FACIAL FEATURE DETECTION AND RECOGNITION FOR VARYING POSES

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ABSTRACT**:** *In this paper a new technique of facial feature detection for face recognition is proposed which can also be helpful for pose variation. It is hybrid facial feature detection technique. Key feature of this proposed technique is vertical and horizontal segmentations and then applying the template matching technique. After template matching, the face features are calculated in numerical or in hashed form. At the end the face is searched on the basis of calculated hash values.*

Keywords: Hybrid, distance, face, hash, recognition.

INTRODUCTION

Face Recognition has been a challenging task from many years as it requires a complex processing [1]. Generally there are many steps involved in face recognition process. Such steps may be:

1. Face detection [2]
2. Face alignment
3. Feature detection and extraction [3]
4. Processing on features
5. Face recognition

EXISTING WORK

There are a number of facial recognition techniques. But still face recognition area of biometrics is unable to provide the satisfactory results. Some of the facial recognition techniques are PCA (Principle Component Analysis), Eigen faces [4] , Fisherfaces [5] Template matching, LDA (Linear Discriminant analysis) [6] etc. Neural networks [7; 8] based face recognition has also been used for recognition. Although neural networks provide relatively reliable results, still they are too slow to process. Further more if a new face needs to enter in the neural network based database, the whole database needs to train again to stable the weight which is a time consuming process.

This paper represents a face recognition technique for face features extraction, based on face geometry. Some existing techniques for this purpose are discussed below.

Geometric features are used while describing facial recognition in the work presented by V.V. Starovoitov et al. [9]. Creation of different segments by locating different face positions is the main approach used in the proposed method. These segments are then marked on the face. A total of twenty eight features and fifteen segments between different face points get created. Distances between these points are then used for the measurement of features. Similarly geometric mapping is used on the face by Feng Yang et al. [10] which proved helpful in face identification and variation of pose. Muhammad Sharif et al. [11] used Single Image per person for Face Recognition that solves problems of pose variation to some extent. The survey paper by M. Murtaza et al. [12] presented different existing methodologies regarding pose variation.

PROPOSED WORK

The new facial feature extraction technique is a type of geometry based face recognition and has the following modules that are connected together in a serial manner. These modules are:

- Normalization
- Feature Extraction
- Calculated features values

Normalization Module

The first step of feature extraction process is to normalize the image. The most important property of normalization module is the management of scale variations and vertical head rotations. This helps us in detecting and extracting the facial features.

Feature Extraction

The second main module is the coarse primary screening module. After receiving normalized image from the previous step, this module is further divided into the sub modules as follows:

- Face Detection.
- Eyes Detection
- Lips Detection

Face Finding and Detection

Face detection is an important part of automatic facial features detection. This module works as pre-processing for Eyes and Lips detection in the face. The whole face is divided into two main segments; Binary image segment and the Skin detection image segment. The main reason of these segments is to easily make the strips for finding facial features.

Eyes Detection

Eyes detection is the most important part of our algorithm. Eyes detection is the second step after finding face in the image.

The next step is to take the binary image segmentation of face image and then its division into two vertical segments namely top left eye and top right eye for detecting the eyes as shown in Figure 1.

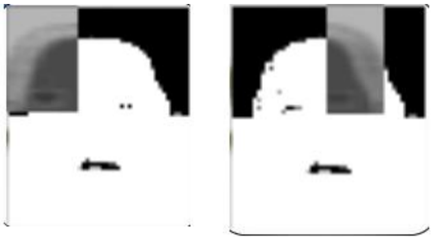

Fig.1. Vertical segmented image

The main reason of dividing the vertical segment into two of binary image segments strip was to narrow down the eyes area and accuracy of detecting the eyes. After this process, template matching technique is then applied to find exact location of the eyes. This process can be shown in Figure 2.

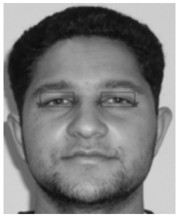

Fig.2. Finding the exact location of eyes

Lips Detection

After finding eyes positions, the algorithm takes the skin segmented strip where the lips exist. After taking the strip, template matching technique is then applied on it to point out the exact location of lips. This is shown in Figure 3.

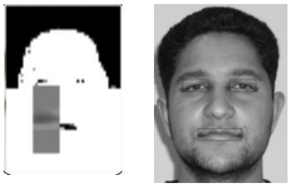

Fig3. Finding the exact location of lips

Calculate features value

This section shows how to calculate the features values as shown in Figure 4. After detecting the facial features (eyes and lips), the next step is to measure the following:

i. Calculate the center locations of eyes and Lips. Suppose the center points coordinates of right eye are R_x(x-coordinate) and R_y (y-coordinate) and the center points coordinates of left eye are L_x(x-coordinate) and L_y (y-coordinate) respectvely. Similarly, the center points coordinates of lips be P_x(x-coordinate) and P_y (y-coordinate).

ii. Find the slope of three lines using the following formulas.

The slope of a line between two eyes

$$m1 = \frac{|R_y - L_y|}{|R_x - L_x|} \text{.........................(1)}$$

The slope of a line between right eye and the lips

$$m2 = \frac{|R_y - P_y|}{|R_x - P_x|} \text{.........................(2)}$$

The slope of a line between left eye and the lips

$$m3 = \frac{|L_y - P_y|}{|L_x - P_x|} \text{.........................(3)}$$

iii. Find the angle (Theta1) between m1and m2

$$\theta_1 = \frac{\tan^{-1}(m2 - m1)}{1 + m1m2} \text{......................(4)}$$

iv. Find the angle (Theta1) between m1and m3

$$\theta_2 = \frac{\tan^{-1}(m3 - m1)}{(1 + m1m3)} \text{......................(5)}$$

v. Calculate the length of three lines using the distance formula as:

$$r2 = \sqrt{((R_y - P_y)^2 + (R_x - P_x)^2)} \text{...........(6)}$$

$$r3 = \sqrt{((L_y - P_y)^2 + (L_x - P_x)^2)} \text{...........(7)}$$

vi. Find the width over height ratio

(Width is calculated as distance between the two eyes).

$$Width = \sqrt{((R_y - 1_y)^2 + (R_x - L_x)^2)} \text{..........(8)}$$

For height, first the center point between two eyes is calculated and then the distance between that center point and lips is calculated. Let these center points be C_x and C_y calculated as

$$(C_x = \frac{(L_x + R_x)}{2}, C_y = \frac{(L_y + R_y)}{2}) \text{.......(9)}$$

The height is calculated as

$$Height = \sqrt{((C_y - P_y)^2 + (C_x - P_x)^2)} \text{.......(10)}$$

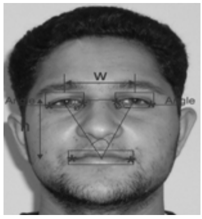

Fig.4. Calculating the features values

The next step is to compare the feature values of image to be searched with training data in the database (The feature values of trained images are pre-calculated and then stored in the database).

The comparison of image to be searched with the trained data in the database is based on the average percentage differences of same features using the following formula.

$$D = \left(\frac{q1 - q2}{\frac{1}{2} * (q1 + q2)} \right) * 100 \text{...............(11)}$$

Where, D is the percent difference between two features. For example to compare r1 of two images, D_{r1} be the difference

$$D_{r1} = \left(\frac{| r1_{pic1} - r1_{pic2} |}{(\frac{1}{2}) * (r1_{pic1} + r1_{pic2})} \right) * 100..............(12)$$

between the r1 of two images to be compared. The above mentioned formula now becomes

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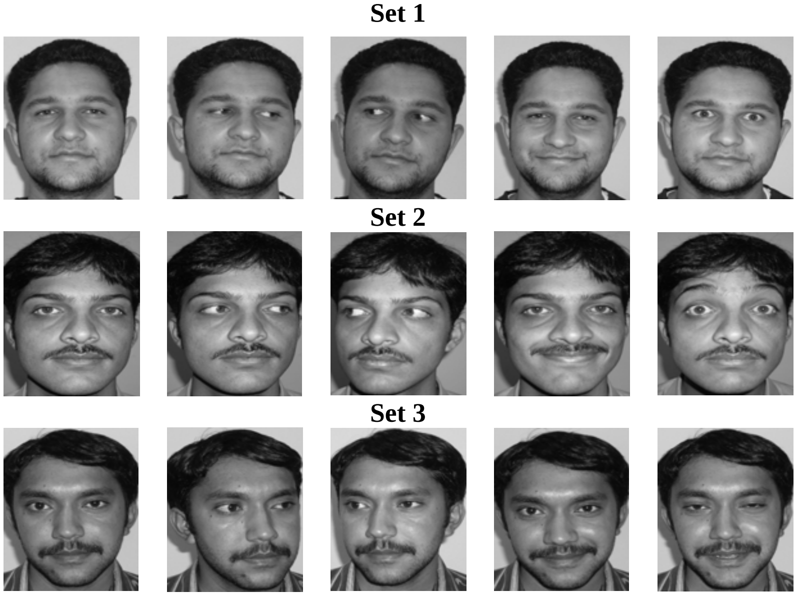
Set 1

Set 2

Set 3

Fig.5. Calculating the features values

Table I: Percentage average difference analysis

Sr.	Pic no	r1	theta1	r2	theta2	w_over_h	Avg %Diff (Variation)
Set 1							
1	1	54.70831747	59.21585347	48.33218389	-65.55604522	1.043478261	2.665184742
2	2	54.70831747	59.21585347	52.81098371	-71.22196678	0.918367347	0
3	3	57.30619513	60.75117366	55.22680509	-58.32453126	1.163265306	3.057591377
4	4	54.62600113	66.25050551	52.32590181	-63.92464442	0.918367347	0.297565312
5	5	55.90169944	63.43494882	53.71219601	-61.04900479	1.040816327	1.569543078
Set 2							
6	1	65.94694838	49.30446896	55.03635162	-65.29756977	1.32	13.64592876
7	2	68.81860214	54.46232221	63.0634601	-62.62229723	1.232142857	13.04717818
8	3	64.03124237	51.34019175	60.41522987	-61.31385243	1.326923077	12.96462084
9	4	64.63745044	55.08059799	61.91122677	-58.8775298	1.301886792	11.06210995
10	5	64.03124237	51.34019175	53.85164807	-55.0079798	1.5	10.86269898
Set 3							
11	1	57.30619513	60.75117366	53.85164807	-68.19859051	1.096	4.489773289
12	2	52.15361924	57.52880771	48.33218389	-65.55604522	1.090909091	5.083496348
13	3	58.83026432	58.20108718	53.85164807	-68.19859051	1.02	3.418007224
14	4	57.30619513	60.75117366	56.35601121	-62.52556837	1.08	3.372998913
15	5	59.94163828	62.15242174	57.7754273	-66.54097592	0.962264151	4.163860507
Set 4							
16	1	58.83026432	58.20108718	55.03635162	-65.29756977	1.08	4.122704172
17	2	62.96824597	57.31944526	57.7754273	-66.54097592	1.075471698	7.046933417
18	3	58.00862005	54.11786275	55.03635162	-65.29756977	1.163265306	6.765888073
19	4	61.40032573	59.67639314	55.6596802	-72.21611156	0.905660377	3.51229233
20	5	62.10230344	56.7685455	55.66443667	-66.5435532	0.944321533	3.627151009
Set 5							
21	1	59.94163828	62.15242174	59.03388857	-63.86899946	1.018867925	4.917156619
22	2	61.40032573	59.67639314	57.7754273	-66.54097592	1.018867925	4.972043299
23	3	62.20128616	53.49855888	53.85164807	-68.19859051	1.14	8.422440494
24	4	61.40032573	59.67639314	66.12866247	-69.64677085	0.931034483	6.76586772
25	5	58.6003413	64.74683661	59.03388857	-63.86899946	0.962264151	4.140699263

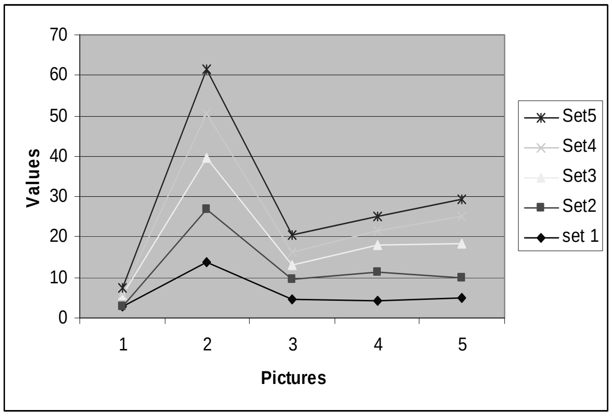

Fig6. Average differences

The same procedure is followed for other features and then the average of differences is taken i.e.,

$$AVG = \frac{\left(D_{R1} + D_{\theta1} + D_{R2} + D_{\theta2} + D_{\frac{W}{H}} \right)}{5} \text{..................}(13)$$

The minimum value of AVG found will be the closest match with the face to be searched.

RESULTS AND ANALYSIS

In this section pose analysis is done by taking five different poses of each person (Figure 5). An original image having the frontal view is taken and comparison is drawn with the various poses of that person and also with the various poses of other persons to analyze the proposed system

The graph and table shown below (Figure 6) present an example of the extracted face feature values and their average percentage differences of five sets for five persons, each containing the pictures of five poses of individuals. The feature values of Image 2 of Set 1 in the following table is compared with rest of all images mentioned in the table and it is analyzed that the set 1 which contains different poses of the image to be compared, has minimum values of average percentage differences. The values vary with large amount for different persons images. This can be seen in the following table and graph. It can be observed from Table I that if the minimum average percentage difference is found between the image to be searched and the database trained image, then it is the indication of closest match. Also if the percentage difference is equal to zero, then it is an indication of exact match

In the above graph, set 1 contains the lowest values as compared to the other sets values. This is because the image to be searched belongs to this set and hence presents the closest matches.

CONCLUSION

In this paper, a technique for face recognition based on facial geometry has been presented. The facial features are extracted on the basis of template matching. After extraction, these facial features helped in finding the facial hashed values. After implementing the technique, the results were taken using images of varying poses. The experiment after implementation of the technique show precise results.

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