An Automatic Face Recognition System from Frontal Face Images using Local Binary Pattern Feature Space and K-Nearest Neighbors Classification

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***Abstract*—To address human face recognition problem lots of algorithms have been proposed in the past few years. Although the available algorithms provides good face recognition, but the field is still looking for the efficient mild stone algorithm which can provide higher face recognition efficiency. To efficiently address this problem, in this paper, an Automatic Face Recognition System (AFRS) is proposed. The proposed system uses an efficient approach for the recognition of human faces on the basis of some extracted features. For the detection of the frontal face proposed method uses Viola Jones face detection technique. Once face detection is completed, feature of interested region that is eyes and mouth are pull out. In feature extraction, local binary pattern (LBP) is proposed as a feature. After the extraction of the LBP feature for the recognition classification or, the proposed method employed highly efficient K-Nearest Neighbors Classification structure to efficiently cluster the obtained LBP features. The whole system is implemented on the dataset of 150 images of frontal faces of 30 persons in five different emotions by using MATLAB 2012(b). The images were collected from the Karolinska Directed Emotional Faces Database. The novel contribution of the proposed face recognition system is the recognition of an individual person on neutral emotion as well as from the frontal images of other emotions. After the successful testing with the proposed system the face recognition efficiency found for the proposed system is very high and close to 100% for all the face images**

Keywords— Face Recognition, Face Features, Feature Extraction, LBP, K-NN Classifier.

I. INTRODUCTION

Face recognition is one of the principal challenges in appearance-based pattern recognition field. This technology has emerged as a tempting solution to address many new needs for identification and verification of identity. It is the well known functionality of visual surveillance systems. It has received much attention for decades due to its numerous potential applications, like national security, surveillance, public safety field and law enforcement. There are many factors that affect the face recognition performance like facial expression, pose, illumination, cluttered background or occlusion. The approach starts with face detection and extraction from the larger image, then normalizing the probe photograph in order that it's in the identical format (size, rotation, etc.) because the images within the database. The normalized face image is then proceeds to the recognition phase. Face recognition can typically be used for identification or verification .In verification a personal is already enrolled within the reference database i.e. it is a one-to-one matching task whereas in identification, a probe image is matched with a biometric reference in the gallery i.e. it represents a one-to-many problem.

There are two possible outcomes: the person isn't identified or the person is diagnosed. Two reputation mistakes may additionally occur: False Reject (FR) which indicates a mistake that arise when the machine reject a acknowledged individual, False Accept (FA) which suggests a mistake in accepting a claim whilst it's far in reality false. In the past many years, there are a plenty of work has been done in face recognition and have achieved success in real application. Despite the used algorithm, face recognition can be decomposed into four phases: preprocessing phase, segmentation or localization, feature extraction phase and recognition phase. Although the available algorithms provides good face recognition, but the field is still looking for the efficient mile stone algorithm which can provide higher face recognition efficiency.

To efficiently address this problem, in this paper, an Automatic Face Recognition System (AFRS) is proposed. The proposed system uses an efficient approach for the recognition of human faces on the basis of some extracted features. For the detection of the frontal face proposed method uses well known Viola Jones face detection technique. Once face detection is performed, region of interest (ROI) that is eyes and mouth are extracted. In feature extraction, local binary pattern (LBP) is proposed as a feature. After the extraction of the LBP feature for the classification or recognition, the proposed method employed highly efficient K-Nearest Neighbors Classification structure to efficiently cluster the obtained LBP features.

II. PROPOSED METHODOLOGY

In this proposed work, an Automatic Face Recognition System is proposed. The proposed system uses an efficient approach for the recognition of human faces on the basis of extracted LBP features. For face recognition, system follows a step by step procedure that comprises face detection, feature extraction and recognition (Classification). For the detection of the frontal face proposed method uses face detection technique known as Viola Jones method

Once face detection is performed, feature of region of interest(ROI) that is eyes and mouth is extracted. In feature extraction, local binary pattern (LBP) is proposed as a feature. After the extraction of the LBP feature for the classification or recognition the proposed method utilized K- Nearest Neighbors Classification structure to efficiently cluster the obtained LBP features. The complete process of the proposed technique is shown in figure (1), with the help of block diagram representation.

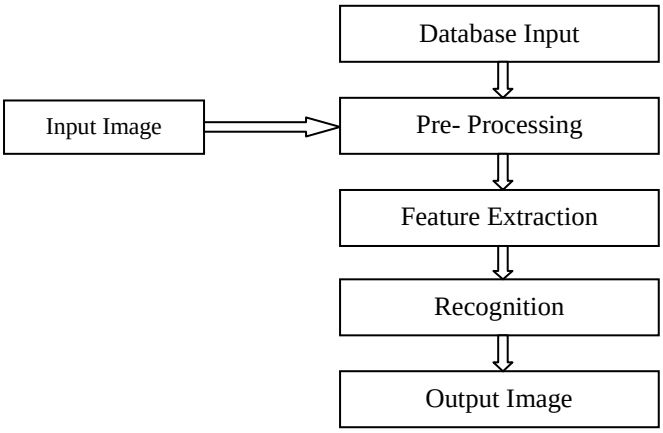

Fig.1 Block diagram of proposed system

A. Preprocessing

Preprocessing is the most essential and the much required step of the image processing, removing any background noise or any piece of input that is not required.This step includes the following functions:

i. Auto Brightness- Thisfunction adjust the brightness of the image.
ii. Auto Contrast- This function function automatically calculates the favorable contrast for the image will increase the brightness of the image.
iii. Auto Color- This function adjust the color of the image.

B. Face Detection using Viola Jones Methood

The basic principle of the Viola-Jones algorithm is to scan a sub-window capable of detecting faces across a given input image. Viola-Jones method rescales the detector in place of the input image and run the detector regularly via the image every time with a unique size. Viola-Jones has devised a scale invariant detector that requires the same number of calculations no matter whatever the size. This detector is constructed using a so-called integral image and few simple rectangular features reminiscent of Haar wavelets.

C. Local Binary Pattern based Feature Extraction

LBP is a type of feature used for classification in computer vision. The LBP feature vector, in its simplest form, is created in the following manner:

- Divide the examined window into cells (e.g. 4x4 pixels for each cell).
- For each pixel in a cell, compare the pixel to each of its 2 neighbors (on its left-top, left-middle, left-bottom, right-top, etc.). Follow the pixels along a circle, i.e. clockwise or counter-clockwise.
- Where the center pixel's value is less than the neighbor's value, write "0". Otherwise, write "1". This gives an 8-digit binary number (which is usually converted to decimal for convenience).
- Compute the histogram, over the cell, of the frequency of each "number" occurring (i.e., each combination of which pixels are smaller and which are greater than the center).
- Optionally normalize the histogram.
- Concatenate (normalized) histograms of all cells

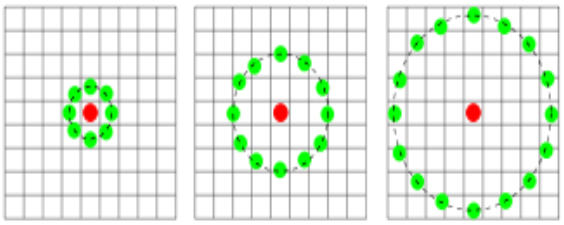

Fig.2 Three neighborhood examples used to define a texture and calculate a local binary pattern (LBP).

D. K-Nearest Neighbour Classifier

In pattern recognition, the K-Nearest Neighbors algorithm (or k-NN for short) is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification or regression:

- In k-NN classification, the output is a class membership. An object is classified by a majority vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of that single nearest neighbor.
- In k-NN regression, the output is the property value for the object. This value is the average of the values of its k nearest neighbors.

K-NN is a type of instance-based learning, or lazy learning, where the function is only approximated locally and all computation is deferred until classification. The k-NN algorithm is among the simplest of all machine learning algorithms. Both for classification and regression, it can be useful to weight the contributions of the neighbors, so that the nearer neighbors contribute more to the average than the more distant ones. For example, a common weighting scheme consists in giving each neighbor a weight of 1/d, where d is the distance to the neighbor. The neighbors are taken from a set of objects for which the class (for k-NN classification) or the object property value (for k-NN regression) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required.

Finally a graphical user interface has been also developed to provide ease in handling of the proposed system. The screenshot of the developed GUI is shown in figure (3).

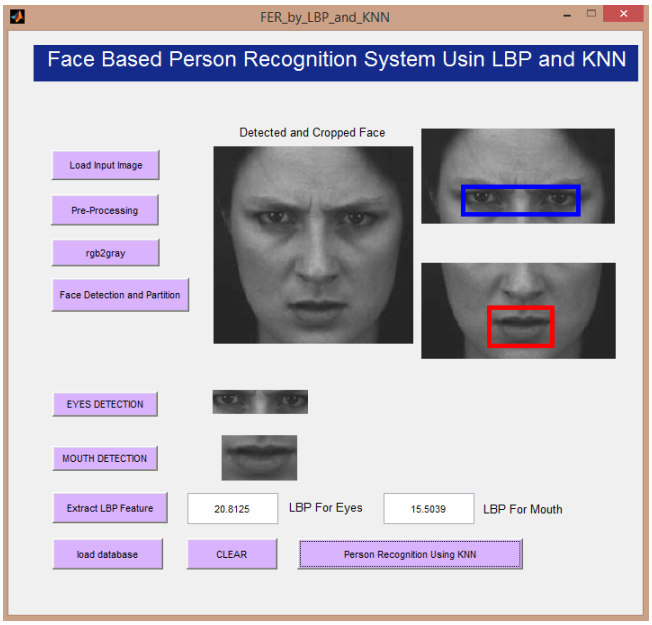

Fig. 3 Screenshot of Developed GUI for Proposed System.

III. RESULTS AND DISCUSSIONS

A complete database of 150 frontal face images of 30 persons is utilized during the development and testing of the proposed system. Out of the 30 persons 15 were male and 15 were females. The Images are taken from the Karolinska Directed Emotional Faces (KDEF) Database [6]. Five different emotions utilized are neutral, angry, disgusted, sad and happy. The complete system is implemented using MATLAB 2012(b) version and gives 97.3% performance for face recognition

Table 1 shows the tabular representation for face recognition using conventional principle component analysis (PCA) feature based face recognition system. While Table 2 shows the tabular representation for face recognition using proposed face recognition system especially designed to recognize the persons under different emotional conditions.

Table-1 Recognition Accuracy Rate for PCA

										Predicted/ Classified Person												
4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

From the table 1, the True recognition efficiency (TRE) and False recognition rate (FRR) for NN classifier based system is obtained as

- TRE for PCA System = True recognition/Total attempts = (133/150)*100% = 88.67 %.
- FRR for PCA System = False recognition/Total attempts = (17/150)*100% = 11.33 %.

Similarly, from table 2, the True recognition efficiency (TRE) and False Recognition rate (FRR) for proposed system is obtained as:

- TRE for proposed system = True recognition/Total attempts = (146/150)*100% = 97.3 %.
- FRR for proposed system = False recognition/Total attempts = (4/150)*100% = 2.7 %.

Table-2 Confusion Matrix for Testing Sam

Confusion matrix		Predicted/														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Actual Person	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
	14	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	21	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0

IV. CONCLUSIONS

This paper presents a fast and efficient approach for human recognition via recognition of frontal faces is presented. This new approach gives effective result. The proposed system uses an efficient approach for the recognition of human being via recognition of frontal faces on the basis of LBP features. For the detection of the frontal face a well-known Viola Jones face detection technique has been employed. After the extraction of the LBP feature for the classification or recognition, the K-NN classifier has been utilized. The K-NN classier used, has inbuilt advantage of online classification capability over conventional classifiers.

The whole system is implemented on the dataset of 150 frontal face images of 30 different persons using MATLAB 2012(b). The images were collected from the Karolinska Directed Emotional Faces (KDEF) Database. After the successful testing of the developed system the recognition efficiency found is very high and close to 97.3% for the 30 enrolled individuals.

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