EFFECTIVE FACE FEATURE FOR HUMAN IDENTIFICATION

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Abstract

Face image is one of the most important parts of human body. It is easily use for identification process. People naturally identify one another through face images. Due to increase rate of insecurity in our society, accurate machine based face recognition systems are needed to detect impersonators. Face recognition systems comprise of face detector module, preprocessing unit, feature extraction subsystem and classification stage. Robust feature extraction algorithm plays major role in determining the accuracy of intelligent systems that involves image processing analysis. In this paper, pose invariant feature is extracted from human faces. The proposed feature extraction method involves decomposition of captured face image into four sub-bands using Haar wavelet transform thereafter shape and texture features are extracted from approximation and detailed bands respectively. The pose invariant feature vector is computed by fusing the extracted features. Effectiveness of the feature vector in terms of intra-person variation and inter-persons variation was obtained from feature plots.

Keywords: *Center points, Edge detected image, Feature Face-image, Pose invariant.*

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1. INTRODUCTION

Recognition of people is usually done using widely accepted biometric traits like signature, fingerprint and face. Face identification can be done naturally by people or artificially using intelligent machines. Naturally people find it easy to identify faces that are well-known compare to strange faces. Machine based face recognition involves capturing of face images using digital camera under variable facial expression thereafter captured face images are sent to system for identification. Face images contain important revealing parts like forehead, eyes, nose, mouth and chin. These parts occupy different locations and vary closely from one person to another. The major challenge that makes automatic face identification difficult is high intra variation within face images of the same person. This intra variation is caused majorly by variable illumination and pose.

Face recognition systems comprise of face detection, face image preprocessing, feature extraction, training and matching. Feature extraction subsystem is mainly considered in this work. At preprocessing level many morphological processing are done to normalize illumination effect [1]. One method of reducing effect of pose variation is by using robust feature as input data to classification algorithm. Extraction of feature from face images can be done in many ways. In the past many researchers have used methods that involves all the pixels of the whole image [2][3]. On many occasions feature are extracted from vital parts of face images [4][5]. Also face images may be decomposed into smaller image blocks before feature extraction is carried out [6][7][8].

Extraction of feature vector was carried out using group of pixel values within eyes, lip and nose regions in [9]. The feature vector size was reduced and further processed by application of Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). In [10], face feature extraction was done using three multi-scale representation techniques based on Gabor filter, log Gabor filter and Discrete Wavelet Transform whereas in [11], invariant face feature was extracted for recognition purpose using Haar wavelet transform and Principal Component Analysis .

In this work new approach for feature extraction different from those used in previous works is introduced. The proposed feature will suppress effect of varying facial expression. This is achieved by extracting local shape features from smaller image blocks. And this feature is fused with texture feature from detailed bands. The rest of the paper is organized as follows: Section 2 describes the collection of input images and decomposition. Section 3 introduces the new feature extraction method, and section 4 describes feature plot result. Finally, conclusion is presented in section 5.

2. INPUT FACE IMAGES

Digital camera was use to capture face images of people under variable illumination and pose conditions. Fig.1 shows set of face image obtained as the input image to the proposed feature extraction algorithm.

2.1 Face Image Decomposition

Firstly, input colour image is resized and converted to grayscale image as shown in fig.2. The image is passed to Haar wavelet transform algorithm. The image is decomposed into four sub-bands (one approximation band and three detailed bands). The output image obtained from this stage is as shown in fig3.

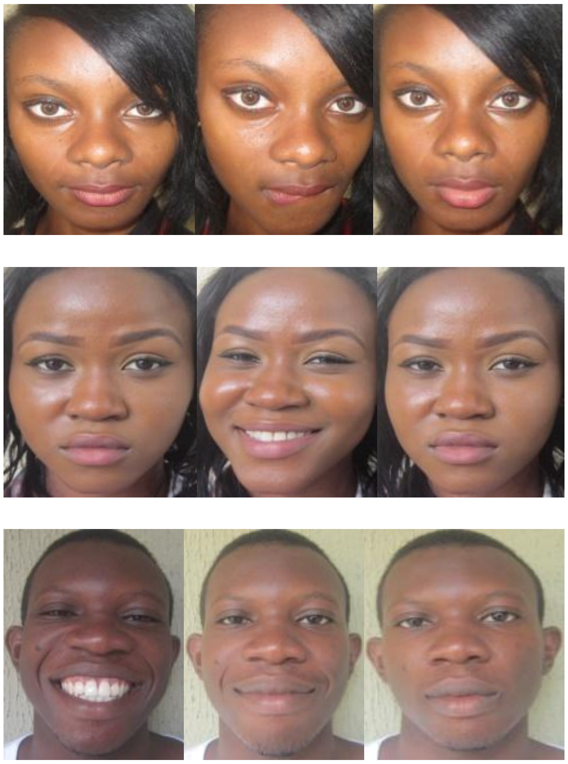

Fig-1: Examples of captured face images.

Fig-2: Sample of input image.

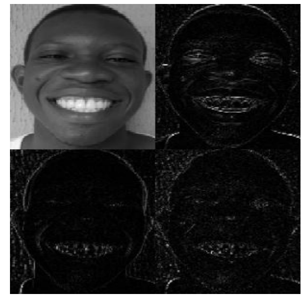

Fig-3: Output of image decomposition.

3. FEATURE EXTRACTION METHOD

Feature extraction technique describes in this section produce fused feature that is able to capture pose variation caused by different facial expression. It is well known that facial components like eyes, nose, mouth and chin have high gray level intensity than the surrounding therefore provide distinguishable edge information. Smooth contour of facial components are created by performed edge detection operation on approximation band. Canny edge detection was used for this operation. The output image was resized as shown in Fig.4.

3.1 Contour Face Feature

Robust geometric feature is extracted from pixels positions of the edge detected image. The feature is extracted using the following steps.

1. Split the edge detected image into two parts

(i) Calculate centre of gravity of the image.

(ii) Partition the image vertically into two image blocks through the centre of gravity as shown in Fig.5.

Fig-4: Edge detected image.

2. Split each of the image-blocks parts obtained from step one into four smaller image-blocks

(i) Calculate centre of gravity of each of the image

(ii) Partition each of the images through the centre of gravity into four smaller image blocks as shown in Fig.6.

3. Obtain two geometric features
(i) Calculate the mean area (mA) of the connected components in each of the eight smaller image blocks as in equation1.

$$A = mA_1 , mA_2 \dots \dots \dots . mA_8 \quad (1)$$

(ii) Calculate the mean perimeter (mP) of the connected components in each of the eight smaller image blocks as in equation2.

$$P = mP_1 , mP_2 \dots \dots \dots \dots . mP_8 \quad (2)$$

4. Concatenate the two features in step (i) and (ii) to obtain geometric feature vector as in equation3.

$$G = mA_1 , mA_2 \dots . mA_8 , \quad mP_1 , mP_2 \dots \dots mP_8 \quad (3)$$

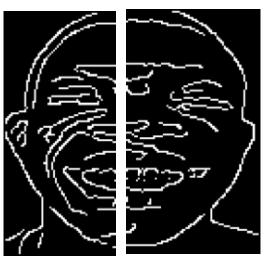

Fig-5: Output of vertical splitting.

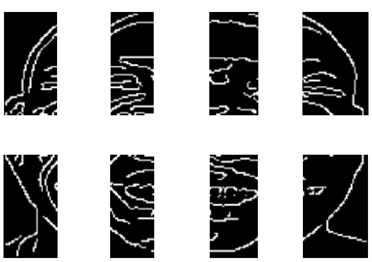

Fig-6: Eight image blocks.

3.2 Textural Face Feature

Texture feature is obtained from the detailed bands using Singular Value Decomposition (SVD). SVD of image H is defined as $H = WSV^T$. Matrix W is the m × m dimension matrix of eigenvectors of the covariance matrix HH^T and matrix S is an m × n rectangular diagonal matrix whereas matix V is the n × n matrix of eigenvectors of H^TH. Given that F1(w,s,v), F2(w,s,v) and F3(w,s,v) are the Single Value Decomposition features extracted from the LH, HL and HH band respectively. Texture feature is calculated using only the first coefficient of the diagonal matrix. Given that F1(s), F2(s) and F3(s) are the coefficient value of diagonal matrix from band LH, HL and HH respectively. Therefore texture feature (T) is calculated as in equation 4.

$$T = (F_1(s) + F_2(S) + F_3(s))/3 \quad (4)$$

3.3 Fused Face Feature

At this stage the features extracted from the approximation band and detail bands are fused together to get the feature that best describe the image. The fuse feature contains relevant information from geometric and texture attribute of the face image. In this work, geometric feature (G) and texture feature (T) are combined at the feature level as it written in equation 5. The fused feature vector obtained at this stage can use as input data to train suitable classifier for face recognition.

$$F_{fuse} = T * G \quad (5)$$

4. FEATURE TEST

Intra-variation and inter-variation of the proposed feature are experimental by plotting the feature graph of two face images of the same person as shown in Fig.7. Also a feature graph of two face images from different persons is plotted as shown in Fig.8.

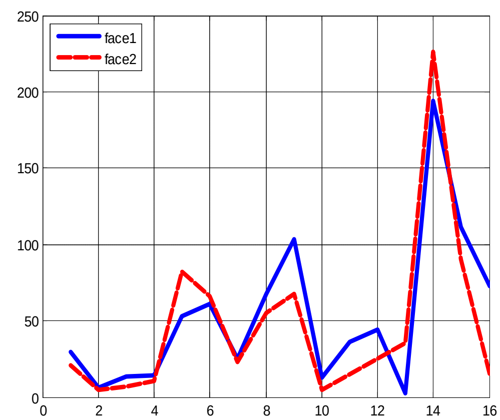

Fig-7: Intra-variation feature plot

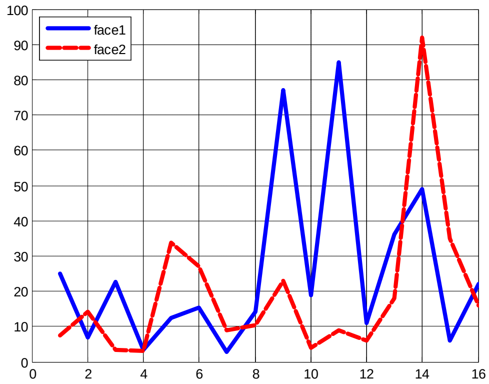

Fig-8: Inter-variation feature plot.

5. CONCLUSIONS

This work presents extraction of fused feature from face images. The feature is robust enough to reduce intra-face images variation and increases inter-face images variation. This feature is produced from first level decomposition of face image using wavelet transform. Geometric feature obtained from approximation band is combined with texture feature from other bands to generate the fused feature vector. Test results proves that proposed face feature extraction method is robust enough to reduce the effect of varying face pose for effective face recognition

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