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A Simple Approach for Face Features Detection

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Abstract: This paper presents a new approach for face features detection; eyes, eyebrows, nose, and mouth, based on sensing the edge points of face features and predict the intra-features points. Pixels sweeping is the approach has been used in this work to detect face corners and face feature edges. The proposed method has been compared to Viola-Jones algorithm and it shows an excellent performance with higher accuracy.

Keywords: Face Detection, Eye Detection, Image Processing, Face components Detection.

I. INTRODUCTION

Human face is the most important part of the body, either for communication or for human identification. Each person owns a special identity that identity can either based on his eye features, face shape, ears, or any combination of these features. This raises a need to develop approaches and systems that provide a computer the ability to interact with and identify human faces. Many studies have been conducted on the computer vision field for face detection since the early seventeenth.

Different approaches have been proposed for face detection in digital images, and each of them attempted to overcome the other drawbacks and limitations, one of the most widely used algorithms is Viola and Jones algorithm [1]. Viola-Jones algorithm consists of integral image for feature computation, and for feature selection an Adaboost used, and cascade for computational resource allocation.

Many studies have been conducted on eye identification, some other have been done on nose and mouth detection. These studies require first to segment the face part from background to deal with it separately and then apply the desired algorithms based on the purpose conducted for. Face parts detection is considered as the first phase on any related studies on face identification or facial expression recognition especially with AUs features. Face Detection in static images or in frame sequence, currently, have many applications such as: auto cameras focuses, security, visual surveillance, traffic safety monitoring, human computer interaction and biometrics [2]. Face detection task faces lots of challenges due to variations of appearance, such as occlusion, orientation, illuminating condition and facial expression and some other challenges.

This paper presents a new approach to detect face parts (eyes, eyebrows, nose, and mouth) based on pixels sweeping. The researchers obtained an excellent performance and high accuracy. On the other hand, our algorithm consumes much time compared to Viola-Jones algorithm.

II. RELATED WORK

Face features detection studies date back to the early 1970th. Various approaches have been proposed to detect face features especially, eyes, mouth, and nose. These approaches differ in the techniques have been used to detect face features. They can be divided into four main approaches:

- Geometry based technique.
- Appearance based technique.
- Color based technique.
- Template based technique.

In Geometry based technique, edges of important face parts are detected and then feature vectors are built from these edges. Some other methods are based on the intensities differences among important and redundant components such as in Adaboost method [3] and LBP [4].

In appearance based technique, Methods such as principal component analysis (PCA) feature vectors are extracted using independent component analysis. PCA is used to reduce the large dimensionality of observed variable to the smaller intrinsic dimensionality of independent variable without losing valuable information [5].

In color based technique, to eliminate the color in the face image, it is transformed to gray-scale then into binary image. The features of face are darker than the background colors [6,7]. In template based technique, detecting features of face using deformable templates [8].

T.Kana de,1997, used Geometry based approach; Gabor wavelet method to extract eyes, mouth, and nose [9]. A Yuille, et al, 1989 [8], have used a template based method; the authors used deformable template to detect eyes, mouth, nose, and eyebrows.

C Chang, et al, 1994, have used color based feature extraction to extract eyes and mouth. The performance was limited due to the variation and complexity of image backgrounds [10].

Y. Tian, et al, 2002, used PCA, ICA, and LDA (Appearance Approach) to detect eyes and mouth with recognition rate 98% [11].

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III. METHODOLOGY

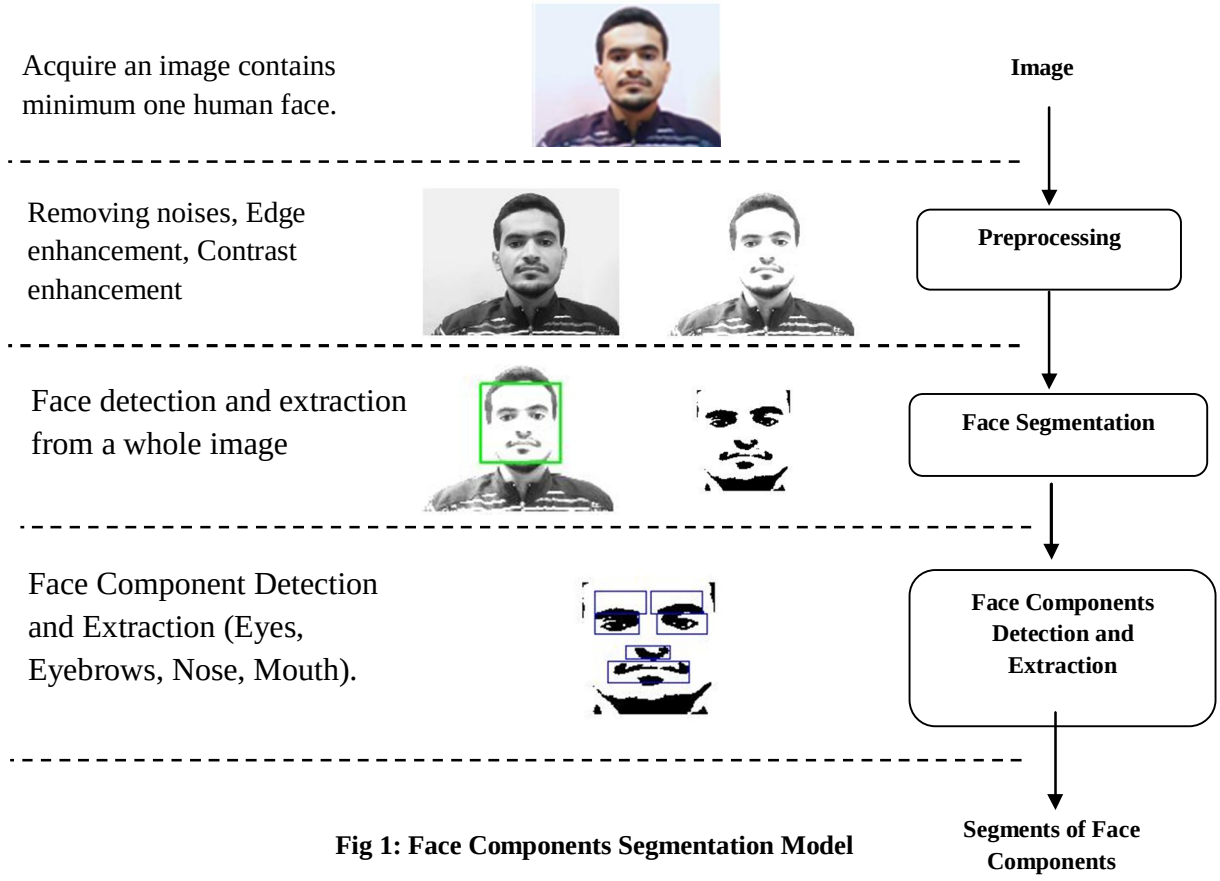

Fig 1: Face Components Segmentation Model

A. **Preprocessing**
This phase is the first one, which includes color to gray image conversion, noises removing, smoothing, background removing, and edge enhancement. The researchers use Median filter and some other special filters.

Fig 2: Preprocessing Phase

B. **Face Segmentation**
In this phase, the researchers use Viola-Jones algorithm for face detection, a very fast algorithm to detect faces proposed by Viola and Jones algorithm[1] using AdaBoost learning algorithm. The extracted face will placed on panel with 300*300 pixels dimensions. A high performance has been achieved due to the method they detect all facial features very fast and leave background from images. Some samples show the results of this phase illustrated in Figure 3.

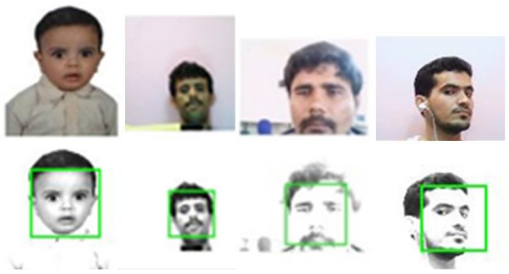

Fig 3: Face Segmentation Phase

C. **Face Components Segmentation**
To segment the face components (Eyes, Eyebrows, Nose, Mouth), The researchers have used a method based on two main units: first is dividing a face into two parts vertically and dividing it horizontally as well. Second, is using the sweeping approach to detect the corners and the edge points of face segments. Figure 5 shows face divided into two horizontal parts and two vertical parts. The virtual division has been done to divide the face into two equal parts, whereas dividing a face horizontally has been done based on experiments, so the upper part is smaller than bottom part. Obviously, as it can be noticed, the left eye and its brow will be placed in the space enclosed with (A,

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Y1, s, X1), where the right eye and its eyebrow will be in the space enclosed with (Y1,B,X2,s). Similarly, the other face components can be determined based on these four segments.

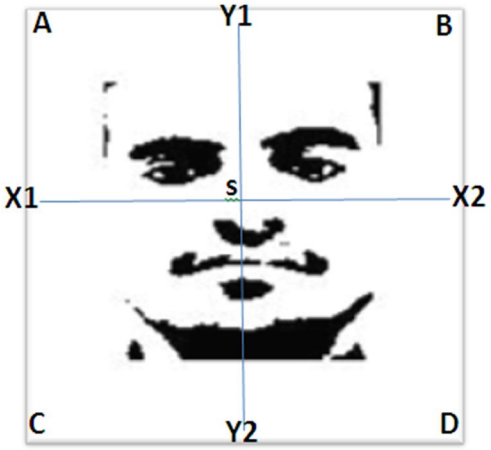

Fig 4: Face Division for Face Features Extracting

To detect and extract right eye by sweeping the eye part panel from right to left, bottom till find the first pixel with zero value (all face parts as binary images), which represents the bottom edge of the right eye. Programmatically, this can be implemented with nested loops. The outer loop represents the column sweeping (vertically), means it sweeps from S to Y1 in reverse. And the inner loop starts from S, where it represents the horizontal swapping till arrive X+40 (approximately specified), this procedure is illustrated in Figure 5.

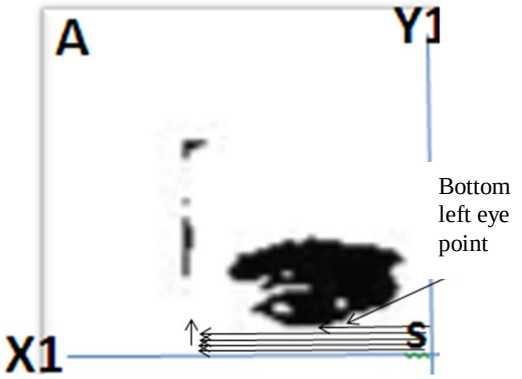

Fig 5: Detecting bottom left eye point

Similarly, same procedure idea will be applied for detecting the vertical ends of eyes.

Fig 6: Eye Extraction

Approximately, 50 pixels is the high of eye starting from the bottom point. Figure 6 illustrates the eye segment after detected.

D. **Eyebrows Detection**

The lower eyebrows edges start from where eyes upper edges end. Applying the same idea of eye detection will produce the eyebrows segments.

E. **Nose Detection**

Generally, the nose will touch the vertical drawn line (Y1, Y2) in Figure 4, but it will be located in the lower portion of the face. Here the same procedure of eye detection is applied, but it starts from S to Y2 vertically, as it is illustrated in Figure 7.

Fig 7: Detecting upper nose point

F. **Mouth Detection**

Mouth detection is an easy task, due to the position it located (below the nose). Similarly to the eyebrow detection procedure, the mouth upper end point starts from the lower end point of the nose (approximately 50 pixels). Figure 8 shows the mouth segment along with other face segments.

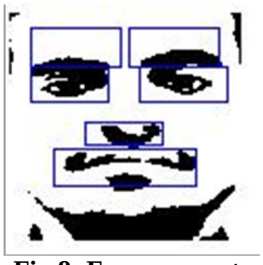

Fig 8: Face segments

RESULTS AND DISCUSSION

The researchers have tested the approach, presented in this paper, using live videos as well as static images. They test it again with other databases such as Cohn-Kanade [12] and JAFFE [13] databases. Algorithm implementation has been conducted with Matlab. An excellent performance has been achieved. Figure 9 show the segmentation procedure without and with glasses.

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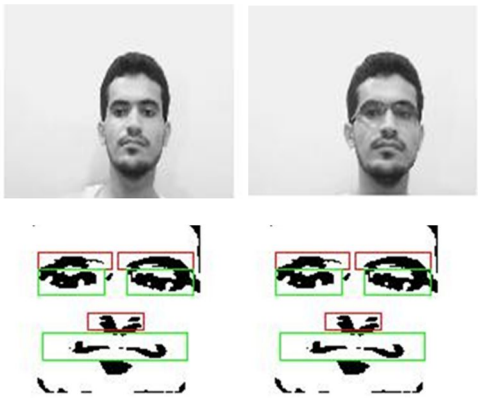

Fig 9: Face segments with and without glasses

Figure 10 shows the segmentation procedure in different faces with different positions. Comparison to the other techniques and approaches of face components segmentation, our approach achieves better as it illustrated in Table 1 and in Figure11.

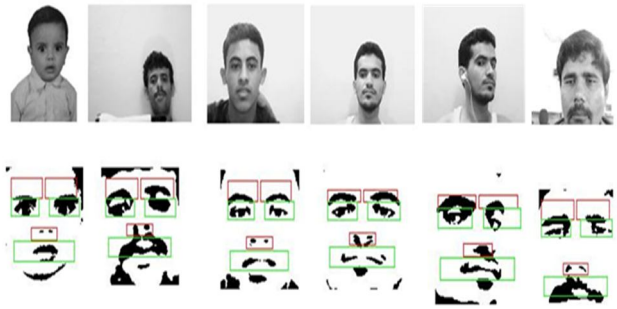

Fig 10: Detecting bottom left eye point

Table 1. Results and comparison

	Cohn-Kanade	JAFFE Databass	Live video
Viola-Jones algorithm	75.6%	79.2%	82.9%
Proposed Approach	97%	93.5%	95.3%

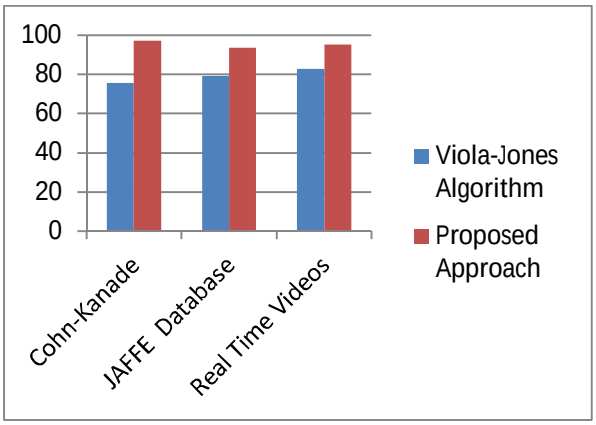

Fig 11: Proposed Algorithm Performance

Samples from Cohen-Kanade and JAFFE databases, in Figure 12 and Figure 13, show the obtained results and performance accuracy of our approach. The researchers have chosen these databases to test the proposed approach due to the variations of appearance, either in the face shape or facial expressions.

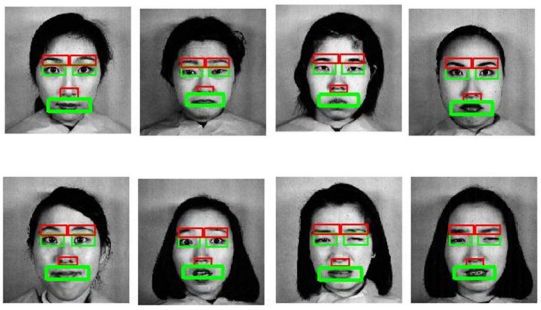

Fig 12: Implementation with JAFFE DB samples

Fig 12: Implementation with Cohn-Kanade DB samples

CONCLUSION

This paper presents a new approach for face parts segmentation; the researchers have developed an algorithm based on two main aspects: first one built on dividing a face into two parts vertically and dividing it horizontally as well. Second, is using the pixels sweeping idea to detect the corners and edge points of face segments. This approach has achieved an excellent performance. The most challenging issues, this approach faces, are related to image rotation and illuminating condition, recommended for further future studies.

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