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AN EFFICIENT FACE RECOGNITION SYSTEM USING CURVELET WITH PCA

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ABSTRACT

This paper identifies a feature space to address the problem of human face recognition from the database images. The face recognition system is based on Principal Component Analysis. By using PCA the features can be extracted. The multi resolution curvelet transform can be used for the efficient face image retrieval. When compared to wavelet transform the curve let transform has better directional and edge representation. The face images can be decomposed when applying the curvelet transform and the curvelet sub bands can be form. In addition the PCA can be used for dimensionality reduction. Then the PCA can be applying for each curvelet sub bands and create feature set. The mahalanobis distance measure can be used to measure the distance between the query and the database images. The well-known face database indicates the potential of this curvelet based feature extraction and gives good retrieval result. The experimental results show that our approach is significantly better than the conventional methods.

Keywords: CBIR, curvelet, PCA, mahalanobis distance.

1. INTRODUCTION

Over the past decades, the face image retrieval is one of the popular techniques to retrieve the images for security purpose, there are two types of image retrieval process they are

i) Text based image retrieval

In this type of image retrieval, each image contains text, one image may include information from multiple classes, so indexing the large databases is very complex and also time consuming process.

ii) Content based image retrieval

Content-based image retrieval (CBIR), was first developed in 1990s, can overcome the disadvantages of text based image retrieval, the CBIR is powerful tool to retrieve the images and it is based shape, color and texture. The process of annotating images manually is time-consuming and is difficult to describe the content of different types of images through human languages. Survey on sparse coding outperforms when compared to other techniques on facial features. new techniques can be used to improve semantic codeword to provide better retrieval rate [1] two methods can be used to retrieve images like attribute enhanced sparse coding and

Attribute embedded inverted indexing [2] by using these methods the similar faces from a large Database can be retrieved the sparse codeword are used to reduce the quantization errors. Attribute enhanced sparse coding will extract less amount of images exactly match with query images. In [3], the facial muscle can be classified based on larger range of facial behavior action can be determined, this method is automatic for image retrieval. The face images can be classified based on HSV color features and then the CBIR can be used to retrieve the face image from extracted facial features. The clustering technique gives less accurate image retrieval and better classification of images [4] David ray back *et al*. [5] query by description features, user picks specific features and match the query verbal description with those features description association the faces stored in Database. In the proposed work[6],the curve let based feature extraction algorithm for 3D face recognition in this the key point in the face can be identified using curve let coefficient in each sub and identifying key point is somewhat difficult process. In [7], the feature vectors can be extracted by using the DCT. Based on this method the face image can be retrieved and the calculation made by this proposed work becomes complexity, the features can be extracted using wavelet_curvelet technique and applied it to face recognition. Then the curve let transform is applied individually, execution time takes place while combining both curvelet_wavelet the size of the image is 64x64 the execution time is reduced and also power is reduced but for the size of image is increased the execution time is also increased[8] the retrieval rate varies from one Database to another Database and the comparison can be made from feature extraction methods like WHT,DCT,DWT[9] Ayşegül *et al.* [10], color face can be recognized based on curvelet transform. In this proposed work they compared the performance of K-NN and SVM for different principal components on color feret database, the experimental result shows that the performance can be increased up to 7% only by using RSCr hybrid color space. In this proposed work [11], presented a face recognition algorithm which uses wavelet transform to obtain on low frequency approximation sub band. Then the Fast Independent Component Analysis (FastICA) is applied to extract features from the approximation sub band. Finally, the extracted features are classified through Radial Basis Function (RBF) neural networks. Xueyan Liu, *et al.* [12], proposed a face recognition method which based on both global and local discriminative features. In this proposed work, global features are extracted from the whole face images by keeping the low-frequency coefficients of 2D-discrete Fourier transform which is believe encodes the holistic

facial information such as eyes, mouth and the whole facial contour. In local feature extraction, Gabor wavelets are used for considering their biological relevance. After that, Fisher's Linear Discriminates (FLD) is separately applied to the global Fourier features and each local patch of Gabor features. In this proposed work [13], presented a hybrid approach based on Bayesian and wavelet transform for face recognition is proposed. Firstly the system uses (PCA) to select the first 10 candidate images. Then these candidate images and each testing image are decomposed into low frequency and high frequency sub-band images by applying wavelet transform. Finally Bayesian recognition is processed using these sub-band images. In this proposed [14] work, an efficient local appearance feature extraction method based the Curvelet Transform (CT) is proposed in order to further enhance the performance of the well known Linear Discriminates Analysis (LDA) method when applied to face recognition. The PCA-Memetic Algorithm (PCA-MA) approach for feature selection. The (PCA) has been extended by MAs where the former was used for feature extraction/dimensionality reduction and the latter exploited for feature selection. The Simulations were performed over ORL and Yale face databases using Euclidean norm as the classifier [15].

2. CURVELET TRANSFORM

The wavelet transform has detected in various types of image processing, it fails to represent objects containing edges and curves and representing line singularities. Gabor filters are better than wavelet transform in representing textures and multiple orientations. The spectral information can be loss in Gabor filters and so it cannot be effective for image retrieve. Initially the ridge let transform concept can be applied in curvelet transform, decomposition, the image denoising, texture based image classification and deconvolution of images, but it is not efficient when it becomes complex ridge let transform. To eliminate the drawback in wave let transform and ridge let transform the curvelet transform can be developed. It has the better edge and directionality capacity compared to other transforms.

Generally a face recognition system consists of some following key steps, namely, input face image collection, preprocessing, feature extraction, classification, and template storage or database. Facial images are generally 8 bit image pixel they have 256 gray levels, In such type of images two very close regions that have conflicting pixel values will increase to edges, and these edges are curved for face images. The wavelet transform is not suitable for that type of curve faces. So curve lets are good at approximating curved singularities, they are fit for extracting edge based features from face images more accurately than compared to wavelet transform.

In this section, image retrieval using curve let transform for feature extraction is described. Curve let based feature extraction takes the Face images as input and these face images are then decomposed into different sub band scales and orientations. The sub band contains the low-frequency components and the rest has the high-frequency details along different orientations. Then the PCA for dimensionality reduction has been applied on those selected sub bands to get an lower dimensional representation. This increases retrieval accuracy. The efficient dimensionality reduction tool is applied on curve let coefficients to achieve higher retrieval rate. Further Curvelet sub images are projected onto PCA-transformed space. Then Co-occurrence matrices are calculated for all the images in the normalized database.

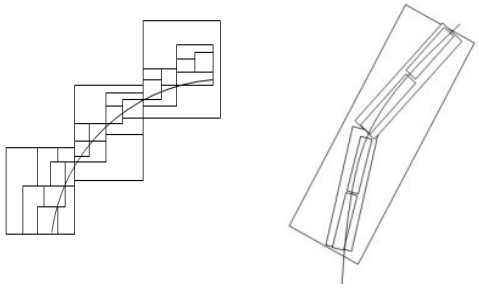

Figure-1. Edge representations of a) Wavelet transform b) Curvelet transform.

The difference between wavelet and ridge let edge information can be given in the above diagram. In this diagram the curvelet captures accurate edge information than the wavelet transform.

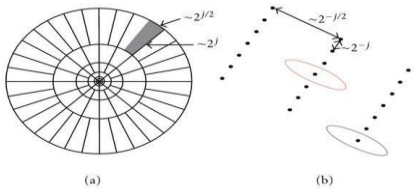

Figure-2. Curvelet frequency tiling in continuous domain.

To construct a basic curvelet ϕ and provide a tiling of the 2-D frequency space, two main ideas should be followed:

- Consider polar coordinates in frequency domain
- Construct curvelet elements being locally supported near wedges

The number of wedges is N_j=4.2j/2 at the scale 2^{-j} i.e., it doubles in each second circular ring.

Let ε=⟦(ε1,ε2)⟧^T be the variable in frequency domain, and r=√(ε_1^2+) ε_2^2,ω=arctan⟦ε1/ϵ2⟧,be the polar coordinates in the frequency domain.

We use the ansatz for the dilated basic curvelet in polar coordinates: To construct a basic curvelet with compact support near a basic wedge, there are two windows W and V_Nj need to have compact support at this time we can simply take W(r) to cover (0,∞) with dilated curve lets and V_Nj such that each circular ring is covered by the translations.

Then V_Nj the admissibility yields $\sum_{j=-\infty}^{\infty} |W(2^{-j}x)|^2 =$ For tiling a circular

ring into N wedges, where Nis an arbitrary positive integer, we need a 2π periodic nonnegative window [2π/N, 2π/N].

3. PRINCIPAL COMPONENT ANALYSIS

The PCA can be used for several reasons, one is it produce low dimension representation with minimum loss of information. So that the data can be easily understand. It was first invented by Karl Pearson. It has variable reduction procedure and obtained data redundancy. The PCA can be used to reduce the large number of variables into smaller number of variables. Goal of PCA is to reduce the dimensionality of the data by retaining as much as variation possible in our unique data set. On the other hand dimensionality lessening implies information loss. The best low-dimensional space can be determined by using principal components. The major advantage of PCA is using it in an Eigen face approach which helps in reducing the size of the database for recognition of a test images. The images are stored as their feature vectors in the database which are found out projecting each and every trained image to the set of Eigen faces obtained. PCA is applied on Eigen face approach to reduce the dimensionality of a large data set. Principal component analysis (PCA) can be used for dimensionality reduction and also used for image compression and face identification techniques.PCA is one of the most powerful tool for face recognition. The eigenvectors of covariance matrix can be calculated by using the principal component analysis. The main advantage of PCA is the data dimension should be reduced.

4. MAHALANOBIS DISTANCE

Mahalanobis distance can be used for data clustering and calculated by measuring two data points in the space defined by relevant features. In this proposed work the distance between query and database image can be calculated using Mahalanobis distance.

$$a = (a_1, a_2 \ldots . a_n)^t$$

$$b = (b_1, b_2 \ldots . b_n)^t$$

$$d_{ab}(\bar{a}, \bar{b}) = \sqrt{(\bar{a}, \bar{b})^T \sum^{-1} (\bar{a}, \bar{b})}$$

$\bar{a}$ and $\bar{b}$ = Mean of the database images

$(\bar{a} - \bar{b})^T$ = Transpose of mean

$\sum^{-1}$ = Inverse of the covariance matrix

5. PROPOSED METHOD USING CURVELET AND PCA WITH MAHALANOBIS DISTANCE

The three existing method (wavelet+PCA+MD), (GLMeP(GT+LMeP),(DWT+RCWF+CD) can be compared with the proposed method. The combined approach of curve let and PCA using Mahalanobis Distance is proposed. Curve let will decompose an image into different scales and orientations. The image coefficients are reduced by using PCA. Approximate image contains only low frequency components. Statistical parameters are calculated from every individual image. Distance between query and database image is calculated by using MD measure. This proposed method gives better retrieval results in comparison with other methods. The proposed Face image retrieval system is shown in Figure.

Block diagram of face image retrieval

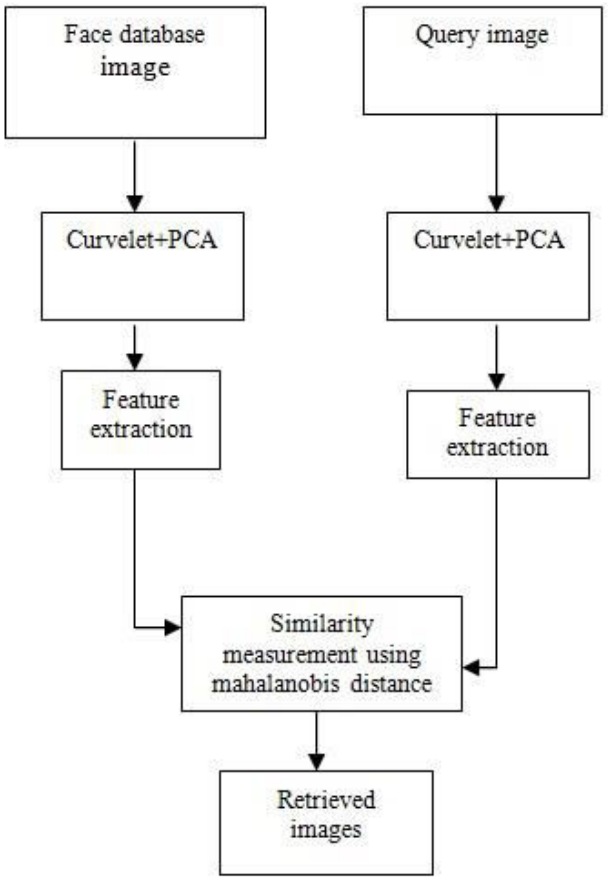

Figure-3. Face image retrieval based on curvelet with PCA with MD measure.

6. RESULTS

In this section different methods can be compared. The wavelet based image retrieval gives 82% efficiency, the global local mesh pattern analysis method gives 80% efficiency, the Dual tree wavelet transform based image retrieval method gives 80%. The effectiveness and efficiency of the proposed curve let and PCA using Mahalanobis distance face image retrieval approach is demonstrated with sample input images. Each database image is used as a sample query. Most relevant images are retrieved. Improved retrieval rate(86%)is obtained by using the proposed method.

Table-1. Comparison of the average precision rate for proposed and existing approach.

No. of Top images considered	Average Recall for Proposed Approaches (%)	Average Recall for Existing Approaches (%)		
	Curve let+ PCA+ MD	wavelet+ PCA+MD	GLMeP(GT+LMeP)	DWT+RC WF+ CD
10	80.4	72	69	67
20	82.1	74	73.4	72.4
30	82	77.5	75.7	74.6
40	83	77	76.1	74
50	84.2	78.3	76.4	75.2
60	84.6	78.8	76.8	75.6
70	84	79.1	77.1	75
80	85.3	79.5	77.5	76.3
90	85.5	79.7	77.7	76.7
100	86	82	80	80

Table-2. Comparison of the average recall rate for proposed and existing approach.

No. of Top images considered	Average Precision for Proposed Approaches (%)	Average Precision for Existing Approaches (%)		
	Curvelet+ PCA+ MD	wavelet+PCA +MD	GLMeP(GT +LMeP)	DWT+RCWF +CD
10	1	1	1	1
20	0.96	0.90	0.89	0.87
30	0.91	0.84	0.84	0.82
40	0.85	0.83	0.78	0.78
50	0.83	0.77	0.76	0.74
60	0.80	0.72	0.71	0.69
70	0.76	0.70	0.69	0.68
80	0.69	0.66	0.65	0.63
90	0.67	0.62	0.60	0.58
100	0.63	0.60	0.58	0.56

Table-3. Comparison of retrieval efficiency for proposed and existing approach.

Approach	Proposed	Existing		
	curvelet+ PCA+ MD	Wavelet+PCA+ MD	GLMeP(GT+L MeP)	DWT+RC WF+CD
Retrieval Efficiency (%)	86%	82%	80%	80%

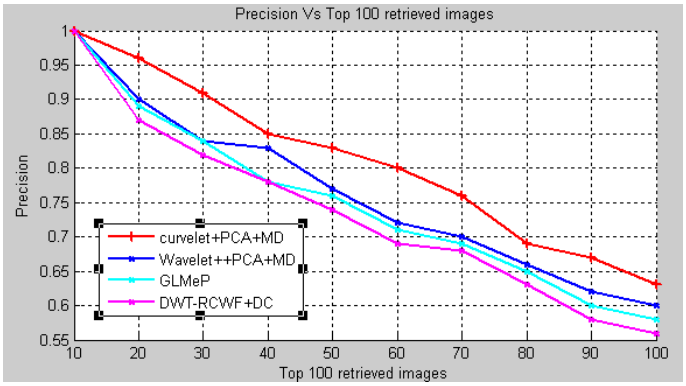

Figure-4. Comparison of precision for the proposed method with existing methods.

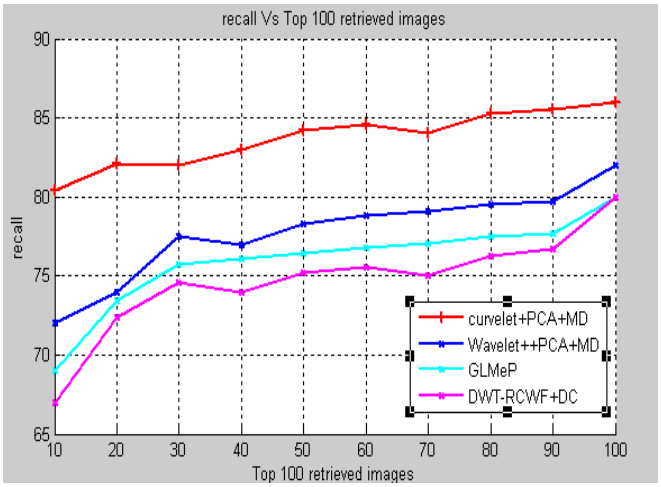

Figure-5. Comparison of recall for the proposed method with existing methods.

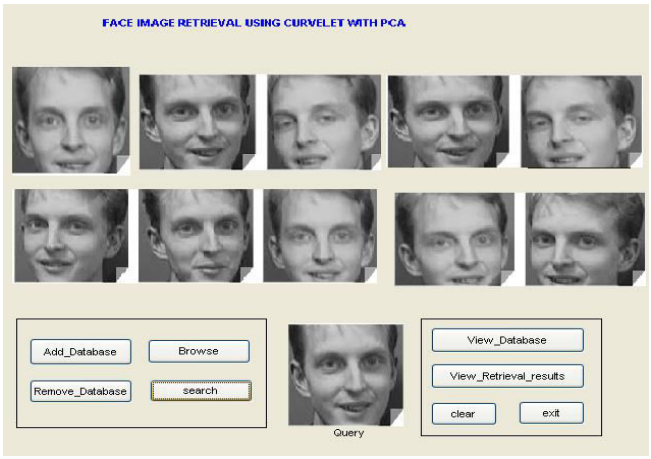

Figure-6. Proposed face image retrieval.

7. CONCLUSION AND FUTURE WORK

The objective of this paper is to improve a feature extraction algorithm for face recognition using multi-resolution analysis tools based on curvelet transform domain. Curvelet transform is defined in both continuous and digital area. For higher dimensions curvelet transform

has been used to extract features from bit quantized facial images. In this paper, the algorithm such as PCA can be combined with curvelet transform. They are well known approaches for dimensionality reduction. The mahalanobis distance can be used to measure the distance between the query face image and database face image. The experiments are done with face dataset, the detection of performance for the algorithm are evaluated and the experimental results shows that PCA based curvelet transform gives a better recognition rate when compared to existing methods.

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