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Face Recognition Using Lifting based DWT and Local Binary Pattern

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Abstract – ***There has always been an exceptional demand across Commercial and Defence fields for real time Biometric application system with accurate and reliable results to ensure highest degree of security. Therefore, Biometric application acts very crucial role in recognizing the uniqueness of an individual among the group. Since Image analysis is the one of the most substantial application, Face Recognition has come across very significant role for the security purposes. This paper proposes a novel approach on face recognition using the techniques, viz., Lifting based Discrete Wavelet Transform (DWT) and Local Binary Pattern (LBP). Lifting is a new technique that is based on spatial wavelet which consists of three steps: split, predict and update. Lifting scheme is the efficient way to construct DWT structure. Local Binary Pattern is used for texture classifications which characterize the image features. Further the features are concatenated and the best match is obtained by using the Euclidean distance. Performance of the proposed system with the parameters such as FAR, FRR, EER and TSR evaluated for the proposed algorithm and the accuracy, recognition rate is increased.***

Key Words: *Face Recognition, Lifting based Discrete Wavelet Transform (DWT), Local Binary Pattern (LBP), False Acceptance Rate (FAR), False Rejection Rate (FRR), Equal Error Rate (EER) and Total Success Rate (TSR).*

1. INTRODUCTION

Biometric is a process of human verification and identification by examining and determining their physical and behavioral characteristics [1]. Biometric is easiest, simplest and user friendly solution because it uses the physical characteristics such as face recognition, fingerprint, iris, palm prints.

Face recognition, probably the most common biometric characteristic used by humans to make a personal recognition are facial images and it is also a non-intrusive method. Face recognition is applied vastly in image processing and film processing, criminal identification, human-computer interaction, etc [2]. Face Recognition has various applications over various commercial, security, surveillance (comparing detected faces to known criminals and tracking them), law enforcement application such as authenticated access control (secure banking, device unlocking, voter verification, employee access etc.), automobile driver alertness recognition, human computer interaction, robot-vision, etc [3]. The very important problems faced are because of variation of images due to expression, illumination, face pose, view point variations of the face images and background, etc [4]. Hence this paper proposes a novel method of face recognition using lifting based DWT and Local Binary Pattern (LBP).

The commonly used techniques used for face recognition is Principle Component Analysis (PCA) algorithm [5],[6], where PCA is used to represent the image by a number of eigenfaces, Independent Component Analysis (ICA) [7] where the faces are taken as the linear mixtures of few unknown latent variables, Discrete Cosine Transform (DCT) [5], where the images are scaled down and the low frequency band is obtained, Binary Particle Swarm Optimization (BPSO) [8], where face images is converted to particle and each particle is represents in its position in binary strings.

The combination of Lifting based Discrete Wavelet Transform (DWT) and Local Binary Particle (LBP) is used for feature extraction in the proposed method. Lifting technique [9] basically is based on spatial to construct the wavelet, which consists of three steps: split, predict and update. DWT [6],[10]-[12], decomposes an images into sets of wavelets that is into four band. These bands are defined as the resolution of images. DWT decomposed an image into both time as well as frequency. LBP [1],[13] is a simple yet very efficient texture operator which labels pixels of an image by Thresholding the neighborhood of each pixel and consider the results as a binary number.

The rest of the paper is organized as follows: an overview of propose face recognition using lifting based DWT and local binary pattern (LBP) with the fusion of these techniques and Euclidean classifier in section 2. Results and discussion are presented in section 3. Conclusion is presented in section 4.

2. PROPOSED SYSTEM

The proposed Face Recognition system consists of four stages: image pre-processing, feature extraction, fusion to select the features and Euclidean classifier to

evaluate the performance, shown in Fig 1. The main concept of image processing is to standardize the variations such as pose, illumination and background and support a high correlation. The major intention of feature extraction for the system is to select the best features which are not impressionable to variations in the environment. Fusion involves the selection of the features that are extracted so that the data can be used by regarding redundancy and at the same time enhances the images.

The image is first subjected to resize, this reduces the size of the original face image, separately decreasing the computational time and the storage memory for images, with less effecting the features on the edge. If the reduction factor is considered as n, the dimensions of the images are reduced by 2^n, because the reduction is using the estimate of four neighborhood pixels.

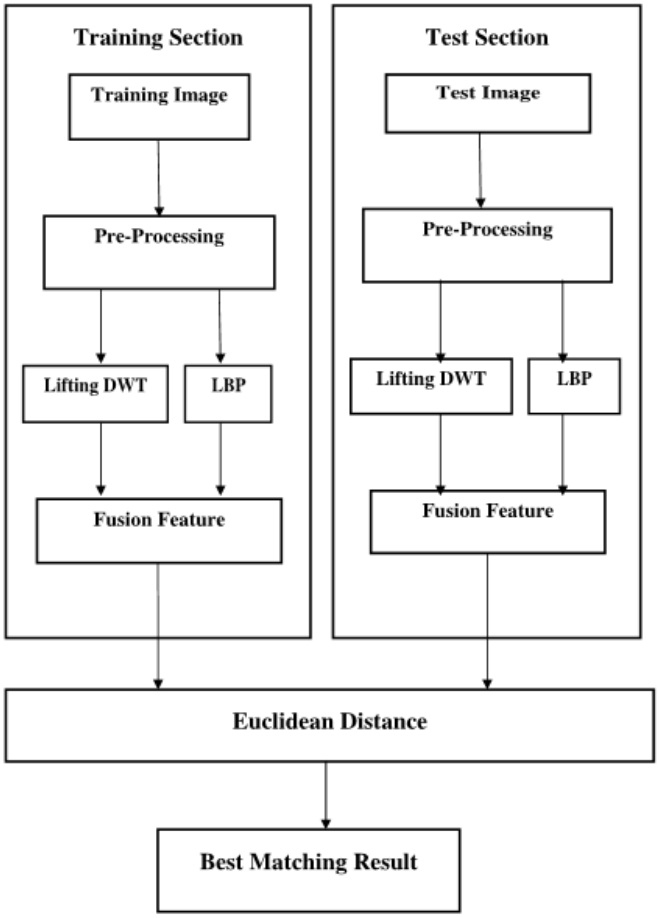

Fig-1: Proposed System

2.1 Lifting based DWT.

Lifting based Discrete Wavelet Transform (DWT) is used [9] to construct biorthogonal wavelets. In the first step to the wavelet, a new wavelet transform is obtained. It does not require high computational power. Lifting wavelet is also known as the second generation wavelet, basic principle of Lifting is to break up the polyphase matrices for the wavelet filters into a sequence of upper and lower triangular matrices and convert the filter implementation into banded matrix multiplication.

Lifting scheme has three steps: 1. Split, 2. Predict. 3. Update as shown in figure 2. Splitting: the samples are reduced by sub-sampling the input. The even samples obtained are multiplied by the predict factor and then the result obtained are added to the odd samples to produce the detailed coefficients. Update: the process where the high band signal is replaced by low band signal.

1. Splitting: the signal X is split into even and odd
   Even part $s_i^{(0)}=x_{2n}$
   Odd part $d_i^{(0)}=x_{2n+1}$ (1)
2. Predicting: the even samples are multiplied by the predict factor and then the results are added to the odd samples to produce the detailed coefficients (d_i). Detailed coefficients results in high pass filtering.
   $d_i^{(1)}=d_i^{(0)}+\alpha*(s_i^{(0)}+s_{i+1}^{(0)})$ (2)
3. Update: the detailed coefficients computed by the predict step are multiplied by the update factors ant then the results are added to the even samples to get the coarse coefficients (s_i). The coarse coefficients gives low pass filtered output.
   $s_i^{(1)}=s_i^{(0)}+\beta*(d_{i-1}^{(1)}+d_i^{(1)})$ (3)

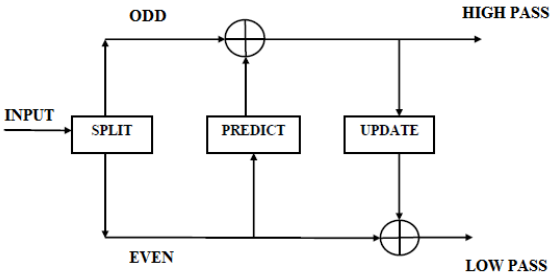

Fig -2: Lifting steps.

Discrete Wavelet Transform (DWT) [2], is established on sub-band coding, is the fastest computation among the wavelet transform. The implementation is easy and the computation time is reduced. The DWT can be obtained both in time and frequency information of a signal. The DWT decomposes an image into a set of wavelets; this decomposition is defined as the resolution of an image.

The DWT also performs localization in both time and frequency domain to obtain the multi-resolution analysis of an image. The final multi-resolution result obtained which is decomposed of the input image contains high pass and low pass filters into four non-overlapping multi-resolution sub-band: LL, LH, HL, HH, as shown in the figure 3. The LL sub-band is represented as the coarse-scale DWT coefficients where as the remaining sub-bands LH, HL and HH represents the fine-scale of DWT coefficients. Here in the proposed face recognition system LL subband is considered as low frequency band which

has more information. The other remaining sub-bands, LH, HL, HH are the high frequency which gives the edge features.

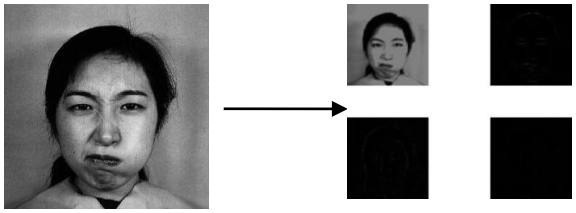

Fig -3:Original Face images and its Discrete Wavelet Transform with four sub-bands.

DWT can be mathematically expressed as

$$DWT_{x(n)}=\begin{cases} d_{j,k} = \sum x(n)\, h_j^* (n - 2^j k) \\ a_{j,k} = \sum x(n) g_j^* (n - 2^j k) \end{cases} \quad (4)$$

The coefficient $d_{j,k}$ is the detail components in signal x(n) and correlate to the wavelet function, $a_{j,k}$ is approximation components in the signal x(n). the function h(n) represents the high pass filter and the function g(n) is the low pass filters with the parameters j and k as the wavelet scale and translation factors.

2.2 Local Binary Pattern (LBP)

LBP operators are an efficient texture operator. The operator labels the pixels of an image by Thresholding the 3x3 neighborhood of each pixel with the center value and considering the result as a binary number as shown in the figure 4. Then the histogram of the labels can be used as a texture descriptor. A Local Binary Pattern is called uniform if it contains at most two bitwise transitions from 0 to 1 or vice versa when the binary string is considered circular[13]. For example, 00000000, 000111110 and 10000011 are uniform patterns.

LBP with the given pixel at (x_c, y_c) can be mathematically expressed as[1]

$$LBP_{P,R}(xc, yc) = \sum_{P=0}^{P-1} S(i_P - i_C) 2^P \quad (5)$$

Where ic and ip are gray-level values of the central pixels respectively. P surrounding pixels in the circle neighborhood with a radius R, and the function S(x) [1] is defined as

$$S(x)=\begin{cases} 1, if\ x \geq 0 \\ 0, if\ x < 0. \end{cases} \quad (6)$$

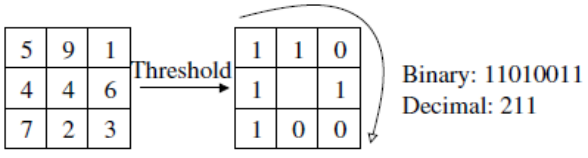

Fig -4: The basic LBP operator

2.3 Fusion

The extracted features will then be fused using the concatenation. The concatenation is defined as an array of elements or features. It is the input features if same data type to create contiguous output signal.

2.4 Euclidean classifier

The feature subset representing each image in the face database that is used for correspondence measurement in the recognition stage. The test images also pass through the same steps as the image in the database that is training images [4]. The Euclidean distance for P-dimensional is mathematically expressed as

$$ED = \sqrt{\sum_{i=1}^{P} (s_i - l_i)^2} \quad (7)$$

Where s_i is the feature of the image in the gallery, l_i is the selected features of the test image.

3. RESULT AND DISCUSSION

The experiment of proposed work is done using JAFFE database. The face images are present in gray scale with the resolution of 256x256. This database contains face images from 10 people, each including 22 different images. The conditions of the images are 7 different emotional facial expressions (6 basic facial expressions + 1 neutral) posed by 10 Japanese female models. In the experiment, eight images are considered as training images and remaining fourteen images are taken as test images. The proposed face recognition system is analyzed with these performance parameters such as FAR, FRR, EER and TSR.

$$FAR = \frac{Total\ number\ of\ persons\ falsely\ accepted}{Total\ number\ of\ persons\ out\ of\ database} \quad (8)$$

$$FRR = \frac{Total\ number\ of\ persons\ falsely\ rejected}{Total\ number\ of\ persons\ in\ database.} \quad (9)$$

$$TSR = \frac{Number\ of\ person\ matched\ perfectly}{Total\ person\ in\ the\ database.} \quad (10)$$

3.1 Lifting based DWT

As the subsection of the proposed system explained about the working of the lifting based DWT. The face images are decomposed using DWT technique obtaining the four sub-band LL, LH, HL, HH. Considering the LL sub-band as the informative sub-band because of low frequency band. By applying the lifting using the two parameters α and β against the one DWT parameter, the efficiency and the speed is increased with the EER of 0.23 at the threshold at 0.08 and Total successive ratio being 100%.

3.2 Local Binary Pattern

LBP can be described by means of composition of micro-patterns of the face images. This is simple and efficient to represent to face recognition. As the proposed system explained, the face image is first divided into

several blocks or facial regions from which, local binary pattern is extracted and generates a histogram feature that represents both their facial micro-patterns and their spatial locations. These features are used for fusion and the accuracy is increased with EER of 0.5 at the threshold at 0.15 and the Total successive ratio being 100%.

3.3 Fusion of Lifting based DWT and Local Binary Pattern

The features are concatenated. The efficiency is increased with the speed and the time consumption is less. Mainly the reason for fusion is to improve FAR, FRR and EER. As the False rejection rate decreased with the False acceptance rate is increased as explained in table 1. The Equal error rate obtained after fusion is 0, threshold at 1.4 with total success ratio has been increased to 100% as shown in the figure 5 and figure 6.

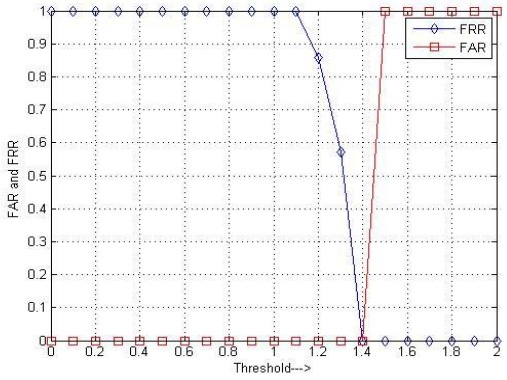

Fig -5: Threshold vs FAR & FRR.

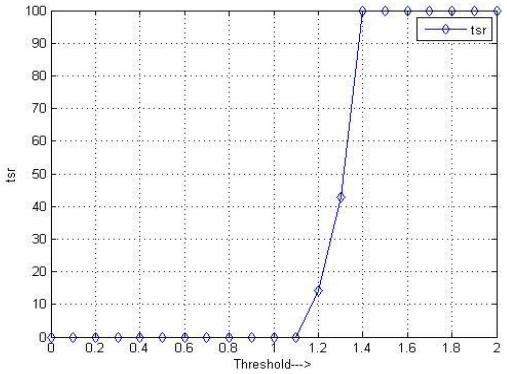

Fig -6: Threshold vs TSR.

Table -1: Result obtained with different sets of threshold for fusion based DWT and LBP

Threshold	FRR	FAR	TSR
0	7	0	0
0.1	7	0	0
0.2	7	0	0
0.3	7	0	0
0.4	7	0	0
0.5	7	0	0
0.6	7	0	0
0.7	7	0	0
0.8	7	0	0
0.9	7	0	0
1	7	0	0
1.1	7	0	0
1.2	6	0	14.2857
1.3	4	0	42.8571
1.4	0	0	100
1.5	0	3	100
1.6	0	3	100
1.7	0	3	100
1.8	0	3	100
1.9	0	3	100
2	0	3	100

4. CONCLUSIONS

The Face recognition is used to recognize a person from group of people for all day to day transactions. A novel approach of face recognition system is approached with the fusion of lifting based DWT and Local Binary Pattern (LBP). Lifting based Dwt is used to decompose the face image. Lifting scheme is used to construct the Dwt. LBP is texture operator. This operator is used to obtain the uniform pattern which is a binary string. Fusing these two techniques the parameter TSR is increased up to 100& with decrease in FRR.

REFERENCES

[1] Siti Anis Amirah Mohd Faudzi, Norashikin Yahya,"Evaluation of LBP-based Face Recognition Techniques", IEEE, 2014.

[2] Thamizharasi Ayyavoo, Dr. Jayasudha T. S, "Face Recognition using Enhanced Energy of Discrete Wavelet Transform", Internation Conference on Control Communication and Computing, pp.415-418, 2013.

[3] Alok Verma, S Achyut Raj, Abhishek Midya, Jayasree Chakraborty, "Face Detection using Skin Color Modeling and Geometric feature", International Conference on informatics, Electronics and vision, 2014.

[4] Pramath P. Hegade, Nishanth. R, K. Manikantan, S. Ramachandran, "DWT-based Face Recognition using Morphological Edge Detection as a Pre-processing Technique", Nirma University International conference on Engineering, pp. 1-6, 2013.

[5] Tripti Goel, Vijay Nehra, Virendra P. Vishwakarma, "Rescaling of Low Frequency DCT Coefficients with Kernel PCA for Illumination Invariant Face Recognition", IEEE International Advance Computing conference (IACC), pp. 1177-1182, 2013.

[6] Paul Nicholl, Afandi Ahmad, Abbes Amira, "Optimal Discrete Wavelet Transform (DWT) Feature for Face Recognition", IEEE, pp. 132-135, 2010.

[7] Naresh Babu N T, Annis Faathima A, V. Vaidehi, "An Efficient Face Recogntion system using DWT-ICA feature", International Conference on Digital Image Computing: Techniques and Applications, pp. 146-151, 2011.

[8] Nihal Winston D'cinha, Sachin A Birajdhar, K Manikantan, S Ramachandran, "Face Recognition using Homomorphic Filtering as a Pre-processing Technique", IEEE, 2013.

[9] S. Vani, G. R. Suresh, "Performance Analysis of Lifting based DWT and MLPNN for epilepsy seizure from EEG", 2011.

[10] M. koteshwara Rao. K. Veera Swamy, K. Anitha Sheela, "Face Recognition using DWT and Eigen Vectors", Internal Conference on Emerging Technology Trends in Electronics, Communication and Networking, 2012.

[11] Seyed Omid Shahdi, S. A. R. Abu-Bakar, "Varying Pose Face Recognition Using Combination of discrete Cosine and Wavelet Transform", International Conference on Intelligent and Advanced Systems, pp. 642-647, 2012.

[12] Vepa Atamuradov, Alaa eleyan, Bekir Karlik, "Performance Evaluation for Face Recognition Using Wavelet based Image De-noising", IEEE, pp. 284-287, 2013.

[13] Md Jan Nordin, Abdul Aziz K. Abdul Hamid, "Combinining Local Binary Pattern and Principal Component Analysis on T-Zone Face Area for Face Recognition", International Confernce on Pattern analysis and Intelligent Robotics, pp. 25-30, 2011.

BIOGRAPHIES

Sanjana Majumder received the BE degree in Electronics and communication from Government engineering college, Kushalnagar, VTU University Belgaum in 2013. She has been taking successive post graduate (M.Tech) in Signal Processing at Maharaja Institute of technology (MIT), Mysore, VTU University Belgaum since 2013. Her research interest includes DSP and Image processing

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