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AN ENHANCED TECHNIQUE FOR TEXTURE BASED IMAGE RETRIEVAL USING FRAMELET TRANSFORM WITH GLCM

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Abstract - Content based image retrieval (CBIR) system is based on Framelet Transform using gray level co-occurrence matrix (GLCM). The Content Based Image Retrieval (CBIR) technique which uses visual contents to search images from large scale image databases. Texture is a very important characteristics for the analysis of different types of images that appears everywhere in nature. Texture can be recognized by everyone but it is not easy to define. In this research work, presents a novel content based image retrieval (CBIR) system based on Framelet Transform combined with gray level co-occurrence matrix (GLCM).The proposed method is shift invariant which captured edge information more accurately than conventional transform domain methods as well as able to handle images of arbitrary size. First Texture features are obtained by computing the energy, standard deviation and mean on each sub band of the Framelet transform decomposed image .Then a new method as a combination of the Framelet transform-Gray level co-occurrence matrix (GLCM) is applied. The results of the proposed methods are compared with conventional methods.

Keywords— CBIR, Euclidean distance, texture features

I. INTRODUCTION

Content based image retrieval is emerging as an important research area with application to digital libraries and multimedia data bases [1]. Content based image retrieval is a technique, which uses visual contents to search images from large scale image databases. The main goal of the content based image retrieval is to find images which are similar to query image visually without using any textual descriptions for the image.

Feature extraction is the basis of content based image retrieval system. Images are usually represented by the visual features such as color, shape and texture. There are mainly two approaches for feature extraction in content based image retrieval. (i) Feature extraction in spatial domain and feature extraction in transform domain. Feature extraction in spatial domain based on statistical calculation on the image. Many of the spatial domain methods suffer from insufficient number of features and also sensitive to noise. The transform domain include the use of Discrete Cosine transform (DCT), Multiresolution methods such as Gabor filters, Wavelet transform, curve let and Contourlet transform for feature representation. Most of the transform domain methods is that they do not capture edge information of an image efficiently. Finding better transform domain approaches, which can capture the edge information, is a challenging field in content based mage retrieval.

Content based image retrieval (CBIR) system perform two main tasks (i) Feature extraction, where in a set of features called feature vector is generated to represent the content of the image in the database. The second task is similarity measurement where a distance between the query image and each image in the database using their feature vectors is computed so that the closest images can be retrieved.

Most of the existing methods mainly focused on the efficient extraction of color, shape and texture features. Color is the basic feature, color histograms are commonly used for color feature extraction. The color histogram method requires simple calculation. However it is unsuitable for images in which there is a great color variation .But it does not include any spatial information.

Shapes are based on contour information in an image which includes edge detection and correlograms. Edge detection leads better results only clear contour information.

Texture is one of the important features due to its presence in most of the real and synthetic radar imagery which makes high attention in CBIR and also medical imaging, Remote sensing etc. Wavelet transform have been used most widely in many aspects of image processing such as noise removal, image compression, image super resolution and image retrieval. The texture feature of an image is extracted by mean and variance of the wavelet subbands .But wavelets [2-4] loses their universality in capturing the edge discontinuities in image which is important in texture representation.

Another multiresolution approach, Gabor filters [5-8] consists of group of wavelets each of which capturing energy at a specific resolution and orientation. Therefore Gabor filters are able to capture local energy of the entire image .But it suffer due to computational complexity, their non-invariance to rotation as well as non orthogonal property of the Gabor filters that implies redundancy in the filtered image.

Framelet transform [22-25] which is similar to wavelets but has some differences. Framelets has two or more high frequency filter banks, which produces more subbands in Decomposition.

This can achieve better time frequency localization ability in image processing. There is redundancy between the Framelet sub bands, which means change in coefficients of one band can be compensated by other sub bands coefficients. After Framelet decomposition, the coefficient in one subband has correlation with coefficients in the other subband. This means that changes on one coefficient can be compensated by its related coefficient in reconstruction stage which produces less noise in the original image.

II. RELATED WORK

The Dual tree complex wavelets transform (DT-CWT) [9-12] as introduced by Kingsbury has been used to found an important tool for image texture analysis and feature extraction which overcome the drawbacks of both Gabor and Discrete Wavelet transform(DWT).

Curvelet transform was introduced by Donohoet al., [13]-[15] is another multiresolution transform which provides more edge information. But computationally is not efficient in in large images.

Contourlet transform was developed by Do et al., [16-19] is a multiscale and directional image representation that uses a wavelet like structure for edge detection and a local directional transform for contour segment detection . This transform also shift sensitive due to up and down sampling of Laplacian filters.

Cunha et al., [20-21] proposed a modified version of Contourlet transform which was constructed by combing a nonsub sampled Laplacian pyramid and nonsub sampled directional filter banks known as Non sub sampled Contourlet transform. Though much advancement made in content based image retrieval system, finding an efficient retrieval method is a major challenge for researchers. In this paper we introduced a new texture feature based on Framelet transform is proposed .The technique makes use of Framelet transform which represents the latest research on multiresolution analysis of digital image processing. This method overcomes the weakness of conventional wavelets to obtain noise free edges of images with less computational complexity

S. Sulochana et al., [4] discusses a novel content based image retrieval system based gray level co-occurrence matrix (GLCM). Its growth is due to some causes such as in many large image databases, conventional methods of image indexing are used. These traditional methods of image indexing proceeds by storing an image in the databases and relating it with a keyword or number that associate with a categorized description, have become obsolete. They have been proven that these methods are insufficient, laborious and extremely time consuming.

H. Yao et al.,[6] proposed textural feature extraction based on coarseness .To improve the performance they used coarseness textural feature and compared its result with the Gray Level Co-occurrence Matrix textural coarseness, Fractual dimension textural coarseness and tamura textural model. And they proposed amongst the three, tamura textural model performance of describing coarseness is best followed by the other two methods.

J. Zhang et al., [7] proposed image retrieval by texture characterization by GLCM texture properties and an edge detector by prewitt edge detection, since by considering the texture properties only coarseness, contrast, energy correlation there is much information left on the edges. Thus they proposed the composition of both the co-occurrence matrix and the edge detector approach, and they used composition of edge information and texture characterizations of GLCM properties and proposed the method which has high retrieval precision.

N. Puviarasan et al.,[9] proposed Retrieval of images from large databases from the image database using CBIR technique. The proposed a combination of texture and shape feature extraction methods like Haralick features and Hu-invariant moments. They first segment the image according to the Fuzzy C-means clustering and comparing with the k-means, and they extracted features according to the texture and shape and use the combination of both features. The corel images database was used for experimentation. And similarity measures Euclidian distance was applied for the retrieval of images.

The texture feature provides vital information for the classification of image because it is useful in describing the contents of numerous real world images such as fruit, skin, bricks, trees, clouds in the sky and fabrics. Texture is mostly used in CBIR. Texture classification and texture based image segmentation are the challenging tasks. Texture is based on neighborhood. It is generally believed that human visual systems use texture for recognition and retrieval of images.

Matching of texture based image is carried out with the similarity between the areas of the images with similar texture. Various techniques have been used for measuring texture similarity by calculating the relative brightness of selected pairs of pixels from each image. The system then retrieves images with texture measures which are most similar to the query. In CBIR, each image is stored in the database and its features are extracted and matched with query image features. It possesses two steps: feature extraction and matching. The first step involves the process of extraction of image features to a distinguishable extent. The second step proceeds by matching of extracted query image features with the features of images stored in the database to yield a result which is visually similar.

Even though many techniques have been implemented for the image retrieval still more issues on image retrieval due to the recognition rate is very low because of image enhancement issues. The Feature extraction of images is not significant. It has more complexity in recognition and retrieval. In existing work, one or two features are been used. Accuracy is poor due to the inefficiency of existing system. Processing an image takes more time.

III. PROPOSED METHODOLOGY

In order to overcome the above problems, there is a need to create a new model. Here, proposed a new enhanced model for CBIR using the texture features. Before analysing images based on their feature extraction from databases of images, pre-processing methods in images are performed in all types of images. Like, firstly, the images resize according to the region of interest for the faster retrieval of images. Deleting and removing complicated background will speed up further image processing.

Haralick first introduced the use of co-occurrence probabilities using GLCM [26-28] for extracting various texture features. GLCM is also called as Gray level Dependency Matrix. It is defined as “A two dimensional histogram of gray levels for a pair of pixels, which are separated by a fixed spatial relationship.” GLCM of an image is computed using a displacement vector d, defined by its radius ä and orientation è. ä values ranging from 1, 2 to 10 and every pixel has eight neighbouring pixels allowing eight choices for è, which are 0°, 45°, 90°, 135°, 180°, 225°, 270° or 315°.

Gray level co-occurrence matrix (GLCM) is generated by counting the No. of times a pixel with i is adjacent to pixel with value j and then dividing the entire matrix by the total No. of such comparisons made. Each entry is therefore considered to be the probability that a pixel with value i will be found adjacent to a pixel of value j.

$$P_r(i,j) = \{C(i,j) \mid (\delta,\theta)\}$$

$$C(i,j) = \frac{P_d(i,j)}{\sum_{i=1}^{G}\sum_{j=0}^{G} P_d(i,j)}$$

Where $C(i,j)$ is the co-occurrence probability between gray levels i and j. i and j = Within the given image window, given a certain (δ, θ) Pair .G is the quantized number of gray levels.

The sum in the denominator thus represents the total number of gray level pairs (i, j) within the window. Graycomatrix computes the GLCM from a full version of the image. By default, if I a binary image, graycomatrix scales the image to two gray-levels. If I is an intensity image, graycomatrix scales the image to eight gray-levels. In order to use information contained in the GLCM, Haralick defined 14 statistical measures to extract textual characteristics. In this paper we used 4 features that can successfully characterize the statistical behaviour Let us consider *P* is the normalized GLCM of the input texture image.

Energy

Energy gives the sum of squared pixel values of GLCM

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

Contrast

Contrast measures the local variation in the gray level of GLCM

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

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

$$\text{Correlation} = \sum_{i,j} \frac{(i-\mu j)(j-\mu j)P(i,j)}{\sigma i \sigma j}$$

The choice of the displacement vector d is an important parameter of the Gray level co occurrence matrix. In general GLCM is computed for several values of d and the one which maximizes a statistical measure computed from P(i,j) is used.

THE PROPOSED ALGORITHM USING FRAMELET TRANSFORM

Step 1: Feature vector (f)Decompose each image in Framelet Transfrom Domain.
Step 2: Calculate the Energy, mean and standard deviation of the Framelet transform Decomposed image.

$$Energy = \frac{1}{MXN}\sum_{i=1}^{M}\sum_{j=1}^{N} |W_k(i,j)|$$

$$Standard\ Deviation\ (\sigma_\kappa) = \sqrt{\frac{1}{(MXN)}\sum_{i=1}^{M}\sum_{j=1}^{N}(W_k(i,j)-\mu_k)^2}$$

μ_κ – Mean value of the K^{th} Framelet transform subband
W_k-Coefficient of K^{th} Framelet transform subband
MxN is the size of the decomposed subband

Step 3: Result

$f = [\sigma_1, \sigma_2, \ldots\ldots \sigma_n, E_1, E_2, \ldots\ldots E_n]$ feature database

Step 4 : Select query image and calculate the feature vector using step (2) & (3)
Step 5 : Calculate the similarity measure using Euclidean distance
Step 6 : Retrieve all relevant images to query image based on minimum Euclidean distance

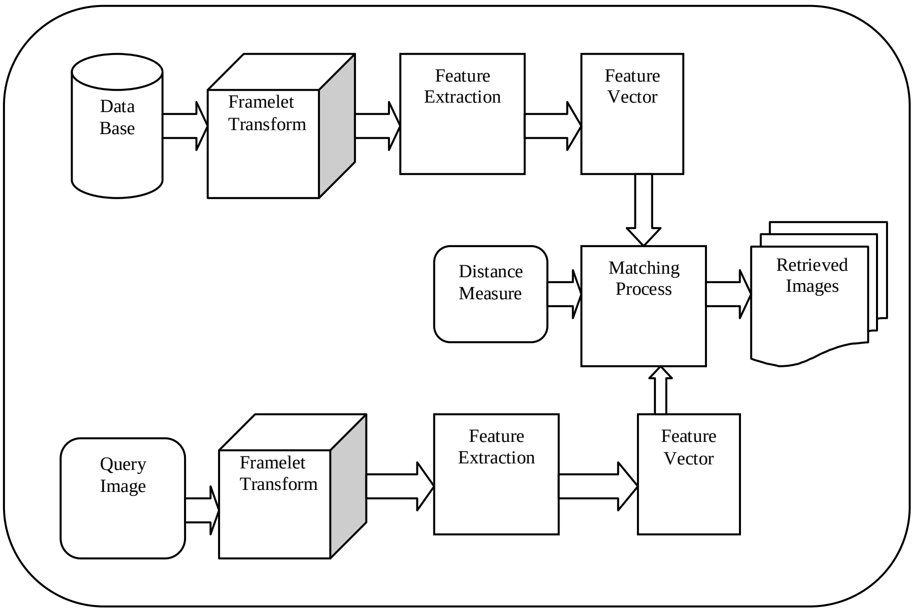

Fig.1: Framelet Transform

THE PROPOSED ALGORITHM USING FRAMELET TRANSFORM-GRAY LEVEL CO-OCCURRENCE MATRIX (GLCM)

Step 1: The images are decomposed using Framelet Transform.

Step 2: GLCM of the Decomposed subbands are calculated with orientation and distance

Step 3: Finally feature vectors such as contrast, Energy, Correlation, Homogeneity were extracted from GLCMs of subbands.

Step 4: The feature vector (f) is

$f = [Contrast_n, Energy_n, Correlation_n, Homogeneity_n]$ *the feature database.*

Step 5: Apply the query image and calculate the feature vector as given in step (2) & (3).

Step 6: Calculate the similarity measure using Euclidean distance

Step 7: Retrieve all relevant images to query image based on minimum Euclidean distance

The feature vectors are stored to be used in the similarity measurement. For creation of feature database above procedure is repeated for the entire image and these feature vectors stored in feature database.

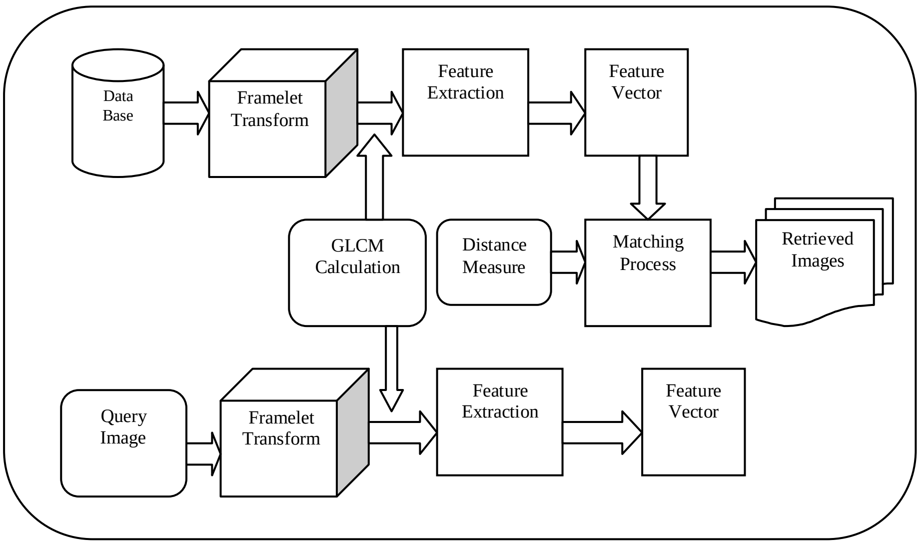

Fig.2: Framelet Transform + GLCM

IV. EXPERIMENTAL RESULTS

A query image is any one of the images from image database. This query image is processed to compute the feature vector. Distance metrics are calculated between the query image and every image in the database. This process is repeated until all the images in the database have been compared with the query image. After completing the distance algorithm, an array of distances is obtained and which is then sorted.

Euclidean distance is not always the best metric. The fact that the distances in each dimension are squared before summation, places great emphasis on those features for which the dissimilarity is large. Hence it is necessary to normalize the individual feature components before finding the distance between two images.

$$D(q,g) = \left(\sum_i |(f_i(q) - f_j(g))|_2 \right)^{1/2}$$

To evaluate the retrieval efficiency of the proposed system, we use the performance measure, Recall and Precision. Recall measures the ability of the system to retrieve all the models that are relevant, while precision measures the ability of the system to retrieve only the models that are relevant.

$$\text{Precision} = \frac{\text{No.of relevant images received}}{\text{Total no.of images received}}$$

$$\text{Recall} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of relevant images}}$$

TARGET IMAGE:

RETRIEVED IMAGE:

Fig 2 Shows the Target and Retrieved Images

The algorithm is implemented in MATLAB platform. Database of 400 images of 4 different classes is used to check the performance of the algorithms developed.

Table.1 : Comparison between existing and proposed methods

	Cars (%)	Flowers (%)	Lions (%)	Buildings (%)
DWT	82.58	86.24	81.98	84.63
Euclidean Distance	86.91	88.63	85.14	87.26

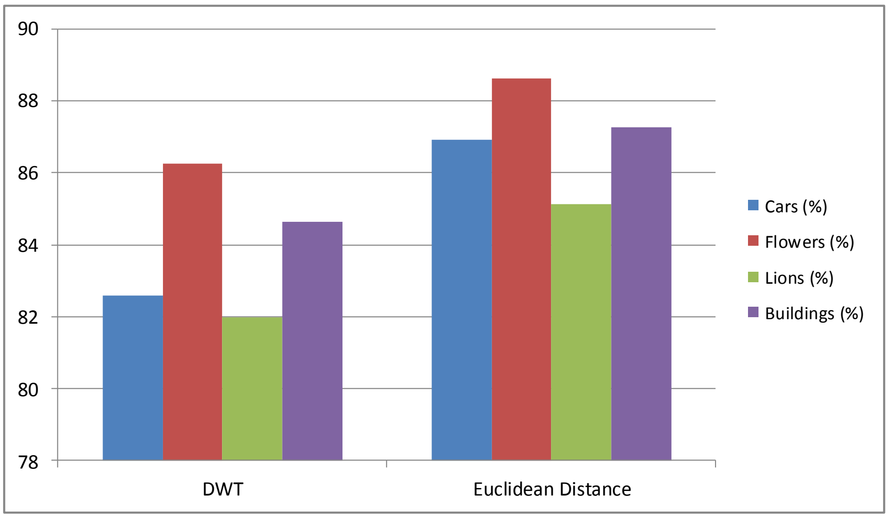

Fig.3: Comparison between existing and proposed methods

To evaluate the algorithms such as Framelet transform and Framelet co-occurrence features in image retrieval, Gray level co-occurrence are used.

First algorithm is based on extracting features from coefficient in the subbands of Framelet Transform. In this Energy, standard deviation and Energy + Standard deviation is used to create the feature vectors. Euclidean distance measure is used to match 4 sample query images with the Database includes 400 images of four different classes. The proposed method gives high precision compared to discrete wavelet transform (DWT) based image retrieval.

In second algorithm Framelet-Gray level co-occurrence matrix (GLCM) method is particularly better than the method based on Discrete Wavelet transform- co-occurrence matrix (GLCM).

In this proposed method used four GLCM statistical measures namely Energy, Contrast, Homogeneity and correlation. Gray level co-occurrence of coefficients of Framelet transform subbands angle(00) and distance (d=1) were used.

CONCLUSION

The search for the relevant information in the large database has become more challenging. More précised retrieval techniques are needed in such cases. In this paper a new algorithm for content based image retrieval was presented. (i) Framelet Transform [Energy+ Standard Deviation] (ii) Framelet transform and GLCM were combined to build a feature vectors. Euclidean distance is used to match the four sample query image with four classes of [Cars, Flowers, Lions, Buildings] 400 images from WANG image database which includes 1000 image of ten different classes. The proposed method gives better retrieval results and higher precision. The proposed method used only four GLCM statistical features with angle (00) and distance (d=1). Future work of this research is Framelet-co-occurrence with different angle and various distances. To extract the feature vectors in images and design the CBIR system based on Framelet-co-occurrence features.

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