RESEARCH ARTICLE

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Parametric Linear Subspace Method for Face Recognition and Pose Estimation

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ABSTRACT

A robust face recognition system is described in this paper which is insensitive to human head pose. The combination of Gabor Wavelet Network (GWN) and Parametric Linear Subspace (PLS) method is used for effective and efficient face recognition process. Multiple feature extraction is done and various steps of pose estimation carried out using new algorithms. In this work, the complete algorithm has been carried out in various stages. Initially, source images are applied and flag is set. In the next step, image is converted to gray scale image and the given image's extension is converted into portable gray map. calculate the analysis mapping that is estimate the pose of head from given image, given image is compared with the database, decision is made according to the matched or unmatched templates, above steps are repeated until matching of last database template.

Keywords: Face recognition, GWN, PLS, Pose estimation, Classification of Face Recognition, LPCMAP.

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INTRODUCTION

Biometric is defined as the characteristics of human which is unique and can be measured for uniqueness or digital authentication purpose. It is the combination of three fields that is image processing, pattern recognition and computer storage system. While defining a characteristic for any biometric system some of the important points that should be noted, every individual should possess defined characteristics like face, iris, palm prints etc, and it should be static in nature. Face recognition and pose estimation is the key area for research in biometric, Face recognition technology (FRT) is embedded with head pose estimation for recognition of individuals with enhanced accuracy and effectiveness [1]. For estimating head pose having different expression and illumination, Parametric Linear Subspace (PLS) method is used. The system combines both verification and identification of images. Gabor wavelets are used in this system for efficient and effective detection of land marks on the face (nose, eyes, mouth, etc.) [2-3].

Face recognition and pose estimation is a key research area in field of biometrics, computer vision, and pattern recognition. In the word of Graphics and machine learning also Face Recognition Technology (FRT) is increasingly becoming popular

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[4]. Face Recognition can be classified in two categories first is face verification and second one is face identification as shown in Figure.1, again the identification can be classified as open set and closed set.In identification the given image is compared with all the templates which is stored is the database and in the result is nearest matched templates is shown, if the given image is found in the database then it is called closed set identification, else the image that matches nearest template is called open set identification, this process is one to many comparisons.

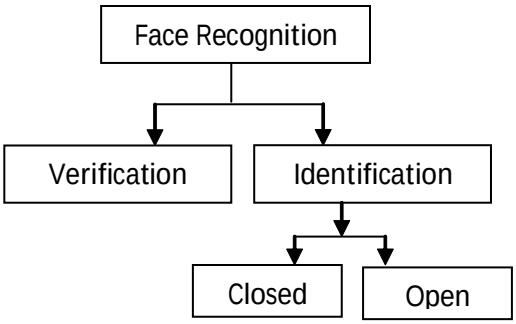

Figure 1: Classification of face recognition

The Linear Parametric Component Analysis Mapping (LPCMAP) method which is the most effective method for pose estimation of human head. A framework for analysis, synthesis mapping is done for mapping head to pose and vice-versa [5]. The Parametric Piecewise Linear Space (PPLS) method by which various poses can be captured in a wide range. Parametric representation model and Piecewise Linear Method is used for preparing Parametric Piecewise Linear Space (PPLS) method [6]. The location and orientation of a given object can be determined using this method and it can be used for finding both pose of a rigid object and constrained object [7].Feature based head pose estimation estimates the pose from monocular images and the Degree of Freedom i.e.roll determines head angle along x- axis, Pitch determines head angle along y-axis, Yaw shows the head angle along z-axis [8]. Arobust face recognition and practical application of the system a pose adaptive filter is used for extracting 3D pose. Mapping Based model in combination of Principal Component Analysis (PCA) which provides the robust solution for pose estimation and animation [9-10].Gabor Wavelets Network (GWN), provides robust landmark tracking system, it detects any facial feature and can capture any geometry of face [11-14]. Pose estimation is basically used in object tracking applications especially for 2D and 3D pose estimation. Component analysis is used for land mark extraction and for face recognition feed forward back neural network is used to detect or recognize the face [15-18].

METHODOLOGY

In this work, the complete work has been divided into six phases. In the first phases, source images are applied. In the next step,image is converted into gray scale image. The given image's extension is converted into portable gray map (filename.pgm) in the subsequent step.Fourth phase, calculate the analysis mapping that is estimate the pose of head from given image.In the fifth phase, given image is compared with the database and finally, decision is made according to the matched or unmatched templates in the last stage. In the seventh phase, the result is shown according to the decision made in previous step, and expected outcome will be either the closed set identification if the given image is mapped exactly with template matched which is stored in the database else result will be the open set. The whole procedure is drawn in Figure.2.

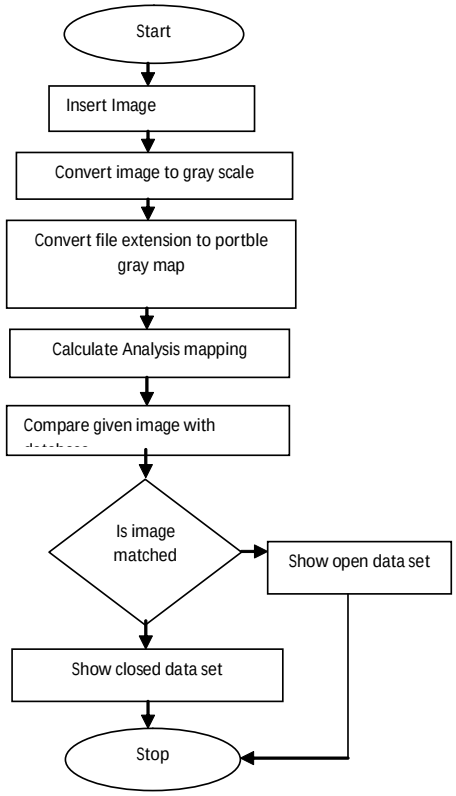

Figure 2: Work Flow diagram of Face Recognition and Pose Estimation

In the present work, appearancebased pose estimation technique is used under which Parametric Linear Subspace method is used as it has a feature of bidirectional mapping. Analysis and synthesis mapping were introduced and the feature extraction is done by using Gabor Wavelets Networks (GWN). Due to change in human head angle the facial image also changes, a new face recognition system is introduced which is insensitive to variation of head pose. And to Compare and identify the given individual's still image with the templates stored in the system's database having different head poses of the same person. The experimental work has been carried out using Gabor Wavelets for feature extraction.

For Image Pre-processing, Image Enhancement, Histogram Equalization, Image Binarization, Image Segmentation process has been used. In the present work, Appearance based pose estimation technique is used under which Parametric Linear Subspace method is used as it has a feature of bidirectional mapping. Analysis and Synthesis mapping were introduced in this work. Feature extraction is done by using Gabor Wavelets Networks (GWN). The most common way to binarization any image is, a threshold value is taken and all pixels with values above this threshold can be classified as white and all other pixels as black. Selecting a correct threshold is a problem.

Many researchers are using various pose estimation techniques. Among them some good estimation technique for pose-invariant face recognition are Multi-view approach, Piecewise Linear Subspace Method, Appearance-based techniques

Multi-view Approach

Multi view approach uses multiview gallery where many templates of different poses single person are kept. But the main disadvantages of this approach is storage system required will be large, so the cost will increase in terms of memory.

Piecewise Linear Subspace Method

As per the theme of the problem and assumptions, the original image suffers from inaccurate calculation of head pose even is some face recognition system head angle cannot be computed. Hence, to remove these problems parametric linear subspace is used. It is also known as analysis synthesis Chain (ASC).

Appearance-Based Techniques

In current work Appearance Based Pose Estimation technique is used for pose estimation. In Appearance Based Method any given image is represented in terms of several objects and image is considered as high dimensional vector.

Parametric Linear Subspace (PLS)

As per the theme of the problem and assumptions, the original image suffers from inaccurate calculation of head pose even is some face recognition system head angle cannot be computed. Hence, to remove these problems parametric linear subspace is used. It is also known as analysis synthesis Chain (ASC). As analysis can be defined as mapping from image to pose which is also known as pose estimation. Synthesis mapping can be defined as mapping from pose to image.

Gabor Wavelets

In analysis synthesis chain there is the procedure for feature extraction and in present work Gabor wavelets network (GWN) is used. It is represented by using Gabor wavelet function $\Psi = \{\Psi_{n1}, \ldots\ldots \Psi_{nm}\}$ of them

$$\Psi_n(x,y) = \exp\Big[-\frac{1}{2}[s_x((x-c_x)cos\theta - (y-c_y)sin\theta)]^2 + [s_y\big((x-c_x)sin\theta + (y-c_y)cos\theta\big]^2\Big] * \sin\big((x-c_x)cos\theta - (y-c_y)sin\theta\big)$$

Where, parameter vector = n, n = $(c_x, c_y, \theta, s_x, s_y)$, (c_x, c_y) denotes translation of gabor wavelets. (s_x, s_y) denotes scaling of Gabor wavelets, θ denotes orientation. Translation, Scaling and Rotation (orientation) of Gabor wavelets can be represented in terms of matrix as.

Scaling matrix S= $\begin{pmatrix} s_x & 0 \\ 0 & s_y \end{pmatrix}$

Rotation matrix R= $\begin{pmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{pmatrix}$

Translation vector C = $(C_x\ C_y)^T$

Implementation of Algorithm

An implementation of algorithm Parametric Linear Subspace (PLS) is described below.

Developed Algorithm (PLS) The developed algorithm called PPLS (Parametric Piecewise Linear Subspace) has been depicted below.

Main program {starts}

Read the known image.
Set the flag for best fit as fbest = 1
Do
If
Image is colour convert it into gray map
Compute Analysis Mapping
Else If
Compare the input template with database
End Do
true then set the flag fbest = 0
Display Result as 'CLOSED SET' or 'OPEN SET'

EXPERIMENTAL RESULTS AND DISCUSSIONS

The present work of this paper with experimental setup of the work that has been carried over a collection of data set of images. The developed algorithm called Parametric Linear Subspace (PLS) for pose estimation has been tested with necessary test data. After collection of data set, different phases and algorithm are implemented. And experimental results are shown for both semiautomatic and fully automatic verification and identification of faces.

A large amount of data set is collected to conduct this experiment. More data set will result in better performance semiautomatic and fully automatic verification and identification of faces.

Collection of dataset as shown in Figure 3, where images of different person having different poses were captured for analyzing the experimental results. More data set will result in better performance of image identification approach. The experimental setup involves image feature extraction, matching, comparisons and final result.

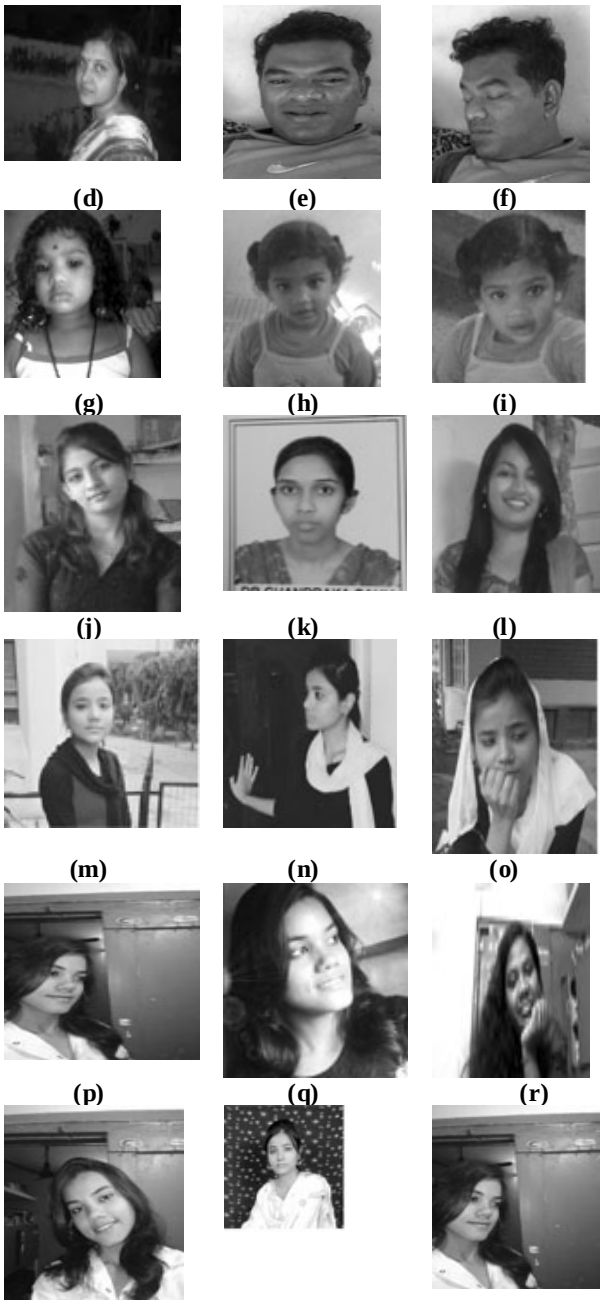

Figure 3: Collection of Dataset

Screenshots of Experiment Performed

After the collection of this large data set, experiment is conducted. For this Graphical User Interface (GUI) is created. The below images of screenshots from figure 4 to figure 11 makes the picture of experiment moreclear. In this experiment source image is inserted. Then on the basis of PLS which is applied

to given image. For these two buttons are provided in Graphical User Interface (G.U.I).

Figure 4: Opening of G.U.I for Performing Experiment

In the Figure 4, G.U.I for robust face recognition tools is made, here three buttons are there namely, train, single test and multi test. Figure 5 and figure 6 show the path for uploading dataset which are all available in the database. Image is selected for comparison with database has been shown in figure 7.

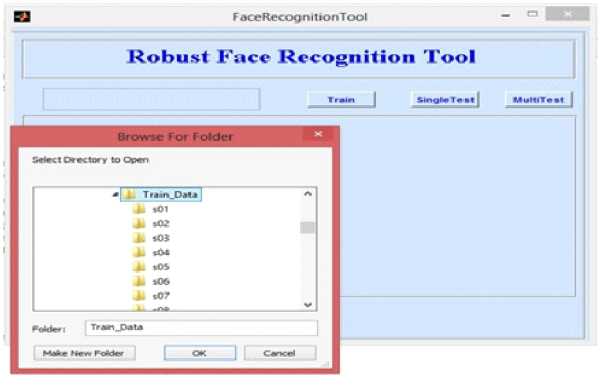

Figure 5: Browsing folder for uploading dataset

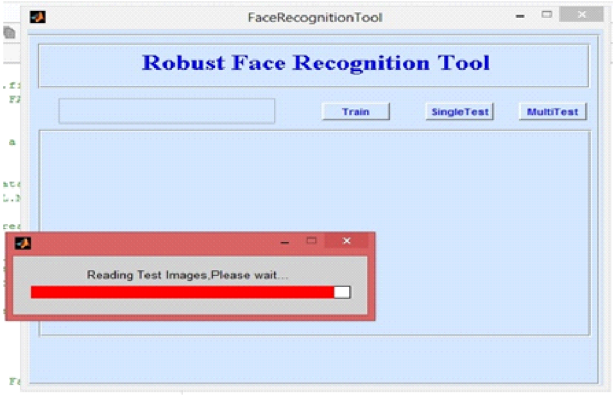

Figure 6: UploadingImages through Browsed Database

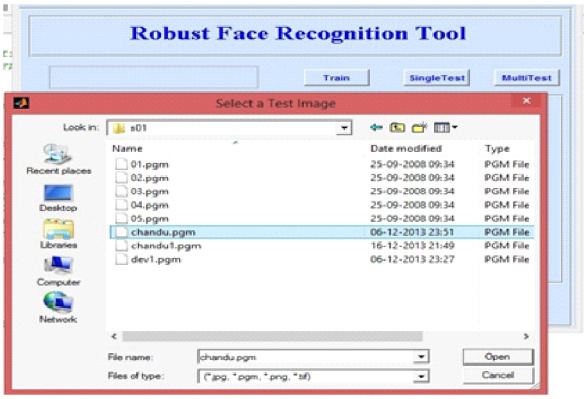

Figure 7 : Selecting image for comparison

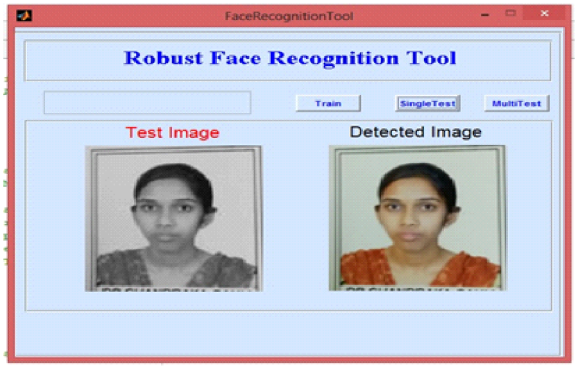

Figure 8 : Possible Outcome

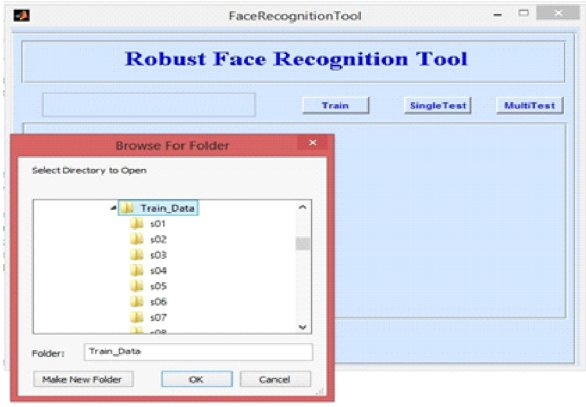

Figure 9: Uploading dataset for multiple tests

Figure 8 represent the comparison of image with possible outcome. Multiple tests for uploading dataset is done in the figure 9. For multiple test user have to again upload data where image is compared for nearest matched face is shown in the figure 10. Figure 11, a multiple test is shown where a user have to decide the detected image is correct or not, as the output is nearest match to the given input image.

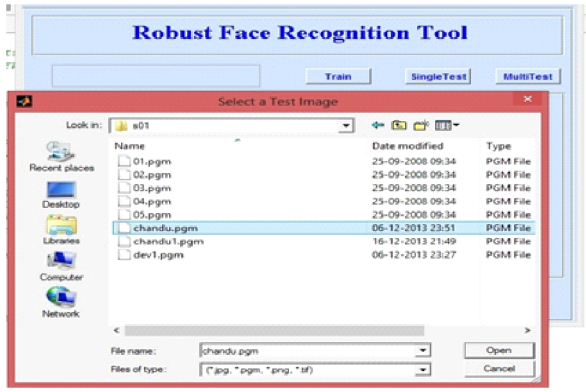

Figure 10: Uploading image for multiple test

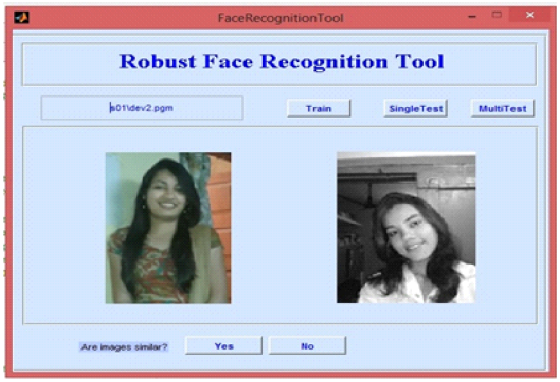

Figure 11: Semi-automatic image recognizer

CONCLUSION

In this paper, face recognition and pose estimation based on multiple features is developed and a comparison is shown in the result in form of snap short. Considerable amount of work has been done on face recognition and pose estimation using different approaches. The work is carried out by using PLS and Gabor Wavelets Network. Multiple feature extraction is done and various steps of pose estimation re carried out using new algorithms.

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