

Review Paper on Different Co-Occurrence Matrices for Texture in CBIR

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Abstract: Content Based Image Retrieval system- Retrieving similar image from the stored database images on the basis of visual properties (Color, Texture, Shape). With the advent of new emerging technologies many texture descriptors as well as various texture discrimination methods have come into being. In this Paper we are going to discuss up-to- date best texture descriptor Gray level Co-occurrence Matrix, Motif Co-Occurrence Matrix which proves that results obtained from the co-occurrence matrices are better than the other texture discriminations methods.

1. INTRODUCTION

Content Based Image Retrieval (CBIR) by content; it actually means that the search will analyze the actual contents (features) of the image. Image consist of two types of features as Low level features and High level features. High level features includes emotions, or different activities present in that Image which is difficult to extract. But truth is they provide relatively more important meanings of objects and scenes in the images that are perceived by human beings [4]. So Low level features such as color, texture and shape are the ultimate way to go along. Hence these features vectors are extracted from the query image; same is done for the images present in the data base. Comparison is carried out and similar image is retrieved on the basis of feature vectors. This can be clearly understood from Figure 1. Flowchart of CBIR Systems.

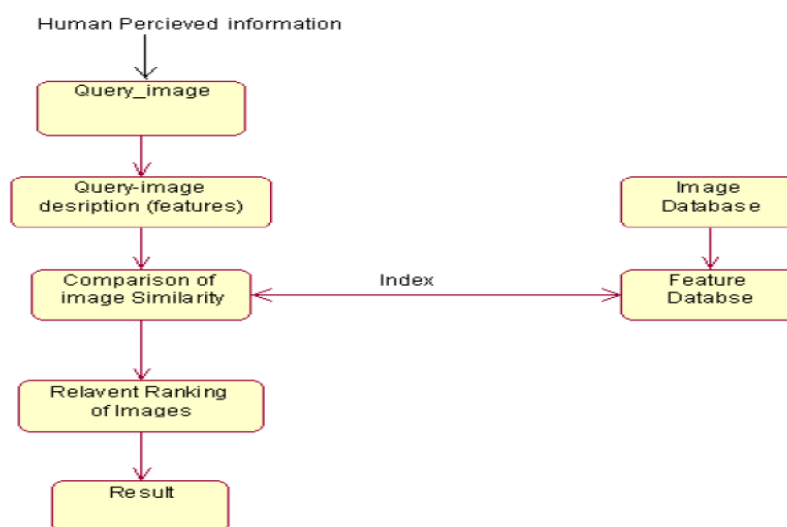


Figure1. Flowchart of CBIR System

At some instant in image retrieval it is to be decided which image points or regions of the image are relevant for further processing. For distinguishing regions in an image analysis is done of low level features such as color, texture and shape. Color relates human's visual perception and also several physic specifications and hence is considerably complex to characterize it. Shape refers to the outline or the appearance of something in the image that describes its geometrical properties. This characteristic can be used to fix patterns to classify objects with similar shapes, hence define different groups of elements with similar shapes. Texture could be understood as the appearance of a specific surface or part of an object in an image. In the same image different textures can be identified defining some regions. Combining this characteristic with some statistic tools important information can be extracted from the image.

An interesting texture feature description is Co-Occurrence Matrix. The main propose of this paper is to implement basic principles on image texture analysis co-occurrence matrices with some statistics, such as energy, homogeneity, contrast and uniformity.

II. CO-OCCURRENCE MATRICES .

A Co-Occurrence Matrix contains the frequency of certain pair of pixels repetition in an image. In order to compute a co-occurrence matrix it is necessary to know the following values [4]:

- Number of Gray levels: A gray scale image has 256 gray levels, which is the high computational cost because all possible pixel pairs must be taken in account. The solution can be thought of generating a matrix which reduces the number of gray levels and hence the number of pixel combinations. It is always a square matrix with same dimensionality as the number of gray level chosen. This value is by default set to eight.
- Angle :Similar to the distance it is necessary to define the direction of pair of pixels. The most common directions are 0,45,90,135 degree and its symmetric equivalent.
- Distance between pixel: The Co-Occurrence matrix stores the number of times that a certain pair of pixel are just neighbors, but it could also be computed the matrix analyzing the relation between non-consecutive pixels. Thus a distance between pixel is previously defined.

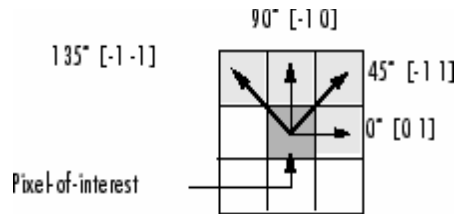


Figure2. 3x3 Grid showing pixel of interest

III. DIFFRENT CO-OCCURRENCE MATRIX

3.1 Gray Level Co-Occurrence Matrix(GLCM).

Gray Level Co-occurrence Matrix (GLCM) is a widely used texture descriptor and it is proven that results obtained from the co-occurrence matrices are better than the other texture discriminations methods. GLCM computes the statistical features based on gray level intensities of the image.[3] Such features of the GLCM is useful in texture recognition, image segmentation, image retrieval, color image analysis, image classification, object recognition and texture analysis methods. It is widely used texture analysis method especially for stochastic textures. It not only enhances the details of an image but also gives the interpretation. The GLCM is a tabulation of how often different combinations of pixel brightness values occur in an image. Definition of GLCM can be summarized as “ A two dimensional histogram of gray levels of pair of pixels, which are separated by a fixed spatial relationship”. [1] Adding on the matrix is sensitive to rotation. With the change of different offsets define pixel relationship by varying directions (rotation angle of an offset: 0, 45,90,135 degrees) and displacement vectors (Distance to the neighbor pixel: 1, 2,3,...), different co-occurrence distribution are resulted from the same image of reference.

GLCM of an image is computed using displacement vector d defined by its radius, (distance or count to the next adjacent neighbor preferably is equal to one) and rotational angle (0,45,90,135). [3] This can be explained with the example given below. For an image in Figure 3(a), intensity values are given in the form of matrix Figure 3(b)., generalized GLCM of an image in Figure 3(c)., and the GLCM of the images with two angle of rotation are shown in Figure 3(e & f)., Where (i,j) represents the number of times the point having j occurs relative to a point having gray level i satisfying the condition satisfied by the displacement vector d . here we are considering displacement vector defined by its radius defined equal to one

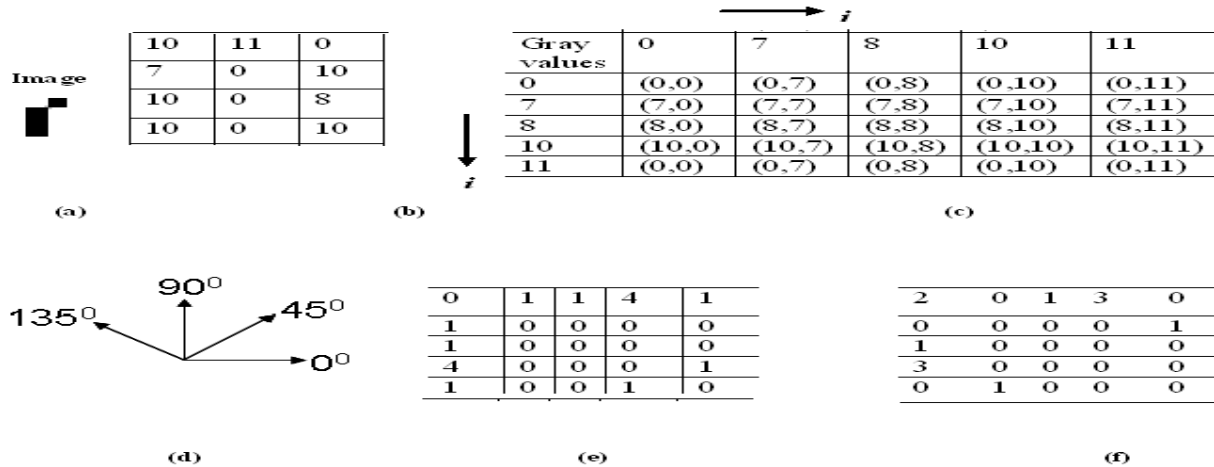


Figure 3. (a) test image; (b) test image intensity values in matrix form; (c) generalized fromof GLCM of test image; (d) roation offsets defines the pixel spatial relationships;(e) and (f) GLCMs of the image at an angle of 0 and 45 degree.

In above example, each element of Gray level co-occurrence matrix represents the probability of occurrence of pixel pair. From the spatial domain GLCM image being an output to of second order statistics, again further statistical parameters like contrast, energy ,homogeneity, and correlation are determined using respective equations as mentioned in further section.[3]

3.2 Motif Co-occurrence Matrix.

In 2004, Jhanwar et al.[2] proposed an image retrieval method using 2x2 local feature, which is a motif scan. A motif kind of pattern obtained from tracing intensities of pixels in a block and is used as descriptor of that block. Motifs were used in image retrieval, since if the images are different, motifs are also different. Also, if an image is degraded, motifs of that image also change with respect to those of the reference image.

In general, 24 different motifs could traverse a 2x2 grid, however, among which 6 are the standard forms which is considered in this paper that start from top left corner of the grid. Jhanwar et. al.[2] previously went with image divided in 3x3 matrix and further 3x3 matrix in to 4 overlapping 2x2 grid with respect to the query image and scan all images using the scan optimal or motif scan pattern to the query image and compared the transformed image in frequency domain[7]. Such an algorithm was useful but computationally expensive at the run time Instead of using the spectrum of such an image suitable features by going one step behind in the process of finding the concentrated spectrum. In order to find the concentrated sequence it is important to know how 2x2 grid in the image was scanned.. Six motifs (shown in Figure 4.) are different scanning paths to determine which motif does each 2×2 grid belongs to. Each grid is scanned from its top-left pixel and then searches its close pixel by minimum pixel-value difference. Before scanning, six motifs are labeled as 0 to 5 respectively. For example, in Figure. 5, the top-left grid contains four pixels {202, 53, 78, 55}, and then the scanning path goes through {202, 78, 55, 53} sequentially. [2]According to this scanning path, the top-left grid is determined as “U motif” and labeled “2” in a motif map. The rest of grids are scanned as above procedures to obtain a motif map of this image (shown in Figure 5(b)). Therefore, the local variance of an image can be observed by the motif map. Further, the motif map is scanned by the co-occurrence matrix technique to generate a motif co-occurrence matrix to obtain texture features.

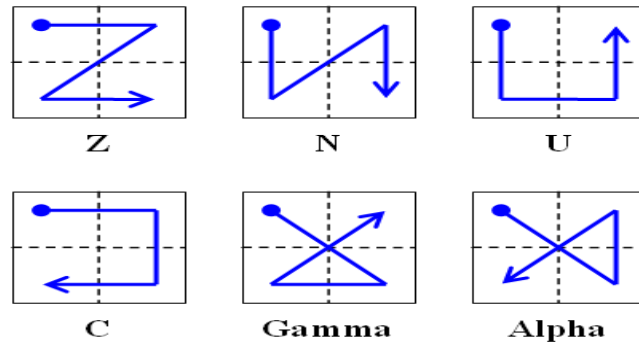


Figure 4. Six Motifs with 2x2 grids

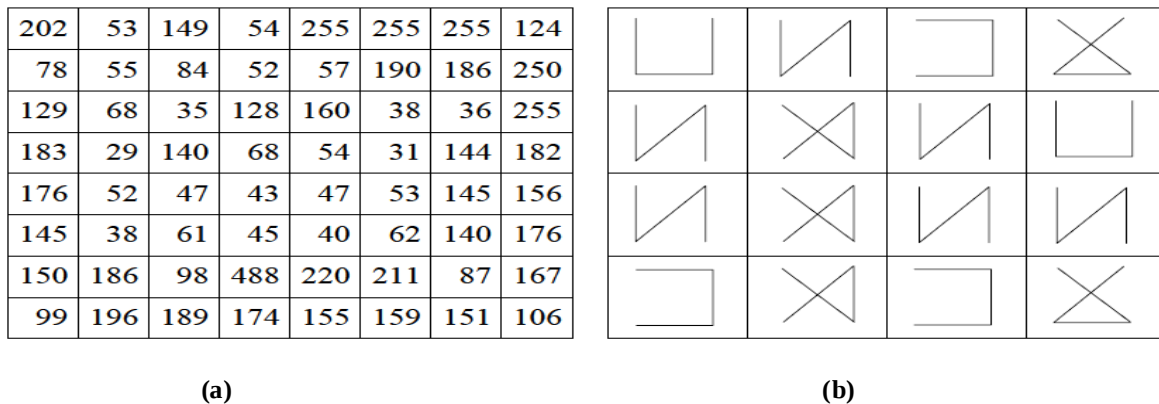


Figure5. (a) An 8x8 image. (b) A Motif map of (a)

IV. FEATURE EXTRACTION USING CO-OCCURRENCE MATRIX.

After co-occurrence matrix of an image is obtained, 14 statistical measures were given by Haralick. These are the texture can be extracted from matrix into a feature vector out of which four are considered here: Energy, Entropy, Contrast, and Homogeneity.[8] These values are calculated using the following equations and as well as range of the respective feature vectors is specified:

1) **Contrast:** It returns a measure of the intensity contrast between a pixel and its neighbor over the whole image. Contrast is 0 for constant image.

Range = $[0, (\text{size GLCM} - 1) \cdot 1^2]$

$$\text{Contrast} = \sum_{i,j} |i - j|^2 \text{GLCM}(i, j)$$

2) **Correlation:** this returns a measure of how correlated a pixel is to its neighbor over the whole image. Correlation is 1 or -1 for a perfectly positively or negatively correlated image.

Range = $[-1, 1]$.

$$\text{Correlation} = \sum_{i,j} \frac{(i - \mu_i)(j - \mu_j) \text{GLCM}(i, j)}{\sigma_i \sigma_j}$$

where μ_i and μ_j , σ_i and σ_j are the mean and standard deviation of probability matrix GLCM along rowwise i and columnwise j .

3) **Energy:** This returns the sum of squared elements in the GLCM. Energy is 1 for a constant image.

Range = $[0, 1]$.

$$\text{Energy} = \sum_{i,j} \text{GLCM}(i, j)^2$$

4) **Homogeneity**: This returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Homogeneity is 1 for diagonal GLCM.
Range = [0 1].

$$\text{Homogeneity} = \sum_{i,j} \frac{\text{GLCM}(i,j)}{1+(i-j)}$$

V. CONCLUSION

Content-based image retrieval (CBIR) is a technique that uses visual attributes (such as color, texture, shape) to search for images. These attributes are extracted directly from the image using specific tools and then stored on storage media. Different algorithm and methods are undertaken for texture description out of which Co-Occurrence Matrix is proved to be better than the other texture discrimination methods. Gray Level Co-occurrence Matrix (GLCM) is a widely used texture descriptor it computes the statistical features based on gray level intensities of the image. A step ahead of GLCM is MCM.

MCM is obtained from motif transformed image in which is divided in 3x3 matrix which is further divided in 2x2 4 overlapping matrix and respectively further replaced by scan pattern and co-occurrence matrix is calculated. MCM performs better than GLCM since it capture third order image statistics in local neighborhood. Hence MCM is an promising texture descriptor than other methods of segmentation and block dividing of an image which includes huge computations as well as time consuming.

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REFERENCES

- [1] R. M. Haralick, K. Shanmugam, I. Dinstein, "Textural Features for Image Classification," IEEE Transactions on System, Man and Cybernetics, Vol. 3, No. 6, pp. 610-621, 1973.
- [2] N. Jhanwar, S. Chaudhuri, G. Seetharaman, B. Zavidovique, "Content-based Image Retrieval using Motif Cooccurrence Matrix," Image and Vision Computing, Vol. 22, No. 14, pp. 1211-1220, 2004.
- [3] Jun-Dong Chang, Shyr-Shen Yu, Hong-Hao Chen, and Chwei-Shyong Tsai, HSV-based Color Texture Image Classification using Wavelet Transform and Motif Patterns, Journal of Computers Vol. 20, No. 4, January 2010.
- [4] R.C. Gonzalez, R.E. Woods, Digital Image Processing , 2nd ed., India: Prentice Hall, 2002.
- [5] H. B. Kekre, D. T. Sudeep, K. S. Tanuja, S. V. Suryawanshi, "Image Retrieval using Texture Features extracted from GLCM, LBG and KPE" , International Journal of Computer Theory and Engineering., Vol. 2, pp: 1793-8201, 2010.
- [6] J. F. Haddon, J F Boyce, "Co-occurrence matrices for image analysis," IEEE Electronics & Communication Engineering Journal., Vol. 5, pp:71-83,1993.
- [7] N. Jhanwar, S. Chaudhuri, G. Seetharaman and B. Zavidovique ,Content Based Image Retrieval Using Optimal Peano Scans." The Sixteenth International Conference on Pattern Recognition, August 11 -15, 2002. Quebec City, Canada.
- [8] MATLAB Help.