Facial expression recognition and gender classification using facial patches

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***Abstract*—Facial expression recognition and gender classification has many applications in affective computing as well as computer vision respectively. The main applications involve human computer interaction, driver safety etc. Principal component analysis(PCA), Linear discriminant analysis (LDA), Linear binary pattern(LBP) algorithms are used in most cases for the detection of facial expression and gender. The drawbacks of existing systems include lower classification rate in the case of low resolution images, confusion between different pairs of expression etc. In this paper, a novel method for facial expression recognition and gender classification based on the two expressions anger and joy along with geometric and appearance based method is proposed. Facial patches are used to detect both gender and facial expression. Facial expression is identified based on the appearance of facial patches. The proposed system successfully tested with Japanese female facial expression (JAFFE) database and Cohn-Kande databases.**

Keywords : Facial Expression, Gender Classification, QDA classifier, Face Detection, Nose Detection, Patches , Lip detection.

I. INTRODUCTION

Facial expression recognition and gender classification are some of the issues to be addressed in the field of computer vision and affective computing respectively, computer vision deals with processing of images, to create symbolic or structured information, which enables the computer system to take appropriate decisions[1]. The main issue that has to be taken into account while dealing with facial expression recognition and gender classification are, face detection as well as appropriate detection of facial features.

Gender classification is done using SVM , when SVMs' are used low resolution of pictures didn't affected the classification rate[2]. There are basically three approaches for recognizing facial expression viz geometric methods, appearance based methods and recognition using salient patches. In geometric feature [3] based methods the expression is recognized by tracking the shape and size of facial landmarks by applying an automatic fiducial point location algorithm. The disadvantage of such an algorithm is that it requires accurate detection of facial landmarks, any error in face detection will affect the overall performance of the algorithm. Also the proportions in which facial features appear vary from person to person. In appearance based methods[4] the features are selected using pixel intensity values, a plenoptic function[5] which calculates radiance of light in free space is used for appearance based models. One big turnoff for this method is time and cost is often high in this method. In recognition using patches [6], salient patches are extracted there by identifying the expression. The main advantage of this approach is once patches are chosen, expression recognition become effortless.

In this paper we combine the problems of gender classification and facial expression recognition. We propose a novel method for expression recognition and gender classification using salient facial patches. The proposed system works well on low resolution images also. This research work has been done on basic six facial expressions anger, fear, joy, surprise, disgust and sadness.

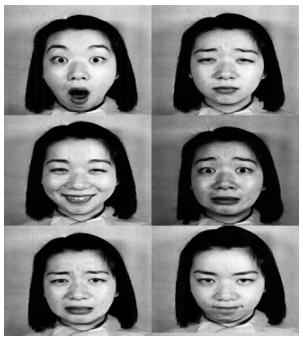


Fig1Basic emotions

II. RELATEDWORK

Gender classification and facial expression

recognition problems are two fundamental problems in the area of computer vision. Classification scheme can be classified into two types 1) static 2) dynamic. Naïve Bayesian classifiers and tree augmented naïve (TAN) bayes classifiers are used for static classification. In the case of dynamic classification, hidden markov model is used. Although accuracy of happiness and surprise were detected with 86% and 93% respectively, other expressions were found to be mismatched with one another [7].

A single image based algorithm was proposed using discrete cosine transform (DCT), local binary pattern (LBP), geometric distance feature (GDF) for geometric and appearance based identification of gender. The main disadvantage in this case is its performance is very poor, when images are not frontal [8]. According to White hill et al support vector machines and Gabor filters can be used to recognize expressions. It proposes automatic facial expression recognition for intelligent tutoring system [9]. Main disadvantage is that accuracy is comparatively lower. Gabor wavelet labeled elastic graph matching and Eigen face are used for facial feature detection. Main turnoff of this approach is that it may be only used to extract categorical information about face[10].

Though there are many advantages in using a facial action coding system, it cannot recognize full range of facial behavior [11]. Some approaches use fiducial points from face to extract facial features and profile-contour fiducial points. From this midlevel feature parameters are defined, and then action units are encoded and certainty of results is evaluated[15]. The main turnoff of this approach is that confusion arose between identifying action units for each pair of expression [12]. Gini index and facial characteristic points can be used in the identification of facial expression. Although it gives promising results for expressions like surprise, fear and joy, for expressions like sadness anger and neutral gives comparatively lower recognition rate [13].

In some facial expression recognition methods, active appearance models are employed, features are extracted using trained AAM and a SVM is build from it and these are further cascaded to improve overall performance [14]. Some approaches use both geometric and appearance based models for facial expression recognition. Here geometric variability elimination and LBP were used as image texture descriptor. This method is robust in performance. This approach also shows comparatively lesser accuracy in detecting expressions like anger disgust and sadness.

K-nearest neighbor classifier may be used to classify gender, it shows high performance [16].

In this paper we propose facial expression recognition and gender classification from facial patches

III. PROPOSEDMETHODOLOGY

A. FACE DETECTION

Face detection is mainly carried out by Viola Jones algorithm. The computational complexity were minimal for this method.

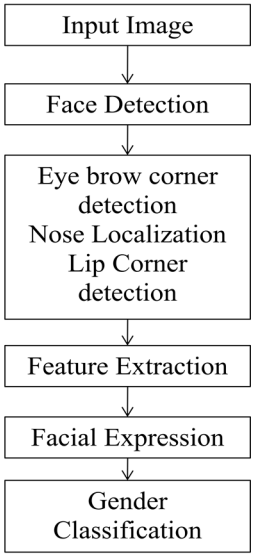


Fig4. overview of proposed system

B. EYEBROW CORNER DETECTION, NOSE LOCALISATION AND LIP CORNER DETECTION

With the help of geometric positions of face, coarse ROI for eyes and nose were selected. Eye detection is carried out by Haar classifiers. Sobel edge detectors are used to extract the lips.

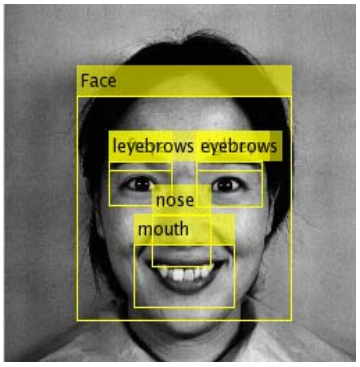
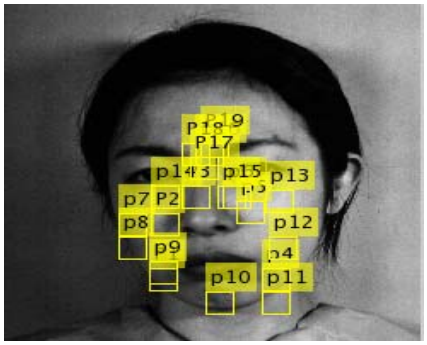
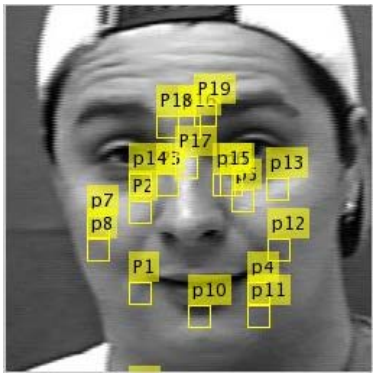


Fig2. Extraction of facial landmarks

C. EXTRACTION OF ACTIVE PATCHES



(a)



(b)

Fig3. Extraction of active facial patches (a)female (b)male

Active facial patches are extracted using LBP.

$$\sum \mathrm{LBP}(x,y) = \sum_{n=0}^{7} (i_n - i_c)\, 2^n \quad \text{.....(i)}$$

$i_c$is the pixel value at co-ordinate (x,y).$i_n$are the pixel value co-ordinates in the neighborhood of (x,y).

$$s(x) = \begin{cases} 0, & x < 0 \\ 1, & x \geq 0 \end{cases} \quad \text{.....(ii)}$$

n is the number of labels produced by LBP operator

D. GENDER CLASSIFICATION

Gender classification can be done in three ways. 1) geometric based methods 2) appearance based models. 3) Expression patches

21 features are calculated from the face image and QDA is used to classify the correct gender.Brightness and contrast around eyes, nose, lips are considered for identifying gender using appearance based features.
Female eyes have long lashes that curl outwards and are oval in shape which makes the eyes bigger. Males have shorter eyelashes and have rectangular shape[17]. For females, the depth of the bridge and ridge of the nose is minimum.

- Inter-ocular distance: The distance between the midpoint of right eye and midpoint of left eye in the face image.
- Lips to Nose: The distance between nose tip and the midpoint of the lips pixel in the facial image.
- Nose to Eyes: The distance between Nose tips to inter-ocular distance in the facial image.
- Lips to Eyes: The distance between lips midpoint to inter-ocular in the facial image.

The ratios that are considered are:

$$\text{Ratio1}=\frac{\text{lefttorighteyedistance}}{\text{eye to nose distance}} \quad \text{.....iii)}$$

$$\text{Ratio2}=\frac{\text{eye to nose distance}}{\text{eye to chin distance}} \quad \text{....(iv)}$$

$$\text{Ratio3}=\frac{\text{left to right eye distance}}{\text{eye to chin distance}} \quad \text{.....(v)}$$

$$\text{Ratio4}=\frac{\text{eye to nose distance}}{\text{eye to lip distance}} \quad \text{.....(vi)}$$

$$\text{Ratio5}=\frac{\text{verical face distance}}{\text{horizontal face distance}} \quad \text{.....(vii)}$$

ii) Appearance Based feature:- Female skin is generally lighter than male skin . But, female eyes and lips are not lighter than male eyes and lips, there should be greater luminance contrast surrounding female eyes and lips than male eyes and lips. The brightness and contrast near the eyes, nose, mouth and whole face is found out. It is proved that brightness and contrast levels vary for females and males .

iii) Expression patches:- The paper mainly focuses on gender classification based on two expressions joy and anger. Research have proved that females express more anger than the male and male express more joy than the females. The anger expression emphasizes the some of the features that make a face appear dominant (e.g., the mouth region often appears more square, and frowning reduces the distance between eyebrows and eyes). Conversely, smiling enhances the appearance of roundness of the faces associated with affiliative and baby faces.

IV. EXPERIMENTS AND DISCUSSION

Computer vision toolbox are available to detect the segments viz face ,eye, nose and lip. Multiple face, mouth, eyes are detected first. This is due to the low resolution of the images. Selection of ROI with threshold values are used to avoid the mismatching. Eyes are detected from face segmented image. The position of the mouth and nose are also checked to avoid duplication. 19 patches are extracted from the segments with landmark. These land marks are trained with QDA and SVM classifier. The geometric based and appearance based features are estimated and gender is calculated with these features . From the performance analysis , it is shown that gender classification with facial features shows better accuracy. The proposed method works well on JAFFE and CK+ databases. It shows greater amount of accuracy with lower computational complexity.

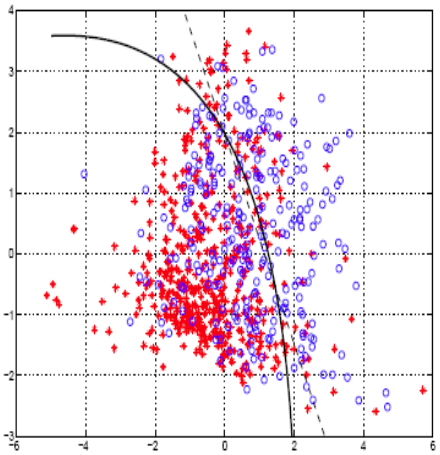


Fig5.QDA Classifier Graph

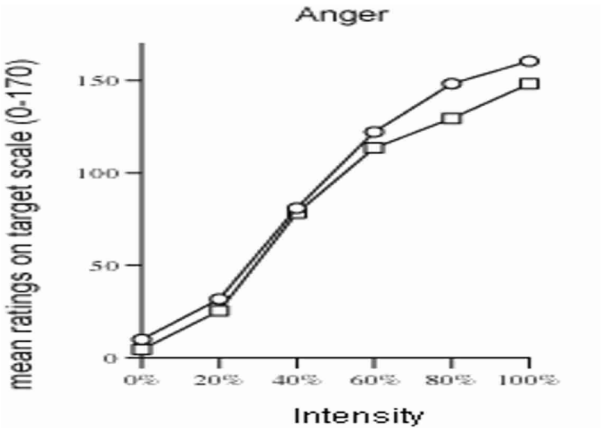


Fig 6 :Intensity and mean ratings on target scale

	Anger	Disgust	Fear	Happy	Sadness	Surprise
Anger	**99.55**	**14.02**	**10.21**	**3.50**	**8.59**	**3.62**
Disgust	**14.42**	**100.00**	**10.86**	**3.87**	**9.52**	**4.77**
Fear	**17.94**	**14.73**	**99.42**	**5.71**	**14.05**	**7.56**
Happy	**9.88**	**9.25**	**8.40**	**99.87**	**10.75**	**5.81**
Sadness	**13.57**	**10.18**	**10.28**	**6.88**	**99.53**	**7.71**
Surprise	**7.11**	**6.76**	**6.28**	**5.22**	**7.69**	**92.84**

Table 1:confusion matrix using ck+ database

Fig.7. Mean accuracy as a function of emotion and apparent gender of the expressor.

V. CONCLUSION

This paper has presented an efficient method to identify facial expression and thereby classification of gender. The eye and nose detection are implemented with haar classifiers. The lip detection is implemented with sobel operator. Quadratic Discriminant Analyzer is used to predict the gender. Gender prediction with geometrical features and appearance feature are also estimated. But facial patches based gender classification shows better accuracy. The proposed system is efficiently tested with CK+ and JAFFE databases.

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