )	Correlation( $F_2$ )	Energy( $F_3$ )	Homogeneity( $F_4$ )
Animal_fur_1	4.25	0.15	0.25	0.75
Animal_fur_2	5.25	0.25	0.25	0.75
Animal_fur_3	2.5	0.15	0.25	0.75
Animal_fur_4	7.5	0.35	0.25	0.75
Animal_fur_5	1.25	0.15	0.25	0.75
Animal_fur_6	3.75	0.85	0.25	0.75
Animal_fur_7	2.25	0.25	0.25	0.75
Animal_fur_8	6.5	0.5	0.25	0.75
Animal_fur_9	3	0.55	0.25	0.75
Animal_fur_10	7.75	0.35	0.25	0.75
Animal_fur_11	2.98	0.25	0.25	0.75
Animal_fur_12	1.53	0.25	0.25	0.75
Animal_fur_13	4.5	0.35	0.25	0.75
Animal_fur_14	5.5	0.95	0.25	0.75
Animal_fur_15	6.25	0.45	0.25	0.75
Animal_fur_16	2.25	0.55	0.25	0.75
Animal_fur_17	6.75	0.25	0.25	0.75
Animal_fur_18	4.25	0.65	0.25	0.75
Animal_fur_19	3.25	0.2	0.25	0.75
Animal_fur_20	1.5	0.5	0.25	0.75



Table 2: The texture feature values by the proposed TTLBP method for Rubber images.

	Contrast (F <sub>1</sub> )	Correlation(F <sub>2</sub> )	Energy(F <sub>3</sub> )	Homogeneity(F <sub>4</sub> )
Rubber_1	12.25	0.15	0.35	0.75
Rubber_2	10.1	0.35	0.35	0.75
Rubber_3	12.3	0.45	0.35	0.75
Rubber_4	11.4	0.25	0.35	0.75
Rubber_5	10.5	0.55	0.35	0.75
Rubber_6	14.8	0.65	0.35	0.75
Rubber_7	13.56	0.25	0.35	0.75
Rubber_8	12.3	0.65	0.35	0.75
Rubber_9	2	0.85	0.35	0.75
Rubber_10	14.2	0.45	0.35	0.75
Rubber_11	11.1	0.35	0.35	0.75
Rubber_12	12.1	0.15	0.35	0.75
Rubber_13	8.9	0.95	0.35	0.75
Rubber_14	4.6	0.35	0.35	0.75
Rubber_15	16.4	0.25	0.35	0.75
Rubber_16	17.3	0.15	0.35	0.75
Rubber_17	14.5	0.25	0.35	0.75
Rubber_18	13.98	0.5	0.35	0.75
Rubber_19	10.2	0.65	0.35	0.75
Rubber_20	15	0.75	0.35	0.75



Table 3: The texture feature values by the proposed TTLBP method for Leaf images.

	Contrast (F <sub>1</sub> )	Correlation(F <sub>2</sub> )	Energy(F <sub>3</sub> )	Homogeneity(F <sub>4</sub> )
leaf_1	22.25	0.65	0.65	1
leaf_2	21.71	0.75	0.65	1
leaf_3	19.75	0.64	0.65	1
leaf_4	24.24	0.58	0.65	1
leaf_5	26.5	0.52	0.65	1
leaf_6	22.1	0.79	0.65	1
leaf_7	18.75	0.76	0.65	1
leaf_8	27.25	0.78	0.65	0.85
leaf_9	28.8	0.69	0.65	1
leaf_10	28.5	0.87	0.65	1
leaf_11	27.1	0.86	0.65	0.95
leaf_12	29.5	0.72	0.65	0.95
leaf_13	28.25	0.61	0.65	1
leaf_14	25.25	0.69	0.65	1
leaf_15	24.25	0.73	0.65	1
leaf_16	26.25	0.97	0.65	1
leaf_17	21.75	0.81	0.65	1
leaf_18	27.25	0.73	0.65	1
leaf_19	29.25	0.67	0.65	1
leaf_20	24.5	0.62	0.65	0.75

Table 4: The texture feature values by the proposed TCM of TTLBP method for Car images.

	Contrast (F <sub>1</sub> )	Correlation(F <sub>2</sub> )	Energy(F <sub>3</sub> )	Homogeneity(F <sub>4</sub> )
Car_1	0.75	0.75	0.5	1
Car_2	1	0.75	0.25	1
Car_3	1	0.5	0.25	1
Car_4	1.25	0.75	0.25	1
Car_5	1	0.75	0.25	1
Car_6	1.25	0.5	0.25	1
Car_7	0.75	0.75	0.25	1
Car_8	0.75	0.75	0.25	1
Car_9	0.75	0.75	0.5	1
Car_10	0.75	0.75	0.5	1
Car_11	1	0.75	0.25	1
Car_12	1	0.75	0.25	1
Car_13	0.75	0.75	0.25	1
Car_14	0.75	0.75	0.25	1
Car_15	0.75	0.75	0.25	1



Car_16	1.25	0.5	0.25	1
Car_17	1.5	0.5	0.25	0.75
Car_18	1.75	0.5	0.25	0.75
Car_19	1.75	0.5	0.25	0.75
Car_20	1	0.75	0.25	1

Table 5: Hit or Miss of Anima fur texture images.

Probe images (Tire)	Hit/ Miss
1	1
2	1
3	1
4	0
5	1
6	1
7	1
8	0
9	1
10	0
11	1
12	0
13	0
14	1
15	0

Table 6: Hit or Miss of rubber texture images.

Probe images (Animal fur)	Hit/ Miss
1	1
2	0
3	1
4	0
5	1
6	1
7	1
8	1
9	0
10	0
11	1
12	1
13	1
14	0
15	1

Table 7: Hit or Miss of leaf texture images.

Probe images (Car)	Hit/ Miss
1	0
2	1
3	1
4	1
5	0
6	1
7	1
8	0
9	1
10	1
11	1
12	0
13	1
14	0
15	1

Table 8: Hit or Miss of car texture images.

Probe images (Leaf)	Hit/ Miss
1	1
2	1
3	1
4	0
5	1
6	1
7	0
8	1
9	1
10	0
11	1
12	0
13	1
14	1
15	1

The overall image retrieval performance based on the proposed TTLBP method is shown in Table 9 and it is also shown in the form of bar graph in Fig.11.

Table 9: Retrieval rate of different textures

Texture Databases	Retrieval rates
Animal fur	60
Rubber	66.66
Leaf	66.66
Car	73.33
<b>Average retrieval rate</b>	<b>66.7</b>



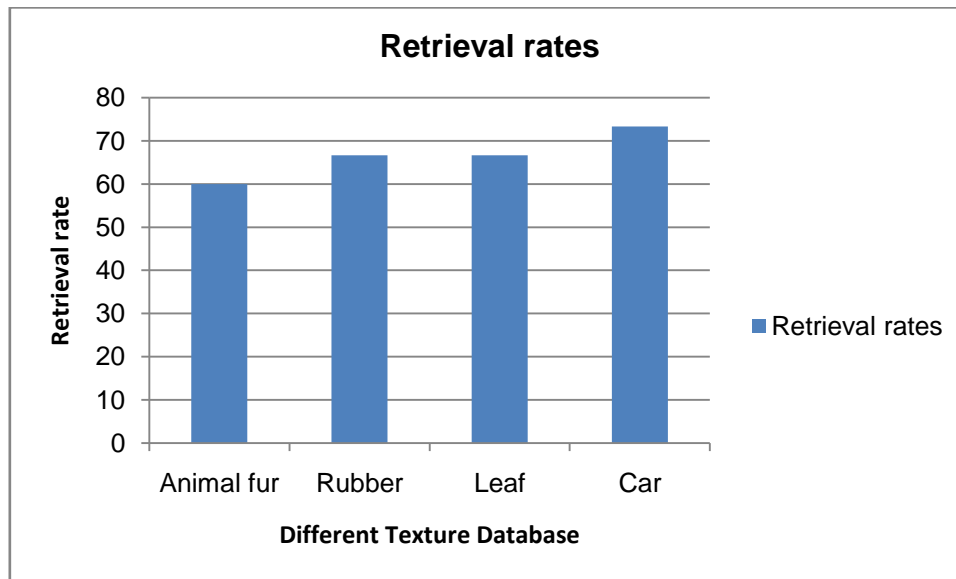


Fig.11: Bar graph representation of retrieval rate of different texture databases.

#### 4. SUMMARY

The present paper integrated three popular methods for efficient image retrieval i.e the LBP, textons and GLCM. Initially the present paper derived circular transitions on LBP to achieve rotational invariance and to reduce huge complexity of LBP codes. The main advantage of the present method is, it reduced all the 256 LBP features into 5 features based on the number of transitions. In the second step the textons are evaluated to represent the shape features. In the third step GLCM features are evaluated for efficient image retrieval.

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