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Extended Local Binary Pattern Features based Face Recognition using Multilevel SVM Classifier

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Abstract*: The Face recognition method is one of the authoritative biometric system in recognition methods to recognize the individual, because face is a distinctive biometric trait of an human being and it is the superior method of recognition. This paper proposes a novel Face recognition method by using extended LBP features. The pre-processing is carried out to extract the face area using viola-johns algorithm and all images are resized to 100x100. The LBP operator is applied on resized face images by rotating the each image by 15 degrees, i.e., at 7 degree left and 7 degree right and at zero degree to extract the feature vectors and final features are obtained by applying histogram technique. The SVM classifier is used for matching the database images with test images to measure the performance such as TSR, FAR, FRR & EER. The performance parameters are compared with existing algorithms for YALE and FERET database.

Keywords: Local Binary Pattern (LBP), Face Recognition Technology (FERET), False Acceptance Rate (FAR), False Rejection Rate (FRR), Equal Error Rate (EER), Support vector machine (SVM), Total Success Rate (TSR),

I. INTRODUCTION

The Biometric authentication is an necessary system that uses the physiological or behavioural trait to confirm an individual's identity, provides the validation at surveillance activities. Authentication of an individual through biometric has become more secure in modern world due to its high reliability in recognition against conventional methods like Passwords, Personal Identification Numbers, ID cards, Smart cards and Badges which are over lived their usefulness and are easily transferable. Biometric authentication technology promise to ensure an more secure alternative because they are based on individual biological characteristics.

Biometrics are considered based on physiological and behavioural characteristics of an individual. Physiological characteristics are based on unique physical trait such as palm print, finger print also a face and Behavioural uses common characteristics of a person such as speaking rhythm, signature, walking style etc. The physiological characteristics are permanent all the way through the life-time, they are unchanged and some characteristic defines the behaviour of an individual which can change with respect to the circumstances are behavioural characteristics.

However inter and intra class variations of different biometric traits have posed a challenging environment in recognition of an individual. The problems of identifying an individual under different circumstances are overcome by stable and reliable methods for longer period of recognition. The proposed biometric system uses physiological biometric trait, face for recognition of individual. As face biometric trait it is easily acquirable trait of an individual. But there are few challenges in face recognition at face acquisition level such as variation in illumination, changes in facial expressions, different styles of moustache and beard, use of spectacles, makeup, mask, jewellery and also in case of twins.

The face recognition methods have challenges with respect to these parameters.

(a)Total Success Rate: The effectiveness of the recognition system, calculated as the ratio of Number of correct test cases matched to the Total number of trained face images inside the database.

(b)False Acceptance Rate: The ratio of falsely matched test cases as true to the Total number of face images not taken in the database.

(c)False Rejection Rate: The ratio of falsely rejected true face images to the Total number of trained face images kept inside the database for analysis.

(d)Equal Error Rate: The value obtained when False Rejection Rate and False Acceptance Rate are intersecting by varying threshold values.

The main cause for low success rate is due to pose variations, background noise etc. In the proposed work, the challenges are addressed by developing an efficient face recognition algorithm for authentication and analysed for different databases.

This paper is subdivided as four sections, section II provide the review of literature on different face recognition methods, the proposed face recognition technique is described in section III, the results of proposed method are discussed and analysed with results of existing methods in section IV and section V gives the conclusion.

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II. RELATED WORK

Ahmed ElSayed et al., [1] presented unsupervised face recognition by applying single image super resolution algorithm and frontalization algorithm.

First Features are extracted by LBP and then using multi scale LBP for super resolution image generated by Convolutional Neural Network and Results are analyzed for Wild Face.

Wei Wang et al., [2] developed a method of face recognition using image pyramid based approach by applying LBP with multi scale is matched using Euclidian distance. The performance is analyzed for different number of training and testing sets for FERET and ORL databases.

XIE Zhihua [3] presented a face recognition method using infrared data. LBP is used for feature extraction of normalized infrared image and then histogram is generated for co-occurrence matrix values. Same session data and time lapse data is considered for performance analysis. Nearest neighborhood classifier is used at matching level for classification.

Jian Zhang and Xiao Xiao [4] proposed a four layered weighted LBP based face recognition method by generating histogram for each blocks and finally cascaded to generate the hierarchy histogram. Performance of the method is analyzed for Yale and ORL databases using nearest neighborhood classifier.

Edy Winarno et al., [5] presented an face recognition system using dual camera approach in image acquisition by taking left portion and right portion of the face and it is merged to form a complete face. Extracted features by applying 3wpca algorithm, Mahalanobis distance method is used for classification performance is analyzed with Euclidian distance.

Srinivasa Reddy K et al., [6] presented face recognition using multi resolution Prominent LBP and performance analyzed for various types of LBP methods are discussed.

Ravi J et al., [7] build up an Face recognition algorithm in which five level Dual Tree Complex Wavelet Transform is used to get the DTCWT coefficient values. Then the features are obtained by applying LBP, Euclidian distance is calculated at the decision level for matching. Results of the algorithm are analysed by measuring different parameters like TSR, FAR and FAR for face database such as L Space k, NIR and JAFFE.

III. PROPOSED FACE RECOGNITION MODEL

In the proposed face recognition method one of the unique physiological biometric traits of an individual, Face is used with different orientations. The face image is rotated up to fifteen different angles; features are extracted by applying local binary pattern for each angular rotation and recorded. The histogram of the recorded features is drawn and histogram values at different intensity values are considered as final features. Features are classified using multilevel support vector machine. Recognition Results are analysed with respect to percentage of recognition by measuring Total Success Rate and mismatch by measuring False Acceptance & Rejection rates to calculate Equal Error Rate. The Block diagram in Fig. 1 depicts the flow of proposed Face Recognition algorithm. The similar flow is carried out at the training phase and also at the testing phases of different databases to recognize the true person as matched and false person as not matched using classifier.

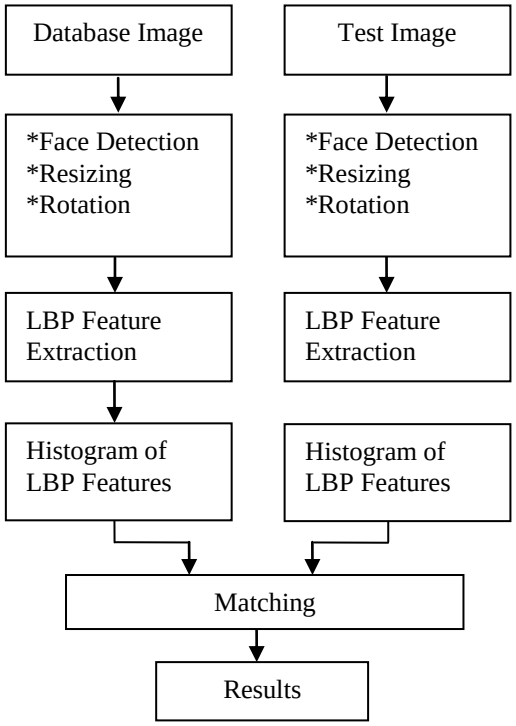


Fig. 1: proposed face recognition model

A. DATABASE

A FERET face database consisting of still faces of individuals is considered in proposed method. Fig 2 shows the sample face images of FERET dataset with similar face images of same person and also different individuals.

Fig. 2: Sample of FERET database

The results of the proposed algorithm is analysed by considering 61 face images in FERET database. Where 56 train images are considered as database and remaining 5 are test images, kept outside the database to determine rate of false acceptance, rejection and success rate [12].

The performance is also analysed for face images of Yale database with different expressions showed in Fig 3 [13]. The database of 15 persons consists of 165 images, where 11 images are taken with different expressions of one person. Out of which, 8 images are train images and 5 are test images.

Total 120 images are inside the database and 45 images are out-of database to measure false rejection, false acceptance and success rate of the algorithm.

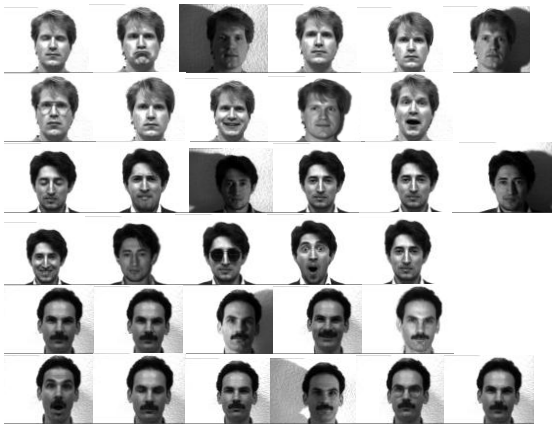


Fig. 3: Sample of Yale Database

B. PRE PROCESSING

In the pre processing stage, the required face portion detection and extraction is carried using Viola Jones face detection algorithm then extracted face images are resized to 100x100.

C. LOCAL BINARY PATTERN [LBP]

The face image is rotated up to fifteen different angles; features are extracted by applying Local Binary Pattern operator for each angular rotation by increasing one degree in clockwise from Zero and one degree anticlockwise from zero and at zero degree angle.

In the proposed algorithm $LBP_{p,q}$ operator is used for future extraction. Where, p is the neighbouring pixel count to the pixel at centre and q is the radius from the centre pixel.

$$LBP_{p,q} = \sum_{p=0}^{7} S(n_p - c_p) \quad (1)$$

Where, n_p= neighbouring pixel values.
c_p = centre pixel value.

$$S(n_p - n_c) = \begin{cases} 1, (n_p - c_p) \geq 0 \\ 0, otherwise \end{cases} \quad (2)$$

The equation 1 can be expressed as follows. If a centre pixel value is lesser or equal compared to neighboring pixel value, it is considered as binary value ‘one’ and if it is greater than the neighbour it is considered as binary ‘zero’. The procedure is repeated for all neighbouring pixel values. The binary values are considered in clockwise direction to construct a binary number and decimal equivalent of that is considered as LBP feature.

The image is subdivided into 3x3blocks and an example matrix is shown in fig 4 and result of LBP is calculated.

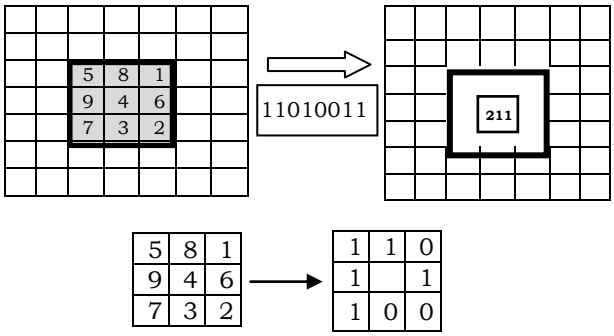


Fig. 4: Example of 3x3 block and LBP output

$$LBP = S(n_0 - c_p)2^7 + S(n_1 - c_p)2^6 + S(n_2 - c_p)2^5 + S(n_3 - c_p)2^4 + S(n_4 - c_p)2^3 + S(n_5 - c_p)2^2 + S(n_6 - c_p)2^1 + S(n_7 - c_p)2^0$$

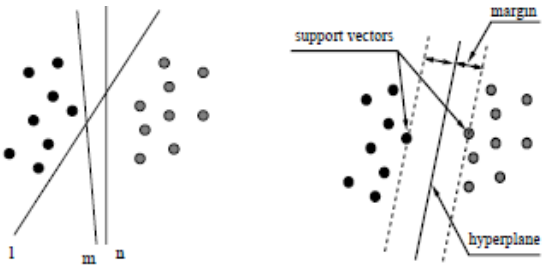
LBP = 1 x 2^7+ 1 x 2^6+ 1 x 2^5+ 1 x 2^4+ 1 x 2^3+ 1 x 2^2+ 1 x 2^1+ 1 x 2^0

LBP = 132 + 64 + 0 + 16 + 0 + 0 + 2 + 1 = 211

The binary values are the LBP features for corresponding 3x3 blocks, final features are extracted by generating the histogram for those LBP features. The obtained histogram values are considered as final features and the same process is carried out for training and also for testing images for matching.

D. MATCHING

The proposed work SVM classifier is used for matching. The SVM is a discriminative classifier, classifies the features by separating in hyper plane. There are different hyper planes generated as shown in Fig. 5(a). SVM draws a line connecting the closest points by subtracting the vectors, then it declares the hyper plane which is the best separating line between two different classes of support vectors, that is the line bisects and also perpendicular to the connecting line as shown in Fig. 5(b). The test image features are compared with the train images features to calculate the match count based on the count value TSR, FAR and FRR are calculated.



(a) (b)

Fig. 5: SVM for two class classification:
(a). arbitrary hyper planes: l, m and n (b). The largest margin hyper plane separated by dashed lines it is in between two support vectors

IV. RESULT ANALYSIS AND DISCUSSION

The proposed algorithm is described below in Table-I, which is used for face recognition based on LBP histogram values. Results of the proposed face recognition algorithm is tested and analysed for FERET and Yale face databases.

Table-I: Proposed Algorithm

Input: Database and Test Face image of an individual.
Output: Matched or not Matched.
Step 1: Train image is read from the database.
Step 2: Pre-processing is carried out.
Step 3: Extracted Face Image is resized to 2^p x 2^q.
Step 4: The matrix of detected face is divided in to sub blocks of 3x3 matrixes.
Step 5: LBP is applied for face image with zero degree and for ±7 degrees.
Step 6: For all LBP features, LBP histogram is generated to obtain final features.
Step 7: Repeat the steps from 1 to 6 for test image.
Step 8: Database features are compare with Test image features using SVM classifier.
Step 9: Image having the equal match count are considered as matched image otherwise it is not matched.

The values of Table-II provide the experimental results for FERET database. Here the Match count is the number of features matched out of 15 features of 15 different orientations and varied from 5 to 15 to obtain the optimum match count and corresponding TSR, FRR and FAR values are tabulated.

TABLE- II: Results for FERET Database

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

It is observed from the Table-II that, as Match Count increases from 5 to 15, FAR decreases and FRR increases. At match count is 8 TSR is 100%.

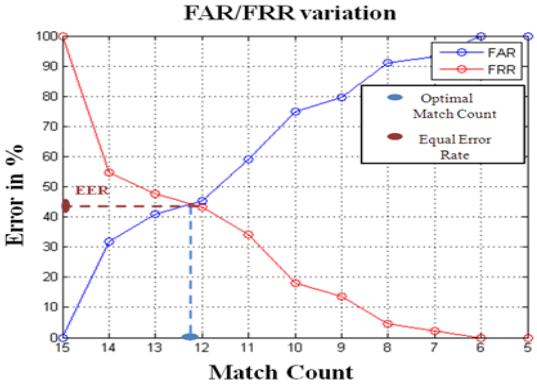


Fig. 6. Graph of Error Rate v/s Match Count and corresponding FAR, FRR values for FERET database.

Fig 6 gives the variation in FAR and FRR values for different Match Counts and corresponding percentage of Error are plotted for FERET database, Equal Error Rate (EER) and optimum value of the Match Counts are also indicated.

It is observe from fig 6 that TSR is 86.36% at optimum Match Count 12.2 corresponding Equal Error Rate is 42% for the FERET data base [15].

Table-III gives the TSR, FAR and FRR values as Match count is varied are tabulated for Yale database. The Total Success Rate is 100% for the match count 8 and FAR of 95.55% for the match count is 5.

TABLE-III: Results for Yale Database

Match Count	FAR (%)	FRR (%)	TSR (%)
5	95.55	0	100
6	93.33	0	100
7	88.88	0	100
8	86.66	0	100
9	73.33	6.66	93.33
10	44.44	6.66	93.33
11	0	13.33	86.66
12	0	20	80
13	0	26.66	73.33
14	0	40	60
15	0	66.66	33.33

Error in percentage with respect to Match Count is plotted in Fig 7. TSR is 86.66% at optimum Match Count of 10.8 and Corresponding EER of 10.3% for Yale database images.

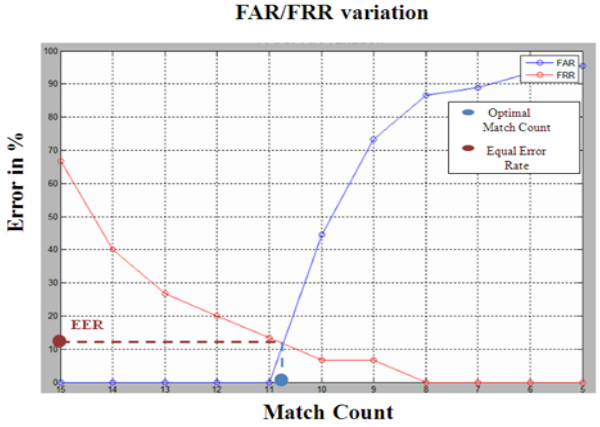


Fig. 7. Graph of Error Rate v/s Variation in Match Count and corresponding FAR/FRR values and for Yale database

It is noticed that, for Yale database the Total success Rate is 86.66% corresponding Equal Error Rate is 10.3% at optimum Match Count of 10.8, the proposed method achieve maximum value of TSR is 100%. The result of proposed technique is compared with existing techniques based on recognition rate, which is tabulated in Table-IV and Table-V. Table-IV gives the comparative analysis based on recognition rate for existing methods with different techniques with proposed technique for FERET face database images.

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It is clearly observed from the Table-IV that, there is an improvement in the recognition rate for proposed work, with respect to other existing methods developed using different methods.

TABLE-IV: Comparison of Recognition Rate: For FERET database with proposed method and existing methods.

Database	Authors	Technique	Recognition Rate in %
FERET	M.Belahcene, M.Laid, A.Chouchane, A.Ouamane and S.Bourennane [10]	BSIF+TLPP	45.83
		TLPP	55.17
	Proposed work	**LBP + SVM**	**86.36**

The comparative analysis for the Yale data base is given in Table V. There is an improvement in recognition rate of proposed face recognition algorithm compared to existing techniques given by M.Belahcene et al., [10].

TABLE-V: Comparison of Recognition Rate: For Yale database with proposed work and existing techniques.

Database	Authors	Technique	Recognition Rate in %
Yale	Kannan Karthik, Harshit Balaraman [8]	OPSRFM	76.36
	Valarmathy.S, Arun Kumar.M, Sangeetha. [9]	LFD, KNN	86.66
	M. Belahcene, M. Laid, A. Chouchane, A. Ouamane and S. Bourennane [10]	BSIF+ TLPP	75.56
		TLPP	73.33
	Maryam Mollaee, Mohammad Hossein Moattar [11]	PCA	86.18
		LDA	84.76
	Proposed work	**LBP + SVM**	**86.66**

The proposed face recognition method gives improved results compared to existing techniques for both FERET and Yale databases. The performance of face recognition method is improved with recognition rate given by Kannan Karthik and Harshit Balaraman[8], Valarmathy.S et al., [9], M.Belahcene et al., [10], Maryam Mollaee and Mohammad Hossein Moattar [11].

V. CONCLUSION

In the proposed Face Recognition algorithm, the face region is detected using Viola-Jones detection algorithm then it is extracted and resized to 100x100 size. The feature extraction stage includes extraction of local features by LBP for 15 different angular rotations and features are recorded. LBP histogram is generated for every angular rotation to obtain final features. Multilevel SVM classifier is used to classify the different classes as matched class and non matched class. Results are analysed by considering for two different face databases, FERET face database with still images and Yale database with images including face expressions. The performance of the algorithm is analysed with parameters like FAR, FRR, TSR & EER and it shows better results compared to existing methods. The results are better for Yale Database compared to FERET database.

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Sujay S N obtained B.E and M.Tech Degree from VTU, Belagavi, and pursuing PhD in Electronics and Communication Department, Global Academy of Technology, Bengaluru, under VTU, Belagavi. He has 6 years of teaching experience and his Research areas are Image Processing, Biometric Recognition and VLSI Design.

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