

Emotion Detecting System

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Abstract: Facial expression recognition has many potential applications that had attracted the attention of researchers in the last decade. In this paper, a proposed system for analyzing the facial emotions is presented. Where features are extracted by applying geometric of the distances that are determined by using the locations of the basic facial components through detecting mouth. Then evaluate them by using the standard dataset "CK" which have been used as test material for testing the results. The percentage of recognition was around 96% when the basic emotion classes were tested, which is considered to be high when compared with the results of other newly published works.

Keywords: Facial expression recognition, Automatic Processing, Facial Emotions, Facial components, Detecting Mouth

1. Introduction

Facial expression is a visible manifestation of the affective state, cognitive activity, intention, personality, and psychopathology of a person [1]. Since each person has different cultural and surrounding background, it is difficult to precisely determine the number of facial expressions that are used daily in our life. However, researchers on analyzing facial impressions have focused on seven basic expressive gestures which are: anger, disgust, fear, happiness, sadness, neutral, and surprise [2]. Till now, the recognition of facial expression still a problem with a big number of challenges. This is mainly due to the following reasons: (i) face detection from the captured image and segmentation process for the purpose of Region of Interest (ROI) extraction is a difficult task [3], (ii) Generating effective descriptors from ROI region (i.e., face region) that reduce the percentage difference between samples per class and increase between classes differences is an important and difficult step for building facial impression recognition system with high accuracy and (iii) difficulty of selection the classifier that classifies the face expression into correct emotional state [4][5][6].

Accurate extraction of facial components is dependent on preprocessing, that include (i) converted the input image from colored (RGB) to gray scale image equation 1 [7] [8] and (ii) noise removal of image, there is many type of noise removal as a Median filter (MED) size (3x3) as illustrated in equation 2. Which is removal noise to blur the image (to reduce background texture effects)[9].

$$\text{Gray Image} = 0.299R + 0.587G + 0.114B \quad \text{eq. (1)}$$

$$f_{3 \times 3} = \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \quad \text{eq. (2)}$$

When preprocessing image needed detection and representing information of the image that is locate objects and boundaries (lines, curves, etc.) by image segmentation that are accomplished in (i) edge detection is fundamentally, a method of dividing an image into segments of discontinuity by locating the points, in a digital image, where there is an unexpected change in

image intensities and . The most popular first order edge detection operators are Prewitt, Roberts, and Sobel which has been explained in [10].(ii) thresholding is a technique for image segmentation which can be considered as an old, popular and simple method. Although image segmentation by thresholding is a simple approach, but at the same time, it is a powerful approach for segmenting images especially when images have bright objects on dark background, or vice versa. Threshold technique value can be viewed global, local, and dynamic threshold which has been explained in [11].

$$T = T[x, y, p(x, y) f(x, y)] \quad \text{eq. (3)}$$

$$T(x, y) = \begin{cases} 0 & \text{if } f(x, y) \leq p(x, y) \\ 1 & \text{otherwise} \end{cases} \quad \text{eq. (4)}$$

Where:

$f(x, y)$ is the gray level of point (x, y) , and $p(x, y)$ denotes some local property of this point such as the average gray level of a neighborhood centered on (x, y) .

If T depends on

1. $f(x, y)$ only - global threshold
2. Both $f(x, y)$ & $p(x, y)$ - local threshold
3. (x, y) - dynamic threshold

When determine the non-regular objects of the face using the (iii) region growing method which will eliminate the irrelevant background regions [12].

In geometric-based feature extraction methods; which are commonly adopted in many research areas like face recognition and facial emotion recognition. In these methods the location of key facial components (such as mouth, eyes, eyebrows and nose) are being tracked and the geometric relationship between certain key points (fiducial points) on the face (as distances, angles and shapes) are determined when making cognition decision. The established feature vectors for performing facial cognition tasks usually transmit the extracted facial components at these key geometric regions on face [13]. In general, there are two main methods for facial emotion feature generation: geometric- based features and appearance-based features. Geometric features always present in the

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face but may be deformed due to any kind of facial expression. One of this operations calculating distances (D) between any two points (P,Q) is calculated by using the Euclidean distance metric as follows in equation 5

$$d_{x,y} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad \text{eq.(5)}$$

When calculated the length of x and y which are the following equations:

$$|x| = |x_2 - x_1| \quad \text{eq.(6)}$$

$$|y| = |y_2 - y_1| \quad \text{eq.(7)}$$

The basic components of the face or the points that represent facial features are extracted from the image spatial domain for purpose of classification can be used to get discriminating geometrical based features [14].

The paper is organized as follows. Section II describes the adopted methodology. Section III explains the results obtained, followed by conclusion and future work in Section IV. In this project first start the preprocessing on the color image input. Next, identify the mouth of the person and classify the whether the person happy, angry, and surprise. The goal is to extract the mouth which is the basic facial component for images containing one face in front position regardless of image illumination.

2. The Proposed System

The proposed system block diagram which is illustrated in figure 1 consists of four main stages.

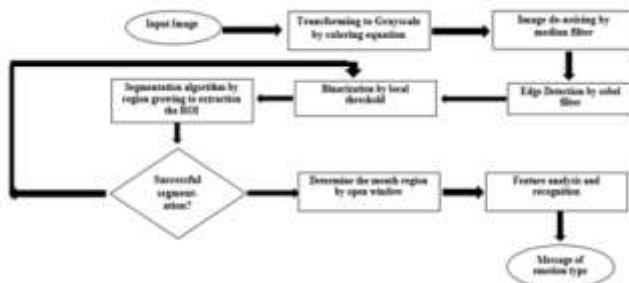


Figure 1: The proposed system block diagram

2.1. Preprocessing stage

In this stage the image is cleared. The system starts with the preprocessing module which consists of two steps:

(i) Transforming the input image to grayscale step: which converts the input image into gray image by using equation (1) true color (RGB) in algorithm 1.

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Algorithm (1): Convert Image
Input: colored image
Output: gray image
Strategy: the images taken from the dataset and convert into gray by using true coloring equation (1).
Steps
1. Input image
2. Digitized the image to use the resulting matrix
3. Applying equation 1
4. Store the resulted image (gray) to be used by the second stage
5. End.
    
```

(ii) Image de-noising step: Which remove the noise from the gray image that was produced from previous step as illustrate algorithm 2.

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Algorithm (2): Noise Removal
Input: Gray image
Output: smoothing the image
Strategy: the images are taken from the result of applying equation true color and converted into image smoothing for remove any pixel that is noising by using median filter mask in equation 2
Steps
1. Input image.
2. Applying MED filter in equation 2.
3. Store the resulted image (median) to be used by the following stage.
    
```

2.2. Segmentation stage

The segmentation module which consist of three steps:

Step1. Edge detection step: is applied on the cleared image that was produced from the preprocessing stage. In this step the edge image is extracted using the sobel edge detector and the edges at those points where the gradient of an image is maximum. In this step uses two filter size 3 x 3 kernels. One for changes in the horizontal direction, and one for changes in the vertical direction as shown in equation 8 and 9 [15].

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \quad \text{eq. (8)}$$

$$G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad \text{eq. (9)}$$

Typically, an approximate magnitude is computed by using equation 10:

$$|G| = |G_x| + |G_y| \quad \text{eq. (10)}$$

Where: G_x is a horizontal sobel mask and vertical sobel mask G_y .

Step2. Thresholding: is applied on the image which was detected in the previous step where converting to the binary. Then determine the value of the threshold to isolate the object from the background. After that the value of the threshold can be applying on local threshold operation $T(x,y)$ on the edge of the image using equation 4.

Step3. Segmentation algorithm step: is applied on the image which was detected in the previous step. Which was performed through algorithm 3.

Algorithm (3): Region growing

Input: Binary image

Output: Segment image to regions.

Strategy: the input image is processed by choosing value of a pixel (Seed_point) automatically for each area and testing the neighbored pixels. After that the xi-axis and yi-axis for each region of the object are converting to 0 or 1 according to its location. Then the rest of the pixels are also checked to extract the number of targets (NoTg) and find the area for each region by applying equation 6 and equation 7.

Steps

1. Binary image
2. Selected seed point(seed_p)
 - Make a Seed seed_p = labeld Ri
 - Set initialize region mean = to intensity pixel in seed_p.
 - Calculate neighbor of R_seed_p
 - Select seed point next and repeat step2 to next Ri
3. Repeat the process until all pixels of the image are labelled into their corresponding regions to find the NoTg number of target by equation 6 and equation 7 and calculated the area object by equation below:

$$A_{xy} = X_{obj} * Y_{obj}$$
4. Store the resulted image (segment) to be used by the following stage

2.3. Regions of interest (ROI) extraction stage

This stage allocates and determine the mouth region by using algorithm 4.ROIs) that are necessary which will be used to determine the emotion type in the system as shown in the mouth detection algorithm 4. A window is created to allocate mouth location in the image which is based on the nature human facial morphology as below:

- a. The face always contains one mouth and should be in the bottom of the face and must be on the same baseline level of symmetric line.
- b. The segment must be under nose point, but not far from it.

Algorithm (4): Mouth Detection

Input: Segment image

Output: Image binary with detection mouth region

Strategy: according to rules are applied which based on the nature human facial morphology to determine the location mouth in the binary image then calculated the area of target (mouth).

Steps

1. Input image
2. Crop interest of region (ROI) by equation:
 $W = \text{width}/2$, and $D = \text{height}/4$
3. Find Max width (x_2) of target Then assign region of mouth by equation below:
 $\text{Area} = x_2 * Y_{obj}$ to the same target

End

2.4. Feature extraction stage

In this stage geometric operations calculating the distances between two coordinating in the mouth region by using equation 5. The feature extraction module is applied after extracting the interested regions from the image produced from the previous stage.

Then feature analysis and recognition is applied geometry-based methods to feature analysis of the mouth region after extraction will be recognition features by a message entitled the nature of the emotion (Angry, Happy, and surprise) and illustrated in recognition emotions algorithm (5).

Algorithm (5): Recognition emotion

Input: matrix of distance number

Output: message of type image with number of DiffX (X_{obj}) and DiffY (Y_{obj})

Strategy: the result of applying equation (6) and (7) to determine value of DiffX and DiffY, then recognition emotions of images that have through some conditions:

- a. If was (DiffY) in mouth region smaller or equal to Ymin the type image is 'Angry'.
- b. If was (DiffY) in mouth region bigger than Ymax and smaller or equal to Ymin the type image is 'Happy'.
- c. If was (DiffY) in mouth region bigger than to Ymax the type image is 'Surprise'.

Steps:

1. Input image
2. Calculated DiffX and DiffY from equation()
3. Comparison DiffX and DiffY :
 - a. If (DiffY <= Ymin) then type_image= "Angry"
 - b. If (DiffY > Ymin && DiifX <=Ymax) then type_image= "Happy"
 - c. If (DiffY > Ymax) then type_image="Surprise"
4. Display message of type_image
5. End

2.5. Performance Parameters

The recognition rate (RR) measure[16] in equation 6, was used for studying the performance of the proposed system. The number of images image that was used for testing are 222 images.

$$RR_E = \frac{\text{Number of the image crrectly recognition}}{\text{Total number of the image test}} \times 100$$

eq.(11)

2.5.1 Emotions Recognition Rate

This emotion is shown in figures 2 that are correctly which recognition them 96% while not recognition is 4%.

Where, the number of the emotion image that recognition is 214 images of the total 222 images, whereas the images are not recognizing their number was 8 images. The figure 2 illustrates RR for each emotion (angry, surprise, and happy).

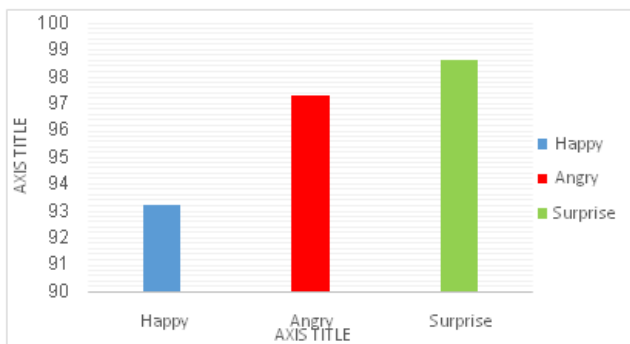


Figure 2: Recognition emotion rate

A. The Surprise Emotions

This emotion is shown in figure 3 the result of applying equation 11 that are correctly which recognition them 99% while not recognition is 1%.

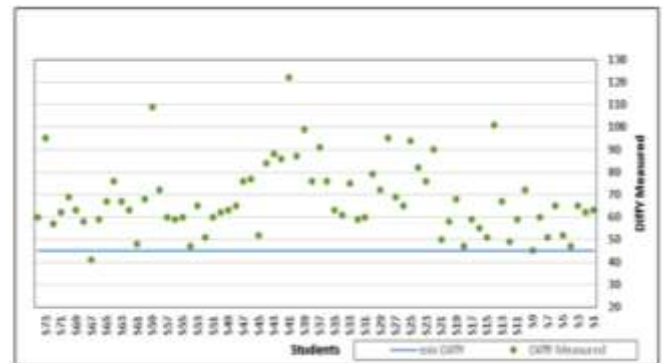


Figure 3: Surprise Emotion Image

B. The Angry Emotions

This emotion is shown in figure 4 that are correctly which recognition them 97% while not recognition is 3%.

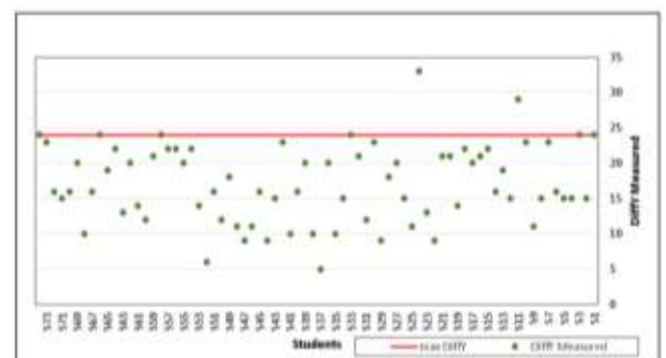


Figure 4: The angry emotion for person

C. The Happy Emotions

This emotion is shown in figure 5 that is correctly which recognition them 93% while not recognition is 7%.

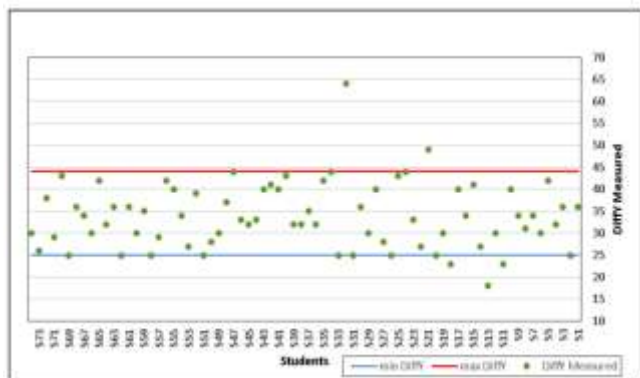


Figure 5: The happy emotion Image

Table 1: The comparison of recognition rate with some other people's independent systems

Authors	Feature Extraction Method	RR
Wang et al. 2013[17]	Discriminant Laplacian Embedding (DLE)	87.4%
Razzak and Hashem 2015 [18]	Haar wavelets transform and Discrete Cosine Transform (DCT)	%92.2
Suhaila and. Dawood 2016 [19]	Distances and Angles	91.72%
The proposed DESS	Distances	96.39%

The confusion matrix for the best recognition result of the proposed system that given in the table (2).

Table 2: The confusion matrix of the proposed DESS

	Happy	Angry	Surprise	Sum
Happy	69	3	2	74
Angry	2	72	0	74
Surprise	1	0	73	74
Sum	72	75	75	222

In the table (3) illustrates the percentage of the proposed system the calculated are in the above table (2) by applying equation RR.

Table 3: The percentage of the proposed DESS

	Happy	Angry	Surprise
Happy	93%	4%	3%
Angry	3%	97%	0%
Surprise	1%	0%	99%
Sum	32%	34%	34%

In table (4) shows the percentage of the comparative with the proposed system were found, it's the best of comparability of the previous study [18] of happy, angry, and surprise emotions.

Table 4: Comparison with the proposed DESS

	Happy		Angry		Surprise	
	Propose Model	Comparative Study	Propose Model	Comparative Study	Propose Model	Comparative Study
Happy	93%	92%	4%	0%	3%	1%
Angry	3%	0%	97%	64%	0%	0%
Surprise	1%	0%	0%	2%	99%	94%

In figure (6) illustrates the recognition of the proposed system in the table (3) above.

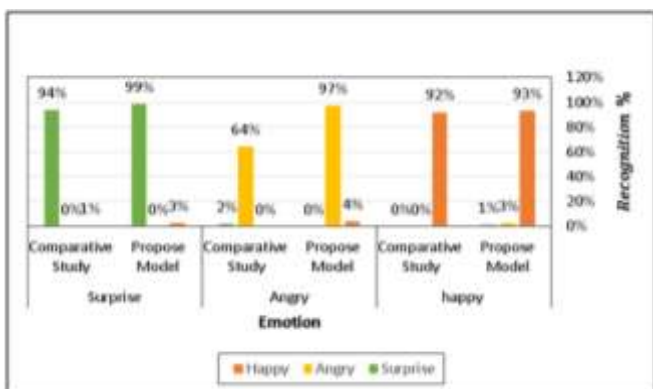


Figure 6: Proposed system comparative other system

In Figure 6 illustration comparative percentage between proposed system and other's:

- In the proposed system the surprise emotion percentage is 99%, while comparative study is 94%.
- The angry emotion percentage in the proposed system is 97% this percentage is a very high comparative study that is 64%.

- The happy emotion percentage in proposed system is 93%, while comparative study is 92%, this percentage is the best rate of 1% but will be processed this case in future work.

3. Conclusions

The proposed system is constructed to support the education system through detecting the emotion of the students in the classroom and informing the teacher about the emotion type in order to react according to student status. The proposed system directive the teacher to change his/her learning methods to influence the students in the class room. The mood of the students in the classroom measures the abilities of the teacher adjusting what is learned. The images that were used in the implementation, conceptualize the impact of student emotions.

Disclaimer

The images used in this research belong to the public data base Cohn-Kanade (Ck) which can be downloaded from web site: The Affect Analysis Group at Pittsburgh (<http://www.pitt.edu/~emotion/ck-spread.htm>).

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