Finding the bezier curve of face based on YCbCr color space and features extraction

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Abstract
The face contains a lot of various details and positions of strength, for which outstanding characteristics can be found that reach more than (50) locations in it and benefit from them in the process of discrimination and classification of persons and thus can be used in various life fields such as banking, legal, justice, security, medical, and others.In our research, we relied on image compounds (YCbCr) to separate the face from the rest of the image's components due to its effectiveness in this field, as well as dividing the image into four blocks then dividing each block into a number of blocks of equal dimensions (8×8) and finding the (mean, standard deviation and energy) for each block and was given For each attribute of a specific weight, then the position of the top four blocks of these attributes is determined and made the control points upon which it draws to draw a bezier curve shape to be adopted in the processes of distinguishing and classification of persons. Experiments were conducted on a database consisting of (400) images representing (40) people and each of them (10) Pictures.

Key words:
Bezier curve, Facedetection, Energy feature, Mean, standard deviation, Feature extraction, Enhancement, segmentation, edge detection, thresholding.

1. Introduction

The essencial issues in build any skin color system of face detection depend on three cases are taking into consider: firstly selection type of the color spaces model; secondly illumination conditions and calibration of camera system; thirdly chooce of suitable mathematical model.
In this work, isolating the face object image from background of it and dividing its to four blocks then each block dividing into smaller blocks (8×8) with neglecting shared blocks where the face area is less than the rest of the background, such as head hair or part of the clothes, especially the edges of the image.The features (mean, standard deviationand energy) calculate for each smaller block, where the mean feature concern with the intensity of the pixel and its proximity to whiteness or blackness in image, as well as standard deviation which is important in the contrast of image, in the end the energy feature care to distribut of pixels in block.In this work, utlizing the Bezier curve because it is leading to a powerful fundamental theory of intuitive geometric construction and strong realationship between algebra analysis and geometry method.

2. Related work

To obtain a binary image that reflects the human face, a color image has been segmented depending on the color information of the skin [1].
There is no doubt that the operation of face detection is considered as a vital component for recognizing a human face. Besides, the segmentation operation of skin based on color is another crucial operation in face detection and for its importance, we made some improvements to it[2].
One of the first examples of face detection is presented by Manish and Sanjay [6]. In this work, the authors design a face detection system that recognizes digital images related to human fontal faces with the aid of the approximated Bezier curve and neural network. Features like face boundaries, nose, lips, eye, eyebrows have been extracted and employed with a minimum of them to conduct face recognition effectively.
Bezier curve technique has been founded it sound in variety applications ranged from face detection, hand waiting to digital recognitions. Due to the ability of the Bezier curve to handle different applications, this open orientation to implement it in image processing especially for providing extra edges in the field of face detection [7].
Automatic extraction of facial and emotion expressions from fixed images is another important field in pattern recognition. Indeed, two major steps are essential for extracting facial and emotion from human faces. The first one relied on detecting the facial region with the aid of color feature-map. while the second one utilized the verification of the motion characteristics via Bezier curve [8].

3. Proposed Technique

Suggested technique consists of four main modules as following below in figure 1:

1. **Preprocessing:**

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a. Enhancement Image to remove noise by Medin filter
b. Transform True color image to YCbCr Model.
c. Isolating and crop the face from the rest of the image depend on Thresholding of (Cb and Cr) to transform to binary image.

2. Modeling algorithm:

a. Dividing a face image to four blocks (quarters).
b. Dividing each block or quarter into number ofblocks (8×8).

3. Features Extraction:

a. Blocks check to extract some features such as (Mean, standard deviationand energy) to locate region of discriminatory power largest energy block in face quarter.
b. Repeat steps (1-2) to (10) images for each person.
c. Assign (4) best of (8×8) blocks (one block of each quarter) and locate center of it depend on max energy features.

4. **Draw Bezier Curve:**

a. Finding (4) control points of (10) images of each person and draw bezier curve of them.
b. Calculate an average of each control points to draw bezier curve to all images.

5. Repeat steps (1-4) to (400) images which images back to (40) persons and each person has (10) images.
6. End

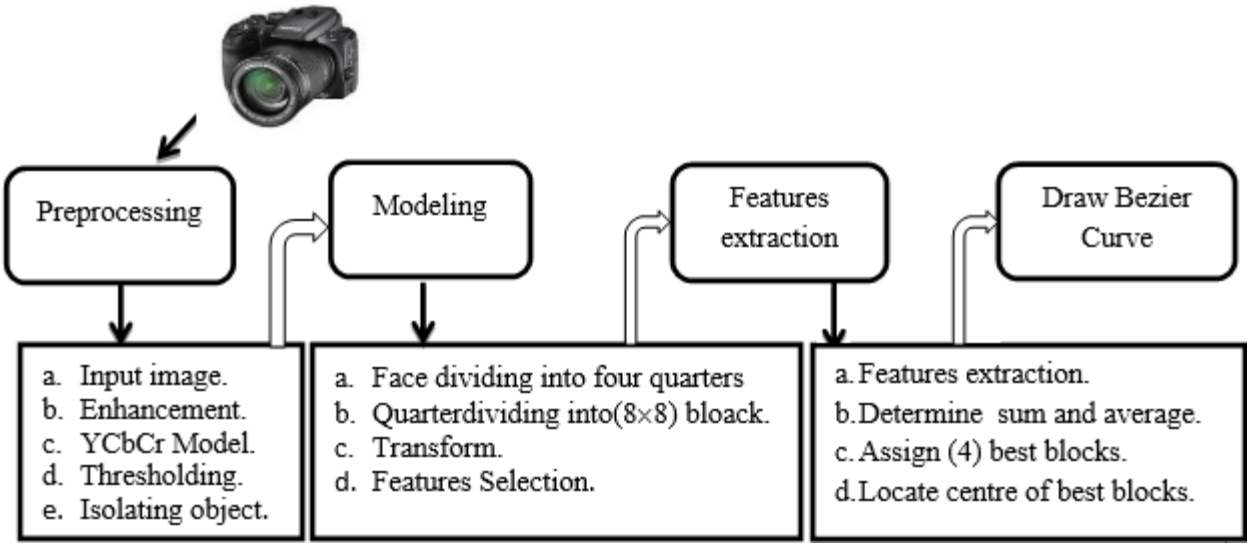


Fig. 1 Shows block diagram of suggested technique stages.

1. Preprocessing

Suggested five stages to specify isolate object (face) about reminder of image as shown in below:

1.1 Input image: True or 256 of Color image of dataset image.

$$Input\ image \begin{cases} True\ color\ 24\ \text{RGB} \xrightarrow{Direct} Using\ Data\ of\ image \\ 256\ color \xrightarrow{Indirect} Using\ Data\ of\ (palette) \end{cases}$$

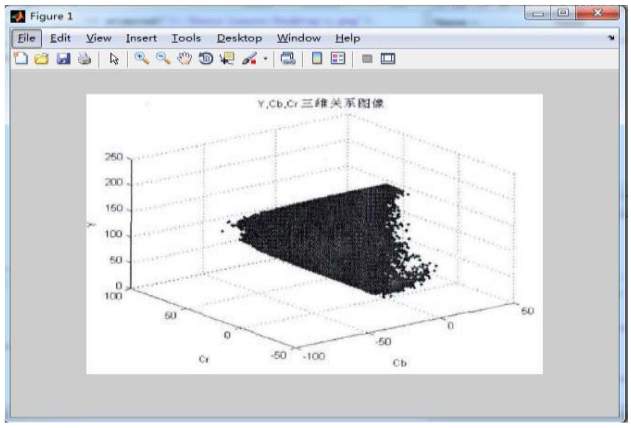
1.2 Enhancement: To improve and remove noise of input image by applied median filter, this steps excute if using gray image.

1.3 YCbCr Model:To distinguish the face from the rest of the image, using the transformation of color space (YCbCr) components.It is a powerful model that has the ability for separating both brightness and tint efficiently [1]. This separation is a vital process since its component represented by tint is considered as a very important element in color image segmentation. The composition of Y in YCbCr is represented via pixel brightness, while CbCr is represented the chromaticity compnet, where Cb

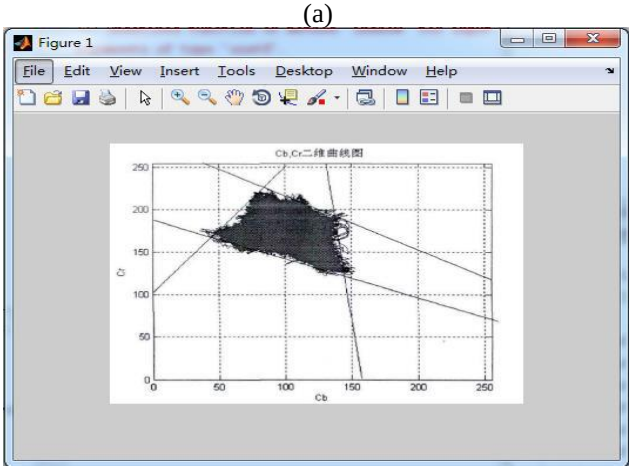
and Cr have represented the blue and red components respectively. Thus, separating both brightness and chromaticity components is done by YCbCr color space. Due to previous consideration, skin color could be clustering efficiently in this color space. Moreover, the impact of chaining brightness could be reduced. The cubic of the YCbCr color space unit is illustrated in the formula below [2, 3 and 4].

$$\begin{bmatrix} Y \\ C_b \\ C_r \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 & 0 \\ -0.169 & -0.331 & 0.500 & 128 \\ 0.500 & -0.419 & -0.081 & 128 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \\ 1 \end{bmatrix} \quad (1)$$

After more expirements on the different faces images, a skin color curve of YCbCr model is shown in figure 1.



(a)



(b)

Fig. 2 A- 3D distribution of skin color on YCbCr. B- 2D distribution of skin color on CbCr [2].

1.4 Thresholding:To detect face and obtain (B/W) image which utilizing matrix as shown in equation (1) and depend on Cb and Cr of separately chrominance components value according to equations(2 and 3) and conditions below.

Cb = -0.1687× R_Comp.- 0.2213 × G_Comp. + 0.500 × B_Comp. + 128 (2)

Cr = 0.500 R_Comp.× - 0.4187× G_Comp. – 0.0813× B_Comp. + 128 (3)

if((Cb>100 and Cb<135) Or (Cr>130 and Cr<160)) Then Assign Face.

1.5 **Isolatting Object** (face) :After execute 1.1 to 1.4 the result is isolated or cropped ROI (Region of interest) face from the rest image and supply to next step .

2. Modling

Receiving the result of preprocessing step and deal with ROI image that consisting of several stages as shown below:

2.1 Dividing: Effective region dividing to four quarters then dividing each quarter into several blocks in Two Dimentional (8×8) blocks.

2.2 Transform RGB to Luminance Components:It is brightness or luminance of pixel can be representing by equation (4) below:

Y = 0.299 × R_Comp.+ 0.587 × G_Comp. + 0.114 × B_Comp. (4)

2.3 FeaturesSelection: After divide object (face) to number of quarters and blocks we determine number of features values explain in next stage to each block such as: (mean, standard deviation and energy).

3. Features extraction

Features extraction is considered a vital component of any pattern recognition task and played a major role in dimensionality reduction. In the image processing landscape, features extraction operation has efficiently reflected the important parts of the image as a vector of features [5].

The face includes many details and control points, especially in the formation of the lips, mouth, nose, eye, eyebrows and face shape or boundary, as well as texture, gradations of intensity, and formation of its distribution.

In this work after isolation ROI (face object) from background image and dividing the face boundary to four quarters and each quarter dividing into equal size blocks (8×8) of each it with specify weight of each feature (Mean, Standard deviation and energy) to calculate results from equation (9):

3.1 Features Extraction Values:It is main part of modeling which it apply mathematical models by equation (5, 6, 7 and 8) below to determine a mean of each block, probability of all gray levels,standard deviation and energy in it :

a. mean of block: it is the average of pixels values in the blocks a more bright image will have raised mean, while a dark image will have a minimum mean, thus the gray levels ranged between 0 to 255 as shown in equation (5) below:

$$Mean = \frac{1}{N\times M}\sum_{r=1}^{N}\sum_{c=1}^{M} I(r,c) \quad (5)$$

b. Probability of each gray:

$$p(g) = \frac{N(g)}{N\times M} \quad (6)$$

N(g): Represents the total number of pixels on g gray level

d Standard deviation: It is a statistic measure that calculate the amount of variation, and revals smoethine hiding about contrast. This measure demonsterates the propagation in the image pixcels. In other words, whenever we have a high image contrast, we will have high variance and vice versa. It is define as follows

$$:\boldsymbol{\sigma} = \sqrt{\sum_{x=0}^{L-1}(\boldsymbol{g}-\bar{\boldsymbol{g}})^{2}\boldsymbol{P}(\boldsymbol{g})} \quad (7)$$

L: Max number of gray level.

e Energy of block:it is measuring tells us sometimes about how the gray level are distributed, it is defined as in equation (8):$Energy = \sum_{g=0}^{L-1}[p(g)]^2$ (8)

The energy metric maximum range value is 1 for constant image. This measure has been progressively degrased as the values of the pixcel are saperated more in gary level values

3.2 Results

To test ten images for each person and calculate all features of blocks.

a. One control points to each quarter (Center of max energy block).
b. Four control points of each image.
c. Draw Bezier curve to each image.
d. Sum and average of each control points to (10) image s of each person.
e. Draw one Bezier curve to each person.

4. Bezier (Bernstein) Curve

Bezier curve is more important for types of applications of biometric system recognitionsuch as (fingerprint, faceand gait). It is defined by four points, it is contained (start and end) points and two control points in medium as shown in figure 3 below.

Curve generatation on constraining to pass exactly through the existing data points is a type of curve fitting [9].The essential characteristic of Bezier curve is interactive between algebra and geometry sciences that leads to a strong method intuitive geometric building [6].

The effects of parameters on the curve that reflect the shape become more comprehensible in an effective matter Bernstein polynomials of degree n are a class of polynomials that have enhanced characteristics than interpolation polynomials. The i-th Bernstein polynomial of degree n (i $\in$ {0, . . . , n}) is demonstrated by the following equation (11) below[10]:

$$B_i^{(n)}(t) = \binom{n}{i}\cdot (1-t)^{n-1}\cdot t^{i} \qquad (t\in[0,1] \quad \text{.....11}$$

Bernstein polynomials accept two mainfeatures.$B_i^{(n)}(t) \in [0,1] \ for\ all\ t \in [0,1]$ i.e. the Bernstein polynomial values are within the unit interval between (0 and 1) [10].

$$\sum_{i=0}^{n} B_i^{(n)}(t) = 1 \qquad for\ all\ t \in [0,1]\text{.....12}$$

Bezier curves utilizes Bernstein polynomials of degree n to approximate (n+1) control points b0, . . . , bn$\in$Rp.

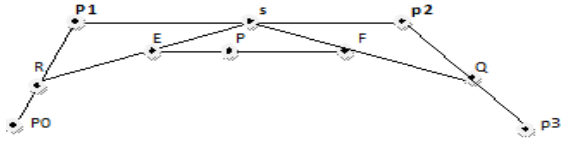


Fig. 3 :Bezier Curve Control Points [6].

Point R, S and Q are locate among P0P1, P1P2 and P2P3 points on the sequences and given value at u in fraction as well as point E and F are locate at a fraction u from R to S and S to Q points and so on it is repeated for each fraction u between 0 and 1[7].

The general expression for a Bezier-Bernstein polynomial as equations below:

$$P(u) = \sum_{K=0}^{M} \frac{M!}{(M-K)!\,K!} u^{K}(1-u)^{M-K}P_K \quad , \qquad 0 < u \leq 1 \quad \text{.....13}$$

Here 0! And uK = 0 when u and K are both 0 so

$$P(u) = \sum B_{K,M}(u)P_K \ or \ \sum_{K=0}^{n} P_K B_K(u), \quad 0 \le u \le 1 \quad \text{.....14}$$

Where blending function BK, M (u) is defined as

$$B_{K,M}(u) = C(M,K), u^K(1-u)^{M-K}, C(M,K) = \frac{M!}{(M-K)!K!} \text{.....15}$$

The Parametric shape of a cubic Bezier curve is calculated by 4 control points P0, P1, P2, and P3.

$$B(t) = (1-t)^3P_0 + 3t(1-t)^2P_1 + 3t^2(1-t)P_2 + t^3P_3 \text{.....16}$$

5. Experimental Results

5.1 Preprocessing

a. Input image RGB or Gray image and ten image for each person.
b. **True Color (24 bits) image**:By YCbCr model to obtain Y- component or direct using gray image.

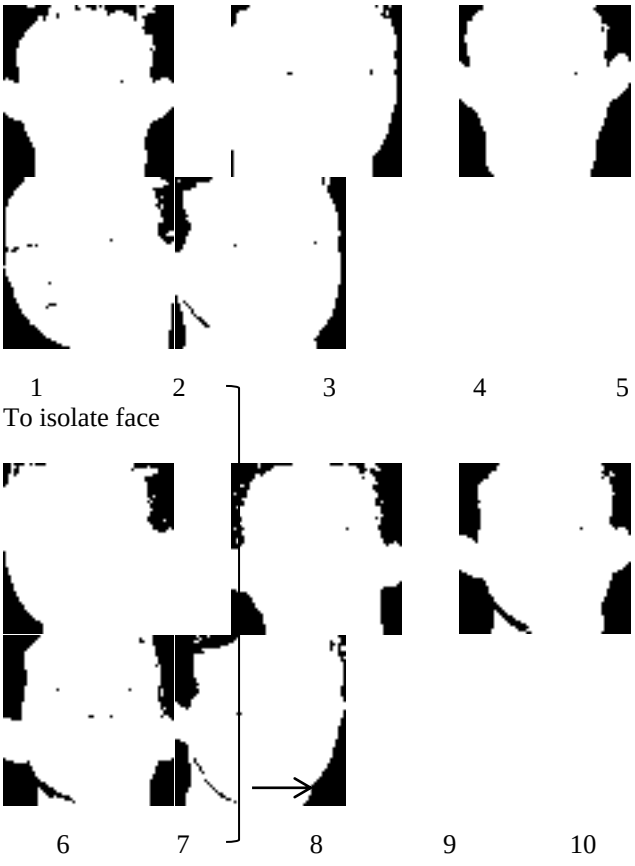
RGB Gray Enhancement

1 2 3 4 5 YCbCr components

6 7 8 9 10

Fig. 4 Convert True color image to gray by Y component and using median filter toenhancement model.

c. YCbCr Model: To find Cb and Cr components by transform from equation 1.
d. Thresholding: Using two conditions of Cb and Cr in equations 2 and 3 to obtain binary image:



1 2 3 4 5 To isolate face

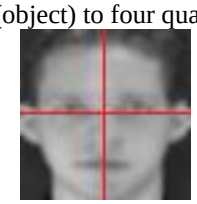
6 7 8 9 10

Fig. 5 Binary images by Thresholding Cb and Cr components.

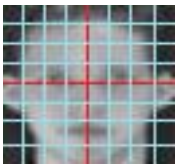
e. **Isolating (Crop) Image**: To limit face and separate of background image.

5.2 Modeling

a. Dividing face (object) to four quarters.



b. Each quarters of image divide into number of blocks (8×8).



c. Calculate features (mean, standard deviation and energy) of each block with remove blocks of background image and assign center of max energy block in each quarters.

Table 1: The value of feature extraction to first quarter (32 × 32).

No.Blk	Start Y	Start X	Mean	Stand. Dev.	Energy	Case
1	0	0	0.0000	0.0000	0.000000	Remove
2	0	8	101.1094	64.5109	0.000029	Face
3	0	16	177.1250	10.9822	0.000081	Face
4	0	24	170.2188	9.9286	0.000133	Face
9	8	0	0.0000	0.0000	0.000000	Remove
10	8	8	126.2031	65.8175	0.000061	Face
11	8	16	183.8594	16.7648	0.000508	Face
12	8	24	151.5469	26.2559	0.000044	Face
17	16	0	0.0000	0.0000	0.000000	Remove
18	16	8	177.6875	24.2976	0.000137	Face
19	16	16	179.4062	6.6302	0.000946	Face and Max Energy
20	16	24	166.3281	10.2547	0.000143	Face
25	24	0	154.4375	17.0614	0.000051	Face
26	24	8	170.9844	6.1808	0.000498	Face
27	24	16	164.1719	10.4501	0.000085	Face
28	24	24	164.4062	8.8701	0.000345	Face
CenterX= DimX +4		CenterY= DimY +4				

0,0 0,7 1: ×	0,8 0,15 2: √	0,16 0,23 3: √	0,24 0,31 4: √
8,0 8,7 9: ×	8,8 8,15 10: √	8,16 8,23 11: √	8,24 8,31 12: √
16,0 16,7 17: ×	16,8 16,15 18: √	16,16 16,23 19:√, Δ	16,24 16,31 20: √
24,0 24,7 25: √	24,8 24, 15 26:√	24,16 24,23 27:√	24,24 24,31 28: √

Fig. 6 First quarters arrangment blocks and assign background '×', forground '√' and max energy 'Δ'.

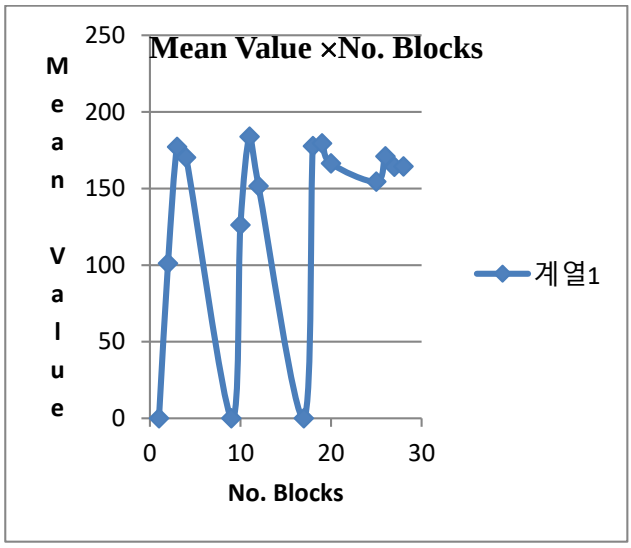


Fig. 7 Relationship between mean value × Number Block.

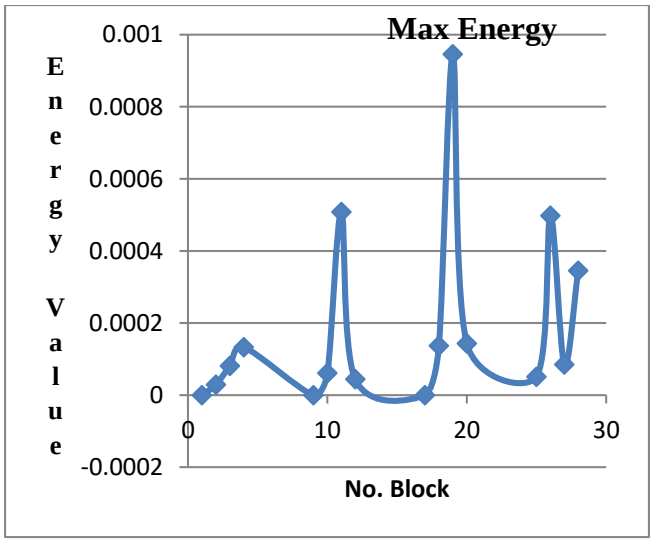


Fig. 8 Relationship between Energy Feature × Number Block.

6. Conclusion

The Baiser curve characterize by a high degree of complexity, and also provides flexibility in increasing or decreasing complexity degree, as well as ability to change the number of control points used in drawing the curve.
We use three features such as (mean, standard deviation and energy) because dealing with intensity, contrast and distribut of pixel wthin the blocks, espacilly to energy feature the number of gray levels in the blocks of image is few then the energy is nearest to maximum energy of this block which means that the distribution is focused only on a small number of heterogeneities gray level.

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