Face Recognition using Fusion of Spatial and Frequency Transform

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***Abstract*—Face recognition, one of the popular technique in recognizing human characteristics. Face recognition continue to attract large research interest among image processing field. Face algorithm is focused on improving their performances, basically increasing the reliability and reducing error rates. CLBP is really a very suitable technique to explain the texture and model of a digital picture. In this paper, the CLBP method and its application for depicting different faces are encountered. ORL face database is considered to validate the effectiveness. Different experimentations depicts that CLBP is the suitable technique in order to recognize the facial expressions of humans. The desired outputs are obtained in terms of FAR, FRR & TSR.**

Keywords—Face Recognition, Compound Local Binary Pattern (CLBP), CLBP Operator, Discrete Wavelet Transform (DWT), Feature Extraction, and Euclidean Distance(ED)

I. INTRODUCTION

A technique of creating an enhanced image by digitizing the data obtained from an image is called as Image processing. In our daily life, digital images play a vital role. We can encounter the applications of digital images in the fields like Biometrics, Satellite television, Computer tomography, Magnetic resonance and even in the areas of scientific research and technology such as astronomy and in the systems which provide geographical information.

An automatic verification of the peoples identity using behavioural traits associated with the people refers to Biometrics. The behavioural characteristics such as universality, unique, acceptability, collectable and the least cost identify the individual based on these features. The Finger scan, Palm Scan, Iris Scan, Face Scan and Retina Scan etc. and Behavioral biometric are Voice, Keystroke, Gait, and Signature etc. are physiological biometrics. The physiological biometrics measures the specific part of body, behavioral biometric are more concerned with mood and environment. The recognition of face is a toughest and rapidly in boom used in biometrics. Face acts as the primary focus of attention in social interaction, playing a major role in conveying the identity. The recognition of face is a toughest and rapidly in boom used in biometrics. Maintaining Reliability and Robustness (accuracy) has become more and more essential.

The feature of face can be derived using-

Spatial domain- The processing of an image is carried out directly on pixel value.

Examples are PCA, LBP, CLBP, SUD, ICA, and LTP.

Transform domain- In this, any particular transform is applied on an original image to get a transformed image on which further processing is done.

Examples are FFT, DCT, DWT, DTCWT, STFT, and CWT.

Fusion- In this technique, it combines the advantages of both Spatial and Transform domain.

LITERATURE SURVEY

The surveys on various papers are discussed as follows:

Ali Cheraghain et al., [1] proposed Recognizing of face based on Gabor Wavelet Transform, Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). In order to reduce the size, the above concepts are made used. Experimentation is performed with database frav3d with different facial and poses.Preprocessing is the first step; later on the features are extracted. The three dimensional normalisation of face and deep extracting is taken into account. It has 3 steps,

(a) Noise Removal. (Median filter is used)

(b) Selection of ROI (Region of Interest).

(c) Robust identification (Rotate and Register).

Gabor Wavelets are used for Feature Extraction.K-NN (k-Nearest Neighbor) classification technique has been used.
Chengliang Wang., [2] proposed the paper to increase the rate of recognition. To extract the features of image, Principle component analysis is used and to indulge in the problems with recognition of face, Support vector machine is being implemented. For Recognition of patterns, SVM is used as a classifier. In this algorithm, both PCA and SVM have taken into account to experiment on database ORL face images, and comparison is done with (PCA&NN) and SVM on the rate of recognition and period of time. In this paper, no preprocessing of images is made; On the selection of parameters & classifying strategies, Support vector machine classifier is same. PCA technique based on KL-Transform is implemented to extract the features of face images. SVM based on statistical learning (optical separating hyper plane) is used as classifier.

Zhifeng Li et al., [5] proposed a discriminative model for age invariant face recognition. In this proposal, a model is proposed to deal with the matching of face with the variation of an age. The 2 types of local descriptors are sampled from the entire facial image, relevant data, which includes the distribution of the edge direction in the face image can be extracted for further analysis. This experiment of face recognition is implemented. In this process each face images are represented with a patch based local feature representation scheme (local image descriptor based technique). LDA based classifiers is used.

Rangaswamy Y et al., [8] proposed a Transform domain that generates dual sets of OLBP features. Firstly, Dual Complex tree wavelet transform coefficients of High frequency DWT helps in extracting the features of Overlap binary local pattern. Secondly, DTCWT coefficients are being extracted from features of OLBP. Finally the features are generated by concatenating first and second features. The features of test images are then made to go through comparison test with the features available in the database using Euclidian Distance (ED).

Surya Kant Tyagi and PriteeKhanna [9] proposed both DCT (discrete cosine transform) and the Nearest Neighbor Discriminant Analysis (NNDA) for face recognition. DCT is applicable mainly for feature extraction, due to the low frequency DCT coefficients are being carried out for most of the information. NNDA is applicable for discrimination analysis. For non-matching faces, 2-level DWT and the vertical coefficients of DWT are smoothened by zeroing it. The databases considered are ORL and YALE databases respectively.

Duan-Yu Chen et al., [10] proposed the analysis of varied facial expressions that are based on the gender of the human subjects are being classified. Different sets of images of the similar gender are taken into account. The variations in faces are due to sparsity. Compressive sensing enables to give 2 features of a given gender-first, common feature of a face and second is varied faces in the samples.

ThamizharasiAyyavoo et al., [11] proposed, Face is divided into 4 blocks and energy for each block is computed and hence the complexity is degraded by factor 4. By maximizing this block value, the image will be enhanced. The face image which is obtained after preprocessing step undergoes K mean clustering. Binary threshold is applied on the clusters. The ORL database is considered for testing of an image.

III. PROPOSED METHOD

The flow of the proposed algorithm is shown in Figure 1.

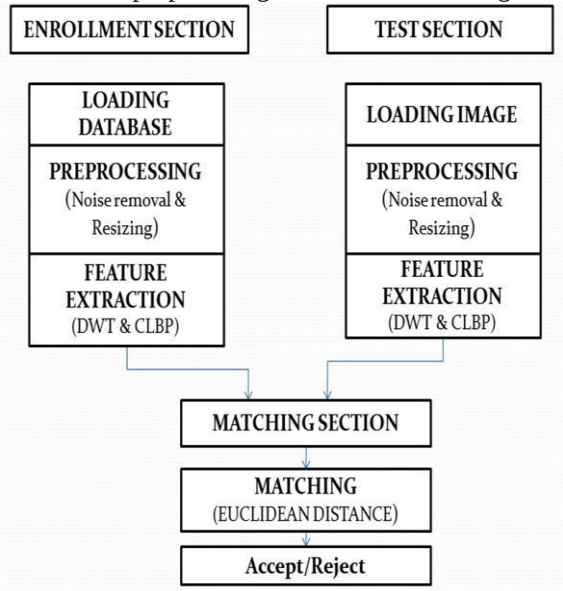


Figure 1: Flowchart of the proposed algorithm

- Loading of database

Biometric data samples of face are collected from standard database such as NIR, ORL, COMBINED and YALE. In this project, we have made use of ORL database which comprises of grey-scale images of size 112*92.

- Preprocessing

The preprocessing is mainly done to obtain a transformation of an image with outstanding clarity. It includes Noise Removal and Resizing. The preprocessing step involved in face recognition is resizing of images. Resizing helps in elimination or at least minimization of the variations.

- Feature Extraction

Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. When performing analysis of complex data one of the major problems stems from the number of variables involved. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy. Feature extraction is performed by applying CLBP and DWT on the images.

1. COMPOUND LOCAL BINARY PATTERN

Compound Local Binary Pattern (CLBP) is modified version of the Local Binary Pattern (LBP) texture operator. The CLBP operator when operated on sub block windows provides two components of sign and magnitude feature values. The features are represented by binary bits.

The face image is scanned throughout rows and columns considering. The window of 3x3 matrix is chosen with centre pixel intensity value as *Ic* and surrounded neighbouring pixel values say *Ip*.

The sign bit patterns for 3x3 matrixes are generated using

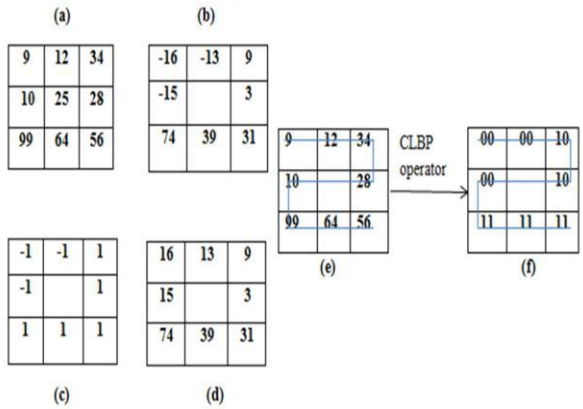
$$S(I) = \begin{cases} 0: & Ip - Ic \leq 0 \\ 1: & Ip - Ic > 0 \end{cases}$$

The magnitude bit pattern is generated using

$$M(I) = \begin{cases} 0: & Ip - Ic \leq M_{avg} \\ 1: & Ip - Ic > M_{avg} \end{cases}$$

Where M_{avg}= (|m1|+|m2|……+|m8|) / 8

The sub image 3x3 matrix is considered in Figure 2(a). The values of neighbouring pixels are subtracted with centre pixel value and are given Figure 2(b). The sign of each coefficient in Figure 2(b) is represented in Figure 2(c) as sign component of CLBP. The magnitude components of CLBP are shown in Figure 2(d) by considering only magnitude of Figure 2(b). The average value of CLBP magnitude component is computed and is compared with neighbouring CLBP magnitude coefficient values and assigns binary values using equation 2 to generate CLBP magnitude pattern given in Figure 2(f).



(a)3x3 matrix grid (b)Difference (c)Components of Sign (d)Components of Magnitude (e)original matrix (f) CLBP Matrix

Figure 2: CLBP operator

The number of centre pixels available for image size 112*92 is 10304 using 3x3 window matrix. The binary eight bits of sign and magnitude of each pixel are converted into decimal values for feature extraction. If the CLBP sign and magnitude coefficient features are considered directly for an image size of 112*92, the algorithm requires 10304 for sign and 10304 for magnitude i.e., total number of features are 20608.

2. DISCRETE WAVELET TRANSFORM

DWT refers to compressing and noise removable algorithm. Wavelet is a set of locally oscillating basis function.For decomposing a signal into sub bands, DWT is considered as highly flexible and efficient technique. DWT is helpful for image compression.

A 2-D DWT is same as that of using two 1-D DWT, where, it transforms both in rows and columns using the two available 1-D DWT. The way of operation of 2-D Discrete Wavelet Transform is it inserts array transposition between the two 1-D DWT. With single level decomposition the processing of rows of the array is done first. This result in two sub bands i.e. the array is divided into two vertical halves where the average coefficients are stored in first vertical half and second half stores the detail coefficients. Later the same process is repeated with the columns. And finally we will obtain four sub-bands.

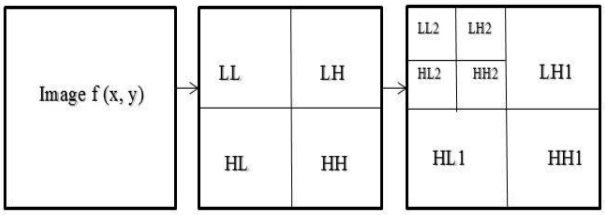


Figure 3: The resulting decomposition

- Matching

The features which are extracted from the test image are made to undergo comparison test with the features available in the database. For calculating and matching the results, we use Euclidean distance (ED). Euclidean distance gives the formula for computing the distance between 2 images. The resultant vector is always unique and changes as per change in comparing images.

$$d(q,p)=d(p,q)=\sqrt{(q_1-p_1)^2+(q_2-p_2)^2+\ldots.+(q_n-p_n)^2}$$

Where

$p=(p_1,p_2\ldots..p_n)$

$q=(q_1,q_2\ldots..q_n)$

IV. RESULTS

1. *Performance Parameters*

The Performance parameters for face database ORL are FAR, FRR and TSR.

The motives are-

- To maximize TSR (Total Success Rate)
- To minimize FRR (Falsely Rejected Rate) & FAR (Falsely Accepted Rate)

i. False Acceptance Rate (FAR)

FAR is the ratio of total no. of persons falsely taken as valid to the total no. of persons out of the database, given by the formula below

$$FAR = \frac{\text{Total no of individuals falsely accepted}}{\text{Total no of individuals out of database}}$$

ii. False Rejected Rate (FRR)

FRR is the ratio of total no. of individuals falsely neglected in database to the total no. of individuals in database, which is given by the formula below:

$$FRR = \frac{\text{Total no of individuals falsely discarded}}{\text{Total no of individuals in database}}$$

iii. Total Success Rate (TSR)

TSR is defined as the ratio of no. of individuals matching perfectly to the total no. of individuals in the database is given by the formula below.

$$TSR = \frac{\text{Number of individuals matching perfectly}}{\text{Total persons in the database}}$$

The ORL Face Database with 40 persons, 10 images per person in the database is considered. Ten numbers of persons are treated as database and eight images are considered for per person. Totally 20 images are taken for test case, in which first 10 are considered for obtaining FRR and the next 10 images are from out of database considered to obtain the FAR.

2. Comparing the results of FAR, FRR & TSR in CLBP, DWT & Proposed system

The values of FAR, FRR & TSR for CLBP, DWT and the proposed system with different values of thresholds are mentioned in the Table 1. As the threshold values increases, the TSR values increases. In the proposed system, the values of TSR are more when compared to CLBP and DWT. For the betterment of the performance of the proposed model, CLBP and DWT features are fused.

	CLBP in %			DWT in %			Fusion method in %		
Threshold	FAR	FRR	TSR	FAR	FRR	TSR	FAR	FRR	TSR
0	0	10	0	0	10	0	0	10	0
0.1	0	10	0	10	0	100	0	10	0
0.2	5	0	90	10	0	100	0	6	40
0.3	5	0	90	10	0	100	1	1	90
0.4	5	0	90	10	0	100	7	0	100
0.5	5	0	90	10	0	100	10	0	100
0.6	5	0	90	10	0	100	10	0	100
0.7	5	0	90	10	0	100	10	0	100
0.8	5	0	90	10	0	100	10	0	100
0.9	5	0	90	10	0	100	10	0	100
1	5	0	90	10	0	100	10	0	100

Table 1: Variations of FAR, FRR & TSR for CLBP, DWT & proposed system

The database is created to test the performance of an algorithm by considering thirty persons inside database and ten persons outside database. The variations of FAR, FRR and TSR with threshold using CLBP technique is shown in Figure 4. The value of FRR minimizes with maximum threshold values. The FAR and TSR values increase with increase in threshold values. The Maximum TSR obtained is 90%. The EER values are less.

In the figure 4, TSR are of 90% at the threshold value of 0.2 obtained by using CLBP by considering forty persons with ten images of each individual.

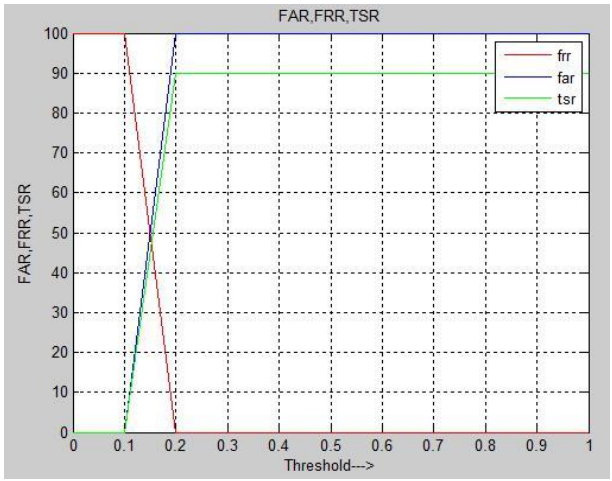


Figure 4: Variation of FAR, FRR & TSR in CLBP with threshold

The variation of FAR, FRR and TSR with threshold using DWT technique is given in Figure 5. The values of FRR decrease with increase in threshold values. The FAR and TSR values increase with increase in threshold values. The Maximum TSR obtained is 100%. The EER values are less.

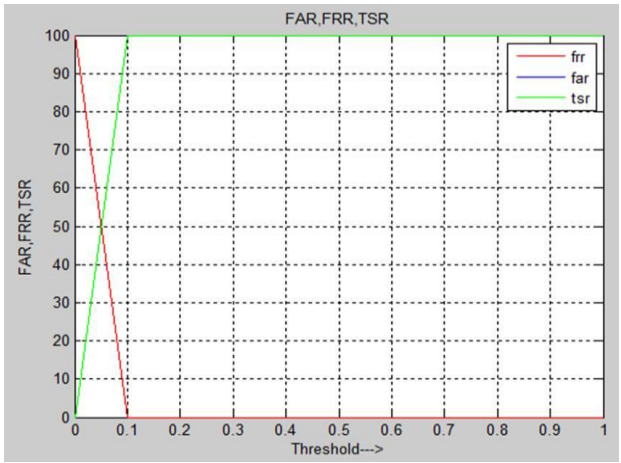


Figure 5: Variation of FAR, FRR & TSR in DWT with threshold

In the figure 5, TSR are of 100% at the threshold value of 0.1 obtained by using DWT by considering forty persons with ten images of each individual.

The variations of FAR, FRR and TSR with threshold using Fusion technique are shown in Figure 6. The value of FRR minimizes with maximum threshold values. The FAR and TSR values increase with increase in threshold values. The Maximum TSR obtained is 100%. The EER values are less.

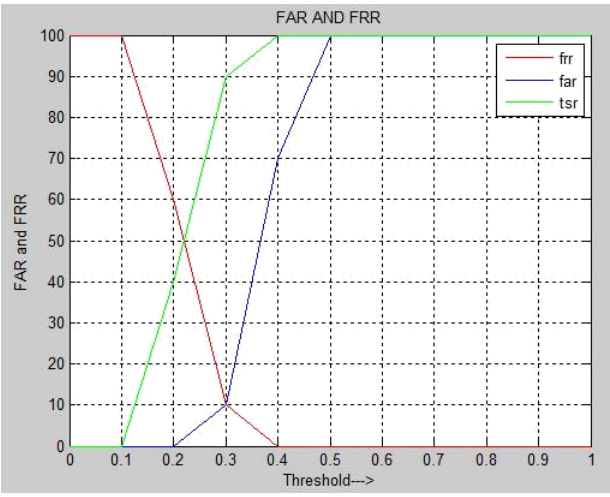


Figure 6: Variation of FAR, FRR & TSR of proposed system with threshold

In the figure 6, TSR are of 100% at the threshold value of 0.4obtained by the fusion process of CLBP & DWT.

3. Comparing the results of the proposed system to the Existing system

The performance parameters i.e., EER, Optimum TSR and Maximum TSR are noted in Table 2. The values Optimal TSR & Maximum TSR are high in the case of Fusion technique when compared to OTDFR, Hybrid & Lift DWT techniques.

Authors	Techniques used	ERR in %	Optimal TSR in %	Maximum TSR in %
Rangaswamy Y [8]	DWT + DTCWT + OLBP	0	-	95
Sujatha B M, K Suresh Babu, K B Raja &Venugopal K R [12]	CLBP + DWT + FFT	18	80	93.33
Satish S B et al.,[13]	Lift DWT	--	--	93.33
Proposed method	CLBP + DWT + Fusion of CLBP & DWT	10	90	100

Table 2: Comparison of EER, Optimal TSR and Maximum TSR of existing with proposed method

CONCLUSION

Compound local binary pattern (CLBP) for recognition of face has become a booming topic in varied fields like security, surveillance etc. Fusion of CLBP and DWT gives the best
performance in terms of recognition rate. CLBP technique gives the highest recognition rate than LBP. The percentage of recognition rate is more in the case of proposed algorithm when compared to existing algorithms.

In regards to further enhancement in the future, Face recognition method is still a developing science. Other feature extraction techniques can be used to improve the results. Rich quality of test database can be used for the performance betterment.

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