Face Detection and Emotion Recognition Based on 8-connected neighbors approach

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Abstract

Face detection and emotion recognition has become an important issue in many applications in computer visions communication and automatic access control system. This paper proposes accurate and robust detection system for face and lip. The algorithm recognizes the face from images and ignores the rest. It depends on color of the skin and edges of the face. Irrelevant regions are removed from images by applying Morphological connected transformations. After face detection the system divides the face to objects and then detects the lips and recognizes them. The algorithm depends on the connected components analysis without boundaries. It also adopted the 8-connected neighbors approach. A proposal work is used to recognize some of facial features. Additionally, the algorithm compares the detected lip with set of templates to extract the facial emotion.

Key words:

Face recognition, Emotion extraction , Facial expressions, 8-connected neighbors,.

1. Introduction

Most of academic researches trying to emulate human vision by analyzing the digital images. The human efficient feature is skin color that is used in detect the face. Three color spaces RGB,HSI and YCrCb could be adopted to recognize the digital images. Facial region is detected by applied the erosion and dilation operation [1]. RGB color model is the combination of the red (R), green (G) and blue (B) components. The value of each pixel in the image is identified as a vector in three spaces. The HSI components are hue (H), saturation (S) and intensity/value (I/V). The HSI color mode is used to separate intensity from the color components. Where

the YCrCb color space components: (Y) is the luminance, Cr and Cb are color-difference components.

Face detection and recognition are most difficult problems. The detection processing could be used to improve many security systems by identifying the access control and prevent of unauthorized usage of any system such as in mobile. The Principle Component Analysis PCA is the successful method that is used in image recognition [2]. The preprocessing of input images is needed to increase the accuracy of recognition. The time is minimizing also in detection. This could be done with change input images from RGB to Gray scale, normalization equations and using filtration [3].

Facial features recognition, in many studies and researches, depend basically on mouth, nose and eye recognition [4].

The recognition of facial expressions can make more human computer communication and interaction. It has a lot of benefits in machine vision, image processing, speech processing and medicine, for remote patient monitoring [5]. Performing image recognition is to minimize the face space dimension and accuracy image training [6].

The present work detect faces in images after the preprocessing these images. The proposed system adopted the connected component analysis to recognize image components after face detection. This is based on 8-neighborhood system. We used Matlab to programming our work.

The outline of this paper is as follows: in the Section 2 we will be explain, in general the proposed system algorithm. While the Section 3 the face and skin detection will discuss the color spaces that are used in the system and a brief description of morphological operation which are used in our work, with the basic steps of emotion extraction in Section 4. Section 5 will describe the strategy that is used for comparing the images; find the similarities in these images and the results. Finally, Section 6 contains some remarks and conclusions.

2. The Algorithm and System Architecture

The work consists of two parts; face detection and emotion extraction as in Figure (1). The proposed algorithm adopts easy and general approach to detect facial regions as well as lip regions. The system depends on color and edge properties to segment the facial region.

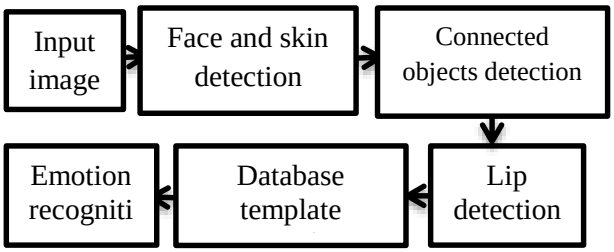

Figure (1) : A block diagram of system algorithm.

3. Face and Skin Detection Part

The work in the first part based on RGB, HSV and YCbCr color models to specified skin region and face detection. Figure (2) explains the algorithm steps. The model techniques used HUV to classify each pixel as being skin or not. The face will be separated from any background [7].

The system converts the images from RGB color space into HSV to use the sensitivity to illumination intensity in the last space.

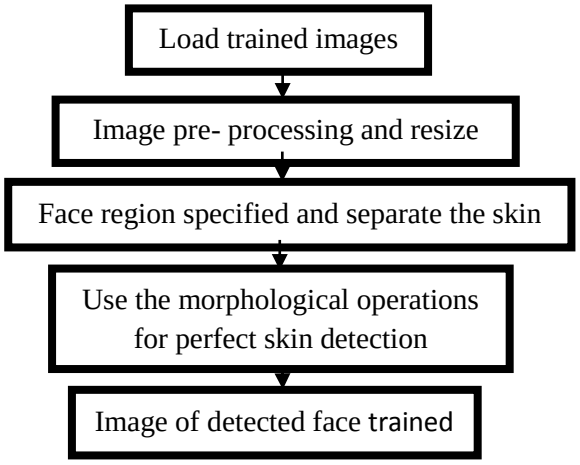

Figure (2): A block diagram of face detection.

The work depends on the Equations (1) to convert to YUV space. This transformation is used to achieve quick transformation and for best segmentation of skin by minimizing the noise and light affecting [9]. Figure (3) shows the representation of YUV depending on the basic color space RGB.

$$\begin{pmatrix} Y \\ U \\ V \end{pmatrix} = \begin{pmatrix} +.0247 & +.504 & +.098 \\ -.148 & -.291 & +.439 \\ +.0439 & -.368 & -.071 \end{pmatrix} \cdot \begin{pmatrix} R \\ G \\ B \end{pmatrix} \begin{pmatrix} 16 \\ 128 \\ 128 \end{pmatrix} \quad (1)$$

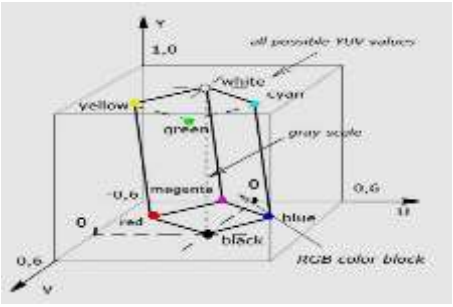

Figure (3) : RGB color cube in the YUV color model [8].

2.1.1 The Morphological Connected Transformations

Face detection also depend on morphological operations beside the color spaces transformation in our system. Morphology is a technique based on applying structure elements to an input image, creating output image of the same size. The role of morphology transform is very important in image enhancement [10].

Basic morphology operations are erosion and dilation. Both two operations based on the intersection between structuring element with the pixel of the image. Structuring element is a matrix of 0's and 1's and it has specific size and shape. There are two types of structuring elements, flat and non-flat. Disk, diamond, line, octagon and square are examples of the flat structuring elements. Ball is an example of the non-flat type. In this paper, we used disk structuring element to preprocess the scaling input image.

Dilation operation permits to expand objects, filling small holes and connecting the disjoint object. While erosion etching away objects boundaries and shrink them [11].

These two operations depend basically on the right selection of structure element. Combined dilation and erosion in the system will produce new two operations, opening and closing. Figure (4) shows that the image would be part of next computational process. This process is used to extract the skin from the image. The all morphological operations, which are used in the system, to simplified the extraction of skin.

Figure (4): The effect of dilation and erosion on an image of system data base.

The proposal model depends on closing operation, which is implies erosion of an image, followed by dilation of the resulting image. This process will smooth the contours, join narrow

areas and fill holes in the image as in Figure (5) [12].

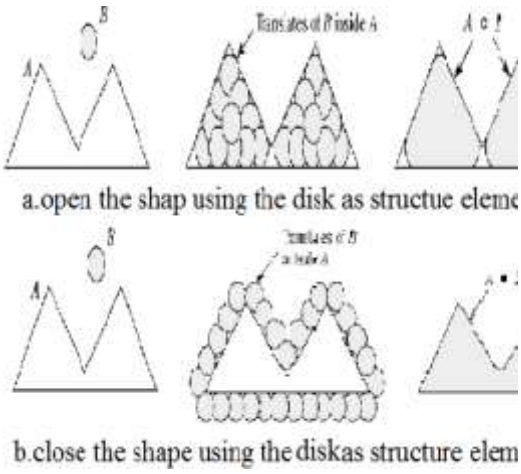

Figure (5): Morphological operations.

The results of the first part of the model are summarized in Figure (6).

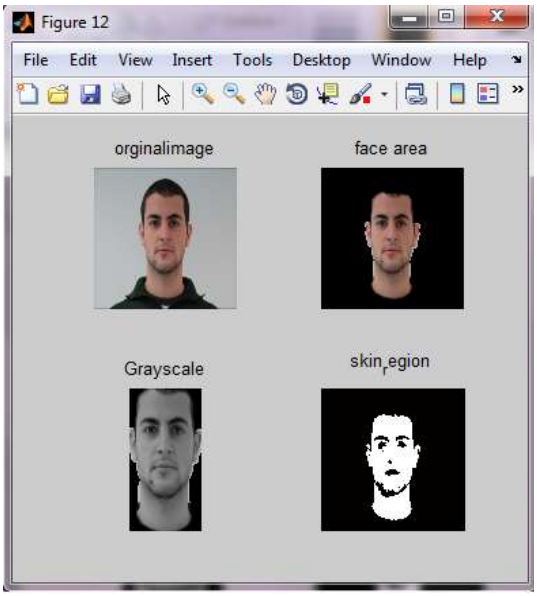

Figure (6): The abstract result of the first part of the system.

All the previous process on the input images is considered as preparing to the next steps: the expression extraction

4. Emotion Extraction Part

The images from the previous part of the system are normalized with Equation (2) [1].Figure (7) shows the basic process in the second part of the model.

$$g(x,y) = a + \frac{\log(f(x,y)+1)}{b * log(c)} \quad (2),$$

where f (x,y) is the image from the previous part, a, b and c are parameters are used to effects on the illumination and chosen 10, 0.25 and 2, respectively. The log transform function is used to normalize luminance of the input image f (x, y) and produce the normalize image g (x,y).

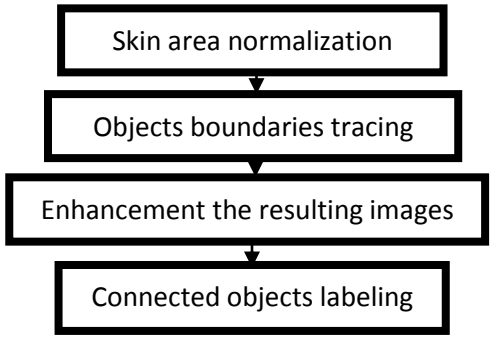

Figure (7): A block diagram of emotion extraction part.

Different lighting conditions could be effect on the appearance of the skin color.

The Equation (2) is used to minimize this effect and increase the segmentation robustness. The model depends on 8-neighbours strategy of the object. The images are scanned vertically, horizontally, and diagonally in this strategy. The system traces the parents objects and the children objects in the normalized images. The nonzero values in the images represent the objects and the zero values represent the background. These objects should be refined by remove all connected objects that have fewer than specified pixels. This process is called the area opening use to enhance the result images. The enhancement implies the holes fill in the images. The image will be as a matrix of connected objects. The pixels of each object will be labeled with the same number. The pixels of the first object are labeled with 1.The second object labeled with 2 and so on. Zero value represents the background. Figure (8) show an example of the objects labeling.

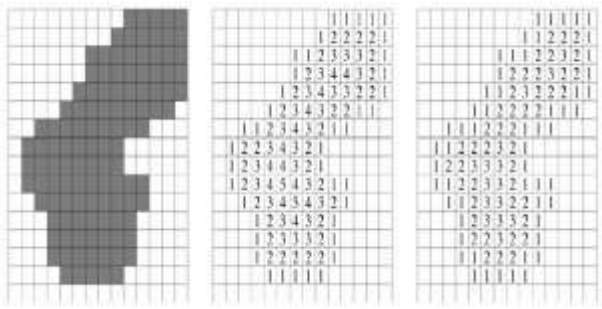

Figure (8): Connected objects labeling.

The proposal model isolates each part of the face depending on the previous techniques. These connected objects of the face components are: eyes, ears and mouth. In this way, the comparisons to recognize the emotion could be done easily as in Figure (9).

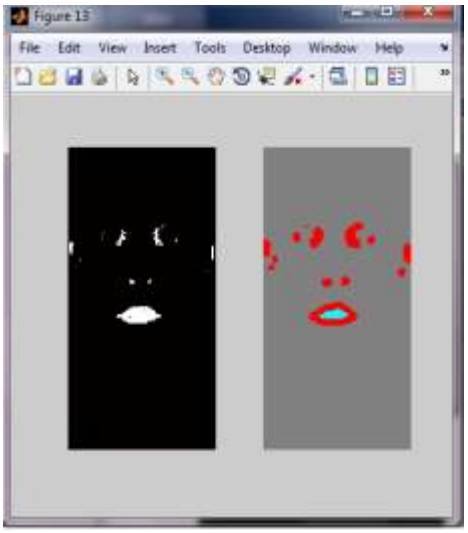

Figure (9): labeled the face object.

The comparison algorithm compares each image in the specified database with for templates (smile, laugh, neutral and sad).

In proposed system, the degree of similarity between the template image and an image is specified depending on four manners: first, find the cross correlation between two blocks of two images A and B. The maximum value which is founded from this comparison refers to close correlation between the image and the templates

depending on the Equation (3) [1].The specified template refers to the emotion of input image.

$$c(i,j) = \sum_{m=0}^{Ma-1} \sum_{n=0}^{Na-1} A(m,n).conj(B(m+i,n+j)) \quad (3)$$

Where Ma,Na are the dimension of image A, Mb, Nb are the dimension of image B, conj refers to complex conjugation, 0≤ i < Ma+Mb-1 and 0≤ j <Na+Nb-1.

In the second manner, we try to find the structural similarities between the images by comparing the pixels in these images and find the differences. The two later manners depend on the visual comparison. The absolute differences of two images could be used to show the images as one matrix. Zero's values in this matrix refer to the similarities between the images.

5. Results and Discussion

The programming environment is Matlab 2014a. GTVA Face Database is used in system process [13].Various types of images are used like jpeg and bitmap format. These images were in different sizes

First, the system detects the skin parts of the in front images for single person. The proposed system depends on HSV and YUV transformation to detect the skin.As seen from the above sections the face is detected from based on the skin color. Figure (10) explains the relation among the input image and the templates in the model algorithm. Where the maximum value 708.024 refers to that the input image is in sad situation.

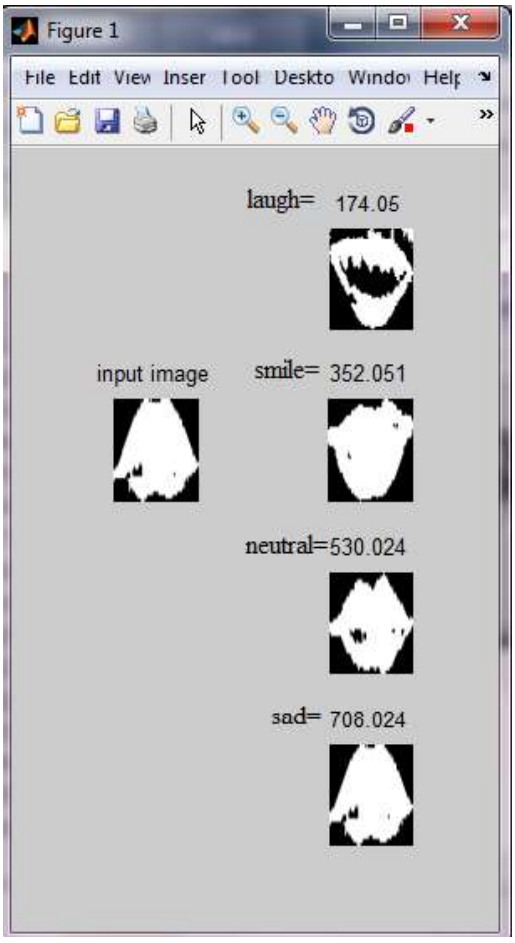

Figure (10): Compare the input image with four templates.

The experiments were done on 80 images with different background color. The

model works efficiently on 72 images as in Table (1). The rest images were either with bad resolution or didn't in front scene, for this reasons the model couldn't recognize them. The shape of mouth is very important in specifying one of the four states (laugh, smile, sad and neutral). The model depends on the cross correlation approach for finding similarities beside the structural method which is used as a second manner to check the pixels of two images.

Table (1): The system accuracy.

No. of images	Positive Detection	Accuracy
80	72	%81

6. Conclusions

The proposed system separates the face in the input image by the skin recognition. This step simplifies the face objects separation. The model extracts the person emotion situation (laugh, smile, sad and neutral) depends on its mouth. The system can recognize the emotion situation accuracy without any complicated.

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اكتشاف الوجه وتمييز المشاعربالاعتماد على المتجاورات الثمانية

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المستخلص

اصبح اكتشاف الوجه لتحديد ملامحه من الامور المهمة والمفيدة في العديد من التطبيقات،من هذه التطبيقات هي الاتصال من خلال الحاسب والسيطرة التلقائية للانظمة.النظام المقترح قدم موديلا دقيقا ومحكما لاكتشاف الفم.الخوارزمية المقترحة تميزالوجه من الصور المدخلة مهملة ماتبقى.فهي تعتمد على لون الجلد وحدود الوجه في اكتشاف الوجه.كل المناطق الغير مرغوب بها تزال من خلال Morphological connected transformations .بعد تمييز الوجه من الصورة يقوم النظام بتقسيم الوجة الى مكوناته وهي الفم والانف والعين.الخوارزمية الخاصة بالنظام تتبنى مبدأconnected components analysis و eight connected neighbors approach.يتم تمييز الملامح للصورة من خلال مقارنة الفم مع مجموعة نماذج محددة مسبقاtemplates.

الكلمات المفتاحية:تعابير الوجه،معالجة الصور،تمييز الوجه،استخلاص المشاعر.