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Facial Emotion Detection Based on the Features of Mouth Regions

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Abstract: **- Emotion is a mental state which involves the lot of behaviors, actions, thoughts, and feelings. Emotion recognition is the process of identifying the human emotion, most typically from facial expressions. Different types of facial expressions are Joy, Sadness, Fear, Disgust, Surprise, and Anger. The eyes and mouth (lip) movements will generally exhibit the emotions. The main aim of this research work is to propose a technique to detect the facial emotion from the features of the mouth region. The facial images with different emotions are captured, preprocessed and mouth regions are detected by Viola-Jones algorithm and extracted by means of Bounding Box method. Then Edge detection, region filling, and morphological algorithms are proposed to extract the lips and filled mouth region for which the area of the region is calculated with the help of the number of extracted mouth region pixels. Then Data mining Decision Tree Classifier is applied to classify the emotions based on the area values. The input images of various expressions are taken, results are analyzed and their performances are evaluated.**

Keywords: **Emotion recognition, Viola-Jones, Edge Based Segmentation, Morphological area Extraction, Feature Extraction.**

I. INTRODUCTION

Humans are generally pretty good in recognizing emotions expressed from the face. Emotional aspects have huge impact on Social intelligence like communication understanding, decision making and also helps in understanding behavioral aspect of human. Various basic facial expressions of a human are listed and shown in Fig 1.

- Joy – Happiness is a mental or emotional state of well-being positive or pleasant emotions.
- Sadness- Sadness is a natural part of life and is usually connected with certain experiences of pain or loss or even a meaningful moment.
- Surprise - Surprise is the sense of astonishment, wonder, or amazement that is caused by something sudden or unexpected.
- Anger- The anger is a humans feel is being triggered by far less consequential factors than serious wrongdoing.
- Disgust-Disgust is a feeling of dislike. Human may feel disgust from any taste, smell, sound or tough.

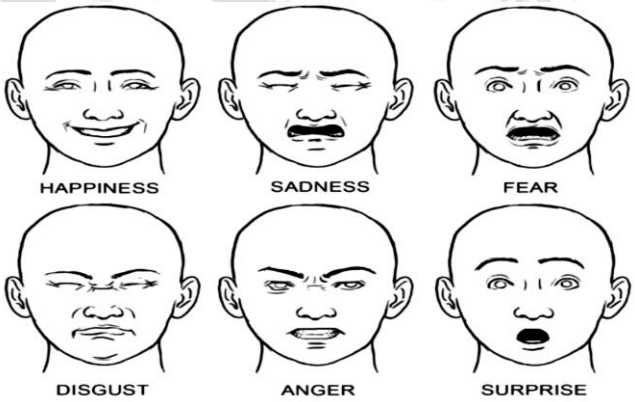

Fig 1. Basic Facial Expressions of a Human

Analysis of facial expression has many applications like Human Computer Interaction (HCI), Social Robot, Animation, Alert System & Pain monitoring for patients.

The major contribution of this research work is the segmentation of images, particularly the mouth regions from the face images. It discusses viola Jones algorithm to detect the mouth region. Then Edge based techniques and morphological operations are used to extract the lips and filled mouth region for which the area of the region is calculated. Then Data mining Decision Tree Classifier is applied to classify the emotions.

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II.LITERATURE SURVEY

Since the main aim of this research work is to extract the mouth region from the facial image; a survey on various existing research works to segment the face expression images is reviewed. Akanksha Manuj (2015) et al., presented "Automated Human Facial Expression and Emotion Detection: A Review". They discussed the methods for detection of human emotions from still images. Various challenges and methods which related to the emotion detection are reviewed. These techniques focus on many factors namely face detection, lip detection, eye detection, etc. The emotional recognition rates are much better even with the small number of training images. In this reviewed methods gave 90-95% result [1].
A. D. Chitra (2014) et al., presented "An Approach for Canny Edge Detection Algorithm on Face Recognition" They provide image color space transformation, Gaussian Filter Coefficient and Hysteresis thresholding by using high and low value thresholding. It performs better than all other edge detection algorithms. The canny edge detection has greater noise ratio is the experimental result [2].
S.P.Khandait (2011) et al., presented "Automatic Facial Feature Extraction and Expression Recognition based on Neural Network" and discussed the combination of Susan edge detector, edge projection analysis and facial geometry distance measure to locate and extract the facial feature for gray scale images. Finally feed forward back-propagation neural network is used to recognize the facial expression. This method gives 95.26% accuracy [3].
Deepika Ishwar et al., presented "Emotion Detection Using Facial Expression" which is a simple approach adopted for the recognition of facial expression analysis. The algorithm is performed in two major steps: one is a detection of Facial Region with Skin Color Segmentation and calculation of feature-map for extracting two interested regions focused on eye and mouth. And the other is a verification of the facial emotion of characteristic features with the Bezier curve and the Hausdorff distance. This was done with the images of different age group under different situations [4].
From this review, it has been decided to propose Region based segmentation with morphological operations to extract the mouth region from the human image.

III. PROPOSED METHODOLOGY

A novel technique to detect the facial emotion from the features of the mouth region is proposed in this paper. The schematic diagram of the proposed work is shown in Fig 2.

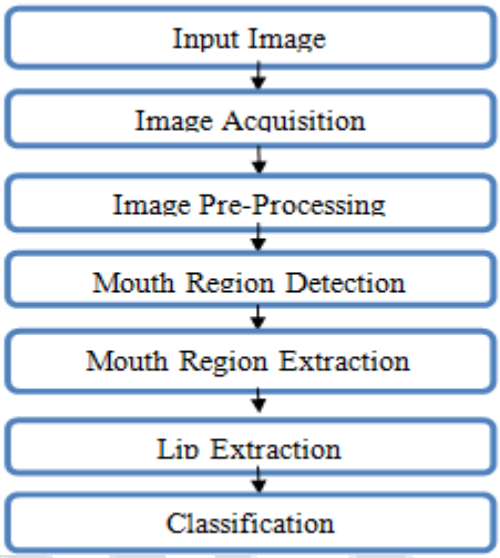

Fig 2. Schematic Diagram

A. Image Acquisition

The Static image or image sequences are used for facial expression recognition. The individual facial expression images of persons of different age group with different emotions are captured by digital camera and taken as input. The sample input image is shown in Fig 3.

Fig 3. Input Face Expression Image

B. Preprocessing

Pre-Processing stage of image processing techniques will enhance the quality of the input image. In the proposed research work, the median filter is applied to remove the impulse noise particles and Contrast stretching is applied to enhance the image. In general the preprocessed images will have improved visual impact by increasing the pixel brightness. Schematic Diagram for image pre-processing is shown in Fig 4.

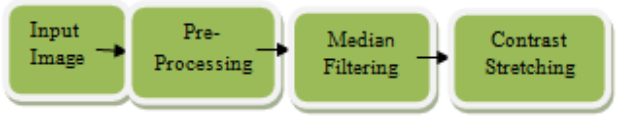

Fig 4. Schematic Diagram for pre-processing

1. Median Filtering

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Filtering is used to filter the unnecessary information from on image. A simple and powerful non-linear filter is known as median. Median filter provides excellent results when applying to reduce the salt and pepper noise. The formula for Median filtering is given in equation 1:

$$f\hat{}(x,y) = median\{g(s,t)\} \quad \ldots\ldots (1)$$

The sample preprocessed image is shown in Fig 5.

Fig 5. Preprocessed Face Expression Image

2.Contrast Stretching

Contrast Stretching is determined by the image color to increase the brightness of the objects. So the preprocessed input image is contrast stretched to enhance the mouth region alone. The sample of Contrast Enhancement is shown in Figure 6.

Fig 6.Contrast Stretching

C. Mouth region Detection

To extract the mouth region from the preprocessed image, initially Viola-Jones algorithm is applied to detect mouth region. The Viola–Jones algorithm was suggested by Paul Viola and Michael Jones in 2001. It is a framework which is used for detecting objects in real time but mainly applied to face detection application because its training rate is very high and the result is more accurate compared to others. The detected mouth region is displayed by a rectangle box and shown in Figure 7.

Fig 7. Mouth Region Detection

D. Mouth Region Extraction

After determining the position of the mouth region to extract the mouth portion the region is converted from RGB to YCbCr color.

The YCbCr color model Equation is given in equation 2.

$$\begin{aligned} Y &= 0.257R + 0.504G + 0.098B + 16 \\ Cb &= -0.148R - 0.291G + 0.439B + 128 \\ Cr &= 0.439R - 0.368G - 0.071B + 128 \end{aligned} \quad \ldots\ldots (2)$$

The area covered by bounding box is extracted by using imcrop() method.

Fig 8. Bounding box Mouth Extraction Image

E. Lip Extraction

After extracting the mouth region, the image will be segmented by Edge Based and Morphological operations to extract the lip area to find the expressions.

1.Edge Based Techniques

In this work, the edges of the mouth regions are extracted by using Edge Based Segmentation Techniques. The output of the sample Edge Based Segment Techniques is shown in Figure 9.

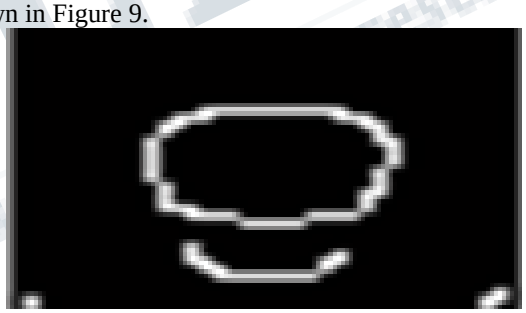

Fig 9. Edge Base Segmentation Image

2.Mathematical Morphology

The morphological operations Region filling and Boundary extraction are applied to extract the mouth region for area calculation.

3.Region Filling:

Region filling attempts to fill the mouth region boundary with white pixels. The region filling method defined in equation 3.

$$X_k = (X_{k-1} \oplus B) \cap A^c \quad k = 1,2,3 \quad \ldots\ldots (3)$$

where X0 is simply the starting point inside the boundary, B is a structural element and Ac is the complement of A. This equation is applied repeatedly until Xk is equal to Xk-1. Finally the result is unioned with the original boundary.

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4. Describing a region

The closed mouth region is obtained imfill () function. The region filling function imfill(BW, 'holes') is applied and the result is shown in Figure 10.

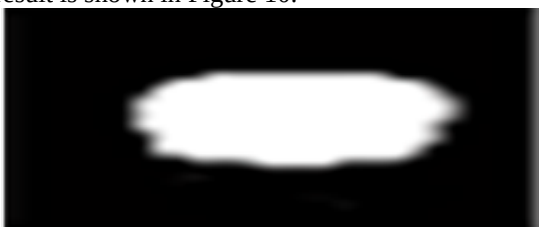


Fig 10. Region Filling Image

5.Boundary Extraction:

The boundary of the filled region is extracted by subtracting the eroded image from the given input image is given in equation 4.

$\beta(A) = A - (AyB)\ldots$ …… (4)

where B is structural element and the extracted mouth region boundary is shown in Figure 11.

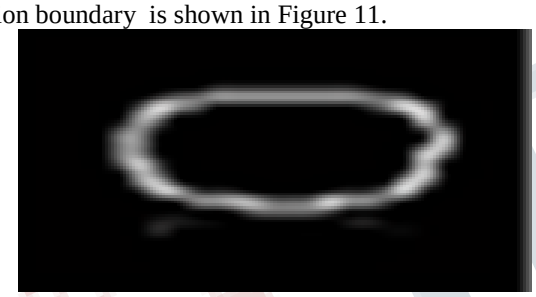


Fig 11. Boundary Extraction image

After the mouth region is extracted, the facial emotions are recognized based on number of white pixel values. The expressions are detected from the value of area of mouth region calculated as below.

6.Mouth area calculation (white pixels):

The mouth object area is calculated by counting the number of pixel values.

```
% Find Area for mouth region
region1= sum (Bwpixel2 (:));
Region= region1*0.264583333
 (total number  of pixels);
  display (round (Region));
```

F.Classification

A data base with five images having different emotions namely Natural, Angry, Happy, Surprise and sadness are taken and the area of the extracted mouth regions is calculated. Based on these area values, Decision tree is constructed to classify the images into various emotions. For the input images taken the area of mouth region falls within the range 40 to 130 for the images 40 to 47 for Surprise, 48 to 56 for Natural, 57 to 67 for Happy, 68 to 78 for Angry and 79 to 130 for Sad. The range of area values for each emotional expression is shown in table 3.1.

Table I. Mouth Area Values for Emotions

S.No	Emotions	Mouth Area (mm)	
		Min	Max
1	Surprise	40	47
2	Natural	48	56
3	Happy	57	67
4	Angry	68	78
5	Sad	79	13 0

The structure of the Decision tree is shown in Figure 12.

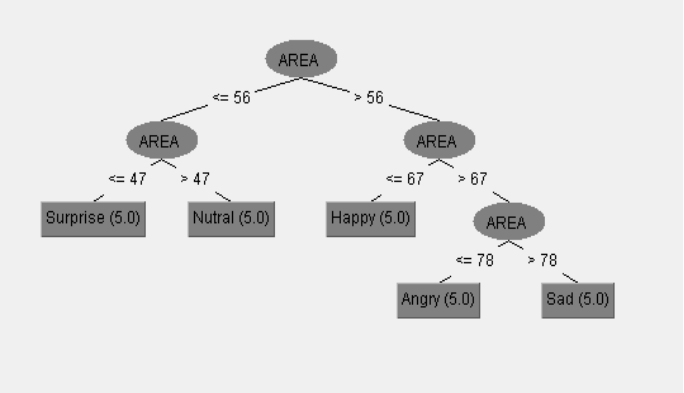
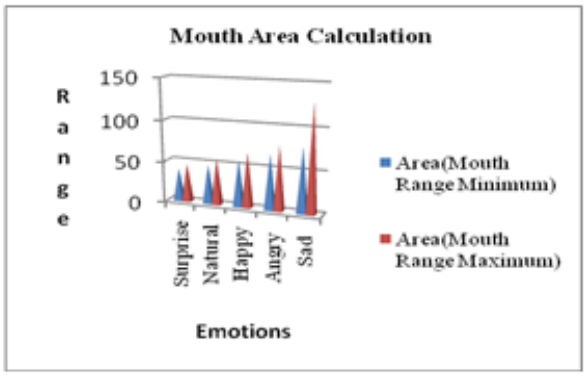


Fig 12. Decision Tree classifier

The comparative analysis is given below.



For Performance analysis hundred different adult

Performance analysis of our proposed method we have taken hundred different adult images to find the emotion namely Natural, Angry, Happy, Surprise and sadness. There are 90% images are giving the better result.

G. Experimental Results and Analysis

The experimental results and analysis of the proposed technique executed on various facial emotional images is

provided in this section. The proposed methodology is applied on a set of various facial emotional input images and their extracted mouth regions are shown in Table 2.

Table II. Extraction of Mouth Region for Lip Extraction

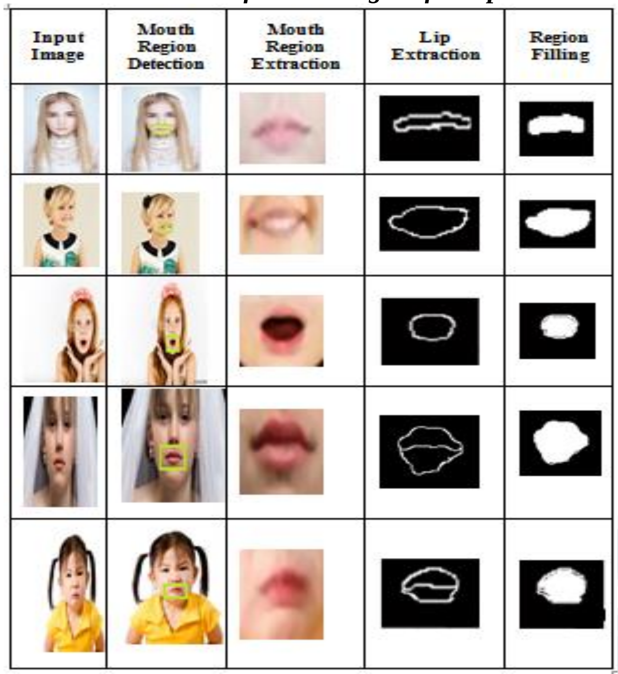
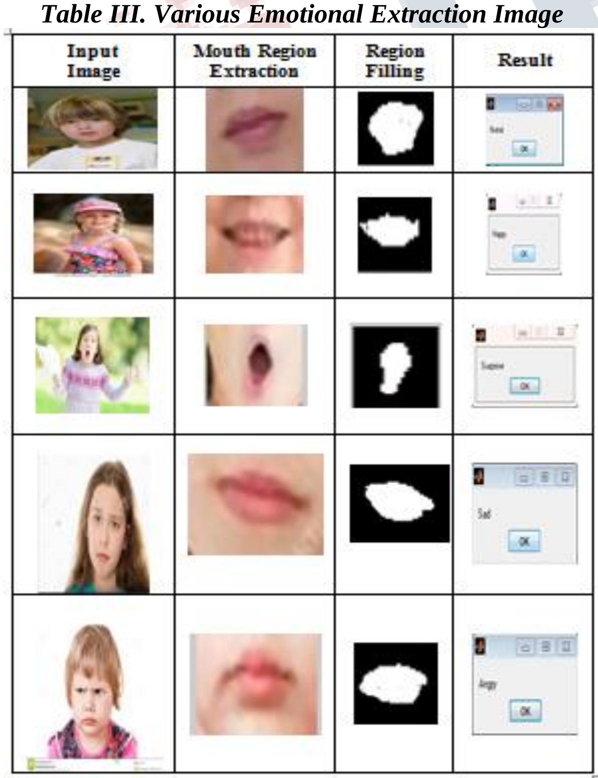
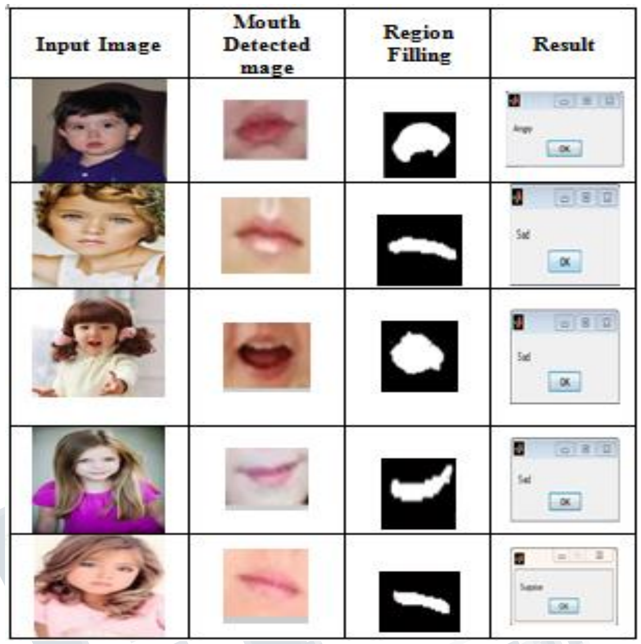


Table III. Various Emotional Extraction Image



The images which are misclassified are listed in Table 4.

Table IV. Misclassification Emotional Images



IV. CONCLUSION

The main aim of this research work is to propose a Face recognition technique to detect the facial emotion from the features of the mouth region. The facial images with different emotions are captured, preprocessed and mouth regions are detected by viola Jones algorithm and extracted by means of Bounding Box method. Then Edge detection and region filling algorithms are proposed to extract the lips and filled mouth region for which the area of the region is calculated with the help of number of extracted mouth region pixels. Then Data mining Decision Tree Classifier is applied to classify the emotions based on the area values. The facial images of five different adults are taken and the results are identified. In future this research work may be extended to apply various methods and techniques to identify the emotions from various parts of the face images.

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