ISSN No. 0976-5697

Volume 3, No. 1, Jan-Feb 2012

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

Face Emotion Recognition for All Geographical Regions using Particle Swarm Optimization Algorithm and Feed Forward Network

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Abstract: One of best and easiest methods for emotion recognition is facial expressions. Facial expression gives important information about emotion of a person. Face emotion recognition is one of main applications machine vision that widely attended in recent years. It can be used in areas of security, entertainment and human machine interface (HMI). Emotion recognition usually uses of science image processing, speech processing, gesture signal processing and physiological signal processing. In this paper particle swarm optimization algorithm using feed forward neural network based on two dataset of images to face emotion recognition in two different geographical regions has been proposed. We recommend use of eye and lip as biometric elements for face emotion recognition. Face emotion recognition process involves three stages pre-processing, feature extraction and classification. One of biggest problems in classification emotion is overlap in range of values. In the other words to increase accuracy in face emotion recognition we recommend use of feed forward neural network. This method used for two different geographical regions (Indian and Japanese) and can be used for any geographical area with certain error. The obtained results show that success rate and running speed for two different geographical areas are acceptable.

Keywords: Feature extraction, Projection profile, Particle swarm optimization algorithm and Feed forward network.

I. INTRODUCTION

Emotion recognition with facial expressions is a method low-cost and practical and provides much information about emotion of a person. A human can express his/her emotion through lip and eye. 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 face emotion recognition using eye and lip. This method consists of four main parts. The first part describes various stages in image processing include preprocessing, filtering, edge detection. Projection profile method to reason has high speed and high precision use in feature extraction. The second part discusses a PSO-based approach to optimize eye and lip ellipse characteristics. In the third part we use of eye and lip optimal parameters to classify of emotion. Finally we compare obtained results between two countries. The general process for face emotion recognition is shown in Fig. 1. The rest of this paper organized as follows. Section 2 is an overview of related works. The method with PSO algorithm is described in section 3. Efficiency analysis and results of the method is discussed in section 4 and section 5 contains conclusions.

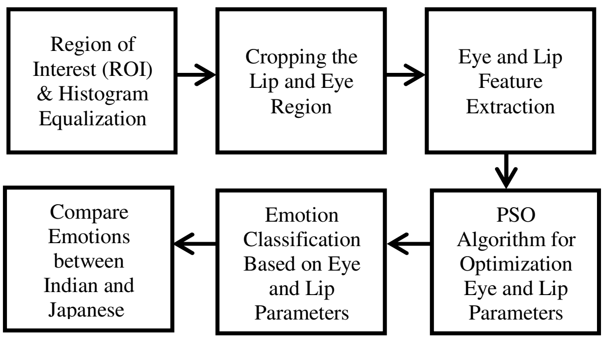

Figure1. Emotion recognition process

II. RELATED WORKS

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 [1]. Mase proposed an emotion recognition system that uses the major directions of specific facial muscles [2]. 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 [3]. 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 used of a rule-based system with 88% of accuracy. Black et al. used parametric models to extract the shape and movements of the mouse, eye and eyebrows [4].

They also built a mid- and high-level representation of facial actions by using a similar approach employed in [3], with 89% of accuracy. Tian et al. attempted to recognize Actions Units (AU), developed by Ekman and Friesen in 1978 [5], using permanent and transient facial features such as lip, nasolabial furrow and wrinkles [6]. 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 [7]. 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 [8].

III. THE PROPOSED METHOD

The main purpose of this paper this is whether face emotion recognition using eye and lip for each geographical region and every nationality is possible? The main goal of this paper is design a optimize method by particle swarm optimization. In the end we compare the results. Contrast adjustment is a fundamental requirement for the skin color segmentation and so a histogram equalization method should be applied. This method usually improves overall contrast in many images when data available of image is represented with values very close. With this adjustment, intensities can much better distribute on the histogram. Area of low intensity to becomes high intensity area. The histogram equalized image is filtered using average and median filters to build the image more soft and smooth. The sobel edge detected region of lip and eye region are shown in Fig.2 and Fig. 3.

Figure 2.The surprise and happy emotion [9-10]

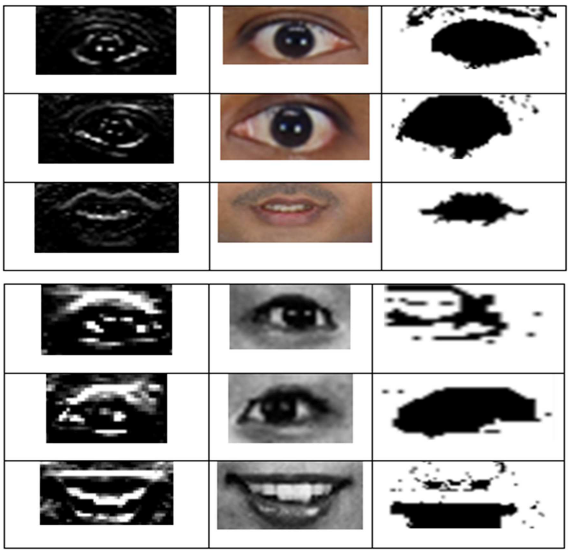

Figure 3.Sobel edge detected [9-10].

Feature extraction method is implemented with the row-sum and column-sum of white pixels in the image was obtained by sobel filter [8].The template of row-sum along the column show with (M_h) and template of column-sum along the row show with (M_v) and these features defined for each region [8]. These features are defined as projection profile. Allow f (m, n) is shown with a binary image of m rows and n columns [8]. The vertical profile (M_v) with size n is shown by (1) [8].

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

The horizontal (M_h) with size m is shown by (2) [8].

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

The human eye shape is very similar to a regular ellipse and shown in Fig.4.The minor axis of ellipse is a feature of eye and different for emotion each person. The major axis of ellipse with name "a" is different for each person. The regular ellipse is displayed with its minor and major axes and also parameter "a" fixed and "b" calculated by (3) [8].

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \qquad (3)$$

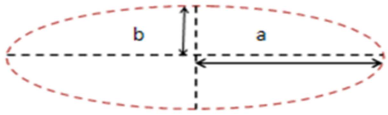

Figure 4.The regular ellipse

Human lip is an irregular ellipse and shown in Fig.5.An irregular ellipse has two variable axes. In the irregular ellipse parameter "a" fixed and parameters "b_1" and "b_2" are calculated. In the next section PSO algorithm adopted to optimize these features.

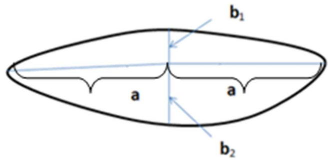

Figure 5.The irregular ellipse

Particle Swarm Optimization Algorithm (PSO) will be used to optimize regular and irregular ellipse characteristics. In this algorithm each particle is shown as a proposed solution. In this algorithm each particle has a fitness value. These values are calculated from fitness functions in order to optimize. Each particle has a velocity that will show direct the particle. The global best, local best, personal best, particle velocity vector, particle position vector and a random number in range (0,1) respectively gbest, lbest , pbest ,v[] , x[] and rand() are shown. To update the position and velocity of particles we use of following relations (4), (5).

v [] = v [] + c_1 * rand () * (pbest [] - x []) + c_2 * rand () * (gbest [] - x []) (4)

x [] = x [] + v [] (5)

Learning factor is typically in range of values 0 and 2 and with c_1 and c_2 are shown.

PSO algorithm parameters are shown in Table **I.**

TableI.Parameter settings for PSO processing

Parameter	***Value***
Defined particle	(x, x_1, x_2)
Number of particles	200
Particle dimension	3
Particle dimension Range	x_1>=0 and x_2<=0
V_{max}=20	Variable
Learning factor	[0-2]
stop conditions	500(maximum repetition) , minimum accuracy for ellipse axes
version	local
inertia weight	W_{max}=0.9 , W_{min}=0.4
max iteration	500
W(iteration)	W_{max}-((W_{max}- W_{min})/ max iteration)* iteration

IV. EXPERIMENTAL RESULTS

In this study on Indian and Japanese subjects seven emotions and 350 images were examined. The eye and lip features have been given as input to PSO algorithm to find optimized values (ellipse optimum). Optimization process was repeated 20 times for each emotion. Thereupon optimal parameters (x, x_1, x_2) come from optimal ellipsoid axes. In Table II manual measured parameters and PSO optimized parameters (The mean of parameters) from 350 Indian images are shown. Sample images of Indian are shown in [9]. In Table III manual measured parameters and PSO optimized parameters (The mean of parameters) from 350 Japanese images are shown.

Sample images of Japanese are shown in [10]. By comparing Table II and Table III:

a. Various parameters of eye and lip are used to face emotion recognition.
b. In this case the comparable between Indian and Japanese, accuracy for Japanese is relatively lower than Indian.
c. This method can be implemented for each geographical region with standard parameters.

V. CONCLUSION AND FUTURE WORKS

This paper is presentation of applications sobel filter, feature extraction of projection profile and PSO algorithm for face emotion recognition in seven emotions happy, sad, angry, fear, neutral, surprise, dislike without consider natural emotion. Current methods for emotion recognition are facial expressions, vocal, gesture and physiology signal recognition. In related works several method were investigated for facial expressions. The main purpose of this paper this is whether face emotion recognition using eye and lip for each geographical region and every nationality is possible? Firstly 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 use in feature extraction. Secondly eye and lip features are given as input to PSO algorithm to compute optimized values of b, b_1 and b_2. In the third stage with using obtained features on optimized ellipse eye and lip, emotion a person according to results Table II and Table III have been classified. By compare Table II and Table III we reached the following conclusions:

a. Various parameters of eye and lip are used to face emotion recognition.
b. This method can be implemented for each geographical region with standard parameters.
c. In this case comparable between Indian and Japanese, accuracy for Japanese is relatively lower than Indian.

Future work:

a. Standard table can be created for each geographical region. Each table contains standard parameters are that in all geographical areas these values are different.
b. With giving an image and identify its nationality, Tables can be used to face emotion recognition

Table II. Manual and PSO optimal measured parameters for Indian

Emotion	*Manually Computed Mean Value (in pixels)*			*Optimized Mean Value by PSO (in pixels)*			*50 Images For each emotion*	*Duration of Emotion Recognition (sec)*
	b_1	b_2	b	x_1	x_2	x	**Success Rate**	**Mean Time**
Natural	40	44	25	39.8165	43.2366	24.9852	93%	48
Fear	27	44	21	26.2525	43.6355	19.6565	89%	39
Happy	27	50	20	26.9612	48.2256	19.6353	92%	51
Sad	28	37	22	27.1464	36.5598	21.9751	88%	49
Angry	27	36	19	26.1256	35.2684	18.6521	94%	53
Dislike	37	32	18	35.2565	31.2255	17.9850	87%	39
Surprise	46	60	20	45.9680	58.2685	19.1451	94%	52

Table III. Manual and PSO optimal measured parameters for Japanese

Emotion	*Manually Computed Mean Value (in pixels)*			*Optimized Mean Value by PSO (in pixels)*			*50 Images For each emotion*	*Duration of Emotion Recognition (sec)*
	b_1	b_2	b	x_1	x_2	x	**Success Rate**	**Mean Time**
Natural	26	22	18	25.1454	21.8449	17.9852	90%	42
Fear	19	27	17	18.8675	26.0782	15.6565	86%	31
Happy	21	32	23	20.5266	30.8992	22.6353	90%	42
Sad	22	25	27	21.5544	24.7565	26.9751	96%	38
Angry	21	23	25	20.1091	21.9728	24.6521	96%	45
Dislike	21	24	21	20.0370	23.5860	20.9850	86%	34
Surprise	29	29	23	28.7725	28.2365	21.1451	86%	43

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