Face Recognition for Authentication by Using Anthropometric Model

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Abstract

This paper presents an automatic technique for detecting important facial features' points using a developed anthropometric face model. The facial features' points we work on are about the areas of mouth, nose, eyes and eyebrows. The anthropometric means the scientific study of the measurements and proportions of the human face. Several processes are performed in order to recognize human personality authenticated or not, these processes are beginning by capturing colored image using fixed digital camera and ending by features isolated into separated sub images and the lengths and distances among them representing authenticated persons information are stored into database..

In authentication stage all the extracted features are compared with stored authenticated facial features in the database, the person is authenticated if a percentage of similarity equal to or greater than 78% is achieved.

Keywords: face recognition, face detection, anthropometric, facial feature points

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التخويل بتمييز الوجه باستخدام نموذج قياسات الوجه

الخلاصة

في هذا البحث نقدم تقنية لاكتشاف و تحديد ملامح الوجه المهمة بالاعتماد على طريقة مطورة من نموذج   Anthropometric للوجه. ملامح الوجه المستخدمة في هذا البحث هــي مناطق العين , الحاجب, الانف و الفم.   Anthropometric   تعني الدراسة العلمية لقياسات و تناسق وجه الانسان. هنالك مجموعة من العمليات يتم تنفيذها للتحقق من هوية الشخص هــل هو مخول ام لا , تبدأ هذه العمليات بالتقاط صورة ملونة للشخص باستخدام كاميرا رقمية ثابتة. و تنتهي بعزل كل واحدة من هذه الملامح على حدى في صورة لوحدها و الاطوال و المسافات بينها و التي تمثل معلومات صفات الشخص المخول ثم تخزن في قاعدة البيانات.

في مرحلة التخويل نفس العمليات السابقة يتم تكرارها و تقارن النتائج مع المعلومـــات المخزونة في قاعدة البيانات للاشخاص المخولين. عند حصول التطابق بين النتائج المستحصلة و المعلومات المخزونة بنسبة 78% او اكثر عندها يعتبر الشخص مخول.

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1. Introduction

Authentication is any process that verifies if someone is who he claims he is. Authentication is commonly done through the use of passwords, but can include any other methods of identity demonstration such as Smart card and Biometric characteristics like face recognition, finger print, iris, retina,……… and so on.

There are two different cases of authentication:

- **Message Authentication**

It is a procedure, which when established between two communicates allows each communicate to verify if the received messages are genuine [4], message authentication permits the receiver to validate the properties of message's origin, timelines, and intended receiver.

- **User Authentication**

User authentication is central component of currently deployed security infrastructure [5].
There are three main techniques for user authentication which include:

1. Password authentication
2. Token authentication
3. Biometric authentication

Face recognition has gained a lot of interest in the last decade because of the rapid developments in the computational technology and increasing concern for security. Face detection and recognition are some key aspects for vision based security systems. Although face is one of the natural measures which are used to recognize humans, the wide acceptance of face as biometric still remains a problem to be solved because of variations due to lighting, face pose and face expressions[1].

There are mainly two kinds of face recognition, one is based on feature matching and the other is based on template matching[2]. A face authentication system usually consists of four main modules: data acquisition, feature extraction, feature matching, and decision making [3], to extract face features there are many methods , the most common method is the eigen face method, anthropometric model.

The proposed system depends on anthropometric model by using only five distances between many points of face to be principal parameters of measurement as will be explained later.

3.Facial recognition

Facial recognition, is a kind of biometric recognition, makes human recognition a more automated, computerized process [6].

Facial recognition is a form of computer vision tha uses faces to identify a person or verify the identity of a person. Facial recognition is accomplished in five steps:

1. An image of the face is acquired
2. Detect the location of any faces in the acquired image.
3. Analyze the spatial geometry of distinguishing features of the face to extract the identifying features of a face and then generate template from these features.
4. Compare the template generated in step three with those in a database of known faces. This process yields scores that

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indicate how closely the generated template matches each of those in the database.

5. The final step is determining whether any scores produced in step four are high enough to declare a match.

4. Anthropometric Face Model

Anthropometry is a biological science that deals with the measurement of the human body and its different parts. Data obtained from anthropometric measurement informs a range of enterprises that depend on knowledge of the distribution of measurements across human populations [7].

The landmarks points that have been used in our face anthropometric model for facial feature localization are based on Figure (1). It has been observed from the statistics of proportion evolved during our initial observation that, location of these points(P3, P4, P6, P7) can be obtained from the distance between two eye centers (P1 and P2) using midpoint of eyes (P5) as an intermediate point since distances between the pair of points (P1 and P3), (P2 and P4), (P5 and P6), (P5 and P7) maintain nearly constant proportions with the distance between the center of left and right eyes (P1 and P2).

5. The Proposed System

The idea of the proposed system depends on anthropometric face model building, a model of the face that is used to find the key points which involve right eyebrow center, right eye center, mouth center, left eyebrow center, left eye center, midpoint of eyes, and nose tip).

The model is built after many processes to extract the pure face image without any background by using skin color segmentation and elliptical mask technique. Once the key points are obtained, the feature distances of the face image can be computed.

The following steps represent the essential operations that will be performed in the system as shown in Figure (2)

Step one: *Capturing image* by using fixed digital camera that is connected to computer system. The image is captured within fixed environments and according to accepted pose to the authenticated persons as shown in figure (3).

Step two: *Preprocessing* : This process is very important to detect human face shape, isolating it from the background, and converting the background to black. To achieve this main process the following steps should be performed:

- *Skin segmentation:* This process is performed to classify pixels into skin and nonskin pixels depending on RGB color space and according to the following threshold :Human skin at daylight ranges within $R>95$ an $G>40$ and $B>20$ and $ABS(R-G)>15$ and [Max (R, G, B) Min (R,G,B)] > 15 an $R>G$ and $R>B$ [8, 9].As shown in figure (4)

- *Binary mask:* this process is done to remove any noise from the image by three steps:

- The isolated face from the previous skin

segmentation step is converted to binary.

- Filling the small holes in the face to generate a white mask of the face.

- Eliminate small white areas in the background (if any).

Now a binary mask of the face is created (which can be considered as template of the face) as shown in figure (5).

- *Anding* the resulting mask from the previous step with the original image to extract the face without any noise (small black holes) as shown in figure(6).

- *Image resizing*: to reduce unnecessary information, columns and rows of the background that contain only black pixels will be eliminated from the image to determine the

- face area position, which facilitates the process of enclosing the face with elliptical mask because face position is determined exactly as shown in figure(8).

Step three : *Masking*: To extract human face an elliptical mask will be used, the face in the resized image is enclosed with an elliptical mask which is adjusted according to the face boundary. An elliptical mask is used because it is close to human face shape, then face contrast is increased to differentiate easily between skin and nonskin pixels (nonskin pixels represent features) and facilitate the process of features extraction. Then nonskin pixels are converted to black pixels which can be used in

feature extraction step to measure distances as shown in figures (9, 10, and 12). A filter is applied to the enclosed face to get more clearness in features and to ensure the ability to analyze features (feature extraction). This is done by Sobol operator applied to sharpen face details (features). The result is shown in Figure (7).The mask that is used:

$$\begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Another mask similar to Laplacian filter with some changes is used to increase image contrast by enhancing image details and make it different from its surrounding pixels (skin pixels). The result is shown in Figure (11).The mask which is used for this purpose is:

$$\begin{bmatrix} 1 & 0 & -1 \\ 1 & 1 & 3 \\ 1 & 0 & -1 \end{bmatrix}$$

Step four : *Feature extraction*: To extract face features an anthropometric model is used by computing distances of face features, (such as the distance between the two eyebrows … etc), (will be explained later in Geometrical feature extraction) then store the results in database which represents the information of the authenticated persons as shown in figure (13).

Step five : *Authentication (yes or no)*All the above operations for the captured image will be performed and compared with stored information to determine

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the person in the image is authenticated or not.

7. Geometrical feature extraction

Extraction stage (explained in step four) depends upon calculating distances of face features. Features that will be used in this stage are: (Eyebrows, Eyes, Nostril, and Mouth). To calculate these features distances the skin region of the face are divided into four subimages in the following sequence:

1- The Eyebrows Region subimage (1)

2- The Eyes Region subimage (2)

3- The Nostril Region subimage (3)

4- The Mouth Region subimage (4)

a. Compute Eyebrows Distances

Distances of the eyebrows that are means:

♦ The length of the right and left eyebrows

♦ The distance between the two eyebrows

♦ The center of each eyebrows

- **The length of each eyebrow is calculated as follows:**

- Determine the start point of the eyebrow by scanning subimage of each eyebrow from right to left

-Determine the end point of the eyebrow by scanning subimage of each eyebrow from left to right.

- The difference between the two points represents the length of the eyebrows. These calculations are performed on each subimage separately from the other.

-The distance between the eyebrows

The subimage that contains the two eyebrows is scanned from left to right thus the process is done as follows:

- Determine end point of the first eyebrow which represents the inner corner of the right eyebrow.

- Determine start point of the first eyebrow which represents the outer corner of the left eyebrow.

- The difference between the two points represents the distance between the two eyebrows.

-The center of each eyebrow

As the length of each eyebrow is known this length is divided by two which represent the center of each one, then to determine the location of each center, the result of the division is added to the start point of the right eyebrow and to the start point of the left eyebrow to get the center of each one.

b.Compute Eyes Distances

The distances that are computed are:

♦ The length of the right and left eyes

♦ The distance between the two eyes

♦ The center of each eye

♦ The center of lower and upper eyelids for each eye

♦ The width of eye open

These distances are calculated by the same way of the distances of the eyebrows.

c. Compute Nostrils Distances

To compute the center of each nostril the subimage of nostril is scanned from left to right and from right to left to determine start and end points of each nostril. Then the difference between start and end points for each nostril represents the center for each one.

d.Compute Mouth Distances

Calculations that are performed are:

• Mouth width (length)

• The center of upper and lower lips.

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These distances are calculated by the same way of the distances of the eyebrows.

- After extracting the required features they are stored into a database that contains the following fields: (Person ID, Person name, Eyebrow length, Eyebrow center, Distance between the two eyebrows, Eye length, Distance between the two eyes, Upper eyelid center, Lower eyelid center, Eye open width, Center of left nostril, Center of right nostril, Mouth width, Upper lip center, Lower lip center) To build this database the features for each authentic person are computed and stored in it. The extracted features are stored as numbers which represent distances between features and length of each extracted feature.

8. Authentication Decision

In authentication phase the scanned image is processed by the same operations mentioned above but the results are compared with the Data base fields of each authentic person which is stored previously to determine if the identity of the claimed person is authorized or not. The comparison is done by comparing the result of the previous features measurements with the stored features measurements in the data base, for example the length of the eyebrow of a person whose authorization is being tested is compared with the length of the eyebrows of all the authorized persons that are stored in the database, then if a similarity by 78% or more is achieved then the person is identified as authorized person otherwise he is not.

9. Experimental Results

The experimental results explained in table (1) lead to say that face image must be with clear background,

frontal view with specified pose and within stable environment.

10. Conclusions

From the practical experience of the proposed system and the previous executed systems and different algorithms some conclusions can be drawn as follows:

1. There is no system which can recognize an image with 100% of accuracy and this means that such systems allow a little percentage of errors. The practical implementation of the proposed system has shown that error percentage could reach 22% or little more and the results are good.

2. Using human skin color feature only to recognize human face from other image parts is not enough because skin color is close to other things, therefore, other factors should be taken into consideration such as shape, location, and the size of the area.

3. The kind of the digital camera and its resolution has an important role in the accuracy and the speed of image recognition.

4. The anthropometric face recognition algorithm provides very accurate results but requires a high programming to get such accurate results.

5. If the background or the person clothes contain red color or colors close to human face such brown, this will confuse the extraction process and will not be removed but will be analyzed as human skin.

6. If lighting conditions are not controlled there will be some shadow on the face or the background, which makes face detection and extraction difficult, thus when an image is picked there should not be any shadow on the face (controlling lighting conditions).

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References

[1]Farah Tawfiq Abdel_Hussien, " **Face recognition for Authentication by using Anthropometric model"**, M. Sc. Thesis , Computer Science Department, University of Technology, 2008.

[2]Xiaoming Liu Tsuha Chen B.V.K. Vijaya Kumar, "**On Modeling Variation for Face Authentication"**, Department of Electrical and Computer engineering, University of Carnege Mellon University, 2002.

[3]Fei Yang, Shiguang, Bengpeng Ma, Xilin Chen and Wen Gao , "**Using Score Normalization to Solve The Score Variation Problem in Face Authentication"**, Computer College, Harbin Institute of Technology, Harbin, 150001, China, S.Z. Li et al. (Eds.): IWBRS 2005, LNCS 3781, pp. 31–38, 2005, Springer-Verlag Berlin Heidelberg 2005.

[4]A.J. Goldstein & L.D. Harman, **"Identification of Human Faces"**, proceeding of the IEEE, Vol.59.no 5, (1971).

[5]Seberry J. and Pieprzyk J**.,"Cryptography, an Introduction to Computer Security",** Prentice hall of Australia ptd, ttd, 1989.

[6]John D. Woodward, Jr., Christopher Horn,Julius Gatune, and Arny Thomas,**"Biometrics a Look at Facial Recognition"**, Prepared for the Virginia State Crime Commission, 2003.

[7]Abu Sayeed Md. Sohail and Prabir Bhattacharya, **"Detection of Facial Feature Points Using Anthropometric Face Model"**, Concordia University , West

Montréal, H3G 1M8, Québec, Canada, 2006.

[8]Vladimir Vezhnevents, Vassili Sazonov, Alla Andreeva**" A Survey on Pixel_Based Skin Color Detection",** Graphics and media laboratory, Faculty of Computational Mathematics and Cybernetics Moscow state university, Moscow, Russia, 2003.

[9]Harsh Verma1, Punect Sharma2, Vishal S. Sharma3, **"A Procedure for Face Detection and Recognition"**, 1 Department of computer science and engineering, 2 Department of electronic and communication engineering, 3 Department of industrial engineering, National institute of technology, Jalandher, India, proceeding of the 18th iasted international conference, modeling and simulation, May 30 June 2007, Montreal, Quebec, Canada.

Table (1) The experimental results by implementing the system on 27 images for each state

Image state	Successful rate
Clear background without skin color	78%
Clear background with skin color	8%
Clear front view image	78%
Pose front view image	35%
Face with some changes like sunglasses	13%
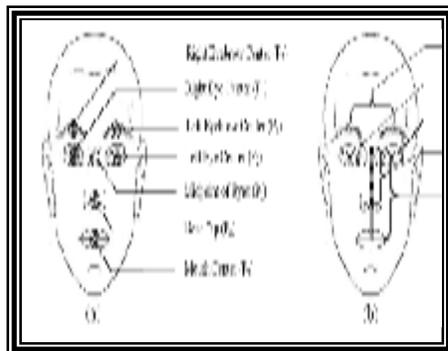
Figure (1) Anthropometric Face Model for facial feature region localization (a) Landmarks used in the Anthropometric Face Model (b) Distances (Anthropometric Measurements) [7]
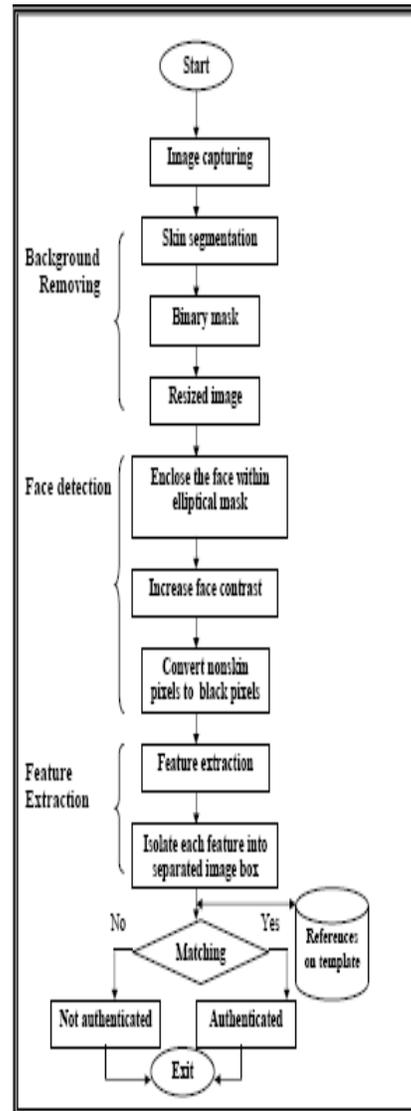
Figure (2) The proposed system flowchart

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Figure (3) The original image

Figure(6) The extracted face without any noise

Figure (4) Face extraction and background removing to black color

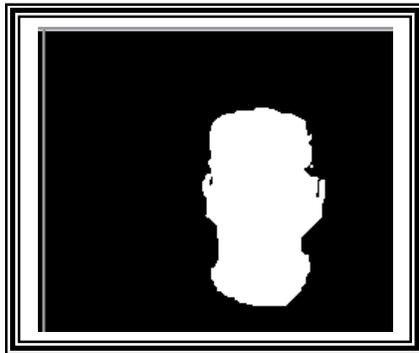

Figure (7) Edge detection with Sobel filter

Figure (5) White template of the face
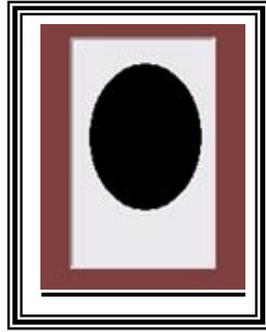

Figure (8) Reduced image

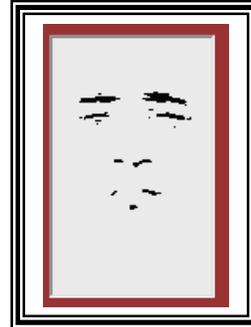**Figure (9) Elliptical   mask used to enclose the face in resized image**

Figure (12) Convert to black pixels
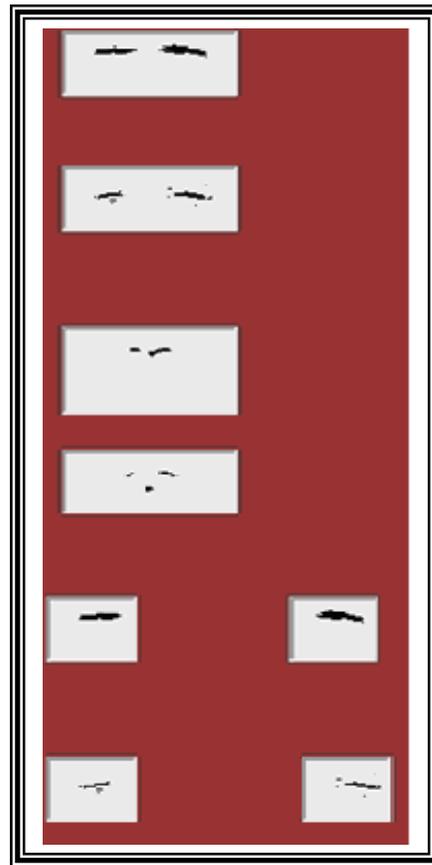

Figure (10) Elliptical mask encloses the face in resized image

Figure (13) Feature Extraction

Figure (11) Icrease Face Contrast

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