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Efficient Implementation on Human Face Recognition under Various Expressions using LoG, LBP and SVM

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Abstract:
Humans have always had the innate capability to recognize and distinguish between faces; recently computers have shown an equal ability to recognize and distinguish the human faces. Facial recognition is a biometric method of identifying an individual by comparing live capture or digital image data with the stored record for that person. In this paper face recognition is performed under various facial expressions. Comparison is done on the recognition rate of Local Binary Pattern (LBP) with Laplacian of Gaussian (LoG) method, Principal Component Analysis (PCA) and Local Binary Pattern methods. The Laplacian of Gaussian (LoG) method is used for edge detection and for feature extraction LBP and PCA methods are used. The Support Vector Machine Classifier is used to classify the images. The LBP with LoG gives better recognition rate than the PCA and LBP methods. But it takes more time to recognize face compared to the other two methods.

Keywords: Face Recognition, Local Binary Pattern, Principal Component Analysis, Laplacian of Gaussian, histogram, expression variations

I.INTRODUCTION

Human facial expressions play an essential role in several applications such as human computer interaction, video surveillance. It contains very abundant information of human's behaviour which can further reflect human's corresponding mental state. Facial expression recognition is to develop the friendly man-machine interface to enable the system to have communication analogous to man-machine communication, behavioural science, video conferencing, clinical studies and many more. The face recognition technology is mainly used for the purpose of security, which works on the biometric principles. The characteristics of a person such as: palm, finger print, face, and iris etc. which can be used for biometric identification. One of these biometrics methods face recognition is advantageous because it can be detected from much more distance with or without need of scanning devices this provides easy observation to identify individuals in group of persons. Most of the military application security systems, attendance systems, authentication, criminal identity etc. are performed using this face recognition technology. The computer uses this recognition technology to recognize or to compare the person with same person or with some other person. The human faces are very important factor to identify who the person is and how the people will identify his/her face. Verification and Identification steps are used in face recognition technology for comparing the face with his own face or with the other person's face. The first method is verification which compares the face image with his/her image which is already stored in database. It is one to one matching, it tries to match individual against same person's image stored in database. The second method is identification which is to identify the unknown person. It is called one to n matching, it matches individual person's face image with every person's face images. If the face images are in different expression then it is difficult to identify the human face. This paper is organized as follows: Section II reviews the related works done on face recognition with different expressions. Section III describes the proposed system. Section IV provides the simulation results. Section V provides the conclusion of the paper

II. RELATED WORK

Face Recognition has become one of the most biometrics authentication techniques from the past few years. Face recognition is an interesting and successful application of Pattern recognition and Image analysis. It compares a probe face image against all image patterns in a face database. Face recognition is very important due to its wide range of commercial and law enforcement applications, which include forensic identification, access control, border surveillance and human interactions and availability of low cost recording devices. Principal Component Analysis and Independent Component Analysis [1], Elastic Bunch Graph Matching [2], K-nearest neighbour algorithm classifier and Linear Discriminant Analysis [3], Local Derivative Pattern and Local Binary Pattern [4]. These algorithms are still have some problems to recognize the face under the constraints like variations in pose, expression and illumination. These variations in the image degrade the performance of recognition rate. Local Binary Pattern (LBP) and Laplacian of Gaussian (LoG) is used to reduce the illumination effects by increasing the contrast of the image which does not effect to the original image and differential excitation pixel used for pre-processing which is to make the algorithm invariant to the illumination changes [4]. LoG is applied to the input image to get the edges of the face images for feature extraction. The LoG image is given as input to the LBP, which extracts the features of the face image. LBP divides the face image into several regions and generates the feature information locally for ll the regions and finally combining all the local feature information to get global information. The histogram is plotted for the LBP image of both the test and train images and the histogram is matched

to get the recognized face image. The Local Directional Pattern descriptor (LDP) uses the edge values of surrounding pixel of the centre pixel and Two Dimensional Principal Analysis (2D-PCA) is used for feature extraction. LDP is an eight bit binary code which is assigned to the each pixel of an query image. This pattern is calculated by comparing the relative edge value of a pixel in different directions. The illumination effect is degraded using the binary pattern descriptor. 2D-PCA uses Euclidean distance to measure the similarity between training database images and test image features. The Euclidean distance calculates the distance between the features of face image which is extracted such as eyes, nose, and mouth. The distance between features is calculated to get the similarities between the two images. The nearest neighbour classifier is used to classify the images

[5]. The nearest neighbour first computes the distance between the test and all the train images stored in the database and chooses which image is nearest to the test image.

To reduce the influence of illumination from an input image an adaptive homomorphism filtering is used in adaptive homomorphism eight local directional patterns (AH-ELDP) [6] method. This method produces eight directional edge images and it is used to create an illumination-insensitive representation for face recognition, it uses all the directional information to recognize the face image with different illumination conditions. One of the disadvantage of this method is constructing the linear subspace requires the several sample images. The light variations impact more on recognition of the image because the changes in the lightning condition may increase or decrease the intensities of the face regions due to the shadow cast given by some light source [7]. The Local Directional Pattern (LDP) is used to describe the local image feature. A LDP feature is obtained by computing the edge values in all eight directions at every pixel position and it generates a code from the relative strength magnitude. Each bit of code sequence is determined by considering a local neighbourhood.. Finally an image descriptor is formed to describe the image by accumulating the occurrence of LDP feature over the whole input Illumination normalization is an important task in the field of pattern recognition and computer vision. One of the most important problems of illumination normalization is face recognition under different illumination conditions. To normalize the illumination condition many normalization algorithms are proposed. Belhumeur et .al. [8], used three principal components to reduce the illumination changes in the images by normalizing the face image. The performance of illumination normalization is done according to the face recognition rate by the normalized correlation similarity measurement. The face expressions [9] are most natural used to identify the expressions of the person. The face image with different poses is also recognized. One of the limitations of the non-frontal view method is that the images will be in different poses. The training dataset should contain the data having possible views of face images to identify the angle of view and face image with different expressions before using algorithms directly. Though all these methods are used for particular applications but due to some drawbacks of these methods the local feature extraction method is used. Survey of face recognition under varying facial expressions is done in order to analyse different techniques, motion-based, model-based and muscles-based approaches have been used in order to handle the facial expression and recognition [10]. Facial expressions not only exposes the sensation or passion of any human being but can also be used to judge his/her mental views. This survey is done based on the methods used to recognize the various facial expressions of the person SVM-LBP method [11] is used to recognize the face under complex background and different face positions. Median filter is used to remove the noise from the image. It is used to detect the edges of the image. Local Binary Pattern is used to extract the features of face, which divides the face image into different blocks and locally the image information is generated to get the global pixel information of the image by combining all the local pixel information of each block. Support Vector Machine (SVM) classifier is used to classify the face images. SVM classifier finds maximum distance with the closest points in the training data set. Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) is compared to recognize facial expressions of the human face [12]. The Euclidean distance is used to calculate the distance between the images which are to be tested and the already available images used as the training images. Then the minimum distance is observed from the set of values. In testing, the Euclidean distance (ED) is computed between the new image Eigenvector and the Eigen subspace for each expression, and minimum Euclidean distance based classification is done to recognize the expression of the input image. PCA gives the better recognition rate than LDA; LDA gives more rejection rate than PCA.

III. PROPOSED SYSTEM

A. In the proposed human facial expression is recognized using the Local Binary Pattern and Laplacian of Gaussian methods. The final output is compared with Principal Component Analysis and Local Binary Pattern methods. The query image consist of different facial expressions like fear, happy, depression, surprise and sad. Laplacian of Gaussian (LoG) method is used for pre-processing. Then the LBP operator is applied to the face image to extract the facial feature. The Support vector machines used to classify the training and test dataset images. JAFFE image database is used as training dataset. *Laplacian of Gaussian (LoG)*

The LoG operator is used to detect the edges of the face image to get the image information. The LoG of an image highlights the area where the intensity is changed and it eliminates the noise from the detected face image. The LoG operator will take gray level image as input and it will produce gray level image as an output. LoG method works under first and second order derivatives of an image. In LoG, gradient method is used to detect the edges in first order and Laplacian method is used to search the zero crossing in the second order derivative. Then the LBP operator is applied to the face image.

B. Local Binary Pattern (LBP)

The Local Binary Pattern (LBP) algorithm is used to extract the face image features. The LBP code is calculated for every pixel in the image block and features like eyes, nose, and mouth distances are calculated. LBP code is noted. Then the face image is split into some blocks to calculate the local histograms values of the each block. Histogram of each block is calculated and then it is combined together to single vector to get global histogram values [13] as shown in Figure 1. The LBP is used to summarize the local structure in an image by comparing every pixel with its surrounding neighbourhood. Centre pixel value is taken and threshold it with its neighbourhood pixel. If the intensity of the centre pixel value is more than or equal to neighbour pixel value then denote it

with 1 otherwise 0. With 8 surrounding pixels 2^8 possible values combinations will get.

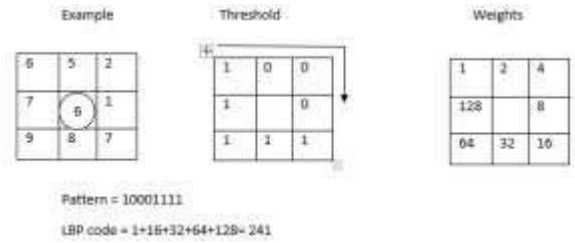

Figure 1 Basic LBP operation

C. Principal Component Analysis

Principal Component Analysis is used to extract the facial features. To match the face images mean values are calculated first. Then finding the difference between the mean image and each of database image. Finding the Eigen values and Eigen vectors, then Euclidian distance is calculated between weight vectors of unknown image and database images. If this distance is less than threshold then test image is considered to be in database. Finally plotting the histogram for both test and train images.

D. Support vector machines (SVM)

Support Vector Machine is applied to the face image to classify the images. It can be used for various applications such as text recognition, character recognition and handwriting recognition. SVM classifier [13] finds the separation between the two images. The classifier matches the training dataset images with the query images and gives the final output that whether the image is matching or not matching.

IV. SIMULATION RESULTS

For the experiment, we have used MATLAB 2013a. The JAFFE training data set has been used to recognize the images with different facial expressions. JAFFE data set contains face image with different expressions. Since we are focusing in the expression variation only frontal face image for each subject with 5 different expressions like happy, fear, sad, depression, surprise are selected, 25 images in total are taken from the dataset, some of which are shown in Figure 2.

Figure.2. Images with different expressions

A. Image Base Results

Expression Variation

Expressions are basically variations in some region of the face. So there are changes in only some particular area of face instead of entire face image. In this paper we have taken 5 different expressions like happy, fear, sad, dipression, surprise. For the cropped image LoG is applied to detect the edge and for the edge detected image LBP is applied. The LoG and LBP image is shown in figure 3.

Figure.3. LoG and LBP images

B. Histogram Base Results Expression Variation

In Figure 4, the histograms of the two different facial expression of the same subject are shown. The difference histogram with threshold values proves the algorithm is capable of recognizing the person with different expression.

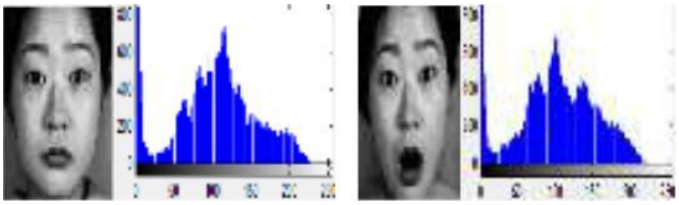

Figure 4 Different Expression Images and their LBP histograms.

The Principal Component Analysis is compared with the Local Binary Pattern with Laplacian of Gaussian method. The figure 5 and figure 6 shows recognition rate of the LBP with LoG and PCA.

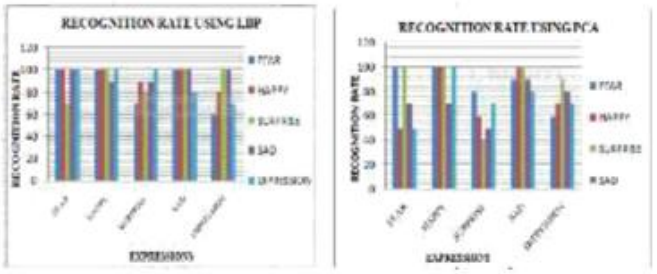

Figure 5 Recognition rate using LBP
Figure 6 Recognition rate using PCA

The average recognition rate of LBP with LoG and PCA is shown in the figure 7 and figure 8. The LBP gives better recognition rate than the PCA method.

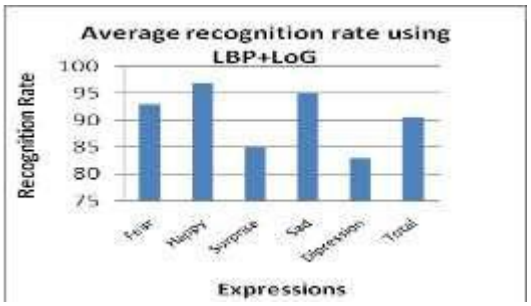

Figure 7 Average recognition rate using LBP + LoG

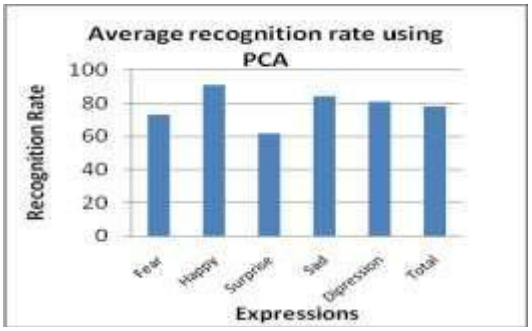

Figure 8 Average recognition rate using PCA

Expression invariant images are recognized using the JAFFE image dataset. The recognition rate of LBP with LoG, LBP and PCA is compared. The LBP with LoG gives 93% and PCA gives 78% recognition rate and LBP method gives 78%

recognition rate. The LBP method takes less recognition time compared to other two methods as shown in the table 1.

Table 1 Recognition Rate for various operators applied on JAFFE dataset.

Methods	***Recognition Rate***	***Recognition Time***
Local Binary Pattern	91%	0.04643
Principal Component Analysis	78%	0.04876
LBP + LoG	93%	0.04764

V. CONCLUSION

In the proposed face recognition system Local Binary Pattern (LBP) method is used along with Laplacian of Gaussian method. Laplacian of Gaussian (LoG) method is used for edge detection. Edge detection is mainly used to identify and locate the discontinuities in the edges of the face image. The LBP method is used for feature extraction. Principal Component Analysis (PCA) method is compared with the LBP and LBP with LoG methods. During the classification phase Support Vector Machine (SVM) classifier is used for classification. As per the analysis LBP method gives the better recognition rate. The PCA method takes more recognition time and the recognition rate is less than the other two methods. The LBP with LoG method gives the more recognition rate than LBP method but it takes more recognition rate compared to the LBP.

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