International Journal of Computing Science and Information Technology, **2015, Vol.3,Iss.2 01-05**
ISSN: 2278-9669, April 2015 (http://ijcsit.org)

Face Recognition of Illuminated Images Using Dwt and Pca

G.Sucharitha[1], Ranjan K.Senapati[2]
Department of Electronic and Communication,
[1]ICFAI Foundation for Higher Education, India
[2]Koneru Laxmaiah University , India
[1]sucharithasu@gmail.com
[2]rksphd@gmail.com

Abstract

The look of a face image is severely affected by illumination conditions that obstruct the routine face recognition process. To recognize faces under varying illuminations, we have proposed a 2D wavelet-based normalization method so as to normalize illuminations. This method enhances the contrast as well as the edges of face images simultaneously in the frequency domain. It outperforms the predictable illumination normalization method which is based on the histogram equalization. Histogram equalization method only enhances image pixel gray-level contrast in the spatial domain. However, in the proposed method, face recognition system works effectively under a wide range of illumination conditions. The experimental results obtained by testing on the Yale face of database B. A simple metric, called PSNR is used as classifier.

Keywords: Dwt, Pca, YaleB.

1. Introduction

Face Recognition technologies have been widely applied in the areas of intelligent surveillance, identity authentication, human-computer interaction, and digital laughter[3]. However, one of the main boundaries in deploying face recognition systems for practical use is their relatively low presentation due to illumination variations So face illumination normalization is a central task in face recognition, and many algorithms have been developed to tackle this issue[3]. Training and recognition are the major issues' in Face Recognition process. Training stage involves pre-processing, feature extraction, feature selection and creation of a face gallery [4,5]. Recognition stage involves pre-processing of the test images, feature extraction, feature selection and classification/identification of these images.

To the best of our knowledge, one ideal way of solving the illumination variation problem is to normalize a face image to a standard form under uniform lighting conditions. In fact, the human visual system usually cares about the main features of a face, such as the shapes and relative positions of the main facial features, and ignores illumination changes on the face while recognizing a person [11]. In.Ref[1],Liu and Lam proposed a method to restore a face image captured under arbitrary lighting conditions to one with frontal illumination by using a ratio-image between the face image and a reference face image, both of which are blurred by a Gaussian filter. An iterative algorithm is then used to update the reference image, which is reconstructed from the restored image by means of principal component analysis (PCA). In.Ref[17],Shiji, Face images are projected onto a face space that encodes best variation among known face images. The face space is defined by Eigen faces which are eigenvectors of the set of faces, which may not correspond to general facial features such as eyes, nose, lips. The Eigen faces approach uses the PCA for recognition of the images.

Training and recognition are the major stages in face recognition process. Training stage involves pre-processing, feature extraction, feature selection and creation of a face gallery. Recognition stage involves preprocessing of the test images, feature selection ,feature extraction, feature identification of these images[12-14].

For databases with illumination variance such as YaleB[15], edge detection is required for feature extraction. To improve the recognition rate of the Face recognition system on images with varying illumination conditions, we have proposed a DWT based pre-processing technique named as 2D-DWT based Multilevel Illumination Normalization (DWT-MIN). This technique normalizes the illumination variant images by decomposing the image in the frequency domain. The high frequency and low frequency components are manipulated separately to obtain a normalized image.

The rest of the paper is organized as follows: Section 2 deals with the various levels of proposed face recognition. Section 3 introduces the proposed DWT-based Multilevel Illumination Normalization (DWT-MIN). Section 4 presents the PCA based face recognition. Section 5 gives PSNR and MSE for two different algorithms. The Experimental results and discussions are presented in Section 6, Conclusion and Future work is highlighted in Section 7.

2. Block diagram of proposed system

The block diagram of the proposed face recognition system is shown in Figure. 1. It shows the various steps involved in processing an input image. Figure. 2 shows the various pre-processing steps. For the training purpose, the images are taken from YaleB[13] database which are highly illuminated images. At the second step each image from training set is converted into the single column matrix called vector. For example, if the size of each image is NxN and no. of images in training set are M, then the vector matrix will be N^2xM.

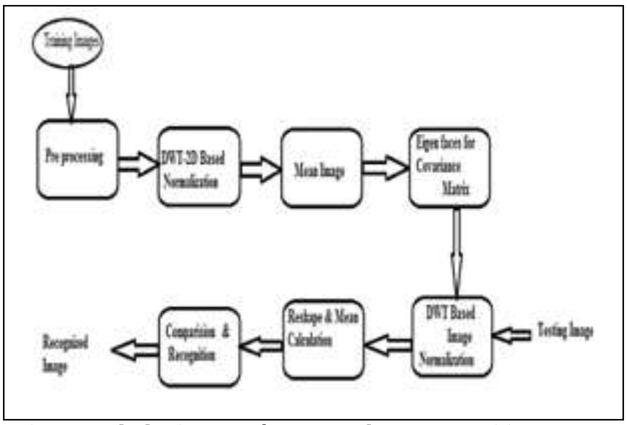

Figure 1: Block Diagram of a Proposed Face Recognition system

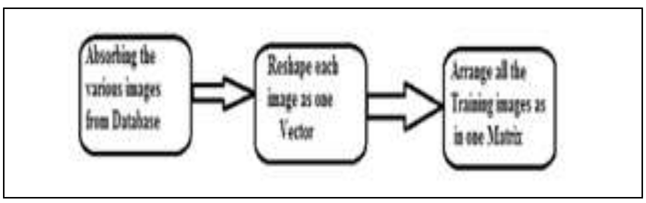

Figure2: Pre Processing Steps

3. Discrete wavelet transform

This paper presents a photometric normalization technique in which before applying the Wavelet transform moderate the high and low pixels by finding out the no.of high and low pixels. Then proposed technique used to decompose the image via the 2D Discrete wavelet transform (DWT) as to obtain the four sub-bands: the low-low sub-band generated by the approximation coefficients and the low-high, the high-low and high-high sub-bands generated by the detail coefficients. The level one decomposition of an input face image into the four sub-bands using the DWT is presented in Figure. 3,4. Note that the detail-coefficient-images (i.e., the images resembling the gradient magnitude of the input image) are scaled to the 8-bit interval for visualization purposes.

After the decomposition, the four sub-bands are subjected to the photometric normalization procedure. First, histogram equalization is applied to the approximation coefficients to increase the dynamic range of the image and to enhance the image's contrast. Then, the detail coefficients are multiplied by a scalar value higher than 1(i.e 1.5) to enhance edges present in the input image. Once all the sub-bands have been modified, the illumination invariant face representation is obtained using the inverse DWT. The described procedure resembles the image enhancement technique histogram equalization, with the distinction that it also enhances the high frequency information contained in the input image. Some examples of the effect of the presented technique on the appearance of the facial images and a comparison with histogram equalization are shown in Figure5.

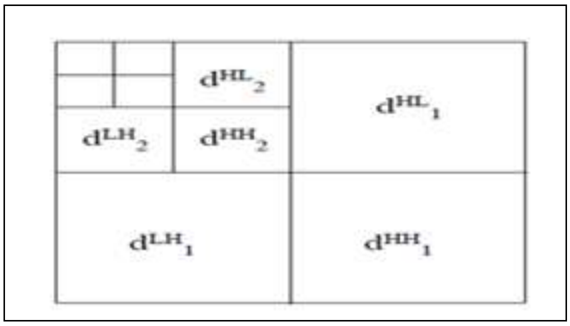

Figure3:SubBand Images

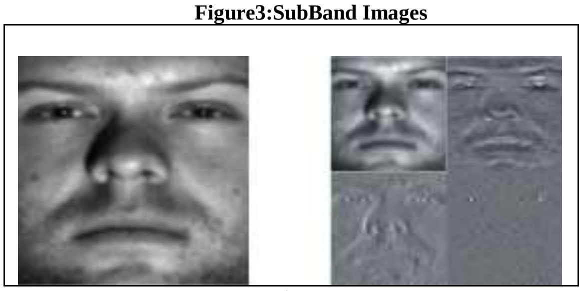

Figure4(a) An sample image from the YaleB Figure(b) wavelet decomposition of 4(a) database

Figure 5: Impact of the wavelet-based normalization techniques (a) Original image, (b), (c) and (d) normalized images using the DWT technique

Note that the presented wavelet-based normalization technique could be extended to the multi-resolution case (which is a common practice with the DWT) with an arbitrary wavelet.

4. Principal component analysis

The Principal Component Analysis (PCA) is one of the most flourishing techniques that have been used in image recognition. The inner idea of principal component analysis (PCA) is to diminish the dimensionality of a data set consisting of large number of interconnected variables, while retaining as much as possible of the variation present in the data set[16,17].
The images of a particular face lie in a linear subspace of the high dimensional image space. The image is linearly projected into a subspace in a manner which discounts those regions of the face with large deviation i.e. it identifies variability between human faces and thus reduces the feature space dimension. Using PCA, the extracted features of all faces in the face database are transformed into face space. Then face recognition is achieved by transforming any given test image into face space and comparing it with the training set vectors. The closest matching training set vector should belong to the same individual as the test image.

PCA does not attempt to categorize the faces using familiar geometrical differences, such as nose length or eyebrow width. Instead, it determines which 'variables' account for the variance of faces. In face recognition, these variables are called eigenfaces, because, when plotted they display a resemblance to human faces. The advantage of PCA comes from its generalization ability. It determines which projections are preferable for representing the structure of the input data. Those projections are selected in such a way that the maximum amount of information (i.e. maximum variance) is obtained in the smallest number of dimensions of feature space.

First the eigenvectors of the covariance matrix of the set of face images is found out and then they are sorted according to their corresponding eigenvalues. Then a threshold eigenvalue is taken into account and eigenvectors with eigenvalues less than that threshold values are discarded[7].

So ultimately the eigenvectors having the most significant eigenvalues are selected. Then the set of face images are projected into the significant eigenvectors to obtain a set called eigenfaces which gives the best variance in the data. Later, the training images are projected into the eigenface space. Next, the test image is projected into this new space and the distance of the projected test image to the training images is used to classify the test image [8].

5.Peak Signal To Noise Ratio

The PSNR is most commonly used as a measure of quality of reconstruction . The signal in this case is the original image (gray scale image with 0pose and not illuminated), and the noise images are Wavelet and DCT normalized images of highly illuminated images from YaleB database. When comparing normalized images it is used as an approximation to human perception of reconstruction quality.

It is most easily defined via the mean squared error (MSE) which for two $m \times n$ monochrome images I and K where one of the images is considered a noisy approximation of the other is defined as,

$$\text{MSE} = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (1)$$

PSNR defined as

$$\text{PSNR} = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

$$= 20.\log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \quad (2)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. The PSNR and MSE values for DCT and Wavelet algorithms as shown in figure6(a)and 6(b). As of we know higher PSNR represents higher image quality.

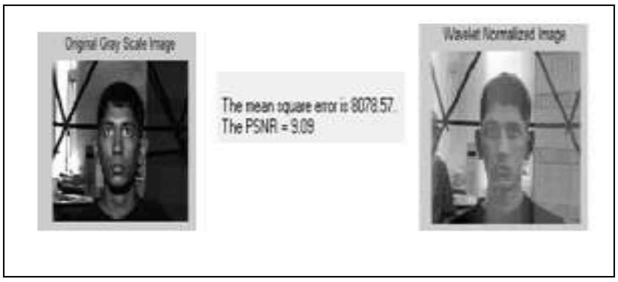

Figure6(a) Original and Wavelet Normalized images with MSE and PSNR

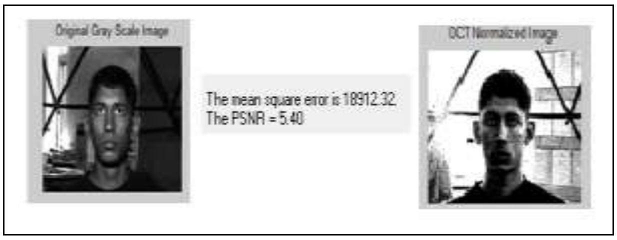

Figure6(b): Original and DCT Normalized images with MSE and PSNR

6. Result Analysis

The experiments were performed on 2D face Yale-B database which is having high illuminated images. We tested our algorithm on a number of images from the above database. Some acquisition, normalization, Eigenfaces and recognition results are shown in Figure 7. From 7(a) &(d) we can observe the original images and their eigenfaces, from 7(b)&(c) highly illuminated images and their normalized images using proposed normalization technique. To test the validity of the combination of DWT and PCA a highly illuminated image is taken and applied the DWT normalization and using PCA eigenface is calculated and compared with the eigenfaces of original images in the training database as shown in figure 7(e) . The combination of the these two algorithm given a good result in finding the original image.

When compared to the single scale retinex method, the wavelet-based normalized image has not only enhanced contrast but also enhanced edges and details that will facilitate the further face recognition task. Thus, the result shows that the wavelet method can improve the face recognition rate.

In DCT normalization, coding is complex and low-frequency DCT coefficients which are highly related to illumination variations should be discarded. An appropriate number of discarded DCT coefficients should be chosen in order to normalize the illumination well if not weaken important facial features.

7. Conclusion

A narrative move towards a flexible face recognition system is proposed which uses DWT for Multilevel Illumination Normalization (DWT) as well as for feature extraction using PCA. DWT has played a key role in image normalization. A successful attempt has been made to equally handle all illumination image variations (High, Low and surroundings). The proposed method exhibits extremely good performance based on their PSNR ratios under frontal poses. Moreover the training dataset is consisting of only one gray scale image with any illumination. The experimental results indicate that the proposed method has performed well under very illumination variations with top recognition rate having reached 100% Yale B considering only pose 0 as shown in figure7(e). Thus, the proposed method is efficient in practical situations where the images may be taken in uncontrolled and unknown surroundings.

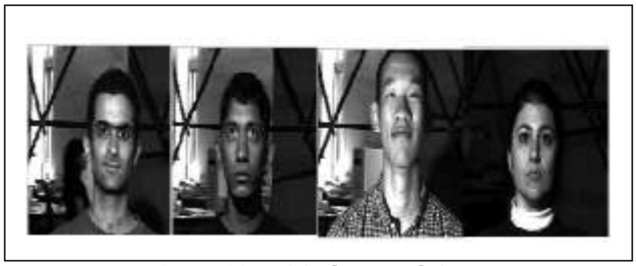

Figure 7(a): Original gray scale images

Figure 7(b):Highly illuminated images

Figure 7(c): Normalized images using DWT for images in 7(b)

Figure 7(d): Eigen faces for 7(a) images

Figure 7(e): Testing image with high illumination and reconstructed image from dataset.

REFERENCES

[1] Dang-Hui Liu, Kin-Man Lam, Lan-Sun Shen," Illumination invariant face recognition" Pattern Recognition, Elsevier, Volume 38, Issue 10, October 2005, Pages 1705–1716.

[2] X. Cao, W. Shen, L.G. Yu, Y.L. Wang, J.Y. Yang, Z.W. Zhang," Illumination invariant extraction for face recognition using neighboring wavelet coefficients", Pattern Recognition, Elsevier Volume 45, Issue 4, April 2012, Pages 1299–1305.

[3] K Manikantan1, Milan S Shet1, Minal Patel1, S Ramachandran2, "*DWT-based Illumination Normalization and Feature Extraction for Enhanced Face Recognition*" International Journal of Engineering and Technology,Vol.no.4,issue no 1,2012,pg.no 483-504.

[4] A.A. Bhurane, S.N. Talbar, P.N. Gophane, "*Comparative Analysis of Conventional, Real and Complex Wavelet Transforms for Face Recognition*", International Journal of Computer Applications.vol no. 39, 2012 pg.no 6-12.

[5] C.M. Mohan,V.V. Kumar,V.V. Krishna, "*Novel Method of Adult Age Classification using Linear Wavelet Transforms"*, International Journal of Computer Science and Network Security vol. no.10,2010.

[6] Aamir Khan, Hasan Farooq, "Principal Component Analysis-Linear Discriminant Analysis Feature Extractor for Pattern Recognition", IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 6, No 2, November 2011.

[7] Preethi Augustine," Uncontrolled illumination rectification using wavelet normalization on face recognition", International Journal of Emerging Technology and Advanced Engineering , Vol. 3, Issue 8, August 2013.

[8] Alex Pentland, Baback Moghaddam, and Thad Starner, "*View-Based and Modular Eigenspaces for Face Recognition*", IEEE Conf. on Computer Vision and Pattern Recognition, MIT Media Laboratory Tech. Report No. 245 1994.

[9] Y. Su, S. Shan, X. Chen, and W. Gao, , "Hierarchical ensemble of global and local classifiers for face recognition," IEEE Conf, on Image Processing, Pg.no.1-8,oct,2007.

[10] S. Du, and R. Ward, "*Wavelet-based Illumination Normalization for Face Recognition*," Proc. of the IEEE International Conference on Image Processing, ICIP'05, September 2005 .Vol. no2, pp954-957.

[11] Weilong Chen, Meng Joo Er, *Member, IEEE*, and Shiqian Wu, *Member, IEEE, "*Illumination Compensation and Normalization for Robust Face Recognition Using Discrete Cosine Transform in Logarithm Domain" IEEE Transactions On Systems, Man, and Cybernetics, Vol. 36, no. 2, April 2006.

[12] A.A. Bhurane, S.N. Talbar, P.N. Gophane, "Comparative Analysis of Conventional, Real and Complex Wavelet Transforms for Face Recognition", International Journal of Computer Applications.Vol.no 39 ,2012,pg.no 6-12.

[13] C.M. Mohan, V.V. Kumar, V.V. Krishna, Novel Method of Adult Age Classification using Linear Wavelet Transforms, International Journal of Computer Science and Network Security Vol.no10 .2010.

[14] Rabab M. Ramadan, Rehab F. Abdel Kader, Face Recognition Using Particle Swarm Optimization-Based Selected Features, International Journal of Signal Processing, Image Processing and Pattern Recognition Vol.no.2 ,2009,pg.no 51- 65.

[15] Yale Univ. Face Database: <http://cvc.yale.edu/projects/yalefaces/yalefaces.html>.

[16] Jian Yang, David Zhang, Alejandro F. Frangi, and Jing-yu Yang," Two-Dimensional PCA: A New Approach to Appearance-Based Face Representation and Recognition", IEEE transactions on pattern analysis and machine intelligence, vol. 26, no. 1, January 2004.

[17] Shiji,S.K, "Biometric prediction on face images using eigenface approach",IEEE conference on Information & Communication Technologies (ICT),p.p,104-109, Vol.no.1, April 2013.