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Research paper

Improving the Performance of Face Recognition Technique using Brightness Preserving and Contrast Limited Bi-histogram Equalization

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Abstract

The Face Recognition technique is one of the highly secured method for incorporating the authentication. Since it uses bio-metric technique which is unique for a person. Face recognition technique involves extraction of feature and train the features for using classifiers for matching. The Extracted features must be precise so that identification becomes perfect. This paper proposes an innovative method of facial recognition in which facial image is enhanced by the technique Brightness Preserving and Contrast Limited Bi-Histogram Equalization for the image. Then Features are extracted and those enhanced features extracted are used for Classification using Multi-Class SVM and matching. FERET data base is used. Various parameters such as FAR, FRR, TSR and EER are calculated and compared with the traditional techniques.

Keywords: *Face Recognition, Support Vector Machine, Local Binary Pattern, Brightness Preserving Histogram Equalization*..

1. Introduction

In day today, life there are so many networks and individuals accessing the resources. To limit the accessibility so many authentications are incorporated such as Password Protections, PIN Numbers, Barcode Scanning, RFID tag. Among available methods Biometrics-based authentication provides more security since it involves Physiological Characteristics of a person such as Finger Print, Palm Print, Iris Recognition, Voice Recognition, Gait Recognition and Face Recognition. These Physiological Characteristics are unique for different sets of People and it will remain forever throughout the life time. Face is a Physiological characteristic using which we can identify a person's uniqueness. In case of twins also there will be minute variations in Facial Features through which a person's identity can be detected.

Face recognition steps are preprocessing such as Color to Grey Scale Image Conversion, Acquisition of the facial image portion, featureshasto be extracted, and the extracted features are used for classification and Matching.

In the proposed algorithmFacial image is enhanced in the preprocessing step itself to get the precise features. By using this enhancement technique in the Preprocessing step over all face recognition will be improved with the obtained set of enhanced features. This paper proposes a novel technique for improved Face recognition that incorporates Brightness Preserving and Contrast Limited Bi-Histogram Equalization for enhancing the features of the image. Enhanced features are used classification and matching for face recognition. This improved Facial recognition algorithm will be tested for improvement in various parameters such as TSR, FSR, FRR, ERR by comparing with the existingtechniques.

The arrangement of this framework as followed Section II gives the background survey, Section III gives the proposed face recognition technique, Section IV explains the results and comparisons with the available techniques, Section V gives the Conclusion.

2. Background Survey

SanqiangZao and Yongsheng proposed a face recognition algorithm in which discriminative features are separated. To verify the performance Multi directional binary pattern algorithm was usedon a set of shape driven points [1]. Performance analysis of Face recognition algorithms such as PCA, ICA and EDA are compared with Face Recognition algorithm using SVM classifier by R. Senthil Kumar and R.K. Gnamoorthy [3]. Face Recognition systems using Localized Binary Pattern and Zernike Moments by Concatenating the combination of local and Global features was discussed by Shahbaz Majeed, For the proposed face algorithm classifiers such as Euclidean distance, Chi Square, Square Chord, Histogram intersection and Canberra distance are used for comparing the performance [2]. FRDL algorithm using Dual Tree Complex Wavelet Transform to obtain DTCWT coefficients by applying 5 level of decomposition by Ravi J *et al*. Final Features were extracted by applying LBP Algorithm. For Matching the Features Euclidean classifiers were used.Results are compared using various parameters such as FAR, FSR, TSR for databases NIR, JAFE and L-space k database [4]. A. Pugazenthi and L.S. Kumar proposed the method Contrast Enhancement by Automatic Multi HistogramEqualization [15]. Krishna Dharavath*et.al* discussed about the impact of image preprocessing in face recognition systems [14[.Virendra P. Vishwakarma proposed Illumination Normalization using Fuzzy Filter in DCT domain for face recognition. The effect of illumination variations was suppressed and preserving the low frequency details using DCT was achieved [16]. Liu Hui and Song YuJie proposed Face Recognition Algorithm based on improved Convolution Network.Convolution Neu-

ral Network will extract the Features automatically. Support Vector Machine was used for classification of extracted features [17].Shree Devi Ganesan and Munir Ahmed Rabbani Ahmedexplained algorithm for Image Contrast Enhancement for improved Face Recognition accuracy.In the Proposed algorithm Neighborhood Metric with Histogram Equalizationwas used by which increases face recognitionaccuracy [18].Zhijun Yao *et al* proposed Brightness Preserving Contrast Limited Bi Histogram Equalization[12].Jiwen Lu *et al*. discussed Simultaneous Local Binary Feature Learning and encoding for Homogenous and Heterogenous Face Recognition Systems [19]. Sujay S.N *et al* discussed an algorithm for Face Recognition System using extended LBP Features and Multilevel SVM Classifier. The Proposed algorithm is applied to YALE and FERET database and the performance was compared using parameters such as FAR,FRR, TSR and EER [8].

3. Proposed Face Recognition Technique

In the Proposed Face Recognition first image is preprocessed by converting the color image to Grey Scale Image. Brightness Preserving and Contrast Limited Bi-Histogram Equalization (BPLCBHE) will beapplied to image to get the enhanced image features in the preprocessingstep. By applying Viola Jones algorithm Facial Portion of the image is segmented. Image is resized to 100*100. Features are extracted by generating Local Binary Pattern of the Training and testing images by rotating the images of FERET image data base. at 15 different angles. Extracted features are trained using Multi-class Support Vector Machine for matching with the database. The results and performance of the proposed technique is compared with the traditionaltechnique under the parameters False Acceptance Rate, False Rejection Rate, Total Success Rate and Equal Error Rate.

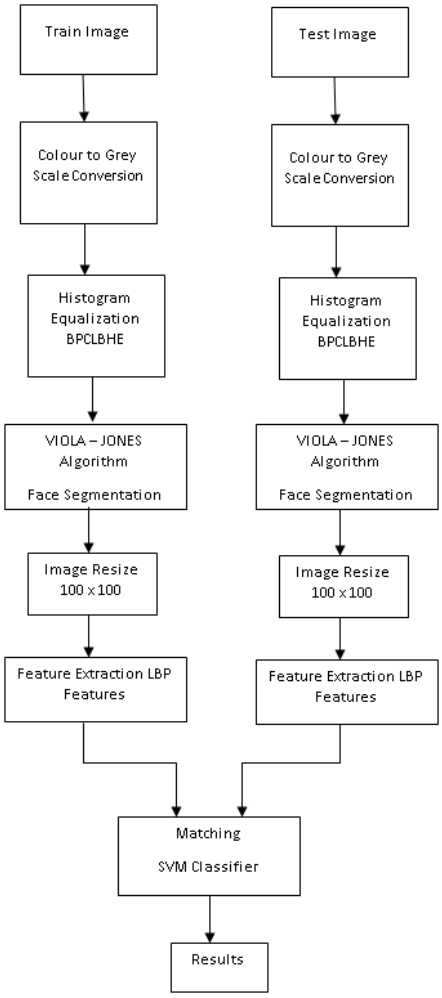

Fig 1: Block Diagram of the Proposed Face Recognition Framework

3.1 FERET Data Base

To train the images, FERET database is selected [11],[21]. Out of 856 individual facial images 61facial images are taken as database. Out of 61 data base images 56 are considered to be train images and the remaining five are taken as out of the data base for measuring FAR, FRR and TSR.

3.2 Pre-Processing

Initially color images are converted into Grey Scale Image. Image is Enhanced by Histogram Equalization technique. This histogram equalization technique enhances the features of the image so that face recognition technique will be precise. The histogram equalization technique adopted for enhancing the image features.

3.3 Histogram Equalisation

In a grey scale Image, the standard range of the grey levels is [0,255]. Histogram is pictorial representation of occurrence of various levels in an image in the form of Bar Chart. Histogram equalization is a technique by which intensities are adjusted in such a way that histogram appears to be uniform through out entire range of the greyscale. By applying Histogram Equalization Technique contrast of the image will be enhanced to a greater extent[20].

3.4 Preserving and Contrast Limited Bi-histogram Equalization

Brightness Preserving and Contrast Limited Bi-Histogram Equalization technique is applied to images to get enhanced features.

In the first step Mean brightness is calculated and based on the mean brightness, image is decomposed into low intensity image and high intensity image. Clipping technique is adopted for each decomposed image. Histogram Equalization is applied to clipped histograms. Both Histograms are united together which will contain enhanced features of the original image.

3.4.1 Image Division

For an image that is containing natural scenes range of the gray scales will be [0,255]. Probability density function PDF of the image Iis given by

$$h(p) = \frac{H(p)}{M} \tag{1}$$

Whereas H(p) is the number of elements in a group {I(x,y) | I(x,y)=p∀ I(x,y) ∈ I} and $M = \sum_{p=1}^{255} H(p)$

Segmentation threshold is calculated as followed

$$I_m = \sum_{p=0}^{255} h(p) \times p \tag{2}$$

Based on the segmentation threshold image is decomposed into low intensity image and high intensity image.

$$\mathbf{I} = \mathbf{I}_h \cup \mathbf{I}_l \tag{3}$$

Whereas

$$\mathbf{I}_h = \{\mathbf{I}(x,y) | \mathbf{I}(x,y) > I_m, \forall \mathbf{I}(x,y) \in \mathbf{I}\} \tag{4}$$

$$\mathbf{I}_l = \{\mathbf{I}(x,y) | \mathbf{I}(x,y) \leq I_m, \forall \mathbf{I}(x,y) \in \mathbf{I}\} \tag{5}$$

$I_h = \{I_0, I_1, I_{2,\ldots\ldots}I_m\}$ and $I_l = \{I_{m+1}, I_{m+2}, I_{m+3,\ldots\ldots}I_{L-1}\}$

3.4.2 Histogram Clipping

The Histogram of the two decomposed images are given by

$$\mathbf{H}_l(p) = n_{lp}, p = 0.1.1 \dots, I_m \quad (6)$$

$$\mathbf{H}_l(p) = n_{hp}, p = I_m + 1, \dots, 255 \quad (7)$$

Where$n_{lp}$and $n_{hp}$are the occurrence of k^{th} grey level in two decomposed images I_l and $I_h$respectively.
The clipping limit is calculated by

$$CL_l = \left\lceil \frac{N_l}{I_m+1} \right\rceil + round\left(\gamma * \left(N_l - \frac{N_l}{I_m+1}\right)\right) \quad (8)$$

$$CL_h = \left\lceil \frac{N_h}{255-I_m} \right\rceil + round\left(\gamma * \left(N_h - \frac{N_h}{255-I_m}\right)\right) \quad (9)$$

where
$N_l = \sum_{p=0}^{I_m} n_{lp}$ and$N_h = \sum_{p=I_m+1}^{255} n_{hp}$ are the number of pixels in $I_l$and$I_h$respectively and γ is a parameter to control the contrast.
Total number of pixels that overflow the clipping limit is given for each decomposed histogram.

$$T_l = \sum_{k=0}^{I_m} \max(\mathbf{H}_l(k) - CL_l, 0) \quad (10)$$

$$T_h = \sum_{k=I_m+1}^{L-1} \max(\mathbf{H}_h(k) - CL_h, 0) \quad (11)$$

Using T_l andT_h Average Increment of two decomposed histogram are given as

$$AI_l = \left\lfloor \frac{T_l}{I_m+1} \right\rfloor \quad (12)$$

$$AI_h = \left\lfloor \frac{T_h}{L-1-I_m} \right\rfloor \quad (13)$$

Using CL and AI, the two decomposed histograms are clipped and termed H_l'(p) andH_h'(p)

$$\mathrm{H}_l'(p) = \begin{cases} CL_l & \mathbf{H}_l(p) > CL_l - AI_l \\ \mathrm{H}_{l(p)+AI_l} & else \end{cases}, p = 0,1, \dots . I_m \quad (14)$$

$$\mathrm{H}_h'(p) = \begin{cases} CL_h & \mathbf{H}_h(p) > CL_h - AI_h \\ \mathrm{H}_{h(p)+AI_h} & else \end{cases}, \quad p = I_m + 1, \dots, 255 \quad (15)$$

3.4.3 Histogram Equalization

Both clipped histograms of decomposed images are histogram equalized by their respective Probability Density Function and Cumulative Distribution function. Histogram Equalized are joined together by means of Union Function.
E = $E_l \cup E_h$

3.5 Face Segmentation

Once the image is enhanced by histogram equalization technique BPCLBE, the images with improved features are obtained. Facial portion of the image are segmented by applying Viola Jones Algorithm. Segmented face is resized to 100*100

3.6 Feature Extraction Using Local Binary Pattern

Resized Images are rotated at 15 different angles in both clockwise and anticlockwise direction and it is divided into subblocks. For each sub block Local Binary Pattern is applied and features are extracted.
The $LBP_{P,Q}$ is given as

$$LBP_{P,Q} = \sum_{p=0}^{7} S(g_p - g_c)2^p \quad (16)$$

Where P is the number of neighboring pixel values of the center pixel, and Q is the radius around the center pixel value$g_p$is the intensity of the neighboring pixels and $g_c$is the intensity of the central pixel value.

$$S(g_p - g_c) = \begin{cases} 1, (g_p - g_c) \geq 0 \\ 0, otherwise \end{cases} \quad (17)$$

3.7 Matching

In the proposed Improved Face recognition systems contains two phasesTraining Phase and Testing Phase. Feature extraction is done by the above-mentioned extended LBPalgorithm by rotating the resized images at 15 different angels in both clockwise and anticlockwise for both training phase and testing phase. Each set of fifteen features of training phase are compared with the same number of features of test phase and features are checked for matching. A Multi-class SVM classifier is used for matching.

4. Result Analysis and Discussion

FERET database is taken for analysis of results. No of features to be matched is increased from 5 to 15 and is called match count.

Table 1: Variations of Match Count and Corresponding FAR, FRR and TSR values for FERET Database without Applying Enhancement Technique using Histogram Equalization Technique.

Match Count	FAR %	FRR %	TSR %
15	0	100	0
14	31.81	54.54	77.27
13	40.90	47.72	86.36
12	45.45	43.18	86.36
11	59.09	34.09	88.63
10	75	18.18	88.63
9	79.54	13.63	93.18
8	90.90	4.54	100
7	93.18	2.27	100
6	100	0	100
5	100	0	100

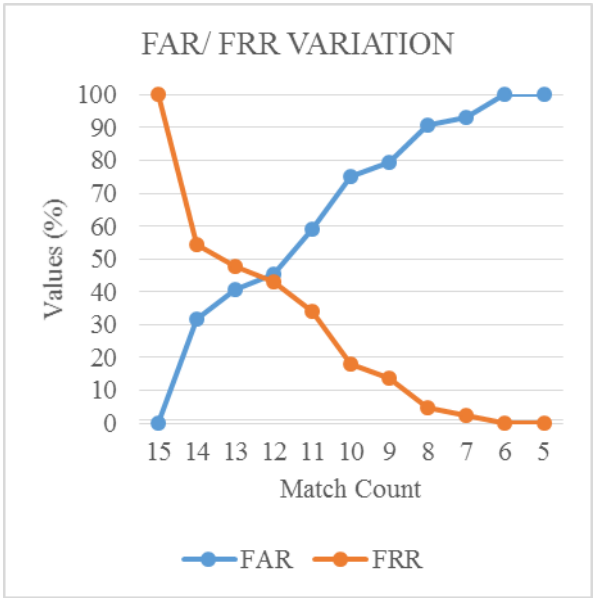

Fig 2. Graph of Variations in Match Count and FAR / FRR Variations and Error Rate for FERET Database without Enhancing using Histogram Equalization

Table 2: Variations of Match Count and Corresponding FAR, FRR and TSR values for FERET Database by Applying Brightness Preserving and Contrast Limited Bi-Histogram Equalization

Match Count	FAR %	FRR %	TSR %
15	0	100	0
14	0	100	82.07
13	0	100	91.26
12	0	37.18	91.36
11	36.4	28.19	93.83
10	48.6	12.38	94.03
9	72.6	7.93	98.98
8	86.7	0.4	100
7	99.2	0.02	100
6	100	0	100
5	100	0	100

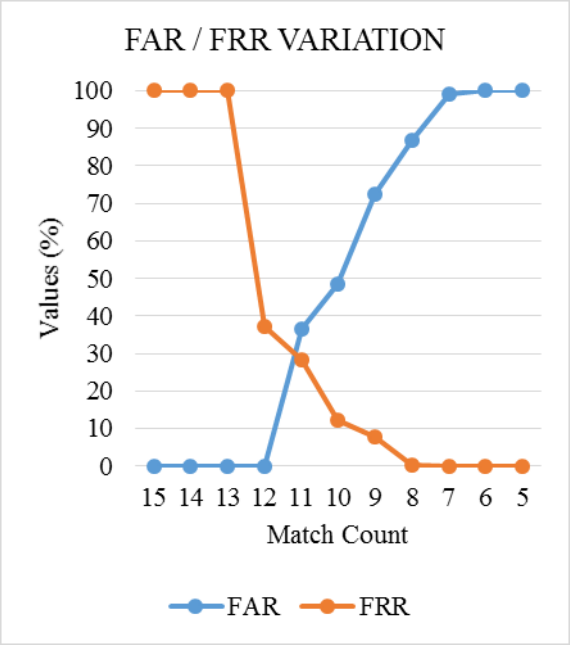

Fig 2: Graph of Variations in Match Count and FAR / FRR Variations and Error Rate for FERET database by applying Brightness Preserving and Contrast Limited Bi-Histogram Equalization

Plotting the FAR / FRR Variations of for FERET data base for face recognition algorithm with and without enhancement using histogram equalization Error in %can be observed From Figure 2 ERR for Face Recognition algorithm without applying the histogram equalization technique is observed as 45.2% and from Figure 2 after applying Histogram Equalization technique is noted as 29.8%. From the experiment it is inferred that on applying the image enhancement technique using Brightness Preserving and Contrast Limited Bi-Histogram Equalizationat the preprocessing step of face recognition algorithm, the accuracy of detection process is increased.

5. Conclusion

FERET database was used to analyze the performance of proposed face recognition technique. In the preprocessing step color image is converted into gray scale image. For the grey scale converted image, one method of histogram equalization technique Brightness Preserving and Contrast Limited Bi-Histogram Equalization is applied. By applying this algorithm features of the image are enhanced to a greater extent. Faces in the image are segmented from the histogram equalized image using Viola – Jones algorithm. Segmented image is resized to 100*100. By applying LBP extended features of the resized images are obtained by rotating the resized images to various angles. Matching of the features with the trained images are carried out using Multi Class SVM classifier. The performance of the mentioned algorithm for FERET database is analyzed using various parameters such as FAR, FRR, TSR and EER and the results are compared with the face recognition algorithms without Enhancing the images. By Comparing with and without Enhancement by histogram Equalization techniques, it is proved that face recognition algorithms with enhancement technique provides the better face recognition.

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