Face Recognition using Local Binary Pattern

Abin Stanly¹, Krishnapriya M. Mohan², Merlin Maria Tom³,
Biju V.G⁴, Anith Mohan⁵, Laxmi T.J.⁶

¹,²,³,⁴,⁵,⁶ Department of ECE, College of Engineering Munnar

Abstract—For the past few years, face recognition has a significant role in many fields such as commercial, banking, social and low enforcement areas. But face detection and recognition is a challenging issue due to wide variety of face and image backgrounds. In this paper, the proposed method is Local Binary Pattern algorithm for the recognition of area of interest. The whole process is divided into three stages which involve Face detection, Feature extraction and Face recognition. Different algorithms are employed for each stage and they are Successive Mean Quantization Transform (SMQT), Skin color based detection and Local Binary Pattern (LBP) respectively. The proposed method is tested in different lighting and zooming conditions and calculated the accuracy, precision, sensitivity and selectivity for each conditions. The efficiency of the system in zooming condition is 71.42%.

Keywords— Discrete Wavelet Transform, Local Successive Mean Quantization, SNoW classifier, Local Binary Pattern

I. INTRODUCTION

Face recognition comes under the biometric system, which include the identification of eye region, iris, finger prints etc. Many face recognition algorithms are proposed during the past twenty years. Principle Component Analysis (PCA)[13], Independent Component Analysis (ICA)[6], Linear Discriminant Analysis (LDA)[9], Based on eye region judgments [12], Adaboost Support Vector Machine(SVM)[5] etc. are included. The main issues of automatic face recognition is feature selection and classification of new images based on chosen feature.

In PCA, a mathematical procedure transform a number of possibly correlated variables into uncorrelated variables called principle component. Mathematically. Principle component of the distribution of faces are found using Eigen face approach [4]. First, the Eigen vector of the covariance matrix of the images are found and sorted according to the Eigen values. A threshold Eigen value is set and Eigen vectors with value less than threshold is discarded. At last there is a set of faces with most significant Eigen value is remained which is called Eigen faces. The weight of the Eigen faces are found and stored. It is then compared with the weight of the data base and the best match is found. Independent component analysis (ICA) is a recently developed method in which the goal is to find a linear representation of non-Gaussian data so that the components are statistically independent, or as independent as possible. Such a representation seems to capture the essential structure of the data in many applications, including feature extraction and signal separation.

LDA is a powerful face recognition technique that overcomes the limitation of Principle component analysis technique by applying the linear discriminant criterion. In LDA [9], the data base is divided into number of classes, each class contain a set of images of the same person with different pose, facial expression, backgrounds etc. It assume that all images consist of only face region and are of same size. By defining all the face images of the same person in one class and faces of other people in different classes we can establish a model for performing cluster separation analysis. It is achieved by defining two terms named between class scatter matrix and within class scatter matrix. The linear discriminant criterion tries to maximize the ratio of the determinant of the between class scatter matrix of the projected samples to the determinant of the within class scatter matrix of the projected samples.
Many face detection applications use the traditional Adaboost face detection system which was proposed by Viola and Jones in 2004[5]. Viola and Jones used the Adaboost training algorithm and the Haar-like features in their proposed traditional Adaboost face detection system, which had a high detection rate but long training time. Many studies have attempted to reduce the training time and retain the high detection rate of the traditional Adaboost face detection system. The detection rate of the Adaboost-based face detection system cannot compete with the traditional Adaboost face detection system when the training time is reduced significantly. The eye region study proposes the judging existence of eye region (JEER) [12] method to enhance the detection rate of Adaboost based face detection system. The eyes are more salient and representative feature than other facial parts such as the mouth or ears, especially when mask is worn on the human face. Therefore, the eye region based face detection system can be used as a better solution to replace the adaboost-based face detection system. The experimental result shows that the eye region judgment based face detection system is effective in detection and training.

II. PROPOSED METHOD

The proposed algorithm recognizes the input image and compares it with the database. The recognition process comprises of three stages, they are Face detection, Feature extraction, and Face recognition. Initially, the input image is equalized using General Histogram Equalization (GHE) [1] and Discrete Wavelet Transform and this equalized image is further processed. SMQT [2] is used to detect the area of interest and the result is the face cropped in a rectangular frame. Skin color based detection algorithm is applied to this image because we have chosen skin as the tool for feature extraction. It separates skin and non-skin portions by setting a threshold value and thus reducing the effect of background in the rectangular frame. Finally, LBP [1] algorithm is applied to recognize the face.

![Face Recognition System](image.png)

**Figure 1: Face Recognition System**

III. METHODOLOGY

Instead of directly going to the face detection stage of the input image, it is first equalized. The equalization involves the following steps [1].

1. Equalize the low contrast input image using GHE.
2. Apply discrete wavelet transform to the equalized image and non-equalized image. This will result in four frequency sub bands, that is high-high (HH), high-low (HL), Low-high (HL) and Low-Low (LL).
3. Since the LL component has the most information, LL band from both images that is input image and equalized image has chosen for further process.
4. Calculate a correction coefficient Z using the following equation $Z = \frac{X}{Y}$, where X is norm of LL band of equalized image and Y is norm of LL band of non-equalized image. Since we are using color image as input, we have to apply above steps to each red, green, and blue components of the image separately.
5. Calculate the new Y as $Y = Z \times Y$
6. Reconstruct the equalized image by applying inverse discrete wavelet transform to y and HH, HL, LH of the non-equalized image. $A = \text{IDWT}(y, \text{HHA, HLA, LHA})$. 
3.1. Local SMQT

The equalized image will then undergo Successive Mean Quantization Transform (SMQT). In this paper, SMQT is applied and examined for the detection of face. As a result the face is cropped in a rectangular frame. In SMQT, first take a local area in the image and apply the algorithm. Let x be the pixel of local D, then SMQT transform D(x) into M(x), a new set of values [1][2]. Each local pattern with similar structure yields the same SMQT pattern. The general steps for SMQT based face detection is given in the figure 2.

First we input the intensity image and check whether the image is greater than 32×32 size. If it is, we have to down size the image by a factor 1/ 1.2, due to this the detection of faces with different sizes are possible. Then transform the image by using local SMQT into 9 bit image and it’s then scanned by using 32×32 patch. The face and non-face tables are trained in order to create the split up SNoW classifier. The SNoW classifier stands for spare network of winnows. One of the strong properties of this is the possibility to create look-up tables for classification. After applying SNoW classifier the face portion will score 1 and others have 0. Overlapped detections are disregarded. This operation is repeated till non-overlapped detection is obtained. The result of SMQT is the face that is cropped in a rectangular frame. There may be chances for presence of some part of background or hair in that frames. So that we apply skin color based detection followed by SMQT. This will create a mask for the face and finally we get the face portion alone. Figure 2 shows the output images of SMQT and skin color based detection.

![Figure 2: a) Input image, b) Output of SMQT, c) Mask generated by skin color detection](image-url)
3.1.1. Local Binary Pattern

The LBP operator describe the local special structure of an image [1]. At a pixel position, the LBP operator compare the central pixel with eight neighbor pixels and assign 0 or 1 to each pixel depending whether the neighbor pixel is less than or greater than the center pixel. Then the binary value of corresponding local is calculated. Then it is converted to decimal value [1]. Before starting the recognition process the entire image is sub divided and PDF for each sub image is calculated. These PDFs are concatenated to get a single PDF. We have already applied the LBP to the images in our database. Finally, compare the output image with trained set of images in the database, so that best match can be found. The figure 3 shows the example of LBP operation.

Figure 3: Steps of SMQT
IV. RESULTS AND DISCUSSION

In this paper the test images at different lighting and zooming conditions were analyzed. Table 1 shows the accuracy, precision, sensitivity and selectivity of the test images at bright, dim and zooming conditions. From the study, obtained accuracy of proposed system using LBP at bright condition and zooming condition is 50% and for dim condition it is 12.5%. The precision obtained for bright, dim and zooming condition are 57.14%, 14.28% and 55.55% respectively. The selectivity obtained is similar to the precision value for each conditions. The sensitivity for bright condition is 66.66%, for dim condition it is 50% and for zooming condition it is 83.33%. Further we calculated the efficiency for each condition separately and the values for bright, dim and zooming conditions are 40%, 11.11% and 71.42%. The overall efficiency obtained for the proposed system is 52%.

<table>
<thead>
<tr>
<th>Condition</th>
<th>precision(%)</th>
<th>Accuracy(%)</th>
<th>sensitivity(%)</th>
<th>Selectivity(%)</th>
<th>Efficiency(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bright</td>
<td>57.14</td>
<td>50</td>
<td>66.66</td>
<td>57.14</td>
<td>44</td>
</tr>
<tr>
<td>Dim</td>
<td>14.28</td>
<td>12.5</td>
<td>50</td>
<td>14.28</td>
<td>11.11</td>
</tr>
<tr>
<td>Zoom</td>
<td>55.55</td>
<td>50</td>
<td>83.33</td>
<td>55.55</td>
<td>71.42</td>
</tr>
</tbody>
</table>

Table 1: Analysis of system performance in different conditions

IV. CONCLUSION

In this paper, we have implemented a robust face recognition system using LBP. In the preprocessing stage, input image is equalized using combined GHE and DWT methods. Face localization is done by SMQT followed by skin color based face detection. The result of face localization stage is the extracted face portion from the entire image. LBP algorithm is applied to this image and calculated the PDF of the image. It is then compared with the trained set of images in the database. Finally the best match is found. The proposed method is tested in different conditions. From the analysis it can be concluded that face recognition system using Local Binary Pattern provide best performance in the zooming conditions. The efficiency of the system at this condition is 71.42% and the overall efficiency obtained is 52%.
REFERENCES


[9] suman kumar bhattacharyya1, kumar rahul2. Face recognition by linear discriminant analysis Computer Science and Engineering Department, Indian School of Mines, Dhanbad, Jharkhand-826004, India..


[11] Hwei-JenLin, Shu-Yi Wang, Shwu-HueyYen, andYang-TaKao. Face Detection Based on Skin Color Segmentation and Neural Network Department of Computer Science and Information Engineering Tamkang University, Taipei, Taiwan, China
