

Human Emotion classification based on Eyes and Mouth using Susan Edges

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Abstract: Human facial emotion recognition plays important role in the human mood analysis. Human emotion classification is done based on the facial features such as eyes, nose and mouth. The eyes and mouth plays dominant role in facial expression. Hence in this paper, instead of considering the features of the whole face, only eyes and mouth are considered for human emotion classification such as surprise, neutral, sad, happy and Anger based on the Susan edge operator.

Keywords- Emotion classification, Facial features, feature extraction, SUSAN edge operator



1. INTRODUCTION

Human Facial expression recognition plays an important role in the human mood analysis which involves threesteps viz. face detection, feature extraction and expression classification. Extensive research work has been done in this area yet efficient and robust facial expression system need to be developed. The generic algorithm uses horizontal sobel edges to compute bounding box containing eye and eyebrow [1]. Facial expressions into emotion categories are happy, sad, disgust and surprise. Facial Action Coding System (FACS) code derived descriptions are computed by Latent Semantic Analysis (LSA) and probabilistic Latent Semantic Analysis (PLSA) to detect basic emotion [2].

Susan operator is used to locate corners of eyes and used to set the initial parameter of eyes templates based on threshold & locating similarity of pair to detect two eyes which has greatly reduced the processing time of templates

has been proved in [3]. In [4], an algorithm on Two Level Decision for Recognition of Human Facial Expressions using Neural Network is proposed. In [5], a methodology is invented on an Effective Approach to recognize the Human Facial Expressions based on Multiple Level Decision using ANN. In [6], Lines of Connectivity face model for recognition of the human facial expressions has been described, that recognizes the human facial expressions. In [7], Structured Connectivity-Face model for the recognition of Human Facial Expressions has been explained.

The facial feature points are detected from each region containing facial feature with the so called SUSAN corner detector. The eyebrow regions and the eye regions are rectangle that just contain each individual facial feature.

The eyebrow regions and the eye regions are located by using both the EIM and the ESM[8]. Detection of eyes is very important in face Feature extraction. The valley point searching with directional projection and the symmetry of two eyeballs to locate eyes. SUSAN(Smallest Uni-value Segment

Assimilating Nucleus) is used to extract the edge and corner points of local feature area. [9]

A classification rate (CR) which is higher than the CR obtained using all features. The system also outperforms several existing methods, evaluated on the combination of existing and self-generated databases [10]. Novel Hybrid Facial Geometry Algorithm (HFGA) for facial feature extraction to classify facial expressions based on feed forward backpropagation neural network (BPNN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) classifiers for expression classification and recognition [11].

In this process, facial features like eyebrows, eyes, mouth and nose are extracted using SUSAN edge detection operator, facial geometry, and edge projection analysis [12]. The combination of SUSAN edge detector and facial geometry distance measure is best combination to locate and extract the facial feature for gray scale images in constrained environments if the images are frontal view and clear images without any obstacle like hair [13].

The Longest Line Scanning (LLS) algorithm along with Occluded Circular Edge Matching (OCEM) algorithm proposed to detect the iris center under normal lighting conditions with unexpected noise. LLS is faster, but it is sensitive to noise and the distribution of edge pixels [14]. In [15], face detection algorithm to obtain precise descriptions of the facial features in video sequences of American Sign Language (ASL) sentences, where the variability in expressions can be extreme. Eyes may have very distinct shapes pupil size, and colors.

SUSAN edge detector segment face part from the face image in which potential geometrical features are used for the determination of facial expression such as surprise, neutral, sad and happy [16]. Facial expression detection system has been proposed by applying principal component analysis. face only mouth feature is used for the facial expression recognition which in reduced the

computational cost of analysis. [17] Facial Action Coding System (FACS) action units and the methods which recognizes the action unit's parameters using facial expression data that are extracted (happy, sad, disgust, surprise). Various kinds of facial expressions are present in human face which can be identified based on their geometric features appearance features and hybrid features [18].

Image segments are converted into filtering images with the help of CH approach by varying different threshold values instead of applying morphological operations [19]. Eye candidates are detected using a color based training algorithm and six-sigma technique operated on RGB, HSV and NTSC scales [20]. Different technique that HSV as well as Lab color spaces are employed for removing unwanted pixels in the image and SVM classify the left region in the image as eye or non-eye [21].

An automatic system proposed to find neutral faces in images using location and shape features. Using these features, a window is placed in the detected and normalized face region. Face and facial point features for each face, the eye features are extracted by ellipse fitting based on the binary image of the face [22]. Robustness of emotion recognition (all 7 emotions) systems are used to improve by the use of fusion-based techniques [23]. Detection of facial region with skin color segmentation and calculation of feature-map for extracting two interest regions focused on eye and mouth [24].

In this paper an approach to the problem of facial feature extraction from a still frontal posed image is addressed and classification of facial expression is used for the analysis of emotion and mood of a person using eyes. Experiments are carried out on JAFFE facial expression database. Four basic expressions like surprise, neutral, sad and happy are considered. The rest of the paper is organized as follows. Section II highlights on data collection, section III presents proposed methodology, section IV gives experimental results and analysis, section V presents

conclusion and future scope and last section gives references used.

II. DATA COLLECTION

In this work JAFFE (Japanese Female Facial Expression) database developed by Kyushu University for Japanese women expression is used. The JAFFE database is made up 213 individual images of ten persons, and each person shows anger, disgust, fear, happiness, sadness, surprise and neutral. Few sample images are as shown in Figure-1.

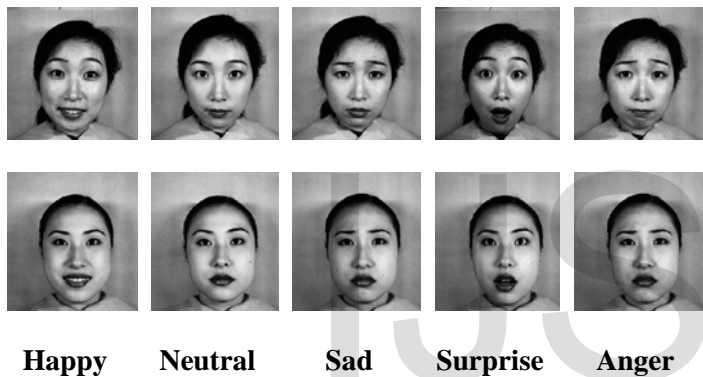


Figure1: Samples images from JAFFE database

III PROPOSED METHODOLOGY

Facial expression recognition is proposed in the block diagram as shown in the Figure-2.

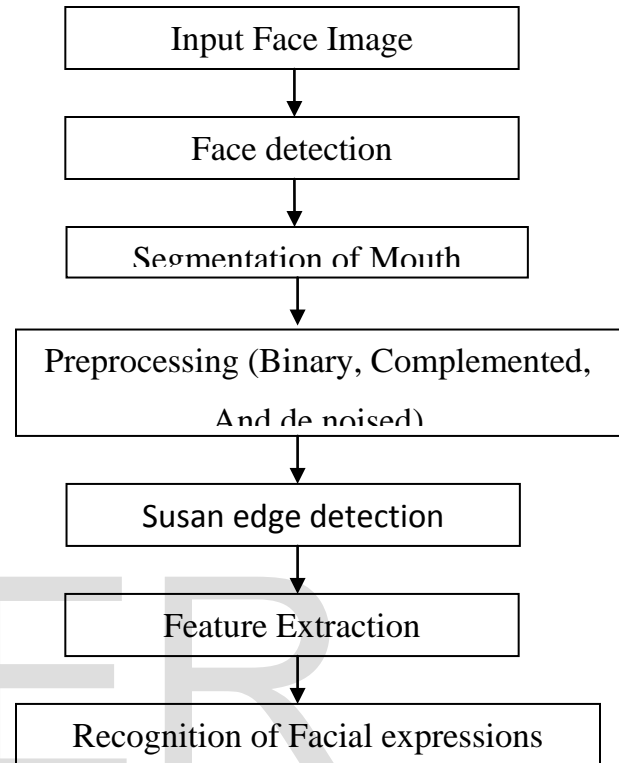


Figure-2: Block diagram of the proposed system

The proposed method detects the face part depending upon the measurement given. In which the algorithm crops the selected facial part from the image which is then divided horizontally into two parts depending upon the central point of the image located. SUSAN algorithm[3,10] selects the larger area in the face such as eye and ignoring smaller regions such as mouth and nose. The SUSAN algorithm then generates binary image of the eye, which is de-noised.

In this paper we used MATLAB R2012a, detailed steps in the proposed system are as follows.

Step1 : Preprocessing : In the given input image, quality of image is enhanced by different filters such as median filter, average filter, wiener filter according to noise present in image, improving contrast of image by histogram equalization, adoptive equalization etc . Holes are filled in the region of interest for good segmentation results using morphological operations.

Step 2 : Eye Detection : Edge detector such as Sobel, canny, pewit etc are applied on the image to detect edges on the given image and face boundary is located by using suitable threshold value. Further, facial feature candidate are located based on Geometrical configurations of a human face. It is assumed that in most of the faces the vertical distance between eyes and mouth are proportional to the horizontal distance between the two centers of eyes. The regions satisfying these assumptions are considered as potential eye candidates.

Step 3 : SUSAN edge detection : There are various edge detectors such as Sobel, Canny, Prewitt are used but they can only detect the edges. But SUSAN operator having advantages to locate corners of regions in addition to edges. So to improve accuracy of feature point extraction SUSAN operator is applied on face area to detect far and near corners of eyes and mouth regions.

Step 4 : Feature Extraction : Geometrical features such as area, height and width of the eye features are extracted for the purpose of expression recognition using the equation (3.1)(3.4).

$$A = w \times l \quad (3.1)$$

$$P = 2(1 + w) \quad (3.2)$$

$$l = \frac{P}{2} - w \quad (3.3)$$

$$w = \frac{P}{2} - l \quad (3.4)$$

Where w = width, l = length and p=perimeter

Step 5 : Emotion Classification : Facial expressions such as surprise, neutral, sad , happy and Anger are recognized based on the statistical features of each expressions satisfying the condition for the classification of human mood. Using equations (3.5)

The algorithm matches with the facial expression templates with the features of query face. The expression having the highest match with the template is considered the mood of the query face. Comparison of the results are made for both eyes and mouth.

$$\begin{aligned} e = normal & \quad \text{if } N_{mmin} < M_a < N_{mmax} \\ e = Sad & \quad \text{if } S_{mmin} < M_a < S_{mmax} \\ e = Happy & \quad \text{if } H_{mmin} < M_a < H_{mmax} \\ e = Surprise & \quad \text{if } SU_{mmin} < M_a < SU_{mmax} \end{aligned}$$

Where N_m , S_m , H_m and SU_m are as mouth for normal, sad, happy, surprise expressions respectively. Width, height measurements remain constant for all the expressions. Hence they are least significant in our approach.

IV EXPERIMENTAL RESULTS AND ANALYSIS

In this work 100 images were selected by choosing 20 images from five persons each from JAFFE database. Sample experimental results are

shown in Figure-3 and statistical results are tabulated in Table-I for facial expressions based on eyes. Similarly experimental results are shown

in Figure-4 and statistical results are tabulated in Table II for the facial expressions based on mouth.

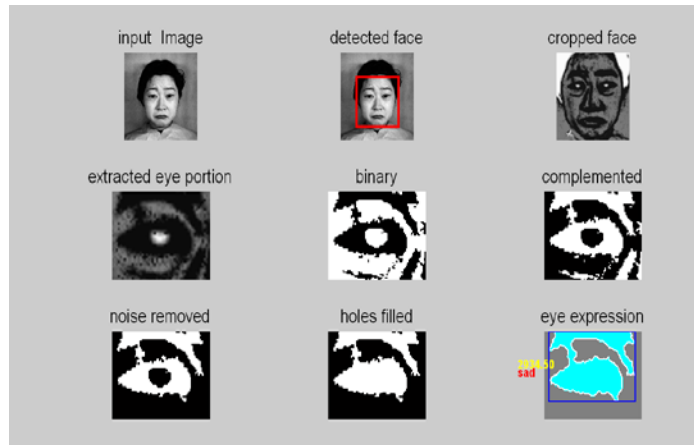


Figure-3:Sample results of Facial expressions based on eyes

Expression	Range of Eye area	
	Min	Max
sad	2688.216000	3024.243000
normal	3024.243000	3696.297000
happy	3696.297000	4032.324000
surprise	4032.324000	4368.351000
Anger	4368.351000	4704.378000

Table I: Statistical values of eye features

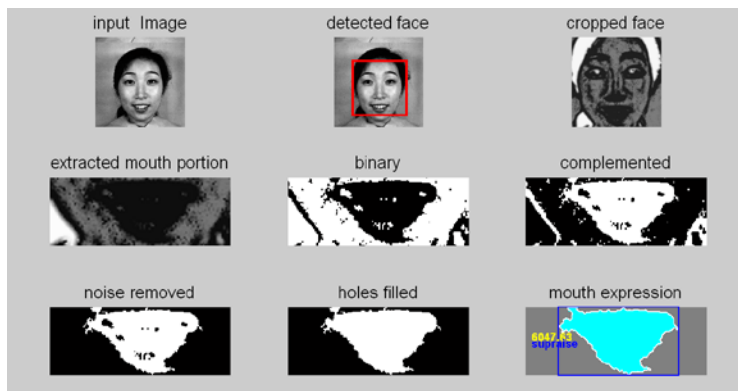


Figure-4: Sample results of Facial expressions based on mouth

Expression	Mouth area range between	
	Min	Max
Sad	3646.748000	4102.591500
Normal	4102.591500	5014.278500

Happy	5014.278500	5470.122000
Surprise	5470.122000	6080.965500
Anger	6080.965500	6536.809900

Table-II: Statistical values of mouth features

Table III shows the comparison of different experimental results between JAFFE database of the four different facial expressions (happy, Neutral, Sad, Anger, Surprise). It is opined that, mouth feature is better than eye features for facial expressions recognition. The success rate shown in Figure 5.

Feature used	Success rate
Based on Eyes	70%
Based on Mouth [12]	97%
Based on Eye and Mouth [20]	78.8%

Table III: Comparison results of facial expression

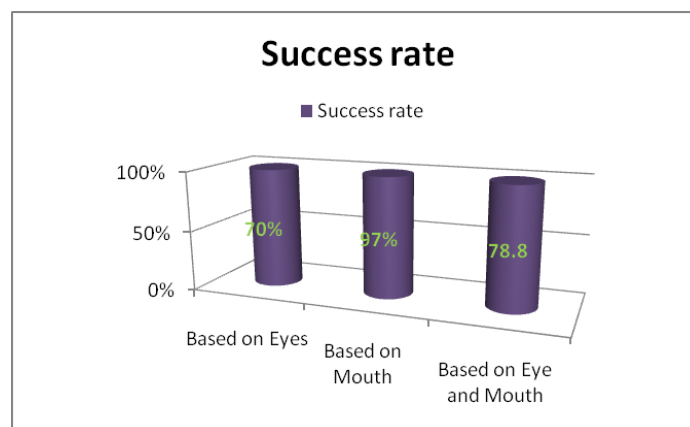


Figure 5: Success rate of the proposed Susan edge operator

V CONCLUSIONS

Human mood analysis is getting very good attention from the research community for which

facial expression recognition plays very important role. In this paper, different expressions of people are classified using eye feature using SUSAN edge detector. Proposed system is tested on widely used standard JAFEE database in which facial expressions of different people in different moods are considered as benchmark testing samples. Proposed method is compared with both eyes and mouth features and found better results with mouth due to its more variations in geometrical aspects. Hence both eyes and mouth features contribute equally significance in the recognition of facial expressions and human mood classification. It is opined that, mouth feature is better than eye features for facial expressions recognition.

REFERENCES

- [1] Ashutosh Saxena ,AnkitAnand , Prof. AmitabhaMukerjee, “Robust Facial Expression Recognition Using SpatiallyLocalized Geometric Model”, International Conference on Systemics, Cybernetics and Informatics, February 12–15, 2004.
- [2] Beat Fasse , Florent Monay and Daniel Gatica-Perez, “ Latent Semantic Analysis of Facial Action Codes for Automatic Facial Expression Recognition” , MIR’04, October 15–16, 2004, New York, New York, USA.
- [3] Ms. B.J.Chilke ,Mr D.R.Dandekar , “Facial Feature Point Extraction Methods-Review” International Conference on Advanced Computing, Communication and Networks’.
- [4] Dileep M R, Prasad M and Ajit Danti, Two Level Decision for Recognition of Human Facial Expressions using Neural Network, International Journal of Computing Algorithm (IJCOA), Volume: 04, Special Issue: (March 2015) Pages: 1368 – 1373, ISSN: 2278-2397.
- [5] Dileep M R, Prasad M and Ajit Danti, An Effective Approach to recognize the Human Facial Expressions based on Multiple Level Decision using ANN, International Journal of Applied Engineering and Research (IJAER) – SCOPUS-ELSEVIER, Volume 10, Number 81, Special Issue(2015), Pages 121-129, ISSN (Print) 0973-4562, ISSN(Online) 1087-1090.
- [6] Dileep M R and Ajit Danti, Lines of Connectivity face model for recognition of the human facial expressions, International Journal of Artificial Intelligence and Mechatronics, volume 2, Issue 2, PP 41-46, (Sept 2013), ISSN 2320-5121.
- [7] Dileep M R and Ajit Danti, Structured Connectivity-Face model for the recognition of Human Facial Expressions, International Journal of Science and Applied Information Technology (IJSAIT), Vol. 3 , No.3, Pages : 01 - 07 (2014) Special Issue of ICCET 2014, ISSN 2278-3083.
- [8] Haiyuan WU, Junya INADA, Tadayoshi SHIOYAMA, “Automatic Facial Feature Points Detection with SUSAN Operator”.
- [9] HuaGuGuangda Su Cheng Du, “Feature Points Extraction from Faces”, Beijing, China.
- [10] JyotiMahajan , RohiniMahajan .” FCA: A Proposed Method for an Automatic Facial Expression Recognition System using ANN”, International Journal of Computer Applications (0975 – 8887) Volume 84 – No 4, December 2013.
- [11] S.P. Khandait, R.C. Thool, P.D. Khandait , “ANFIS and BPNN based Expression Recognition usingHFGA for Feature Extraction”, BuletinTeknikElektrodanInformatika, Vol.2, No.1, March 2013, pp. 11~22.
- [12] S.P.Khandait , Dr. R.C.Thool , P.D.Khandait , “Automatic Facial Feature Extraction and Expression Recognition based on Neural Network”, International Journal of Advanced Computer Science and Applications,Vol. 2, No.1, January 2011.
- [13] S.P.Khandait , Dr.R.C.Thool , P.D.Khandait, “Comparative Analysis of ANFIS and NN Approach for Expression Recognition using Geometry Method” ,International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 3, March 2012 ISSN: 2277 128X.
- [14] kyung-Nam Kim, R.s Ramakrishna, “ Human-Computer Interface using Eye-Gaze Tracking” .
- [15] Liya Ding and Aleix M. Martinez , “Precise Detailed Detection of Faces and Facial Features” Columbus, OH 43210.
- [16] Prasad M , Ajit Danti , “Classification of Human Facial Expression based on Mouth Feature using SUSAN Edge Operator”, International Journal of Advanced Research in Computer Science and

Software Engineering, Volume 4, Issue 12, December 2014 ISSN: 2277 128X.

[17] Prasad M , Ajit Danti , “Eigen Based Facial Expression Using Mouth Feature”, International Journal of Computer Science Trends and Technology (IJCT) – Volume 2 Issue 6, Nov-Dec 2014, Page-115-120, ISSN: 2347-8578.

[18] C.P. Sumathi , T. Santhanam and M.Mahadevi, “Automatic facial expression analysis A survey”, International Journal of Computer Science & Engineering Survey (IJCSES) Vol.3, No.6, December 2012.

[19] Sushil Kumar Paul , Mohammad ShorifUddin and SaidaBouakaz, “Extraction of Facial Feature Points Using Cumulative Histogram” , IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 1, No 3, January 2012.

[20] TanmayRajpathak, Ratnesh Kumar and Eric Schwartz,” Eye Detection Using Morphological and ColorImage Processing” ,Gainesville, Florida.

[21] Vijayalaxmi ,P.SudhakaraRao and S Sreehari, “Neural Network Approach For EyeDetection”, CCSEA, SEA, CLOUD, DKMP, CS & IT 05, pp. 269–281, 2012.

[22] Ying-li Tian and Ruud M. Bolle, “Automatic Detecting Neutral Face for Face Authentication and Facial Expression Analysis” ,AAAI Technical Report SS-03-08,2003.

[23] Ying-Li Tian, Takeo Kanade , and Jeffrey F . Cohn, “ Facial Expression Analysis “,2005, pp 247-275.

[24] Yong-Hwan Lee Dankook University, “Detection and Recognition of Facial Emotion using Bezier Curves” IT CoNvergence PRActice (INPRA), volume: 1, number: 2, pp. 11-19

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