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# Facial Expression Detection

**Nabeelaa Hanjgikar**
*Student, M.E. 2nd Computer Science*
*RMDSSOE, Warje, Pune, Maharashtra, India*

**Dhara T Kurian**
*Asst, Professor*
*RMDSSOE, Warje, Pune, Maharashtra, India*

**Abstract—** Facial expressions are one of important concepts for emotion recognition. The eyes and lip are important elements in facial expression. A category of emotions which universally developed by Ekman are sadness, angry, joy, fear, disgust and surprise without considering natural emotions. The main purpose is implementation of Imperialist Competitive Algorithm (ICA) to optimize eye and lip ellipse characteristics. This process involves three stages pre- processing, feature extraction and classification. Firstly a series of pre-processing tasks such as, skin color segmentation and edge detection are done. One of important tasks at this stage after pre-processing is feature extraction. Secondly ICA is used to optimize eye and lip ellipse characteristics. Finally in the third stage with using features obtained on optimal ellipse eye and lip, emotion a person according to experimental results have been classified.

**Keywords—** Face emotion recognition, Projection profile, Imperialist Competitive Algorithm (ICA), Particle Swarm Optimization (PSO) algorithm and Genetic algorithm (GA).

## I. INTRODUCTION

Facial expressions are one of important concepts for emotion recognition. You can express emotion a human with (her /his) face in comparing with other body parts. The eyes and lip are important elements in facial expression. A category of emotions which universally developed by Ekman are sadness, angry, joy, fear, disgust and surprise without consider natural emotion. The main purpose of this paper is introducing an Imperialist Competitive Algorithm (ICA) to optimize eye and lip ellipse characteristics. Then performance of three optimization methods including Imperialist Competitive Algorithm (ICA), Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) for this issue will be discussed. The obtained results show that success rate and running speed in ICA is better than PSO and these two parameters for PSO are better than GA. In this study for the validity of research a collection of Indian images including 350 images in seven emotions are used. This method consists of three main parts. The first part describes various stages in image processing include pre-processing, filtering, edge detection. Projection profile method to reason has high speed and high precision used in feature extraction. The second part discusses an ICA-based approach to optimize eye and lip ellipse characteristics. In the third part eye and lip optimal parameters are used to classify the emotions. The rest of this paper organized as follows. Section 2 is an overview of related works. The method with ICA, PSO and GA algorithm is described in section 3. Efficiency analysis and results of the method is discussed in section 4 and section 5 contains conclusions.

## II. RELATED WORK

Facial expressions afford important information about emotions. Therefore, several approaches have been proposed to classify human affective states. The features used are typically based on local spatial position or displacement of specific points and regions of the face, unlike the approaches based on audio, which use global statistics of the acoustic features. For a complete review of recent emotion recognition systems based on facial expression the readers are referred to. Mase proposed an emotion recognition system that uses the major directions of specific facial muscles. With 11 windows manually located in the face, the muscle movements were extracted by the use of optical flow. For classification, K-nearest neighbor rule was used, with an accuracy of 80% with four emotions: happiness, anger, disgust and surprise. Yacoob et al. proposed a similar method. Instead of using facial muscle actions, they built a dictionary to convert motions associated with edge of the mouth, eyes and eyebrows, into a linguistic, per- frame, mid-level representation. They classified the six basic emotions by the use of a rule-based system with88% of accuracy. Black et al. used parametric models to extract the shape and movements of the mouse, eye and eyebrows. They also built a mid- and high-level representation of facial actions by using a similar approach employed in, with 89% of accuracy. Tian et al. attempted to recognize Actions Units (AU), developed by Ekman and Friesen in 1978, using permanent and transient facial features such as lip, Nasolabial furrow and wrinkles. Geometrical models were used to locate the shapes and appearances of these features. They achieved a 96% of accuracy. Essa et al. developed a system that quantified facial movements based on parametric models of independent facial muscle groups. They modeled the face by the use of an optical flow method coupled with geometric, physical and motion-based dynamic models. They generated spatial-temporal templates that were used for emotion recognition. Without considering sadness that was not included in their work, a recognition accuracy rate of 98% was achieved. A method that extracts region of eye and lip of facial image by genetic algorithm has been suggested recently.

## III. PROPOSED METHODOLOGY AND DESIGN

The main purpose of this paper is introducing an Imperialist Competitive Algorithm (ICA) to optimize eye and lip ellipse characteristics. Then performance of three optimization methods including Imperialist Competitive Algorithm (ICA), Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) for this issue will be discussed. The

obtained results show that success rate and running speed in ICA is better than PSO and these two parameters for PSO are better than GA. One of main reasons for using sobel edge detection filter is high speed and high accuracy and it is shown in Fig.1.

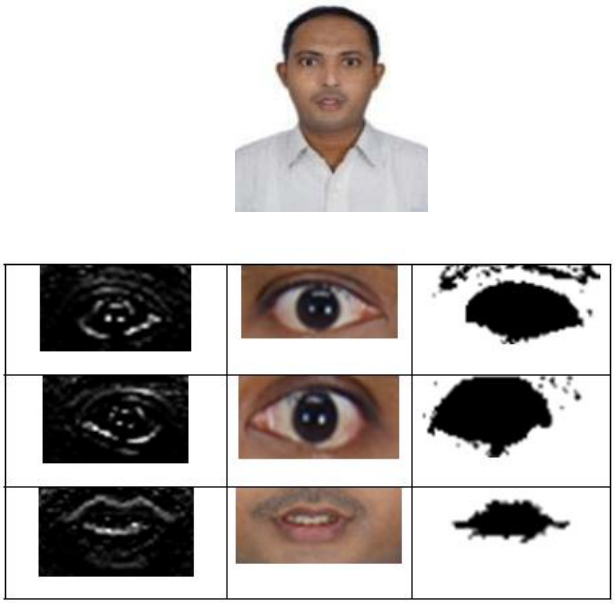

Fig 1. The surprise emotion [11]

A. **Problem Definition:**

To understand and detect human facial expressions and build a system which can identify or detect the facial expressions.

B. **System Design:**

Feature Extraction:

Projection profile is a rapid method for feature extraction. This feature extraction method is implemented with the row-sum and column-sum of white pixels in the image was obtained by sobel filter.The template of row-sum along the column show with (Mh) and template of column-sum along the row show with (Mv) and these features defined for each region. These features are defined as projection profile. Allow f (m, n) is shown with a binary image of m rows and n columns. The human eye shape is more like an ellipse (known as a regular ellipse) and shown in Fig.2.The minor axis of ellipse is a feature of eye and different for each person emotion. The major axis of ellipse with name "a" is different for each person.

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

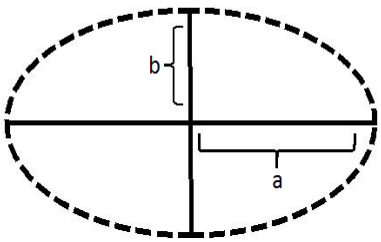


Fig 2. The regular ellipse

Human lip is an irregular ellipse and shown in Fig.3.An irregular ellipse has two variable axes. In the irregular ellipse parameter "a" fixed and parameters "b1" and "b2" are calculated. In the next section ICA algorithm adopted to optimize these features.

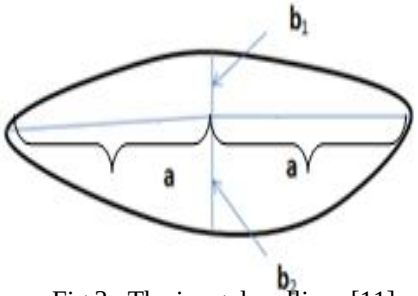


Fig 3. The irregular ellipse [11]

Imperialist Competitive Algorithm (ICA):

In this algorithm a random number of solutions in search space are generated. The initial generated solutions are called as initial countries. Countries in ICA, chromosomes in GA and particles in PSO have a mean. In ICA cost function shows power a country.

C. **Implementation Plan :**

The implementation will be done using .Net and MySql as the Database. The entire project will be implemented in 3 modules as below.

Module 1: Segmentation Module

The input to this module will be an image the user wishes to know the expression about. This will use the initial parts of the color segmentation algorithm. Output to this module will be the color segmented image which will be a gray scale image.

Module 2: Detection Module

The input to this module will be a Skin Color Segmented image. In this module, the algorithm will perform detection of Face, Eyes & Lips using Bezier Curve. The output of this module will be Bezier Curve values of Face, Eyes (Left & Right) & Lips. The UI will show the curves individually

Module 3: Learning Module

The input to this module will be Bezier Curve value of Eyes (Left & Right) & Lips. In this module, the algorithm will perform analysis of the Bezier Curve value of eyes & lips for the purpose of detecting an emotion. This module also learns the emotion from a human if it is unable to identify the emotion. Here the user will have to manually add the name of the emotion for the image and the values of the curve will be saved for future use.

D. **Mathematical Model:**

The vertical profile (Mv) with size n is shown by (1)

$$Mvj = \sum_{i=1}^{m} f(i,j) j = 1,2,3,\ldots,n \quad (1)$$

The horizontal profile (Mh) with size m is shown by (2)

$$Mhi = \sum_{j=1}^{n} f(i,j) i = 1,2,3,\ldots,m \quad (2)$$

E. **Pseudo Code:**

Step 1: Read the image file, picture.

Step 2: Initialize value R, G, B as the red, green and blue values respectively of picture.

Step 3: Initialize value H, S as the hue and saturation values respectively of picture.

Step 4: Initialize value Cb and Cr as the blue-difference and red-difference values respectively of picture.

IF ((R>50 & G>40 & B>20 & (max(R, G, B)-min(R, G, B))>10 & abs(R-G)>=10 & R>G & R>B) OR (R>220 & G>210 & B>170 & abs(R-G) <=15 & R>B & G>B)
THEN
IF (Cb>=60 & Cb<=130 & Cr>=130 & Cr<=165)
THEN
IF (H>=0 & H<=50 & S>=0.1 & S<=0.9)
THEN
Mark as skin region
ELSE
REJECT that pixel.
ENDIF
ENDIF
ENDIF

Step 5: Set blob_pixels as the number of pixels in each connected region.

IF blob_pixels<1500 THEN
REJECT that connected region.
ENDIF

Step 6: Perform hole filling operation and "bwperim" to open up narrowly connected regions.
FOR each connected region
SET breadth as the breadth of the bounding box of the region.
SET length as the length of the bounding box of the region.
SET ratio=breadth/length of the bounding box of the region.
SET eccen as the eccentricity of the bounding box of the region.
IF (ratio<0.4 || ratio>1.1) || (eccen<0.25 || eccen>0.97)
THEN
REJECT that connected region
ENDIF
END FOR

Step 7: FOR each region remaining
Draw a red rectangular box on the region for face detection
END FOR

Step 8: DISPLAY the output image, with the face detection.

ALGORITHM 1 [10]

## IV. RESULT AND ANALYSIS

This study is worked on Indian images with seven emotions and 350 images. The eye and lip features have been given as input to ICA, PSO and GA algorithm to find optimized values (ellipse optimum). Optimization process was repeated 20 times for each emotion. Thereupon optimal parameters (x, x1, x2) come from optimal ellipsoid axes.

## V. CONCLUSION:

Methods used for emotion recognition are facial expressions, vocal, gesture and physiology signal. The main purpose of this paper is introducing an Imperialist Competitive Algorithm (ICA) to optimize eye and lip ellipse characteristics and use of Color Segmentation Algorithm. Then performance of three optimization methods including Imperialist Competitive Algorithm (ICA), Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) for this issue will be addressed. The obtained results show that success rate and running speed in ICA is considered better than PSO and these two parameters for PSO are better than GA. In total a series of pre-processing tasks such as adjusting contrast, filtering, skin color segmentation and edge detection are done. One of important tasks at this stage after pre-processing is feature extraction. Projection profile method to reason has high speed and high precision used in feature extraction.

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