Neuro Fuzzy Model for Human Face Expression Recognition

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*Abstract:*This paper present an approach to recognize human face expression and emotions based on some fuzzy pattern rules. Facial features for this specially eye and lips are extracted an approximated into curves which represents the relationship between the motion of features and change of expression. This paper focuses the concepts like face detections, skin color segmentation, face features extractions and approximation and fuzzy rules formation. Conclusion based on fuzzy patterns never been accurate but still our intension is to put more accurate results.

Key words: Face Detection, Skin Color Segmentation, Face Futures, Curve Formation and Approximation, Fuzzy Patterns.

I. INTRODUCTION

Facial expression analysis has been attracted considerable attention in the advancement of human machine interface since it provides natural and efficient way to communicate between humans [2]. Some application area related to face and its expression includes personal identification and access control, video phone and teleconferencing, forensic application, human computer application [5].

Most of the facial expression recognition methods reported to date or focus on expression category like happy, sad, fear, anger etc. For description of detail face facial expression, Face Action Coding System (FACS) was design by **Ekman**[8]**.** In FACS motion of muscles are divided into 44 action units and facial expression are described by their combination. Synthesizing a facial image in model based image coding and in MPEG-4 FAPs has important clues in FACS. Using MPEG-4 FAPs, different 3D face models can be animated. Moreover, MPEG-4 high level expression FAP allows animating various facial expression intensities. However, the inverse problem of extracting MPEG-4 low and high level FAPs from real images is much more problematic due to the fact that the face is a highly deformable object [1].

II. LITERATURE REVIEW

Designer of FACS, Ekman himself as pointed out some of these action units as unnatural type facial movements. Detecting a unit set of action units for specific expression is not guaranteed. One promising approach for recognizing up to facial expressions intensities is to consider whole facial image as single pattern [4]. Kimura and his colleagues have reported a method to construct emotional space using 2D elastic net model and K-L expansions for real images [7]. Their model is user independent and gives some unsuccessful results for unknown persons. Later Ohba proposed facial expression space employing principle component analysis which is person dependant [9].

III. PROPOSED METHOD

This project consists of following phases:
- A. Face detection based on skin color
- B. Face extraction and enhancement
- C. Face features extraction
- D. Curve formation using Bezier curve.
- E. Fuzzy Patterns
- F. Experiment Results

A. Face Detection Based on Skin Color:

Skin color plays a vital role in differentiating human and non-human faces. From the study it is observe that skin color pixels have a decimal value in the range of 120 to 140. In this project, we used a trial and error method to locate skin color and non skin color pixels. But many of the times, system fails to detect whether an image contains human face or not (i.e. for those images where there is a skin color background).an image is segmented into skin color and non-skin color pixels with the equations

$$120 \leq |Pxy| \leq 140 \text{----------eq. 3.1.1}$$
$$where\ Pxy = pixel\ at\ position\ xy$$

The skin pixels values are set to 1(i.e. #FFFF) and non skin pixels are set to 0(i.e. 0000). The pixels are collected and set as per equation
If
$$\lim_{i \to 1} n\ (\int_1^3 120 \leq |Pxy| \leq 140) = 1\text{--------eq3.1.2}$$
Else
$$\lim_{i \to 1} n\ (\int_1^3 140 \leq |Pxy| \leq 120) = 0\text{-------eq 3.1.3}$$
$$where\ n\ =\ total\ number\ of\ pixels\ of\ input\ image$$
The resultant image becomes as

Original Image   Skin and non-skin pixels

Figure. 3.1.1 (Phase I)

B. Face Extraction and Enhancement:

Literature review point out that, FACS system technique is based on face features extractions like eye, nose, mouth, etc. In this project, we minimize the number of features (i.e. only eyes and mouth) but given the more weightage for fuzzy rules formations from these extracted features. Face extractions consist of following steps

a. Let W and H are the width and height of skin and non-pixel image as shown in fig 3.1.1
b. Read the pixel at position (0,H/2) which is a middle of i.e. left side of image.
c. Travers a distance D_1 = W/6 in horizontal direction to get the start boundary pixel of skin region.
d. Travers a distance D_2= H/6 from a pixel position (W/6, H/2) in upward directions. Same may do in downward direction and locate the points X_1, X_2.
e. Travers a distance D_3=W/3 from the point X_1 and locate the point X_3. Same do from the point x_2 and locate the point X_4.
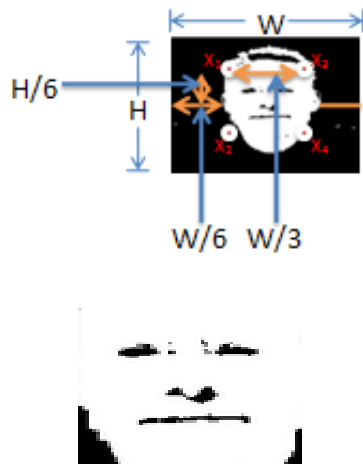f. Crop the square image as shown.

Figure 3.2.2 Face recognition

After face extraction white region pixels (i.e. skin pixels) are filled with skin color. A resultant image with skin color and after enhancement becomes as
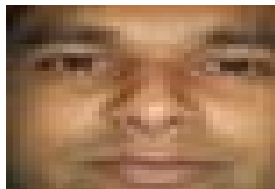

Figure 3.2.3 image with skin color and after dimension enhancement

C. Face Features Extraction:

Human face is made up of eyes; nose, mouth and chine etc. there are differences in shape, size, and structure of these organs. So the faces are differs in thousands way. One of the common methods for face expression recognition is to extract the shape of eyes and mouth and then distinguish the faces by the distance and scale of these organs. The face feature extractions consist of following steps

a. Let W and H are width and height of an image shown in Fig 3.2.3
b. Mark pixel P_i (W/2, H/2) as centre of image.
c. Travers a distance H/8 from the pixel P_i towards upward and mark a point K_1.
d. Travers a distance W/3 from the point K_1 towards leftward and mark a point K_2.
e. Travers a distance H/10 towards downward from the point K_2 and mark a point K_3.

f. Travers a distance W/4 from the point K_3 towards right and mark the point K_4.
g. Travers a distance H/10 from the point K_4 toward up and mark the point K_5.
h. Same steps are repeated for extracting the right eye and mark the point N_2, N_3, N_4, and N5.
i. Travers a distance H/8 from the point P_i towards downward and mark the point M_1.
j. Travers a distance W/6 towards left and right from the point M_1 and marks the point M_2 and M_3.
k. Start with the point M_2 traverse a distance H/10 towards downward and mark the point M_4.
l. Travers a distance W/6 from the point M_4 towards right and mark the point M_5. Same may do from point M_5 and mark the point M_6.
m. Travers the distance H/10 from M_6 towards up that meets to the point M_3.
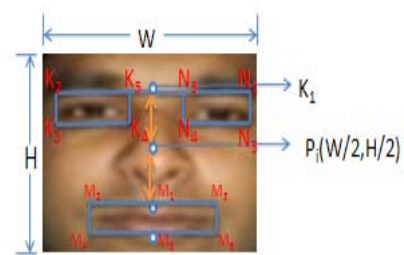n. See the below image.

Figure 3.3.1 Feature Extraction

- Dist $|P_i - K_1| = H/8$

- Dist $| K_1 - K_2 | = $ Dist $| M_1 - M_2 | = $ Dist $| M_1 - M_3 | = $ Dist $| M_4 - M_5 | = $ Dist $| M_5 - M_6 | = W/3$

- Dist $| K_2 - K_3 | = $ Dist $| K_4 - K_5 | = $ Dist $| N_2 - N_3 | = $ Dist $| N_4 - N_5 | = $ Dist $| M_2 - M_4 | = $ Dist $| M_1 - M_5 | = $ Dist $| M_3 - M_6 | = H/10$

- Dist $| K_3 - K_4 | = $ Dist $| K_5 - K_2 | = $ Dist $| N_3 - N_4 | = $ Dist $| N_5 - N_2 | = W/4$

D. Curve formation using Bezier curve:

Eyes and mouth as shown in fig 3.3.1 are located and extracted. Bezier curve formed from this eyes and mouth as per the equation

$$Q(t) = \sum_{i=0}^{n} P_i B_{i,n}(t)\ldots\ldots\ldots\ldots\ldots.\text{eq. 3.4.1}$$

Where each term in the sum is the product of blending function $B_{i,n}(t)$ and the control point P_i. The $B_{i,n}(t)$ is called as Bernstein polynomials and are defined by

$$B_{i,n}(t) = C_i^n t^i (1-t)^{n-i}\ldots\ldots\ldots.\text{eq. 3.4.2}$$

Where C_i^n is the binomial co-efficient given by:
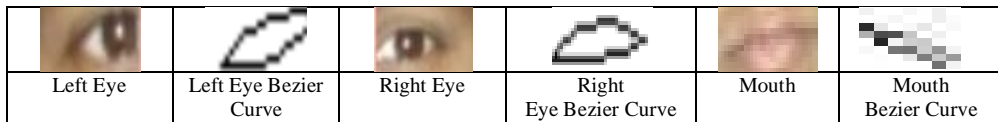
$$C_i^n = \frac{n!}{i!(n-i)} \qquad\ldots\ldots\ldots\ldots\ldots\ldots\ldots.....\text{eq.} \qquad 3.4.3$$

Left Eye	Left Eye Bezier Curve	Right Eye	Right Eye Bezier Curve	Mouth	Mouth Bezier Curve

Figure 3.4.1 Bezier Curve

Once the Bezier curve formed features points are located as shown in below image.

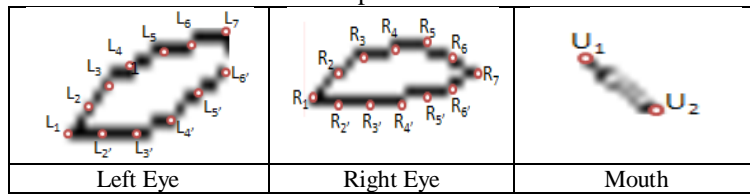| Left Eye	Right Eye	Mouth

Figure 3.4.2 Feature Point Location

The feature point distance for left and right eye is measured with

$$Z=\int_i^n \sum_{i=2}^6 (e^{H_i} sinw_i - e^{H_i'} cosw_i) \quad \text{……...eq. 3.4.4}$$

$$where\ Z = feature\ point\ distance$$
$$n = number\ of\ feature\ points$$

For left eye $H_i = L_i$ and for right eye $H_i. = R_i$.
The feature point distance for mouth is measured with

$$Z'=\int_i^n \sum_{i=1}^2 (e^{H_i} sinw_i/2 - e^{H_i'} cosw_i /2) \quad \text{...eq.3.4.5}$$

An expression id generated from an average of Z and Z' as below.

$$id= (Z+Z')/2 \quad \text{…………………………….eq.3.4.6}$$

E. Fuzzy Patterns:

It is found that expression recognition from the still image never gives a correct output. A one expression id may also false into more than one expression domain. This project forms some fuzzy patterns for expressions. See the set theory diagram below
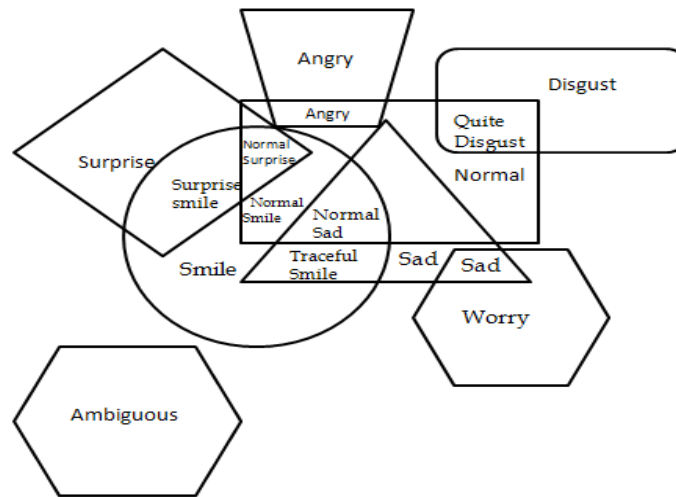

Figure 3.5.1 Fuzzy Expression Patterns

F. Experiment Results:

Table 3.6.1 Result Analysis

Sr. No.	Image Format	Dimension	No. Images tested	Face recognition	Face Extraction	Expression Accuracy
1	JPEG	50*50	50	x	x	x
2	JPEG	100*100	50	√	X	90%
3	JPEG	200*200	50	√	√	√
4	JPEG	500*500	50	√	√	√
5	PNG	50*50	50	x	x	x
6	PNG	100*100	50	√	X	88%
7	PNG	200*200	50	√	√	√
8	PNG	500*500	50	√	√	√
9	BMP	50*50	50	x	x	X
10	BMP	100*100	50	√	X	88%

11	BMP	200*200	50	√	√	√
12	BMP	500*500	50	√	√	√
13	TIFF	50*50	50	x	x	X
14	TIFF	100*100	50	√	X	83%
15	TIFF	200*200	50	√	√	√
16	TIFF	500*500	50	√	√	√
17	GIF	50*50	50	x	x	X
18	GIF	100*100	50	√	X	80%
19	GIF	200*200	50	√	√	√
20	GIF	500*500	50	√	√	√

IV.   CONCLUSION

This paper proposes a new approach for recognizing the category of facial expression an estimating the degree of continuous facial expression change from time sequential images. This approach is based on personal independent average facial expression model.

V. FUTURE WORK

It is found that, current system fails to recognize an expression of images containing skin color background and multiple faces in single image. A strong system is required to diagnose an expression of such image.

VI.   REFERENCES

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