Human Face Classification using Genetic Algorithm

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***Abstract*—The paper presents a precise scheme for the development of a human face classification system based human emotion using the genetic algorithm (GA). The main focus is to detect the human face and its facial features and classify the human face based on emotion, but not the interest of face recognition. This research proposed to combine the genetic algorithm and neural network (GANN) for classification approach. There are two way for combining genetic algorithm and neural networks, such as supportive approach and collaborative approach. This research proposed the supportive approach to developing an emotion-based classification system. The proposed system received frontal face image of human as input pattern and detected face and its facial feature regions, such as, mouth (or lip), nose, and eyes. By the analysis of human face, it is seen that most of the emotional changes of the face occurs on eyes and lip. Therefore, two facial feature regions (such as lip and eyes) have been used for emotion-based classification. The GA has been used to optimize the facial features and finally the neural network has been used to classify facial features. To justify the effectiveness of the system, several images were tested. The achievement of this research is higher accuracy rate (about 96.42%) for human frontal face classification based on emotion.**

***Keywords*—Face Detection; Facial Feature Extraction; Genetic Algorithm; Neural Network**

I. INTRODUCTION

The human face plays a central role in social interaction; hence it is not surprising that automatic facial information processing is an important and highly active subfield of pattern recognition research [1]. In the vision technology area, researchers have started to investigate and develop human face processing systems. Due to the complexity of face recognition, detecting a human face and its facial features and classify the human face base on emotion without identifying the person is of interest [2]. In recent years, there has been a growing interest in improving all aspects of the interaction between humans and computers especially in the area of human emotion recognition by observing facial expressions. The universally accepted categories of emotion, as applied in human-computer interaction are Sad, Anger, Joy, Fear, Disgust (or Dislike) and Surprise [3]. Emotions related to facial expressions. Hence , the features based on the position of the face. Hence, several methods have been proposed to classify emotions. Mase proposed emotion recognition systems that use directions of facial muscles. Muscle movements were extracted use of optical flow with 11 windows method place in the face [4]. For classification, K-nearest neighbor rule was uses with an accuracy of 80% with happy, anger, disgust, surprise emotions [5].Yacoob proposed the same method instead of muscle action, he uses the edge of mouth, eyes and eyebrows, into a frame, mid-level representation, classify the emotions [6]. Black et al. proposed a parametric model. In this model to extract the shape and movement of eyes, mouth, eyebrows, into a mid and high-level representation of facial expression with 80% of accuracy [6]. Ekman proposed a geometric model in which to extract shape and appearance of a lip, nasolabial furrow and wrinkles with 82% accuracy [7]. M. Karthigayan, M. Rizon, R. Nagarajan and Sazali Yaacob proposed a method of Genetic Algorithm and Neural Network for Face Emotion Recognition [3].This research focus on finding, segmenting and classifying human faces, actually includes three parts: human face detection, facial feature segmentations and classification. The goal is to find the face region of a person in an image that is dominated by the upper half of the body, and to segment this face region into four parts: the face region, eyes region, mouth region and nose region. From Segmenting it optimizes the feature value using Genetic algorithm. Then classify face image base on Emotion by Neural Network.

II. METHODOLOGY

As shown in Figure 1, methodological steps for combining genetic algorithm and neural network to classify the facial features based human emotion.

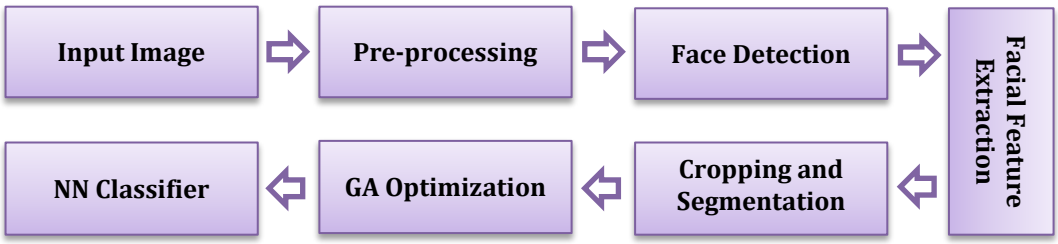

Fig. 1. Block Diagram of the Proposed GANN Classifier

A. Face Image Acquisition

The process of getting the image from any source, especially hardware is called as image acquisition. For image acquisition use a digital camera. In the image processing it is impossible without image receiving/acquisition. The sweetest Acquisition process is a digital camera into various formats such as Bitmap, JPEG, GIF and TIFF etc. and collects image from Google Image.

B. Image Preprocessing

The image preprocessing includes smoothing or filtering and gray-scale conversion. The purpose of smoothing is to reduce noise and improve the visual quality of the image often; smoothing is referred to as ***filtering***. For this purpose of filtering we have used Gaussian Filter. The equation – 1 expresss Gaussian function. If the image is not noisy it is not necessary to filtering.

$$G_{\sigma}(x,y) = \frac{1}{2\pi\sigma^2} EXP^{-\frac{x^2+y^2}{2\sigma^2}} \quad \ldots\ldots\ldots\ldots(1)$$

Filtering is not suitable for all images. Then convert RGB image into Gray Scale image.

C. Face Detection and Feature Extraction

Feature is very significant to any object detection algorithm. The computer vision object detector of Matlab 2013 has been used in this research. The Viola Jones algorithm used for selecting the facial features [8]. There are a lot of features, such as eyes, nose, the topology of eye and nose, can be used for face detection. In Viola Jones face detection, a very simple and straightforward feature has been used. Each feature obtained by subtracting white areas from the black areas. The area means the summation of all the pixels gray value within the rectangle. A special representation of image, named integral image, has been used for calculating these features. At first, the facial region will detect then other parts of the face. This research identifies the human facial feature regions such as face, nose, eyes and lip. It also computes the boundary box value which performs multi-scale object detection on the input image and returns M-by-4 matrix.

D. Cropping and Segmentation

From detecting feature, cropping the Eyes and lip region according to the BBOX value. Image segmentation is typically used to identify objects or other relevant information in digital images. Edge detection of an image which converts in a binary image. For image segmentation and edge detection has been used Sobel operator of Gradient Based Method[9].

E. GANN Face Classification

In this research, eyes and lip are used for human face classification. After detecting the human face, it cropped and segmented the eyes and mouth part as individual segments by using edge detection and then combining the genetic algorithm and neural network (GANN) for classification. The overall process is shown in Figure 2.

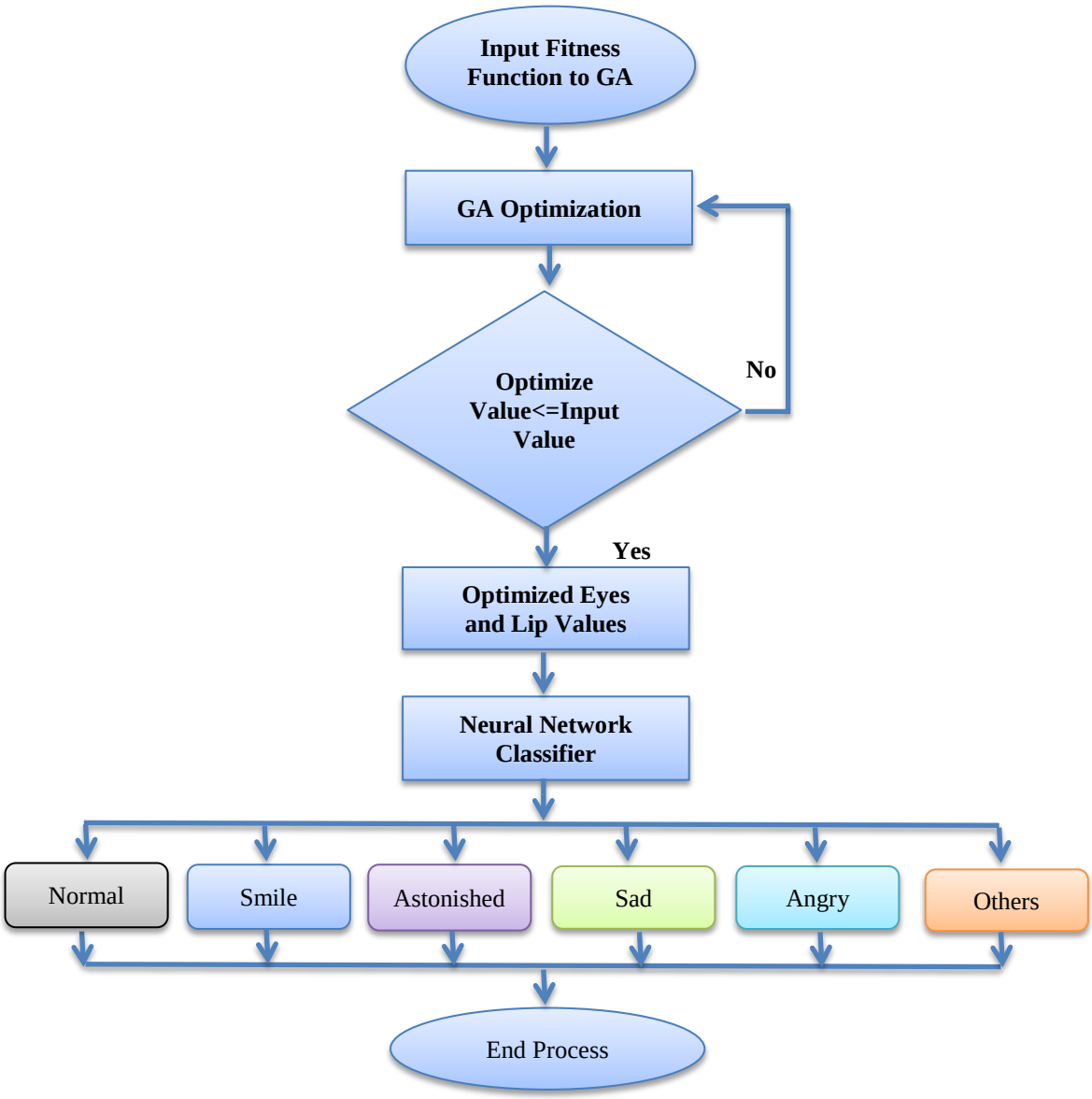

Fig. 2. Flow Chart of GANN Based Face Classification

The height and width of the mouth and eyes white pixel are calculated; so, it is measured from the top and bottom row though the X coordinate and also measure the left and right columns. After segmentation, the shape of eyes and mouth region are looked like an ellipse. The ellipse has two axes such as, the major axis and minor axis. This task is done by using the equations given below:

a = (ymax-ymin)/2; [*ymax- ymin*= mouth width and a= major axis]

b = (xmax-xmin)/2; [*xmax-xmin*= mouth height and b= minor axis]

The research proposed to combine genetic algorithm and neural network (GANN) for classification. In this research, the supportive approach for GANN has been used.

1) GA Optimization

GA is better than conventional AI. It is more robust. GA is a heuristic Search algorithm. They do not break easily even if the inputs changed slightly, or in the presence of reasonable noise. A genetic algorithm may offer significant benefits over more typical search of optimization techniques (linear programming, heuristic, depth-first, breath-first, and praxis) [10]. The region of eyes and lip consider as irregular ellipse. The region of eyes and lip are calculated by ellipse area equations. GA uses ellipse area calculation equation as a fitness function and this equation is given below:

Area=3.1416* a* b

GA takes this irregular ellipse`s major axis and minor axis as input. GA Optimizes the major axis and minor axis of the irregular ellipse and provides a regular ellipse major axis and minor axis value, as shown in Figure 3.

For GA optimization, it uses another function called the condition function where the optimize area is less than or equal to actual area. GA individually optimizes the left eyes, right eyes and mouth major axis and minor axis. The GA optimization uses the mean value of eyes and the ratio of eyes and mouth.

TABLE I. GA PARAMETER

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Population Size	10

The mean value of eyes and the ratio of eyes and mouth are calculated using the following measurement equation (2), (3) , (4), (5):

Mean Eyes Major Axis = (right eye major axis + left eyes major axis)/2……..(2)
Mean Eyes Minor Axis = (right eye minor axis + left eyes minor axis)/2……..(3)
Eyes ratio=(Mean Eyes Major Axis/ Mean Eyes Minor Axis)……..(4)
Mouth ratio=(Major Axis/ Major Axis)……..(5)

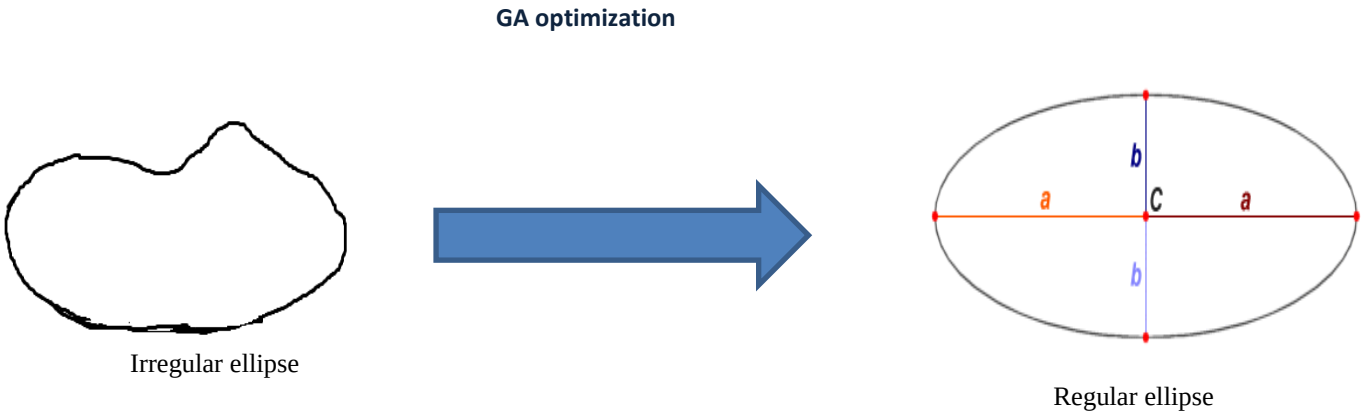

Fig. 3. Converting an irregular ellipse into a regular ellipse

2) Neural Network Classifier

This research uses the ratio value of eyes and mouth for classification of the human face. The proposed system classifies the facial images into six categories based on these values such as normal face, smile face, astonished face, angry face and sad face. The images that do not match in these five classes belong to other class. Therefore, the measurement includes five input pattern and five target pattern. The feed forward neural network with gradient decent adaptive learning algorithm is used for training the input pattern. The network has five input, two hidden and five output layers of twenty five neurons. The tangent sigmoid (tansig) is used as a layer transfer function.

There are several stopping criteria of the network, like as, maximum epochs required, performance goal meet, minimum gradient reach, validation check etc.

III. CLASSIFICATION RESULTS

Table 3 shows the measured ratio and GA optimized ratio value of mouth and eyes. Total 15 images are tested to measure the performance of the classification system. The developed system achieved the better result in face classification. Table 4 shows the performance of the system based on GA.

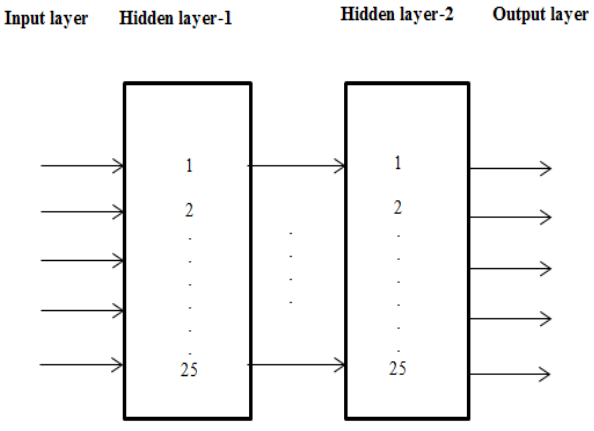

Fig. 4. 5×25×25×5 Neural Network Structure Block Diagram

TABLE II. DETAILS ABOUT NEURAL NETWORK

NN Structure	NN Type	Maximum Epoch	Training Algorithm	Transfer function
5×25×25×5	Feed Forward	1500	Gradient Decent with adaptive learning rate (traingda)	Tangent sigmoid (tansig)

TABLE III. MEAN AND GA OPTIMIZED VALUE OF EYES AND MOUTH AND THEIR CLASS OF EMOTION

Image file	For eyes				For mouth				Class
	Mean Eyes Major Axis	Mean Eyes Minor Axis	Mean Eyes Ratio	GA optim-ized Eyes Ratio	Mouth Major Axis	Mouth Minor Axis	Mouth Ratio	GA Optimized Mouth Ratio	
n1	20	7	2.8571	3.0800	42.5000	17.5000	2.4286	4.4268	Normal
n2	5.5000	5	1.1000	1.6885	39	13.5000	2.8889	3.4962	Normal
n3	19.5000	7	2.7857	2.8992	38.5000	18	2.1389	3.2521	Normal
s1	5.5000	4	1.3750	2.0435	25.5000	15.5000	1.6452	2.4533	Smile
s2	24	11	2.1818	2.1860	39	19	2.0526	2.3428	Smile
s3	10	4	2.5000	2.0526	27.5000	18	1.5278	2.6598	Smile
s4	102	56	1.8214	2.4591	161.500	97	1.6649	2.7444	Smile
w1	15.5000	16	0.9688	1.4465	30.5000	23	1.3261	1.4367	Astonished
w2	12	4	3	2.8684	28	17.5000	1.6000	1.7460	Astonished
an1	19	6	3.1667	4.1110	31	23	1.3478	1.3232	Angry
an2	30	9	2.36	3.33	50	22.50	2.22	1.90	Angry
sad1	29	13.500	2.1481	3.1691	49.5000	27	1.8333	2.9662	Sad
sad2	11.5000	3.5000	3.2857	3.2487	27.5000	16.5000	1.6667	2.5187	Sad
sad3	19.5	7	2.78	3.25	55.5000	27.5000	2.0182	3.0317	Sad

TABLE IV. PERFORMANCE TABLE

Image File	Belong Class	Number of Test	Number of Proper Classification	Number of the Wrong Classification	Accuracy (%)
n1	Normal	10	9	1	90%
n2	Normal	10	10	0	100%
n3	Normal	10	10	0	100%
s1	Smile	10	10	0	100%
s2	Smile	10	10	0	100%
s3	Smile	10	10	0	100%
s4	Smile	10	10	0	100%
w1	Astonished	10	10	0	100%
w2	Astonished	10	9	1	90%
an1	Angry	10	10	0	100%
an2	Angry	10	7	3	70%
sad1	Sad	10	10	0	100%
sad2	Sad	10	10	0	100%
sad3	Sad	10	10	0	100%
Total		140	135	5	96.42%

IV. CONCLUSION

The developed system classified the frontal face of human based on human emotion, like normal, smile, anger, sad and astonished. The achievement of this research is higher accuracy rate for human frontal face classification based on emotion. This research proposed a new fitness function of genetic algorithm and made a ratio based classification of the human face. The developed system achieved the classification performance rate is 96.42%.This system works only frontal face of single image and it's not work by side view of Image. Sometimes it is overlapped when one class is very much close to another class.

ACKNOWLEDGEMENT

The author would like to thanks to the Ministry of Information and Communication Technology of Bangladesh for giving financial support by providing MOICT-Fellowship.

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