Experimental Research on Identification of Face in a Multifaceted Condition with Enhanced Genetic and ANT Colony Optimization Algorithm

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Abstract—**In this paper, a face recognition system for classification and authentication using Genetic algorithm and Ant colony Optimization soft computing techniques are proposed. The system is framed with three steps. Initially Image pre-processing methods are applied on the input image. Consequently face features are extracted from the processed image, which will be taken as the input to the ANT Colony Optimization (ACO) for feature extraction and feature selection and Genetic Algorithm (GA) is applied in the final step for recognizing the faces The proposed approaches are tested on a number of face images. Experimental results demonstrate the higher extent performance of these algorithms.**

Index Terms—**ACO, Feature Extraction, Genetic Algorithm, Image Enhancement,**

I. Introduction

With the advent of electronic medium, especially computer, society is increasingly dependent on computer for processing, storage and transmission of information Computer plays an important role in every parts of today life and society in modern civilization. With increasing technology, man becomes involved with computer as the leader of this technological age and the technological revolution has taken place all over the world based on it. It has opened a new age for humankind to enter into a new world, commonly known as the technological world. Computer vision is a part of everyday life. One of the most important goals of computer vision is to achieve visual recognition ability comparable to that of human . Among many recognition subjects, face recognition has drawn considerable interest and attention from many researchers for the last twenty years because of its possible applications, such as in the areas of surveillance, secure trading terminals, Closed Circuit Television (CCTV) control, user authentication, Human Computer Interface(HCI), Humanoid robot. A numerous face recognition methods have been proposed .In this research paper a novel computational model of face recognition System , which is fast, sensibly simple, and accurate in controlled environments such as an workplace or a household. The proposed approach have advantages over the other face recognition systems in its speed and simplicity, learning capacity and relative insensitivity to small or gradual changes in the face image.

The concern of the design and implementation of the Face Recognition System (FRS) can be subdivided into two main parts. The first part is *image pre processing [1]* and the second part is *recognition techniques.* The image pre processing part consists of Face image acquisition through scanning, Image enhancement, clipping, Filtering, Edge detection. Feature extraction and selection by Ant Colony optimization. Followed by recognition using soft computing techniques by Genetic Algorithm. The first part of FRS consists of several image preprocessing techniques Face image is processed to obtain a

Transformed face image to increase the quality of the face Image, retaining the important characteristics. Firstly face's image acquisition is achieved by web cam/ digital camera or using scanner. Then image clipping is performed using start-point and end-point detection algorithm. Then the edges are detected using high-pass filter, high-boost filter, median filter or several edge detection methods (Canny edge detector). Finally, the features are extracted and selected by ACO. These selected features of the image are then fed into Genetic algorithm. In the first techniques, the extracted features are saved into memory and using genetic algorithm the recognition of unknown face image is performed by comparing this special pattern to the pattern for which an image module is already built. A special advantage of the proposed technique is that there is no extra learning process included here, only by saving the face information of the person and appending the person's name in the learned database completes the recognizing process. In recognition by Genetic Algorithm, matrix crossover, crossover rate 5 and generation 10 have been used. Outline of the system is given below.

Face Image Acquisition	
Face Image Enhancement	Clipping Edge Detection Filtering
Feature Extraction & Feature Selection (ACO)	
Genetic Algorithm (GA) Recognition	

Face Recognition System

II. System Development Methodologies

As discussed in the previous section, the system starts with acquisition of face image and ends with successful recognition. This successful notation comes through the application of a set of image processing, feature extraction and recognition techniques which have been discussed details in the subsequent subsections.

A. Face Image Acquisition

To collect the face images, a scanner has been used. After scanning, the image can be saved into various formats such as Bitmap, JPEG, GIF and TIFF. This Face Recognition System (FRS) can process face images of any format. The face images in the fig.3 have been taken as sample.

Fig.1. Sample Test Images

B. Filtering and Clipping

The input image of the Face Recognition system may contain noise[1](Gaussian ,Salt and Pepper, Shot ,uniform ,film grain and non isotropic noise) and refuse data that must be removed. Filter has been used for fixing these problems. For this purpose median filtering technique has been used.The *median filter* is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in Face Recognition System and digital image processing because under certain conditions, it preserves edges whilst removing noise.After filtering, the image is clipped to obtain the necessary data that is required for removing the preventable background that surrounded the image. This is done by detecting the window co-ordinates (X *min*, Y *mi*n) and (X*ma*x, Y*max*). The clipped form of the previous sample image is shown in fig.4.

Fig.2. Clipped form of the Test Images

***Preprocessing**:*

C. Color Conversion [1]

An RGB color image is an MxNx3 array of color pixels is a triplet corresponding to the red, green and blue components of an RGB image at a specific spatial location. The data class of the component images determines their range of values. If an RGB image is of class double, the range of values is [0, 1]. Similarly, the range of values is [0,255] or [0, 65535] for RGB images of class unit8 or unit16 respectively. The number of bits used to represent the pixel values of component images determines the bit depth of an RGB image. The number of possible colors in an RGB image is $(2b)^3$, where *b* is the number of bits in each component image. For 8-bit case, the number is 16,777,216 colors. Three dimensional RGB is converted into two dimensional gray scale images for easy processing of face image

D. Noise reduction

A noise reduction filter is applied to the binary image for eliminating single black pixel on white background. 8-neighbors of chosen pixels are examined if the number of black pixels are greater than white pixels then it is considered as black otherwise white. Dirt on cameras or scanner lens, imperfection in the scanner lighting etc., introduces the noise in the scanned face image. A filtering function is used to remove the noise in the image and works like a majority function that replaces each pixel by its majority function.

E. Edge Detection [7]

Point and line detections are important in image segmentation. Edge detection is far most common approach for detecting many discontinuities in intensity values. Canny edge detection finds edge by looking for local maxima of the gradient of f(x, y). The gradient is calculated using the derivatives of Gaussian filter. The method uses two thresholds to detect strong and weak edges and includes the weak edges in the output only if they are connected to strong edges, i.e., to detect true weak edges The local gradient is given by Equations (5) and (6)

$$G\,(x\,,y)\;=\;[Gx\;\;+\;Gy\;]^{1\,/\,2}$$

Where Gx and Gy are the first derivatives of the function f(x, y)

$$\alpha\,(x\,,y)\;=\;\tan{}^{-1}\;(Gx\;/\;Gy) \qquad (6)$$

Where α(x, y) is edge direction shown in the Figure 2

1) Thresholding and Linking [1]

Once we have computed a measure of edge strength (typically the gradient magnitude), the next stage is to apply a threshold, to decide whether edges are present or not at an image point. The lower the threshold, the more edges will be detected, and the result will be increasingly susceptible to noise and detecting edges of irrelevant features in the image. Conversely a high threshold may miss subtle edges, or result in fragmented edges. If the edge thresholding is applied to just the gradient magnitude image, the resulting edges will in general be thick and some type of edge thinning post-processing is necessary. For edges detected with non-maximum suppression however, the edge curves are thin by definition and the edge pixels can be linked into edge polygon by an edge linking (edge tracking) procedure. On a discrete grid, the non-maximum suppression stage can be implemented by estimating the gradient direction using first-order derivatives, then rounding off the gradient direction to multiples of 45 degrees, and finally comparing the values of the gradient magnitude in the estimated gradient direction. A commonly used approach to handle the problem of appropriate thresholds for thresholding is by using thresholding with hysteresis. This method uses multiple thresholds to find edges. We begin by using the upper threshold to find the start of an edge. Once we have a start point, we then trace the path of the edge through the image pixel by pixel, marking an edge whenever we are above the lower threshold. We stop marking our edge only when the value falls below our lower threshold.

2) Edge Thinning [1]

Edge thinning [4] is a technique used to remove the unwanted spurious points on the edge of an image. This technique is employed after the image has been filtered for noise (using median), the edge operator has been applied (like the ones described above) to detect the edges and after the edges have been smoothed using an appropriate threshold value. This removes all the unwanted points and if applied carefully, results in one pixel thick edge elements. The advantages is Sharp and thin edges lead to greater efficiency in face recognition

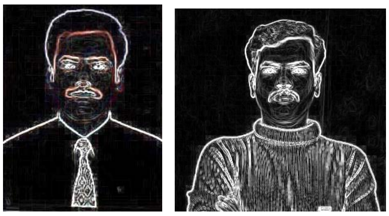

Fig.3. Edges of Face Images

F. Image Scaling [1]

There are various techniques for scaling of the image. Here shrinking technique has been used to get the image 30X30. After scaling, the images are:[1]

Fig.4. Scaling images (30X30)

III. Feature Extraction [8]

Roughly speaking, background, object, edges, pixel intensity and noises are what constitute an image. Face detection by genetic algorithm is in essence to classify the different contents into different classes. Where, features are primary elements, which must be representative and comprehensive. Feature extraction, which influences not only the representation of image information but also the accuracy and efficiency of the subsequent algorithm, is significant in face detection. By analyzing the image, a feature extraction method is proposed. To extract features of the image at first the image is converted into a binary. From this image the centroid (X, Y) of the face image is calculated using equation 1 and 2.

$$X = \frac{\sum m.x}{\sum m} \tag{1}$$

$$Y = \frac{\sum m.y}{\sum m} \tag{2}$$

*Where x, y is the co-ordinate values and m=f(x,y)=0 or 1.*Then from the centroid, only face has been cropped and converted into the gray level and the features have been collected.

A. Features [8]

Inter-ocular distance: The distance between the right eye midpoint and left eye midpoint pixels in the face image. *Lips to Nose:* The distance between nose tip to the midpoint of the lips pixel in the face image. *Nose to Eyes:* The distance between Nose tip to the line joining two eyes midpoint of the pixels in the face image. Lips *to Eyes:* The distance between lips midpoint to the line joining two eyes midpoint of the pixels in the face image *Eccentricity of the face:* The shape of the face containing pixels in the face image. *Ratio of dimension (D):* The ratio of width to height of the face image. The bounding box coordinates of the face image are determined and the width (Dx) and height (Dy) are computed using these coordinates D= Dx/Dy endpoint of the lip to the left endpoint of the lip containing pixels in the face image. *Skin color:* The total number of pixels containing in the face image. *Moustache region:* A strip region above the upper lip containing pixels in the face image. *Lip region:* The region of the two fleshy Parts forming the edges of the mouth opening containing pixels in the face image. *Eye tails:* The end region of eyebrows containing pixels in the face image. *Forehead:* The part of the face above the eyebrows containing pixels in the face image.

Canthus (Cheek): [8] the region on either side of the face below the eye containing pixels in the face image. *Eyelid:* The region of the each upper and lower folds of skin which cover the eye containing pixels in the face image. *Nose wing:* The region which covered both sides of the nose containing pixels in the face image. *Mean:* The mean of a collection of pixels is their arithmetic intensity value average, computed by adding them and dividing by their total number and is given in Equation mentioned below

$$Mean = \sum_{i=1}^{n} \frac{a[i]}{n}$$

Variance: A measure of the average distance between each set of data points and their mean value; equal to the sum of the squares of the deviation from the mean value is given in Equation mentioned below

$$Variance = \sum_{i=1}^{n} \frac{(a[i] - Mean)^2}{n}$$

Standard Deviation (S.D): Square root of variance is the standard deviation is given in below.

$$S.D = \sqrt{Variance}$$

A combination of Global and Grid features are used to extract features. The Global features includes inter ocular distance, the distance between lips to the nose tip, the distance between nose tip to the line joining two eyes, the distance between lips to the line joining two eyes, eccentricity of the face, ratio of dimension, width of lips. The grid features used are the skin color, moustache region and lip region, eye tail, fore head, canthus, eyelid, and nose wing of the face image.

B. Proposed ACO Genetic Algorithm (ACOG)[5]

A combinatorial optimization problem is a problem defined over a set C = c1....cn of basic components. A subset S of components represents a solution of the problem; F ⊆ 2^c is the subset of feasible solutions, thus a solution S is feasible if and only if S ∈ F. A cost function z is defined over the solution domain, z : 2^C----→ R, the objective being to find a minimum cost feasible solution S*, i.e., to find S*: S* ∈ F and z(S*) ≤ z(S), ∀S∈F. They move by applying a stochastic local decision policy based on two parameters, called trails and attractiveness.

By moving, each ant incrementally constructs a solution to the problem. The ACO [14] system contains two rules:

1. Local pheromone update rule, which applied whilst constructing solutions. 2. Global pheromone updating rule, which applied after all ants construct a solution. Furthermore, an ACO algorithm includes two more mechanisms: trail evaporation and, optionally, daemon actions. Trail evaporation decreases all trail values over time, in order to avoid unlimited accumulation of trails over some component. Daemon actions can be used to implement centralized actions which cannot be performed by single ants, such as the invocation of a local optimization procedure, or the update of global information to be used to decide whether to bias the search process from a non-local perspective. At each step, each ant computes a set of feasible expansions to its current state, and moves to one of these in probability. The probability distribution is specified as follows. For ant k, the probability of moving from state t to state ṇ depends on the combination of two values: the attractiveness of the move, as computed by some heuristic indicating the priori desirability of that move; the trail level of the move, indicating how proficient it has been in the past to make that particular move: it represents therefore an a posteriori indication of the desirability of that move.

C. Acog Algorithm

An ACOG [5] is differing from previous algorithm. It uses genetic programming to enhance performance. It consists of two main sections: initialization and a main loop, where Genetic Programming is used in the second sections. The main loop runs for a user defined number of iterations. These are described below:

1) Initialization:

Set initial parameters that are system: variable, states, function, input, output, input trajectory, output trajectory. Set initial pheromone trails value. Each ant is individually placed on initial state with empty memory.

2) While termination conditions not meet do Construct Ant Solution:

Each ant constructs a path by successively applying the transition function the probability of moving from state to state depend on as the attractiveness of the move, and the trail level of the move.

Apply Local Search

Best Tour check: If there is an improvement, update it.

Update Trails:

A. Evaporate a fixed proportion of the pheromone on each road.

B. For each ant perform the “ant-cycle” pheromone update.

Reinforce the best tour with a set number of “elitist ants” performing the “ant-cycle”

TABLE 1 PARAMETER SETTINGS

Chromosome Length	32 bits
Population Size	150
Number of Generation	300
Cross over probability	0.7
Mutation Probability	0.01

Initial Population: Generate randomly a new population of chromosomes of size N: x1, x2,…..x_n.Assign the cross over probability P_C and the mutation Probability P_M.

Evaluate the Fitness function for each chromosome in the population.

Fitness Function: To determine where a selected region is a face or not a function need to assign a degree of fitness to each chromosome in every generation. The fitness of a chromosome is defined as the function of the difference between the intensity value of the input image and that of the template image measured for the expected location of the chromosome. That is for each chromosome n, fitness function is defined as [12]

$$f(n) = 1 - \frac{\sum_{(x,y)\in W} \left| f(x,y) - f_{n,t}(x,y) \right|}{B_{\max} \times xSize \times ySize}$$

where B_{max} is the maximum brightness of the image, *xSize* and *ySize* are the number of pixels in the horizontal and vertical directions of the image, *W* is the window, f *and* $f_{n,t}$ are the intensity values of the original image and the template image when it is justified for the *n*-th position of the chromosome, respectively.

Selection: Select a pair of chromosomes for mating use the roulette wheel selection procedure, where each chromosome is given a slice of a circular roulette wheel. The area of the slice within the wheel is equal to the chromosome fitness ration obviously the highly fit chromosomes occupy the largest areas, where the chromosomes with least fit have much smaller segments in the wheel. To select chromosome for mating a random number is generated in the interval [0.100], and the chromosome whose segment spans the random number is selected.

Cross over: Produce two offspring from two parent chromosomes. Cross over operator chooses a crossover point where two parent chromosomes break and then exchanges the chromosomes parts after that point. As a result two offspring are generated by combining the partial features of two chromosomes. If a pair of chromosomes does not takes place, and the offspring are created as exact copies of each point. This research employs single point cross over, two point cross over and uniform cross over operators. The crossover points are selected randomly within the chromosome for exchanging the contents.

Mutation: Apply the conventional mutation operation to the population with a mutation rate $P_{M.}$ For each chromosome generate a random value between [0,1].If the random value is less than P M choose a bit at a random location to flip its value from 0 to 1 or 1 to 0. The parameter setting approach is shown in Table 1.

By applying the above operation, based on pheromone

trails. The operations are applied to individual(s) selected from the population with a probability based on fitness.
End While

The Performance of Genetic Process:[5]

Genetic generation process involves probabilistic steps, because of these probabilistic steps, non convergence and premature convergence, i.e. convergence to a globally sub-optimal result, problems become inherent features of genetic generation process. To minimize the effect of these problems, multiple independent runs of a problem must be made. Best-of-run individual from a ll such multiple independent runs can then be designated as the result of the group of runs. If every run of GPG were successful in yielding a solution, the computational effort required to get the solution would depends primarily on four factors: population size, M, number of generation that are run, g, (g must be less than or equal to the maximum number of generation G) the amount of processing required for fitness measure over all fitness cases, and the amount of processing required for test phase e, we assume that the processing time to measure the fitness of an individual is its run time, P. If success occurs on the same generation of every run, then the computational effort E would be computed as follows:

$$E= (M \bullet g \bullet \beta \bullet e)$$

Since the value of e is too small with respect to other factors, we shall not consider it. However, in most cases, success occurs on different generations in different runs, then the computational effort E would be computed as follows:

$$E= (M\bullet g\ avr \bullet \beta)$$

Where g avr is the average number of executed generations Since GPG is a probabilistic algorithm, not all runs are successful at yielding a solution to the problem by generation G. Thus, the computational effort is computed in this way, first determining the number of independent runs R needed to yield a success with a certain probability. Second, multiply R by the amount of Processing required for each run, that is. The number of independent runs R required to satisfy the success predicate by generation i with a probability z which depends on both z and P (M, i), where z is the probability of satisfying the success predicate by generation i at least once in R runs defined by:

$$z = 1 - [1- P (M, i)] R$$

P (M,i) is the cumulative probability of success for all the generations between generation 0 and generation i. P (M, i) is computed after experimentally obtaining an estimate for the instantaneous probability Y (M, i) that a particular run with a population size M yields, for the first time, on a specified generation i, an individual is satisfying the success predicate for the problem]. This experimental measurement of Y (M, i) usually requires a substantial number of runs. The computational effort E, is the minimal value of the total number of individuals that must be processed to yield a solution for the problem with z probability (ex: z = 99%):

$$E= M \bullet (\bullet g + 1) \bullet \beta \bullet R$$

Where •g is the first generation at which minimum number of individual evaluation is produced, it is called best generation. •g value is incremented by one since generation •g must also run to reach the solution. From the above equation computational effort depends on the particular choices of values for M, G, P (M, i), and the effort required for fitness evaluation, hence, the value of E is not necessarily the minimum computational effort possible for the problem.

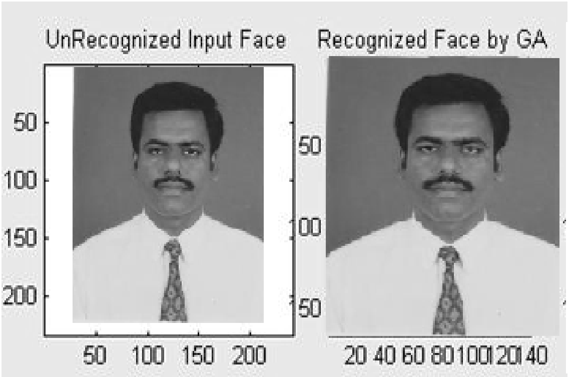

Fig. 5.Recognition phase

IV. Performance Analysis

TABLE 2 :Results for GA

Subjects	Successfully recognized Test Image	Unrecognized Test Image	Efficiency (%)
5	4	1	80
10	8	2	80
15	13	2	86.6
20	18	2	90
25	24	1	96
30	28	2	93.3

V. Conclusion

In this paper, a prototype for Face Recognition System using the Soft Computing techniques like Genetic Algorithm is proposed, with the ACO for feature Extraction and selection and image Pre processing techniques has been discussed. Hence the static Face Recognition system has been developed. The maximum efficiency is 96 % for Face Recognition System by using Genetic Algorithm the competence can be greater than before by using better face scanner, best technique of scaling and well-organized technique of edge detection and feature extraction of the face image. The face images are preprocessed and canny edge detector is used to derive the edges of face images. The features of face are used for matching. Therefore the efficiency of the Face Recognition System by using Genetic Algorithm is most excellent by clustering the ACO when compared with early methodologies. In future the algorithm may be modified for different face angle and illumination variations

References

[1] Rafael C. Gonzalez and Richard E Woods, "Digital Image Processing", Person Education Asia.

[2] M. D. Malkauthekar and S. D. Sapkal, "Experimental Analysis of Classification of Facial Images," IEEE International Advance Computing Conference, March 2009.

[3] Praseeda Lekshmi.V and M. Sasikumar, "RBF Based Face Recognition and Expression Analysis," Proceedings of World Academy of Science, Engineering and Technology, vol. 32, pp. 589-592, August 2008.

[4] S. T. Gandhe, K. T. Talele and A. G. Keskar, "Face Recognition using Contour Matching," International Journal of Computer Science, May 2008.

[5] S.Venkatesan and Dr.S.Srinivasa Rao Madane. Article:Face Detection by Hybrid Genetic and Ant Colony Optimization Algorithm. International Journal of Computer Applications 9(4):8–13, November 2010. Published By Foundation of Computer Science.

[6] S.Venkatesan and M.Karnan:Advvnced Classification using Genetic Algorithm and Image Segmnetation For Improved Face Detection.,computer research and Developemnt 2010 second InternationalConference(ICCRD)7-10 May2010 on Page364-368

[7] S.Venkatesan and M.Karnan: Edge and Characteristics Subset Selection in images using ACO ,Computer research and Developemnt 2010 Second International Conference (ICCRD)7-10 May 2010 on Page 369-372

[8] Ramesha K et al. / (IJCSE) International Journal on Computer Science and Engineering, Vol. 02, No.01S, 2010, 14-23 Feature Extraction based Face Recognition, Gender and Age Classification

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