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VIRTUAL PERCEPTION OF FAMILIAR FACES USING EFFICIENT LOCAL BINARY PATTERN

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Abstract: *Face recognition is one of the most important tasks in computer vision and biometrics where many algorithms have been developed for the betterment of one other. There are many techniques used for face recognition some of them are PCA, LDA, LBP. Among that Local Binary Pattern (LBP) has been proved to be an effective algorithm for facial image representation and analysis, but it is too local to be robust. In this paper, we present an improved method for face recognition named Efficient Local Binary Pattern (ELBP), which is based on Local Binary Pattern (LBP). The efficient LBP method is used to extract local features of the new training subset independently and then a set of feature histogram vectors can be obtained. For a given unknown facial image, sub-feature histogram vectors of the corresponding sub-region are gained after the same preprocessing and partition techniques.*

Keywords *— Face Recognition, Biometrics, ELBP, LBP, PCA, LDP, LBP, Face Authentication, Feature Extraction.*

1. INTRODUCTION

Biometrics is the emerging area of bio-engineering; it is the automated method of recognizing a person based on a physiological or behavioral characteristic. There exist several biometric systems such as signature, fingerprints, voice, iris, retina, hand geometry, ear geometry, and face. Among these systems, facial recognition appears to be one of the most powerful techniques in universal, collectible, and accessible systems. One of its main goals and its objective is the understanding of the complex human visual system and the knowledge of how humans represent faces in order to discriminate different identities with high accuracy.

The face recognition problem can be divided into two main stages: face verification (or authentication), and face identification (or recognition).

The detection stage is the first stage: it includes identifying and locating a face in an image.

The recognition stage is the second stage: it includes feature extraction, where important information for discrimination is saved, and the matching, where the recognition result is given with the aid of a face database recognition methods have been proposed. In the vast literature on the topic, there are different classifications of the existing techniques. The following is one possible high-level classification:

Holistic Methods: The whole face image is used as the raw input to the recognition system to detect.

Local Feature-based Methods: Local features are extracted, such as eyes, nose, and mouth. Their locations and local statistics (appearance) are the input to the recognition stage to detect.

Application: advanced human-computer interaction, video surveillance, automatic indexing of images, video database, and security.
The face recognition technology has performed in many ways, the techniques are called algorithms like Principal Component Analysis, Local Binary Pattern, Linear Discriminant Analysis and so on ., In this, each and every algorithm gives different results and takes different parameters for the face detection. How does the algorithms work is explained below

2. METHODOLOGY

2.1 Local Binary Pattern (LBP):

LBP is the most effective algorithm where it takes the local features for facial recognition. , Local Binary Pattern (LBP) has an increasing interest in image processing and computer vision. Local Binary Pattern summarizes local structures of images efficiently by comparing each pixel with its neighboring pixels. The most important properties of Local Binary Pattern are monotonic illumination changes and its computational simplicity. Local Binary Pattern was originally proposed for texture analysis and has proved as a powerful approach to describe local structures and also one of the most popular and successful applications, for instance, face image analysis, image retrieval, environment modeling, visual inspection, motion analysis. Facial image analysis is an active research topic in computer vision, with a wide range of important applications, e.g., human-computer interaction, biometric identification, surveillance, and security, etc. LBP has been exploited for facial representation in different tasks containing face detection, face recognition, facial expression analysis, and classification.

2.2 Procedure to perform LBP:

Face image is composed of several minute patterns and this can be identified efficiently by LBP operator and it is applied on a given face image. The input face is converted into a Grey image and for it, the binary pattern is calculated by comparing the center pixel with the neighbouring pixels. If the center value is greater than its neighbour pixel's, then it is represented as '1' and vice-versa. A binary number is obtained by concatenating all these binary codes in a clockwise direction starting from the top-left one and its corresponding decimal value is used for labelling. The LBP is applied to the input image in order to extract the features of the image. The derived binary numbers are referred to as Local Binary Patterns or LBP codes. This operator works with the eight neighbours of a pixel, using the value of this center pixel as a threshold. If a neighbour pixel has a higher gray value than the center pixel (or the same gray value) than a one is assigned to that pixel, else it gets a zero. The Local Binary Pattern code for the center pixel is then produced by concatenating the eight ones or zeros to a binary code.

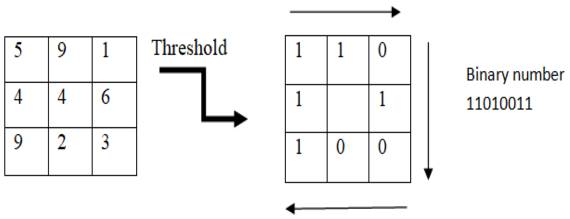

Fig: LBP OPERATION

Later the Local Binary Pattern operator was extended to use neighbourhoods of different sizes. In this case, a circle is made with radius R from the center pixel. P sampling points on the edge of this circle are taken and compared with the value of the center pixel. To get the values of all sampling points in the neighbourhood for any radius and any number of pixels, bilinear or interpolation is necessary. For neighbourhoods the notation P, R are used. Illustrates for the three neighbour-sets for different values of P and R as shown below.

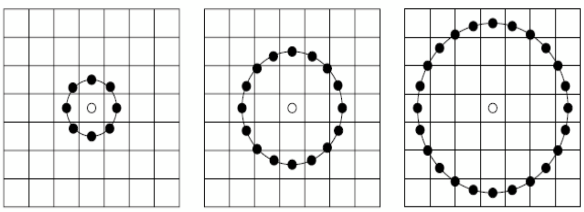

Fig: Circularly neighbour-sets for three different values of P and R

If the coordinates of the center pixel are (x_c, y_c) then the coordinates of his P neighbours (x_p,y_p) on the edge of the circle with radius R.

The Local Binary Pattern features have been extracted from the face image for face recognition that there are several face image uses in the database that compared with the input image. The image depends on viewing lighting and environmental conditions. Besides the face image changes according to the expressions. In this paper research work, which is flexible and efficient, should be solve the problems.

The Local Binary Pattern does this comparison by applying the following formula:

$$LBP_{P,R}(xc, yc) = \sum_{n=0}^{7} s(i_c - i_c)2^n$$

Where i_c corresponds to the value of the center pixel ($x_{c,c}$), i_n to the value of eight surrounding pixels. It is used to find the local features in the face and also works by using basic LBP operator. The feature extracted matrix of size 3 x 3, the values are compared by the value of the center pixel, and then binary pattern code is produced. By using LBP code value is obtained by converting the binary code into decimal one.

3. EFFICIENT LOCAL BINARY PATTERN:

An efficient Local Binary Pattern is used to find better efficiency when compared with other algorithms. In this, we have to find out eight filters and calculate the weight for each vector which is in the size of 2n i.e. (20 to 27). Weight matrix has to be formed after calculating the weights. If it a rotation invariant, possible LBP should be found and by applying filters we have to round to the nearest values. Binary patterns will be obtained by using a condition, if it is greater than or equal to zero it can be represented as zero otherwise one. After performing all these steps we have to find the minimum possible local binary patterns and it is known as efficient local binary patterns.

3.1 ELBP Algorithm

Step 1: Formation of eight filters (3*3*8)
The 3×3×8 single array is formed as filter output

filtR(:,:,1) =

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

filtR(:,:,2) =

$$\begin{bmatrix} 0 & 0.2500 & 0.3535 \\ 0 & -0.8535 & 0.2500 \\ 0 & 0 & 0 \end{bmatrix}$$

filtR(:,:,3) =

$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

filtR(:,:,4) =

$$\begin{bmatrix} 0.3535 & 0.2500 & 0 \\ 0.2500 & -0.8535 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

filtR(:,:,5) =

$$\begin{bmatrix} 0 & 0 & 0 \\ 1 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

filtR(:,:,6) =

$$\begin{bmatrix} 0 & 0 & 0 \\ 0.2500 & -0.8535 & 0 \\ 0.3535 & 0.2500 & 0 \end{bmatrix}$$

filtR(:,:,7) =

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

filtR(:,:,8) =

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & -0.8535 & 0.2500 \\ 0 & 0.2500 & 0.3535 \end{bmatrix}$$

Step 2: Calculate weight of each vector (2^0 to 2^7)
1 2 4 8 16 32 64 32
Step 3: Formation of weight matrix (IR*IC*8)
Step 4: Check whether it is rotation invariant.
Step 5: Find possible LBP
Possible LBP=Binary values of filter *weight of filter * 8
Step 6: Apply eight filters to the image
Step 7: Round to the nearest integer and calculate filter output

$$X_{out} = \frac{1}{N}\sum w_i x_i$$

Step 8: Form binary patterns by using the condition (>=0)
The values are changed into 1 and 0 when the nearest integer is greater than 0 then it is said to be 1 else 0
Step 9: Calculate minimum possible LBP
Step 10: ELBP can be obtained by using minimum possible LBP

ELBP = min(PLBP)

The results of the ELBP with noise is

3.2 COMPARATIVE ANALYSIS FOR NOISE

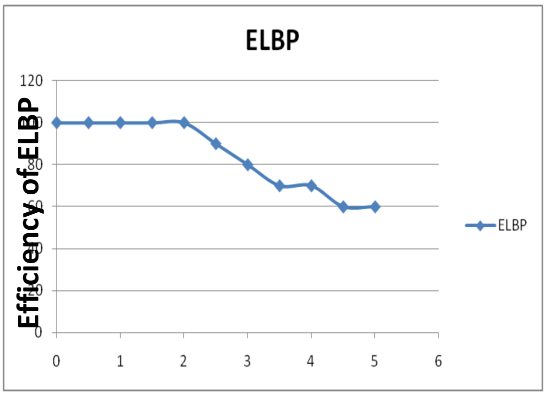

Fig: Graph between the efficiency of ELBP vs. % of noise added to image

The graph below explains the recognition of the image with noise, the recognition is gradual decreases when the noise is added. When at 2.5% noise the graph of recognition falls down gradually and the graph is reaching 50 for the 10% noise. If the noise exceeds more than 10% the recognition rate will fall down gradually to zero. Comparative analysis of different datasets with different types of conditions.

The below-listed results are the comparative analysis of noise, pose, and emotion.

Table: Comparing the efficiency of LBP, LDA, PCA & ELBP for noise

Noise%	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
Efficiency of LBP	98	96	94	90	78	76	58	46	44	38	34	34	32	30	28	26
Efficiency of PCA	94	92	90	85	72	72	55	42	40	32	30	29	29	27	26	24
Efficiency of LDA	80	80	60	60	60	40	40	40	40	38	34	28	26	26	24	20
Efficiency of ELBP	100	100	100	100	100	90	80	70	70	60	60	60	60	60	50	50

The graph below explains about the comparative recognition of ELBP, LBP, PCA & LDA images with noise, the recognition is gradual decreases when the noise is added. When at 2.5% noise in every algorithm, the graph of recognition falls down gradually and the graph is reaching 50 for the 10% noise for ELBP, 20 for LDA, 24 for PCA, 26 for LBP. If the noise exceeds more than 10% the recognition rate will fall down gradually to zero.

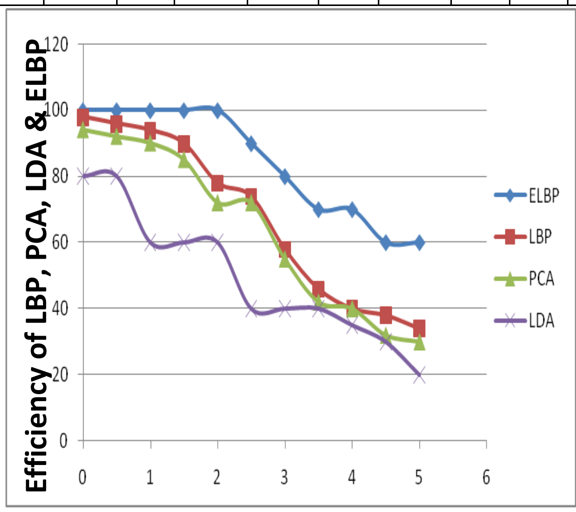

Fig: Comparison of ELBP, LBP, PCA &LDA of noise

3.3 COMPARATIVE ANALYSIS FOR POSE

Table: Comparing the efficiency of LBP, LDA, PCA & ELBP for pose

pose %	-45	-35	-25	-15	-5	5	15	25	35	45
Efficiency of LDA	10	30	10	10	20	10	10	10	20	10
Efficiency of PCA	10	10	0	10	10	20	10	0	20	20
Efficiency of LBP	70	60	60	90	80	80	70	70	80	80
Efficiency of ELBP	92	95	93	98	96	95	96	99	92	98

The graph below explains about the comparative recognition of ELBP, LBP, PCA & LDA images with the pose, the recognition is gradually decreasing when the angle is increased or decreased. When at 30 degrees the recognition rate is falling down gradually and the graph is reaching 98 for the 45 degrees for ELBP, 10 for LDA, 20 for PCA, 80 for LBP. If the pose exceeds more than 45 in – or + the recognition rate will fall down gradually to zero.

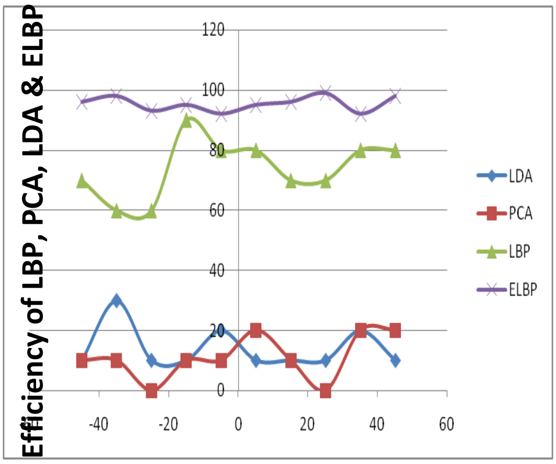

Fig: Comparison of ELBP, LBP, PCA &LDA of pose

3.4 COMPARATIVE ANALYSIS FOR EMOTION

Table: Comparing the efficiency of LBP, LDA, PCA & ELBP for emotion

Emotion%	Angry	Fear	Happy	Netural	Sad
Efficiency of LDA	0	20	10	50	0
Efficiency of PCA	50	70	80	80	80
Efficiency of LBP	90	90	100	100	100
Efficiency of ELBP	90	100	100	100	100

The graph below explains about the comparative recognition of ELBP, LBP, PCA & LDA images with emotions, the recognition is gradually decreasing in different emotions. When at neutral the recognition rate was high for all the algorithms, but coming to the other emotions LDA is the least recognized algorithm, ELBP is the most recognized algorithm, next to the LBP and next to PCA.

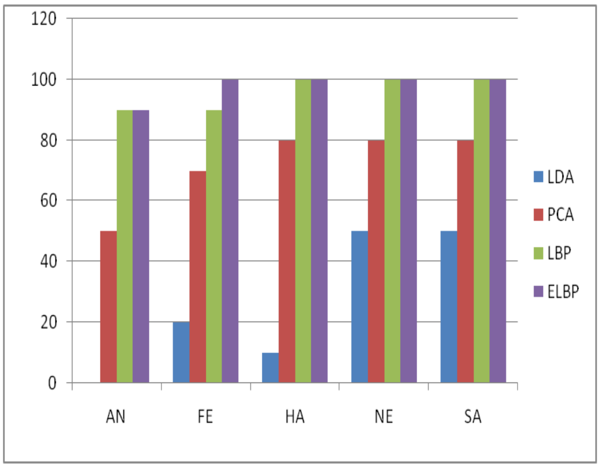

Fig: Comparison of ELBP, LBP, PCA &LDA of emotion

4. CONCLUSION:

In this article, the proposed methodology is assessed with the face recognition task. However, a similar method has yielded outstanding performance in face detection. We also believe that the developed approach is not limited to these few examples as it can be easily generalized to other types of object detection and recognition tasks.

While comparing to the previous existing algorithms the Local Binary Pattern (LBP) has the more efficient, the LBP can't able to find the matched image every time, so we are going to ELBP where we are trying to the possible Local Binary Pattern by adding the filters. The minimum possible LBP is found for better face recognition. LDA is the least recognition technique for face recognition.

Future work includes the AdaBoost method presented in serves as a good basis for this research. Another important topic is looking for image preprocessing methods and descriptors that are more robust against image transformations that change the appearance of the surface texture such as image blurring caused by imaging devices being slightly out-of-focus.

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