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Implementation of Fusion Based Compound Local Binary Pattern Algorithm for Face Recognition

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***Abstract*— Face recognition is the most popular technique in identifying human features. In varied application such as recognizing criminals from video surveillance, where no other physical trait is available, face recognition is the most practical human recognition method. For this reason, 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 the error rates. CLBP is really a very powerful method to explain the texture and model of a digital image. The Compound Local Binary Pattern (CLBP) has becoming a popular technique for face representation. In this paper, the CLBP technique and its application for representing faces are investigated. ORL face database is considered to validate the effectiveness. Broad experiments illustrate that CLBP features are effective and efficient for facial expression recognition. The desired output is obtained in terms of FAR, FRR & TSR.**

***Index Terms*—Compound local binary pattern (CLBP), CLBP pattern, Discrete wavelet transform (DWT), Feature extraction.**

I. INTRODUCTION

A technique of creating an enhanced image by digitizing the data obtained from an image is called as Image processing. The important requirements for image processing of images are that the images must be available in digitized form. 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.

Biometrics refers to the automatic identification (or verification) of an individual identity using certain physiological or behavioural traits associated with the person. The biometrics identifies the person based on features vector derived from physiological or behavioural characteristics such as universality, uniqueness, permanence, acceptability, collectability and the minimum cost. The physiological biometrics is Fingerprint, Palm Scan, Iris Scan, Facial Scan and Retina Scan etc. and Behavioral biometric are Voice, Keystroke, Gait, and Signature etc. The physiological biometrics measures the specific part of body, behavioral biometric are more concerned with mood and environment. The face recognition is a challenging and fast growing area in real time applications of the several Physiological characteristics used in biometrics. Face recognition is one of the sought after areas in automatic face recognition, vision communication and human computer interaction.

Face acts as the primary focus of attention in social interaction, playing a major role in conveying the identity. The face recognition is a challenging and fast growing area in real time applications of the several Physiological characteristics used in biometrics. Face recognition is one of the sought after areas in automatic face recognition, vision communication and human computer interaction. 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..

II. LITERATURE SURVEY

The surveys on various papers are discussed as follows:

Ali Cheraghain et al., [1] proposed An Efficient Multimodal Face Recognition Method Robust to Pose Variations. Face Recognition is based on Gabor Wavelet Transform, Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) has been used for size reduction. The proposed Algorithm is examined with FRAV3D database that has faces with pose variations. Preprocessing is needed before Feature Extraction. 3D face

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normalization and depth extraction technique is used. Gabor Wavelets are used for Feature Extraction. K-NN (k-Nearest Neighbor) classification technique has been used.

Chengliang Wang et al., [2] proposed Face Recognition Based on Principal Component Analysis and Support Vector Machine. In this paper in order to raise recognition rate, Principal Component Analysis (PCA) is used to extract image features and Support Vector Machine (SVM) is used to deal with Face Recognition problems. SVM is used recently as new classifier for Pattern Recognition. In this algorithm, both PCA and SVM have taken to do experiment on Cambridge ORL face database, and compare with (PCA&NN) and SVM on recognition rate and time. In this experiment, no preprocessing/pretreatment of images is made, the SVM classifier is the same on parameter selection & classification strategy. PCA method based on algebraic statistics (KL-Transform) is used to extract the essential characteristics of face images. SVM based on statistical learning (optical separating hyper plane) is used as classifier.

Janarbek Matai el al., [3] proposed Design and Implementation of an FPGA-based Real –Time Face Recognition System. In this paper complete real-time face recognition system consisting of face detection, recognition and down sampling module using an FPGA. This system receives video input from a camera, detects the locations of the face(s) using the Viola-Jones algorithm, and subsequently recognizes each face using the Eigen face algorithm, and outputs the results to a display unit. The complete face recognition system operates at 45 frames per second on a Virtex-5 FPGA. In this process integration of Face Recognition (FR) & Face Detection (FD) using a down sampling module which is responsible for preprocessing detected face image from subsystem to satisfy the requirements of FR subsystem. This system consists of 3 subsystems, they are Face Recognition (FR) down sampling & Face Detection (FD) all are implemented on a Virtex-5 FPGA is used for Feature Extraction. Euclidean distance classification technique, distance buffer is used.

Gayathri Mahalingam et al., [4] proposed Can Discriminative Cues Aid Face Recognition Across Age?. In this paper, the study of effects of discriminative cues (gender and age) in an image based face recognition system across age. This paper proposed a pipeline framework to prune the search space based on gender and age of the test image to aid the process of recognition. A feature based approach which uses the Gabor phase and magnitude images of the face image is used in face image representation. The Gabor phases and magnitudes are encoded through Local Gabor Binary Pattern (LGBP) histograms. The gender and age group information of the face image is extracted using a random forest classifier based on confidence measure. In this process for a given image Local Gabor Binary Pattern (LGBP) is obtained. This is done using Local Binary Pattern (LBP) and Gabor filters. For this process, they use Random Forest (RF). RF works on the idea of utilizing noisy, unbiased and equally weighted models by using their average output. Random forest is an ensemble classifier that consists of many decision trees (models) and outputs the class based on the majority vote from the decision trees.

Zhifeng Li et al., [5] proposed A Discriminative Model for Age Invariant Face Recognition. In this paper, a discriminative model is proposed to address face matching in the presence of age variation. This paper first represent each face by designing a densely sampled local feature description scheme, in which scale invariant feature transform (SIFT) and multi-scale local binary patterns (MLBP) serve as the local descriptors. By sampling the two kinds of local descriptors from the entire facial image, sufficient information, including the distribution of the edge direction in the face image can be extracted for further analysis; multi-feature discriminant analysis (MFDA) algorithm is used to process these two local features. This experiment of face recognition is implemented on two public domain face aging data sets: MORPH and FG-NET. In this process each face images are represented with a patch based local feature representation scheme (local image descriptor based technique). Scale invariant feature transform (SIFT) and Multi-scale local binary patterns (MLBP) are used. Multi-feature discriminant analysis (MFDA) algorithm (LDA based classifiers) is used.

Rangaswamy Y et al., [8] proposed an Overlap Local Binary Pattern (OLBP) on Transform Domain based Face Recognition (OTDFR). Transform domain generates dual sets of OLBP features. Firstly, Overlap Local Binary Pattern (OLBP) features are extracted from Dual Tree Complex Wavelet Transform (DTCWT) coefficients of High frequency components of Discrete Wavelet Transforms (DWT). Secondly, OLBP features are extracted from DTCWT coefficients. Finally the features are generated by concatenating first and second features. The test image features are then compared with database features 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 face images that are done in frequency domain and later 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.

Thamizharasi Ayyavoo et al., [11] proposed a multi-scale DISCRETE WAVELET TRANSFORM is employed for the preprocessing part. 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 means clustering. Binary threshold is applied on the clusters. The ORL database is considered for testing of an image.

III. PROPOSED METHOD

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

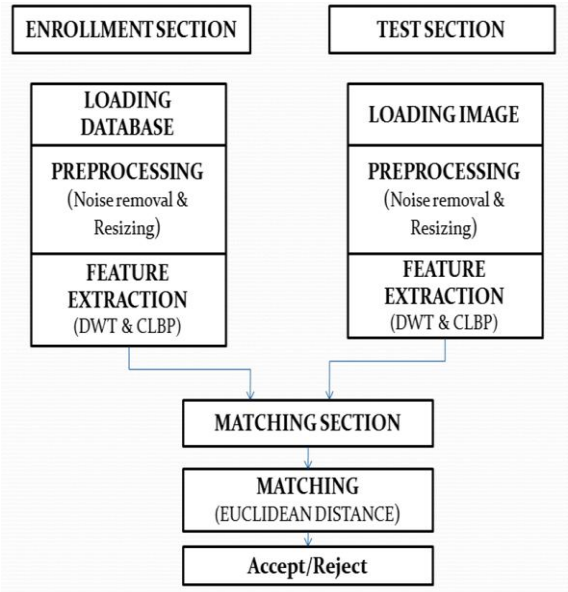

Fig. 1: Flowchart of the proposed algorithm

- Loading of database

The 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 principal objective of preprocessing is to obtain a transformed image with enhanced quality. It includes Noise Removal, Resizing, Rotation, Smoothing and Thinning. 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.

A. 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 Fig. 2(a). The values of neighbouring pixels are subtracted with centre pixel value and are given Fig. 2(b). The sign of each coefficient in Fig. 2(b) is represented in Fig. 2(c) as sign component of CLBP. The magnitude components of CLBP are shown in Fig. 2(d) by considering only magnitude of Fig. 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 Fig. 2(f).

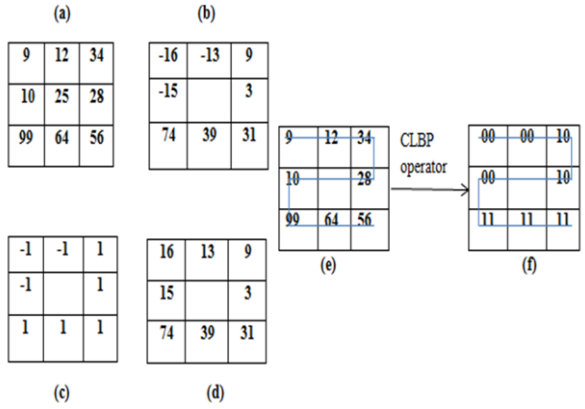

Fig. 2: CLBP operator

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.

B. DISCRETE WAVELET TRANSFORM

Discrete Wavelet Transform (DWT) is a 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.

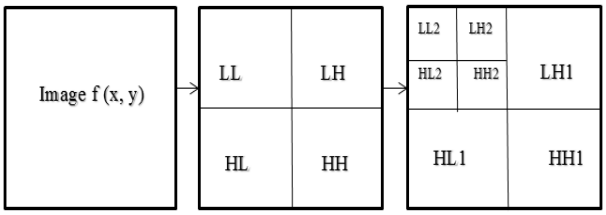

Fig. 3 The resulting decomposition

- Matching

The features which are extracted from the test image are compared 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 $p=(p_1,p_2\ldots..p_n)$ and $q=(q_1,q_2\ldots..q_n)$.

IV. RESULTS

A. Performance Parameters

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

The objectives are-

- To increase TSR (Total Success Rate)
- To decrease FRR (Falsely Rejected Rate) and FAR (Falsely Accepted Rate)

i. False Acceptance Rate (FAR)

FAR is the ratio of total number of persons falsely accepted to the total number of persons out of database, given as an equation below.

$$\textbf{FAR}= \frac{\textbf{Total number of persons falsely accepted}}{\textbf{Total number of persons out of database}}$$

ii. False Rejection Rate (FRR)

FRR is the ratio of total number of persons falsely rejected in database to the total number of persons in database, given as an equation below.

$$\textbf{FRR}= \frac{\textbf{Total number of persons falsely rejected}}{\textbf{Total number of persons in database}}$$

iii. Total Success Rate (TSR)

TSR is defined as the ratio of number of persons matched perfectly to the total number of persons in the database is given as an equation below.

$$\textbf{TSR}= \frac{\textbf{Number of persons matched perfectly}}{\textbf{Total persons in the database}}$$

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.

B. 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 Fig. 4. The value of FRR decreases with increase in 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 Fig. 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

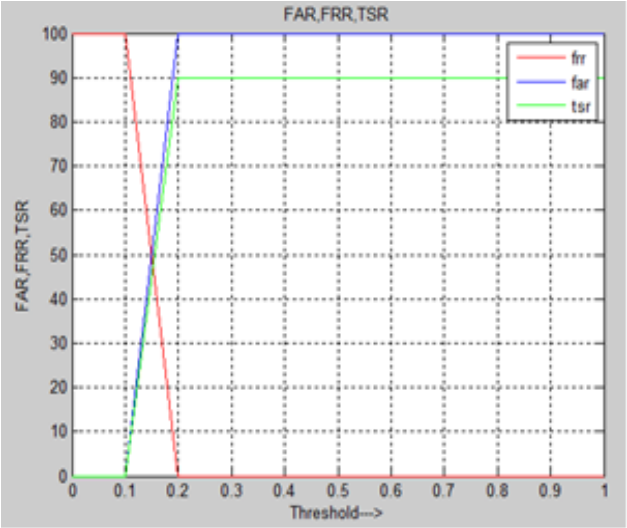

Fig. 4: Variation of FAR, FRR & TSR in CLBP with threshold

The variation of FAR, FRR and TSR with threshold using DWT technique is shown in Fig. 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.

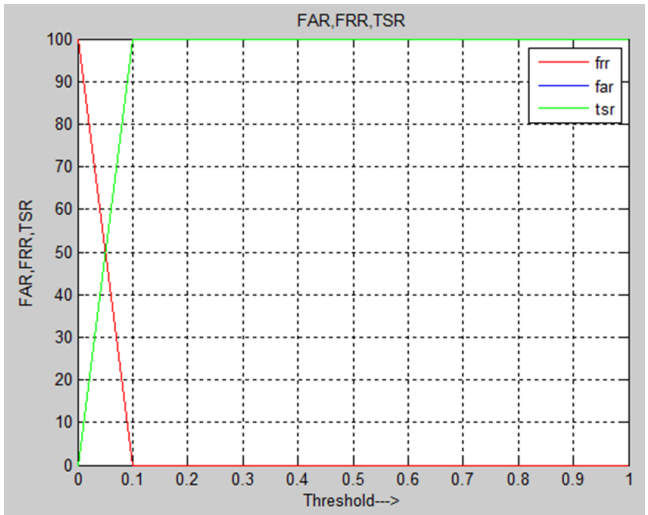

Fig. 5: Variation of FAR, FRR & TSR in DWT with threshold

In the Fig. 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 Fig. 6. The value of FRR decreases 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.

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

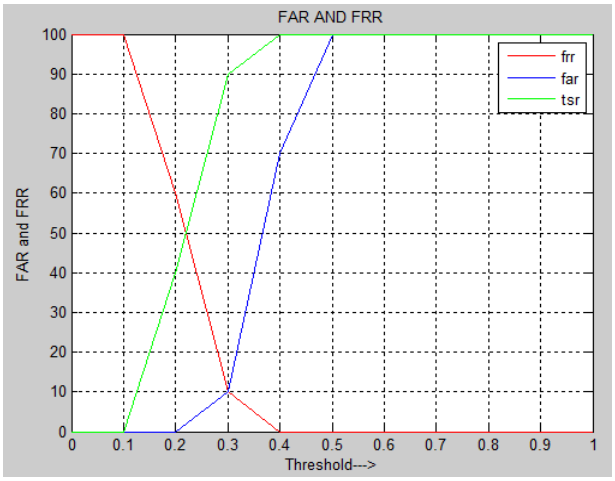

Fig. 6: Variation of FAR, FRR & TSR of proposed system with threshold

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

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

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

Sl. No	Authors	Techniques used	ERR in %	Optimal TSR in %	Maximum TSR in %
1	Rangaswamy Y [8]	DWT + DTCWT + OLBP	0	-	95
2	Sujatha B M, K Suresh Babu, K B Raja & Venugopal K R [12]	CLBP + DWT + FFT	18	80	93.33
3	Satish S B et al.,[13]	Lift DWT	--	--	93.33
4	Proposed method	CLBP + DWT + Fusion of CLBP & DWT	10	90	100

V. CONCLUSION

Compound local binary pattern (CLBP) for face recognition has become a well-known topic in various applications like security, surveillance etc. Fusion of CLBP and DWT gives the best performance in terms of recognition

rate. In CLBP the entire image is split into equal sized blocks. Then compound local binary pattern is computed for each pixel in most blocks by comparing the center pixel with neighboring pixels. This gives a binary pattern for each image. CLBP technique gives the highest recognition rate than LBP. The percentage of recognition rate is high in the case of proposed algorithm when compared to existing algorithms.

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