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A Review on Side-View Face Recognition Methods

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ABSTRACT: Automatic recognition of human face has been an active research area in recent years. The paper gives a review of various techniques for face recognition including support of side view face. Face recognition using occluded face, profile view face images are still an issue in human recognition for various practical applications. In real-life circumstances where the environment is not predicted where have to dealing with pose variations like up down or side-view positions are a significant task for face recognition. Here author gives a brief idea about various techniques used for side-face recognition and proposes an algorithm which can be used for human face recognition with complete face or side-face image as inputs. Also compares the performance of proposed work with other existing front and side face recognition algorithm. The proposed algorithm extracts facial components like Eyes, Nose and Lip corners prior for feature extraction from input image. All face facial features are extracted and that to be compare with corresponding same feature of dataset images.

KEYWORDS*:* Face Recognition, Wavelet transforms, Random Forest, Dynamic Time Warping, Harris corner detection, canny edge detection, Viola Jones, Region of Interest, Local Binary Pattern

I. INTRODUCTION

Face recognition is a process with numerous applications of surveillance systems which deal with identifying people from image, images or video [1]. Face recognition has long been a challenge in computer vision, but only in recent years reliable and efficient computer aided face recognition has become a target of researchers. Novel algorithms and developments have been deployed in numerous of the practical face recognition systems. Face Recognition is defined by consisting of mainly three steps [1]: i) Face Detection, ii) Feature Extraction, iii) Classification Matching.

In detection stage it acquires only face or faces region as ROI with their coordinate, and surrounding parts to detach. In feature extraction stage, it describes particular face parts in form of feature value from face region. Finally in classification stage it match feature value of current face image with correspondence dataset images' face features. Feature extraction stage is very critical because if feature extraction doesn't perform well then best classifier can't produce precise result.

Face recognition techniques can be broadly divided into Geometric and Photometric approaches [2]. Geometric approaches consider individual features such as eyes, nose, mouth etc and then develop a face model base on the size and the position of these characteristics. In Photometric or template method it compare whole face model as single unit. In latter step of both methods, the facet values are extracted. Consequently, these values are compared with the saved templates.

In recent time surveillance systems, home security or smart security application which deal with identifying people from their images or videos where the pose of human is not predictable. And can't expect front view of person all the time for recognize purpose. So here review available methods that are dealing with front as well as side-view face recognition.

II. REVIEW OF SIDE VIEW FACE RECOGNITION TECHNIQUE

Existing side view face recognition method was developed with specific constraint like only for exact side view [3, 11], certain methods require large number of dataset reference image for matching [7, 15, 22], few methods require high quality image [9, 10] for detection and matching. The Side view face recognition method can be classified into

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two major categories: the appearance-based methods and synthesis face creation method. The appearance-based method use pixel element [1] and extract edge value of face profile. Synthesis face creation method focused on face creation from multiple sights of a same person's different angle [1, 2], and that developed face used for match as recognition.

A. ***Discrete Wavelet Transform (DWT) and Random Forest***

This method offer a new inimitable side view face verification method which works based on discrete wavelet transform (DWT) and random forest [3] where it requires more number of training face data which allows subsets to preserve the global information. The flow diagram is shown in Fig.1.

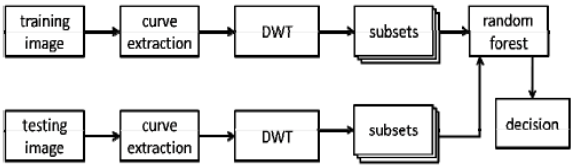

Fig. 1 Flow diagram of the proposed approach

In DWT & Random Forest require visible face outer-line requires being extraction for further investigation and decision. So it starts with edge detection task to find out edges, so it chooses canny edge detector [4] method. Threshold value for edge detection is decided by number of test image sample's edge on outline of face. Once edge has been detected it starts for face alignment using geometric transformation, because face orientation angle can be vary. They suggest tangent-based normalization [5, 6] method for face alignment and rotation. Main purpose in DWT is to fetch coordinate for nose part because nose is center portion of face by which other face features like eyes and mouth spot are easily capture for human recognition.

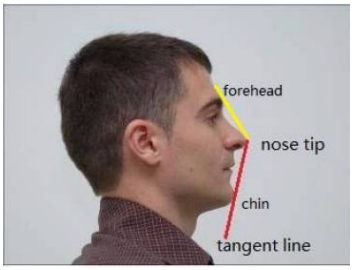

Fig.2 Curve extraction and alignment

After successfully fetching edge value in next step it require to obtain curve descriptor. So, DWT & random forest suggest wavelet coefficient method for corner coordinate as it uses curve with different gesture of face part. As a result it gives face outer line with curve descriptor from lower chin to forehead part. Further step required for face outer line matching, and that can be done with conventional wavelet coefficient [7, 8]. DWT & random forest suggest distance-based methods are not appropriate for above because it cannot predict or expect curves to be aligned exactly on similar place. For prominent result DWT & random forest works with extract side face curve with 90 angles.

B. ***Face Profile Recognition Using Dynamic Time Warping (DTW)***

The principle requirement of DTW algorithm is it require good quality image. DTW method works normally when input is from video streams. So frame by frame DTW fetch front or side face image as ROI. Then begin preprocessing of storing face images because later on it used as synthetic face profile construction [9] and that will be finished by face matching for recognition purpose. Major function of DWT is:

1. ROI to be extract from image called pattern template. Pattern template contain feature that should be detected from frames. Further surroundings background portion of image should be removed.
2. Calculate the normalized cross correlation between the template and the region defined in reference images.

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3. Measure expected object region position and extract region, where the normalized cross correlation gets possible value.

In DTW, Result of face recognition relies on quality of high-resolution image. Also decreases performance if cross face or face occlusion or more side view. Target input contains multi frames so DTW compute interval among frames using Elastic registration algorithm [20].

C. Side-face portrait recognition based on Fourier Descriptor

Face recognition based on Fourier Descriptor method consist of three steps: i) Face outline extraction for choosing ROI from profile image, ii) Fourier Descriptor feature extraction from face part and iii) Feature comparison for recognition [11]. In first step, face outline extracted from whole image background. So as result it acquires overall face contour line. In next step determine two feature points at forehead and lower chin. Further input is to detect curve between two points as extract Fourier descriptor. Fourier Descriptor algorithm locates part which was consistent to rotation, scaling or zooming transformation. The first part of the algorithm is to isolate unwanted background details from image. For that Fourier Descriptor uses distinguishing color in the YCbCr space. The next step is the contour detection and it is possible by finding the binary image of the portrait. The binary image is obtained by using the following equation

$$P = \begin{cases} 0, & s \leq \varepsilon \\ 1, & s \leq \varepsilon \end{cases}$$

Fig. 3 Original Image and Binary image

Figure 3 shows binary image, it get the portrait curve line by simple edge detection method that include both facial information like the shape of forehead, nose and lower jaw as well as some other much uncertain information like the hairstyle and clothing line etc.

Figure 4 display point for start extracting region which is from lower jaw. Lower jaw pattern is average edge through possible four minor edges. Nose region is significant part of the face so using edge value and corner pixels it find out coordinate. To remove hair portion Fourier descriptor select mirror part of counter line from bottom coordinate to nose coordinate.

Fig. 4 Contour line extraction and the construction of the closed curve

Fourier descriptors use edge detection and corner pixel value for closed curves; Face border line start from upper part of forehead to lower jaw. This region used for recognition with dataset reference images. In geometric transformation Fourier descriptors are fairly reactive for translation, rotation with specific angle and zooming or enlarging with pivot coordinate.

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D Side-face Recognition using LBP and Face warping

In LBP and Face warping method the primary task is to register images using manually labeled landmarks [19]. Then, apply preprocessing on registered images to remove surrounding area and warping to achieve shape-free texture images. LBP used Procreates analysis [18] to find the transformation parameters between images. First, LBP aligns the landmarks of the images in the training set to find the average landmarks. Then, it computes the transformation between each image and the average landmarks. In order to have fixed sized images LBP place a bounding rectangle around the face, then it crops the image to find the parameters of the bounding rectangle. Moreover LBP locate the rectangle using the average nose tip landmark, and crop all images accordingly.

Fig. 5: Manually labeled landmark points.

In above Figure 5 can see manual landmark. LBP is a feature description method which is used for describing local spatial structure of an image [17]. It is widely used in face recognition applications due to its invariance against illumination changes, and its computational simplicity. In this system, LBP divide the images into 75 sub regions, and compute the LBP histograms for each region. Then, concatenate these histograms to achieve the feature vector of the image. For classification, LBP use nearest neighbor method using Chi square distance measure [19].

E Side-face Feature extraction using LBP

Another LBP method uses a face feature extraction technique for side view face recognition. The system is attempting for automatically analyze then recognize facial portion [21], in earlier method of LBP it require manual feature extraction. Here LBP applied techniques on these images like Original LBP, Extended LBP and Principal Component Analysis. PCA is used to minimize the features required to represent in each image which turn it to reduce the computational complexity of the system.

Fig. 6: Barack Obama eigenvectors

Purpose of PCA is using Eigen face method that keeps smaller dataset in size with minimal reference image for recognition purpose. These data are stored in form of feature vector that to be match with target input image. PCA on Eigen face is advisable only when dataset size is too large. In Figure 6 can see Obama's eigenvectors. This approach is

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firmly not advisable for strict identification application. Mainly this approach is use to detect and recognize face from crowd.

F Face Recognition based on Gabor Coefficients

In Gabor Coefficients, for face detection they use skin color method with appropriate value of color pixel. This technique works well throughout change in human size, face orientations and face occlusion too. In Gabor Coefficients image need to be converted into YCbCr color space for extracting the face region. Primary task of this algorithm is to fetch face feature eyes, mouth and nose with it's of individual coordinate.

Basic task required is to remove noisy data from frames, and for that Gabor Coefficients use average filter on image. For feature extraction in this method they use edge detection technique for detecting outside edge of human face profile. After that, Gabor Coefficients extracts the corner coordinate value on edge. First it retrieves lowest coordinate on face. They assume height of face is 1.3 times wider than its face width [14]. To finish task it draw rectangle for indication of face region and face components like eyes, nose and lips that are obtained by analyzing the chrominance values.

In Gabor Coefficients, for face recognition it require coordinate of face feature that to be use with fuzzy classification algorithm [20]. For harmonizing purpose it used a neural network that compares geometric distances feature and Gabor coefficients feature. Geometric distances feature and Gabor coefficients can be used separately or combined both [15]. Gabor Coefficients recommend, Gabor coefficients are more powerful than geometric distances [16, 20] approach. For matching purpose Gabor filters are used five different spatial frequencies along with eight different face orientations [15, 16]. They prepare 40 individual testing samples for matching purpose that are displayed in Figure 7 shown below.

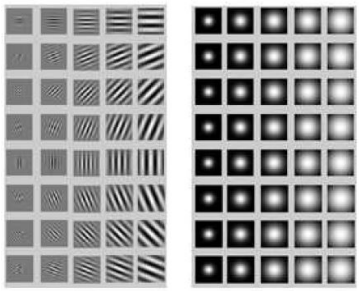

Fig. 7 Gabor Filters; Real part and Magnitude

After successful creation of feature vector it's time to apply on test image. Gabor filters apply feature vector on specific pixel segment. Dimension of selected vector may be large but as result it increase computation and storage cost. To remove kind of problem and make it efficient Gabor features are obtained only at ten extracted fiducially points.

G Profile Face identification from contour line

This method presents a sensible technique for human recognition based on face outer line in accommodating background [22]. In this method it need to extracts individual face features automatically from profile outer line. Then it matches person's profile with their dataset image. They use Euclidean distance as quite diverse approach to facilitate calculates curve's distance of face, using this distance value it strives to prepare face. It starts with position of nose coordinate. In next step it draws half circle with specific radius at forehead for upper face and lower face below at mouth portion. In last part using curves it prepare complete face for matching.

Face creation using curve distance have some pixel distortion. So it produces fair result that is not sensible for firm recognition. Another weakness is it requires very high memory for accumulate and maintain curve values. To achieve good result with this method it expects white colour background. Because in white colour they can exact edge value and produce accurate result. They conclude with speed of technique is prominent but irrespective with accuracy in recognition [22]. Later on this approach extends to 3-Dimentional synthetic face creation.

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III. PROPOSED ALGORITHM

Although considering real time environment the input image may often have other background objects too. So face area should be extracted from the image scene. Viola Jones Algorithm [12] is used to detect face from image scene. Viola Jones face detection algorithm perform feature extraction using boosting and multi-scale detection. The analysis will be efficient only if the feature extraction is free from the exposure and pose variations.

A. *Face Objects Detection*

First step is to extract face components like Nose, Lips, and Eyes. Viola Jones algorithm is also used to isolate Left eye, Right eye, Nose and Lips. Sometimes the profile face area contains only one eye and only one lip corner and a part of nose. So the Viola Jones algorithm selects only those face components. For getting the edges of the extracted Face Objects, Canny edge Detection [4] is used. In edge detection method it's quite possible that it can easily affect by noise [23] and generate wrong result. So in edge detection it's desirable to use Gaussian filter for smoothing the edges on image. Moreover canny edge detection algorithm uses four filters to detect horizontal, vertical and diagonal edges in the noisy image [23].

B. *Feature extraction*

Task of feature extraction is to separate individual face feature from face region. Here feature points are taken by using Harris corner detection [13]. Harris corner detector basically finds the difference in intensity for a displacement in all directions. This helps to get relevant corner points and coordinate positions, and those points are considered as the feature vectors. After getting feature vectors, next step is to compare feature points of available face components with corresponding components in the database and most match result is taken.

C. *Feature Matching*

In Feature Matching step it requires to compare dataset image feature with current face's feature. In Proposed method, it will compare feature value of human face like eyes, nose and mouth one by one. Proposed approach find nearest key points in query image and the reference image. If the distance between two key points is less than a particular threshold, it can be considered as a matched key point. The overall match between two images will depends on the total number of matched key-points.

In Match Result it designate similarity between face feature like eyes, nose and mouth then will do summation and division of it with equal weight of face feature. Average Match Result value may vary for front face, side view with different angle, face occlusion, noise in face feature etc. So may decide different threshold value for different type of image.

IV. COMPARATIVE STUDY OF VARIOUS METHOD

From the evaluation using random samples of selected datasets, following results can be concluded among an assortment of methods. Each method listed below created with restraint. Below table described each method's key features and surroundings where it executes well.

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Author	Technique	Methods	Feature type	Face Occlu. Result	Side view Reco. Support	Face Up down Support	Require Image Quality	Dataset Train Set Size
Sihao Ding, QiangZhai, Zheng, Y.F, Dong Xuan	Geometry based	DWT & Random Forest	Wavelet features from side-face curves	Poor	Good	No	Normal	Large
Zhou. X., Bhanu. B	Template Correlation based	Dynamic Time Warping	Normalized cross correlation coefficients from face region	Poor	Average	No	Good	Less
WU Hong, Ping, Zhen	Geometry based	Fourier Descriptors	Key points from face edges	Poor	Good	No	Normal	Less
Pinar, Spreeuwer, Raymond	Geometry based	LBP based	local spatial structure	Poor	Good	No	Normal	Less
C.Nagaraju, B.Srinu, E. Srinivasa	Geometrical features	LBP features	Texture features from face region	Poor	Poor	No	Normal	Less
Yousra Ben Jemaa Sana Khansfir	Geometrical features	Gabor coefficients	Face localization and key point detection from eyes, nose etc.	Good	Poor	No	Good	Large
C. Beumier, M. Acheroy	face modeling	Contour detection	Triangulation of external contours	Poor	Average	No	Normal	Large
Proposed Method	Adaptive Template matching based	Harris corner detection	Corner key points from face components like eye, nose, lips, nose etc	Good	Good	Yes	Normal	Less

V. EXPERIMENTAL RESULT

We have tested around 400 samples in control environment and real environment too. In front face, we get average 81% matching up to 3 fit distances, 75% matching up to 4.5 fit distances. We have tested side view image up to +-20 angles where we get 72% average matching. In cross face, result decreases up to 64% matching.

In real environment human face expression can't be normal all time so change in face expression may shrink matching result. Some other aspect like glair, shadow, low light, more side view, orientation also responsible for lower matching because principle requirement here is face fragment seems clearly visible for further investigation.

VI. CONCLUSION

We analyzed various profile face recognition techniques with its performance. Most of the existing methods for side face recognition are very primitive and results are not agreeable in all aspects. Some method works fine with only side view face, some works only with clear face and without orientation or occlusion. So, in the proposed method, the available face component is extracted properly and provides good result after match with dataset images. We are trying to increase face matching result value in real time environment where there may be issue of face orientation with respect to cross face and bit increase of side view too. The facial appearances are compared with feature vectors of the corresponding face elements of the face images that are already saved in the database. At certain stage we can manage with no recognition of object but false recognition may mortify method authenticity.

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