Face Feature Recognition System Considering Central Moments

[1]Sundos A. Hameed Al_azawi, [2]Jamila H.Al-A'meri
[1]Al-Mustainsiriyah University, College of Sciences,
[2]Computer sciences Dep. Baghdad, Iraq.

Abstract

Shape Features is used in pattern recognition because of their discrimination power and robustness. These features can also be normalized by Central moment. In this work, Faces Features Recognition System considering central moment (FFRS) is including three steps, first step, some image processing techniques worked together for shape features extraction step, step two, extract features of shape (face image) using central moment, third step is recognition of face features by comparing between an input test face features from the input image and an face features which stored in the features database.

Keyword: Recognition, detection, face feature, moment, image preprocessing, feature database, and central moment.

I. Introduction

To interpret images of faces, it is important to have a model of how the face can appear. Faces can vary widely, but the changes can be broken down into two parts: changes in shape and changes in the texture (patterns of pixel values) across the face. Both shape and texture can vary because of differences between individuals and due to changes in expression, viewpoint, and lighting conditions. One major task of pattern recognition, image processing: is to segment image into homogenous regions, in the several methods for segmentation are distinguished. Common methods are threshold, detection of discontinuities, region growing and merging and clustering techniques [1][2][3].

In recent years face recognition has received substantial attention from researchers in biometrics, pattern recognition, and computer vision communities [4], Computer face recognition promises to be a powerful tool, just like fingerprint scans. Automated face recognition is an interesting computer vision problem with many commercial and law enforcement applications. The biggest motivation for using shape is that it provides additional features in an image to be used by a pattern recognition system [5].

In image processing, image moment is a certain particular weighted average (moment) of the image intensities of pixels, or a function of such moments, usually chosen to have some attractive property or interpretation [1]. Simple properties of the image which are found via image moments include area; Hu [6] has used the moments for character recognition. In our proposed paper, used the boundary description to represented the data obtained from the segment process (black /white pixels) for the gray image and will use the one simple techniques and the task at same time, a technique detect edges to get an image with boundary, then extract a face features after process an image by some preprocessing techniques like enhancement, thinning and limitation for B/W image. The shape features of face image are depending on central moment values for objects of B/W face image result.

Pre-Processing Operations

For extract shape features, color face image must be preprocessed. The preprocessing of the image is done in some techniques: Before convert a gray face image to binary image (B/W), gray face image was enhance to reduce the noise, last operation in this stage is thinned the edge of B/W object to a width of one-pixel (these operations are necessary to simplify the subsequent structural analysis of the image for the extraction of the face shape).

For primary face image, segment the image into small and large regions (objects) such as eyes, nose, and mouth. From the face images, the face is the greatest part of the image, and hence the small object results from Pre-Processing Operations. So, the facial feature objects (eyes, nose, and mouth) are determined.

Shape Feature Extraction

In shape feature extraction stage, the approach is followed using binary image (black and white pixels) and shape information for each face objects (tow eyes, nose , and mouth) extracted by central moments.
There are several types of invariance. For example, if an object may occur in an arbitrary location in an image, then one needs the moments to be invariant to location. For binary connected components, this can be achieved simply by using the central moments [7].

Central Moment has been used as features for image processing, shape recognition and classification. Moments can provide characteristics of an object that uniquely represent its shape. Shape recognition is performed by classification in the multidimensional moment invariant feature space [1][8].

II. Central Moment

Moments are the statistical expectation of certain power functions of a random variable. There are two ways of viewing moments, one based on statistics and one based on arbitrary functions such as f(x) in one dimension or f(x, y) two dimension. As a result moments can be defined in more than one ways [1][4].Central moments are defined as [1][5]:

$$\mu_{pq} = \iint_{-\infty}^{\infty} (x-\bar{x})^p (y-\bar{y})^q f(x,y)dxdy \,.....\, (1)$$

Where, *p* and *q* are the components of the centered, and $\tilde{x} = {M_{10}}/{M_{00}}$, $\tilde{Y} = {M_{01}}/{M_{00}}$.

If $f(x, y)$ is a digital image, then the previous eq. (1) becomes:

$$\mu_{pq} = \sum\sum (x-\bar{x})^p (y-\bar{y})^q f(x,y) \,....\, (2)$$

The central moments of order up to 3 are [1]:

$\mu_{00} = M_{00}$, $\mu_{01} = 0$, $\mu_{10} = 0$, $\mu_{11} = M_{11} - \tilde{x} M_{01} = M_{11} - \tilde{y} M_{10}$, $\mu_{20} = M_{20} - \tilde{x} M_{10}$,$\mu_{02} = M_{02} - \tilde{y} M_{01}$,$\mu_{21} = M_{21} - 2\tilde{x} M_{11} - \tilde{y} M_{20} + 2(\tilde{x})^2 M_{01}$,$\mu_{12} = M_{12} - 2\tilde{y} M_{11} - \tilde{x} M_{02} + 2(\tilde{y})^2 M_{10}$,$\mu_{30} = M_{30} - 3\tilde{x} M_{20} + 2(\tilde{x})^2 M_{10}$, $\mu_{03} = M_{03} - 3\tilde{y} M_{02} + 2(\tilde{y})^2 M_{01}$

It can be shown that:

$$\mu_{pq} = \sum_{m}^{p} \sum_{n}^{q} (-\bar{x})^{(p-m)} (-\bar{y})^{(q-n)} M_{mn} \,....\, (3)$$
$p \quad q$

Shape Features

A set of seven invariant moments can be derived from moments in subsection (1) (eqs. 1,2 and 3), which are Shape Features uses to recognition an face image input.

$\partial_1 = \eta_{20} + \eta_{02}$

$\partial_2 = (\eta_{20} + \eta_{02})^2 + 4 \eta^2{}_{11}$

$\partial_3 =(\eta_{30} + 3\eta_{12})^2 + (3\eta_{21} + \eta_{03})^2$

$\partial_4 =(\eta_{30} + \eta_{12})^2 + (\eta_{12} + \eta_{03})^2$

$\partial_5 =(\eta_{30} + 3\eta_{12})(\eta_{30} + \eta_{12}) [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21}+ \eta_{03})$

$\partial_6 =(\eta_{20} + \eta_{02}) [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + 4 \eta_{11} (\eta_{30} + \eta_{12}) (\eta_{21} + \eta_{03})$

$\partial_7 =(3\eta_{21} - 3\eta_{03}) (\eta_{30} + \eta_{12}) [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{12} - \eta_{03}) (\eta_{21} + \eta_{03}) [3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$

III. Face Features Extraction

After applied shape features extraction steps on the input face image, we define Maximum Four Objects, Right Eye, Left Eye, Nose, and Mouth, in the Face Image Input, for each objects we define a set of seven central moments (subsection2). So 28 moment values have been extracted using Face features algorithm (algorithm1).

Algorithm1: Face Features Extraction
Step 1: Input gray face image.
Step 2: Preprocessing of image that result from Step2. By:
a. Convert Gray Image to Binary Image,
b. Segment Binary image using thresholding technique,
c. Thinning its boundary and limitation for largest objects (in this case : Left eye, Right eye, Nose, and mouth)which result from the thinning, and
d. Smoothing the result thinning object images.

Step 3: Compute The seven Moments values (shape features) , in our case, we have an image include four object(step 2), so we can get seven moment values for each object, that mean we have (7 * 4)= 28 moment values for each input image (7 for each object(tow eyes, nose, and mouth)).
Step4: Saved all moment values (28 features value) for all objects from face images testing in Database system to use it in Recognition system for this research.

Face Features Recognition System (FFRS)

The proposed system including two main algorithms: Face Features algorithm (algorithm 1), and Face Recognition algorithm (algorithm 2).

Face Recognition algorithm:

In the Face Recognition system was show in Figure3, each new gray face image including for the system to recognition it, will be applied first in the algorithm (1) to get their 28 features moment and there threshold to compare its features with features for different images of gray face stored in our database system.

Algorithm 2: Face Recognition

Step 1: Input a new gray face image.
Step 2: applied Algorithm (1), to get 28 Features for new face image input.
Step 3: Compare the 28 Features from step2 within each 14 Features from our database by:

$$F = \sum_{i=1}^{28} (F_i p / F_i\, db) \times 3.57$$

Where: F is the summation of ((F_i p / F_i db) * 3.57), it will between (3.57*28 %) and (100%), 3.57 is the average of (100/28) for 28 features.
(F_i p) is the feature gets it from new person face image; (F_i db) is any feature gets it from our database.
Step 4: we get the rate of F ≥ 80% , to say what one features from database is same of features get it newly from new face input to recognition it.
Step 5: for step 3, if the result is more than one face image features have same rate value (F ≥ 80%), the Maximum value is the nearest features back in to test person face image.

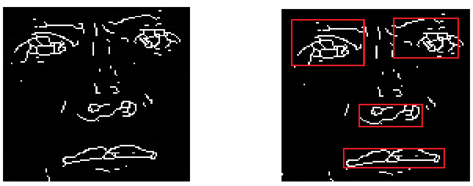
Implementation and Results

Among the 30 images, 10 images are used to train, and another 10 are used to test. The results of shape feature extract, is the basic step in this work and the task to identify and distinguish between face images were entered and stored in database, then compared between the entrance is a newly characterized to any image data back, this process is the discrimination and that will be apply to the face image only to find out of the image of face back to the input image data that was already stored in the database. In the recognition step, the data will be comparing with the specification of the face image and what had been extracted based on the covariance matrix, considering the features that were stored in images database.

The experiment is calculated under the conditions: All of the test images have same size, only the frontal view of the face image is analyzer throughout this system.

For one face images named Face4, Figure 1 show an objects result from shape features application from algorithm1, were subfigure (e) content four facial features (right eye, left eye, nose, and mouth).

a b c



d e

Fig1: Shape features for Face2: (a) gray Face1 image, (b) enhance image, (c) threshold segment, (d) thinning, (e) four features object detect.

Fig2 show some gray face images saved in our database system, every one of this image have a name Face1, Face2, etc., Face1 in fig1 is one of these images.

Fig3, illustrated the another test face image for recognition it with database images. After we find 28 features moment by applied algorithm1, we saved this features by named Face 21, then made a comparison between 28 features of Face21 test image and 28 features for each face in database system.

(a) (b) (c)

Fig3: Test face image for recognition steps: (a) Origin Gray face, (b) threshold segment, thinning and four object detect (two eyes, nose, and mouth).

Table1 including all the features for test Face21 image. Each face image test has 28 features, and it will be saved in the database system to recognition level, where Face21, is the name of test face image for recognition steps, F1, F2, F3,…, F14 are the features for tow eyes objects (left and right eye), F15.F16, F17,…,F21 are the features for nose object, and F22,F23,F24, …, F28 are the features for mouth object.

In compare step from Algorithm2 when compare test Face21 features (Table1) with features of 30 gray face images saved in database system, we find another face image have same rate value (F) which is suggested in our recognition method, named Face10 and its moment features show in Table2, this image have same value of ratio 80.023 %.

Table1: Moment Features for test Face21 image.

Right eye	F1	F2	F3	F4	F5	F6	F7
	0.92770	1.86422	2.48800	398765	3.81953	4.39213	4.01208
Left eye	F8	F9	F10	F11	F12	F13	F14
	1.56432	3.45981	5.10086	6.01256	8.01736	8.01123	9.12043
Nose	F15	F16	F17	F18	F19	F20	F21
	0.76543	111347	2.33410	2.00237	3.05432	3.09873	3.03670
Mouth	F22	F23	F24	F25	F26	F27	F28
	1.84397	3.94329	5.67023	5.87209	8.09648	7.04328	7.95437

Table2: Moment Features for Face10 image

Right eye	F1	F2	F3	F4	F5	F6	F7
	1.01521	1.75422	2.47860	3.86420	3.86297	4.19642	4.00247
Left eye	F8	F9	F10	F11	F12	F13	F14
	1.55397	3.57102	5.10982	6.00532	8.10953	8.27631	8.95021
Nose	F15	F16	F17	F18	F19	F20	F21
	0.84320	1.15072	2.45903	3.01094	3.16832	3.05503	3.00589
Mouth	F22	F23	F24	F25	F26	F27	F28
	2.06591	3.79541	4.95621	5.90742	8.10653	7.11091	7.86021

The result compare steps for this tow face image (Face21 and Face10) are clear in Figs (4,5,6, and 7), were Fig4 show the compare result for left eyes from Face21 and Face10, Fig5 show the compare result for right eyes from Face21 and Face10, Fig6 show the compare result for nose from Face21 and Face10, and Fig7 show the compare result for mouth from Face21 and Face10.

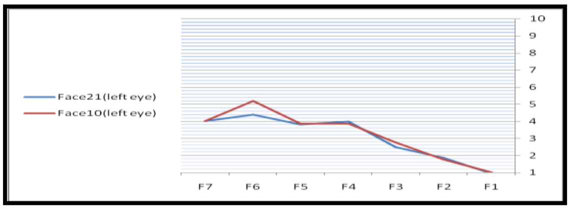


Fig4: Compare result for left eyes from Face21 and Face10

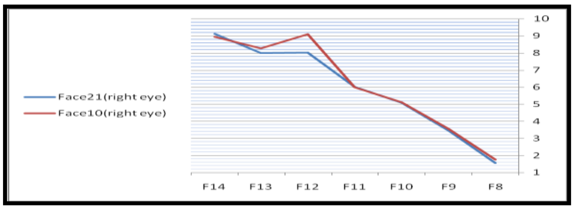


Fig5: Compare result for right eyes from Face21 and Face10

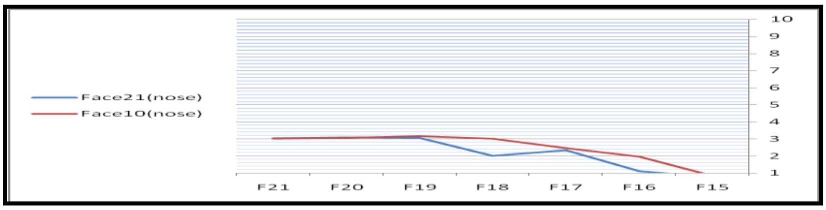


Fig6: Compare result for nose from Face21 and Face10

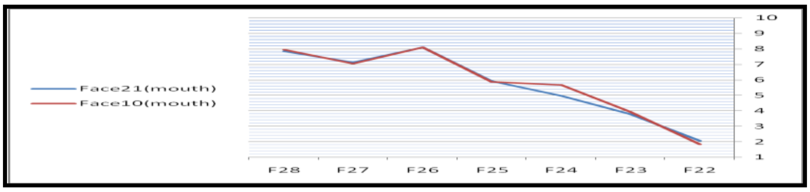


Fig7: Compare result for mouth from Face21 and Face10

IV. Conclusion

This work presented a method for the recognition of human faces in gray images using a object of facial parts (eyes, nose, and mouth) and moment values for these parts. For face recognition these moments can also be. In our proposed paper for Face Recognition based Moment method by using central moment in object of facial parts. First some image processing technique was used together to work for best result of this parts.

Recognition step doing by comparing input 28 features for test gray face image with 28 features for each Faces features saved in database. The image has Maximum rate value it is the true recognized faces back for test face of input image.

References

[1]. Gonzalez R. C., and Woods E., "Digital image Processing",Addison-Wesley Publishing Company, 2004.
[2]. Umbaugh S.E., “Computer Vision and Image Processing”, Prentice- Hall, 1998.
[3]. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern classification (2nd edition), Wiley, New York, ISBN 0-71-05669-3, 2001.
[4]. W. Zhao, R. Chellappa, A. Rosenfeld, and P.J. Phillips, “Face recognition: A literature survey,” CVL Technical Report, University of Maryland, 2000.
[5]. S. Gong, S.J. McKenna, and A. Psarrou, Dynamic Vision: from Images to Face Recognition,Imperial College Press and World Scientific Publishing, 2000.
[6]. "Facial Recognition Applications" .Animetrics. http://www.Animetrics.com/technology / f rapplications.html. Retrieved, 2008.
[7]. B. K. Low, and E. Hjelmxas, “Face Detection: A Survey”, Academic
[8]. Press, computer vision and Image Understanding, 83, 2001, pp. 236–274.
[9]. N. Jaisankar, "Performance comparison of face and fingerprint biometrics for Person Identification", Science Academy Transactions on Computer and Communication Networks, Vol. 1, No. 1, 2011.