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RECONSTRUCTION OF FRONTAL FACE FROM NON FRONTAL FACE USING COMPUTER VISION TECHNIQUE

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Abstract- Face recognition is used in forensic field. Face recognition become difficult when there is variation in poses. It is easy to recognize face from a frontal view. In order to recognize face, reconstruction of frontal face is necessary. Reconstruction can be done in 2D or 3D images. Compare to 3D image 2D is less cost and time saving. In this paper reconstruction of frontal face is analysed for various data bases and to improve the accuracy for better images. Based on the landmark points better half of an image is obtained .using stretching, mirroring and flip operation frontal face is reconstructed. Experiments were conducted on Yale, LFW, PUBFIG databases and the experiment results show that it can handle frontal face reconstruction from a non-frontal face.

Key Words — Landmark points, better half image , stretching, tilting, mirroring

I. INTRODUCTION

In real world application face recognition is a challenge task. Face recognition is used in various application such as surveillance, military applications, crime investigation etc. handling pose variation in uncontrolled environment in comparison with gallery image is difficult. Most of the face recognition algorithm yield satisfactory result. One of the optimum solution to recognize face is to reconstruct frontal face. The existing method has some drawbacks such huge landmark points, manual selection of land mark points, use 3d model generation etc. These method only handles discrete set of poses and require some manual labelling.

A pose normalization approach based on fitting active appearance model was investigated[1] and profile faces with different rotation angle in deep was wrapped into free shape model. A 3D pose normalization that is completely automatic and accurate 2D facial feature were found by the system[2] . A multi dimensional Gaussian process regression is used to learn non linear mapping function from 2D face images at any non frontal pose[3].This method can handle pose variation up to 45 degree to the left or right (yaw) and 30 to up or down (pitch angle)using training set of sparse images , point coordination function was built which are responsible for apparent changes in shape[4].Virtual faces fed in to the system make use of gabor filtering for recognition[4].The non frontal face image is normalized into virtual front image by component by component[5] .A generalized linear mixed model analysis of the Good, Bad, and Ugly Face Challenge, a pre-eminent face recognition dataset used to test state-of-the-art still image face recognition algorithms[6] using permutation methodology in montecarlo sampling procedure the recognition rate results was obtained by PCA , ICA,LDA[7].

II. PROPOSED METHODOLOGY:

The working of face reconstruction algorithm includes the following steps

- Face detection
- Landmark location
- Find the better half
- Extract the better half
- Stretching and Flipping Operation

A novel approach is proposed for reconstruction of frontal face from non- frontal face. The processes of reconstruction frontal face is shown in Fig 1 from the non frontal face salient landmark points are estimated. The facial components such as

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eye, ear, nose are detected using object detection algorithm the division of face into two halves depend on quality of object detection process. It has some advantages such as no head pose estimation, no need for comparing gallery image. The rest of the paper is organized as given section as automatic land mark detection, selection of better half viewed image, other half view of the face selection from better view, results and finally ends up with conclusion.

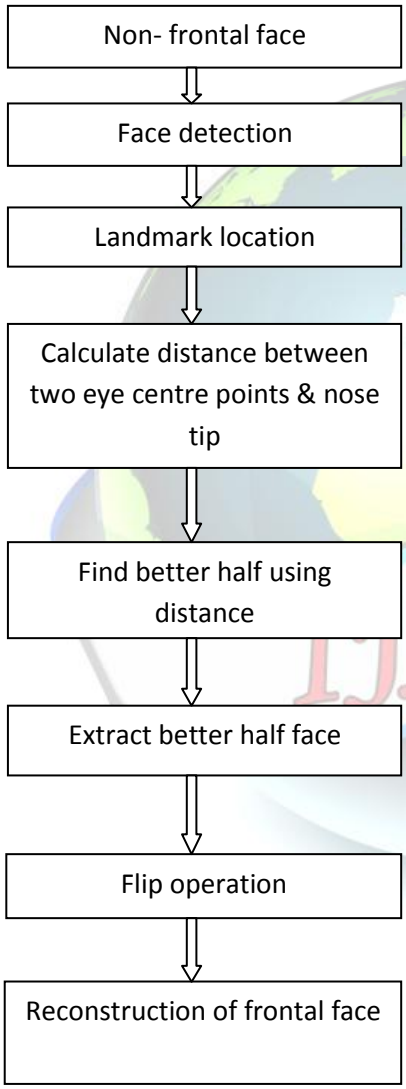

Fig 2.1 Framework for frontal face reconstruction

Given a non-frontal image x, for which the frontal face is to be reconstructed.

Procedure:

1. I/P : Non Frontal Image

2. Face ROI detection

3. Facial Component detection : Left Eye , Right Eye, Nose, Mouth

4. Facial component based and derived landmark point detection

5. Divide the detected face into two halves such as left and right by connecting the landmark points vertically located on the face.

6. Compute d_{nl} , d_{nr}

d_{nl} : The distance between left eye center point, nose point.

d_{nr} : The distance between right eye center point, nose point.

7. If $d_{nl} > d_{nr}$, the better half is the left of the face otherwise right half.

8. Extend / Stretch better half face with respect to the center line of the face ROI.

9. Apply mirroring operation to the stretched better half to get mirrored half.

10. O/P : Reconstructed frontal face

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Fig 2.2 Process of frontal face reconstruction

A. Automatic Landmark Detection:

In order to attain full automation, novel method is used for face detection. The cascade object detector is used to detect facial features such as eyes, nose and mouth. Based on the facial features, landmark points(left eye center point, right eye center point, nose tip, mouth tip) are detected by finding the midpoint of eye(s), nose, mouth rectangular features.

The formula for finding the midpoint of the eye are

Midpoint = $[(le_x + re_x)/2, (le_y + re_y)/2]$

Where le_x is the x axis of the left eye centre point

le_y is the y axis of the left eye centre point

re_x is the x axis of the right eye centre point

re_y is the y axis of the right eye centre point

Next, the chin points are detected by using the distance between the nose tip and the mouth point by placing the landmark below the mouth point(x axis is constant and the distance is added to y axis alone).Comparing to other methods only the above six landmark points are used to reconstruct the frontal face.

Fig.2.3 Landmark detection

B. Finding the better half face:

After detecting the landmark points, the better visible half image is constructed. In order to find the better visible half image, calculate the distance between the left eye centre point and the nose tip and also calculate the distance between the right eye centre point and the nose tip. Compare the two calculated values and depending upon the higher distance the better half face is obtained.

$$d_{nl} = sqrt((no_x - le_x)^2 + (no_y - le_y)^2)$$

$$d_{nr} = sqrt((no_x - re_y)^2 + (no_y - re_y)^2)$$

where (no_x, no_y) is the pixel value of nose tip point and (le_x, le_y), (re_x, re_y) are the pixel value of left eye centre and right eye centre respectively.

dnl>dnr => better half is left

dnl<dnr => better half is right

dnl = distance between nose and left eye centre point

dnr = distance between nose and right eye centre point

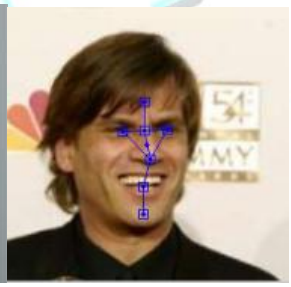

Fig.2.4 Fig.2.5

By using the distance the better half image can be selected

C. Extract the better half:

Extract the better visible half image by nullifying the other side of the face.

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If($dn_l > dn_r$), then the better visible half image is the left side and the right side pixels are made to 0 value.

Fig.2.6 Better Visible Half

D. Stretching and Flipping Operation:

The better half image will not be straight always. The better visible half image is made straight and hence stretching is followed for an efficient reconstruction of frontal face. Some of the pixels are overlapped or some of them are missed, and hence stretch the overlapped portion from the other half face to the better visible half or the missed portion are stretch from the other half to the better visible half. Stretching is the process by which the missed pixel values are filled with existing pixel values or the overlapped pixel values are replaced by existing pixel values. A stretching operation is applied to all the rows of the better exposed tilted half to make them constant length an without missing any pixel values. [8] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is reduced and sensitivity and specificity improved by multiple MTANN.

After successful stretching process, mirroring or flipping operation is performed. By performing this mirroring operation the reconstructed frontal face image is obtained.

Fig.2.7 Reconstruction of frontal face

III. EXPERIMENT RESULTS

We conducted frontal face reconstruction experiments on YALE(30), PUB-FIG(15), LFW(12) databases. YALE databases are most commonly used in face recognition across pose variant under controlled settings and LFW and PUB-FIG databases are for the uncontrolled settings. YALE database only deals with yaw variation whereas LFW and PUB-FIG deals with yaw, pitch and roll pose variations along with variations in other factors such as illumination, expression, resolution and make up variation, age variation, partial occlusion, etc. However the proposed algorithm for frontal face reconstruction is database independent. The experiments done on the LFW and PUB-FIG shows the ability of our system to handle combined pose variation in yaw, pitch, roll angles accurately.

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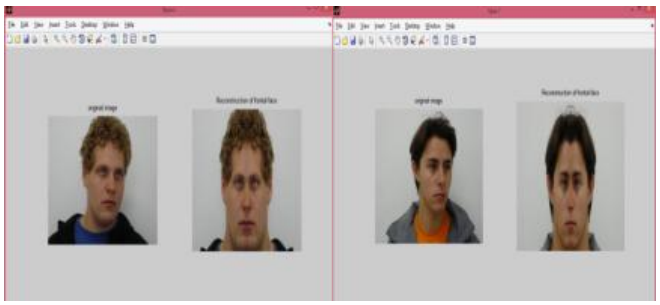

Fig.3.1yale database

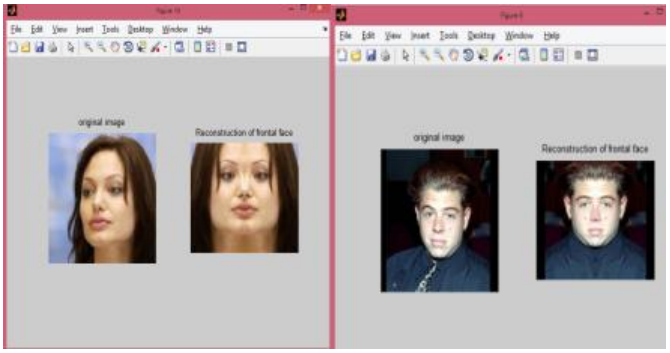

Fig 3.2 Pub-fig , LFW database

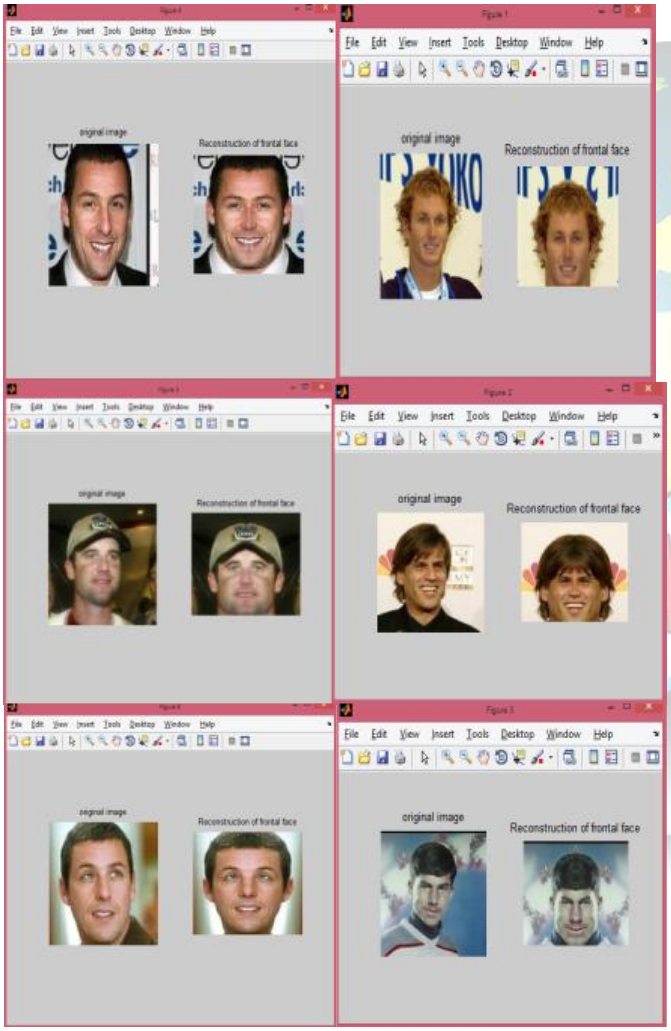

Table 3.1

	Non-frontal image		Reconstructed image	
Data base/test image	**Dnl**	**dnr**	**dnl**	**dnr**
Yale/test image 1	86.9741	38.8909	90.4259	90.2087
Yale/test image 2	53.741	69.2965	68.562	68.2816
Yale/test image 3	40.3051	63.6396	72.4513	72.3700
Yale/test image 4	68.5894	43.1335	84.2289	84.4517
Yale/test image 5	49.4975	62.9325	78.6764	78.5924
LFW/test image 1	26.1630	32.5269	65.5653	65.3526
LFW/test image 2	34.6482	21.2132	73.8704	73.3912

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LFW/test image 3	33.2340	27.5772	57.4528	57.8653
Pubfig/test image 1	45.834	56.721	63.476	63.078
Pubfig/test image 2	50.567	56.984	73.879	73.734
Pubfig/test image 3	48.983	55.478	77.895	77.675
Pubfig/test image 4	47.345	50.678	65.546	65.768

IV. CONCLUSION

The fully automatic reconstruction of frontal face from non frontal face is needed for the pose invariant recognition essentially. The proposed method is helpful in solving the problem of pose variation and also challenges like age variation, expression, illumination, etc. Our method provides a better accuracy in face recognition than the existing method even in an uncontrolled environment (PUBFIG). In order to obtain frontal face, we are concerned about roll and yaw measurement for the better accuracy of the frontal face. The frontal face reconstruction method obtains a better view when compared to the existing method even in uncontrolled environment and there is no need for manual work. The proposed approach not needs any ASM, AAM and its derivatives. In future work we plan to extend the system to a wider range for maximum angle rotation and to apply this for face recognition task.

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