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Human Face Recognition and Detection System with Genetic and Ant Colony Optimization Algorithm

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Abstract: *Face detection is one of the challenging problems in the digital image processing. Digital images have an enormous information and characteristics measures. But until today, a complete capable mechanism to extract these characteristics in an automatic way is so far unknown. Referring to facial images, its detection in an image is a problem that requires a thorough investigation due to its high complexity. Face detection is an important application of visual object detection and it is one of the main components of face analysis and understanding with face localization and face recognition. Here the investigation aspects of genetic Algorithms (GA's) in face recognition are characterized as one of search technique. GA is efficient technique in reducing computational time for a huge stack space. Face recognition from a very huge stack space is a time consuming job hence GA based approach is used to recognize the unidentified image within a short duration of time. This work analyzes the work done by distinguished authors previously and throws light on what next is to be done. Though they don't give exact and accurate results but are very efficient in time bound recognition for very huge databases. For promptness on a random pickup base it gives fastest result. GA is used when user has no time or less time for giving results without going for check related to each database containing facial images. Feature extraction along with GA will prove better for quicker face recognition. The basic plan of face detection is to determine if there is any face in an image and then locate a position of face in an image. Human face detected in an image can represent the presence of a human in a place. Obviously, face detection is the first step towards creating an automated system, which may involve other face processing. A novel face detection system is presented in this work. Early face-detection algorithms focused on the detection of frontal human faces, whereas newer algorithms attempt to solve the more general and difficult problem of multi-view face detection. That is, the detection of faces that is either rotated along the axis from the face to the observer or rotated along the vertical or left-right axis or both. The newer algorithms take into account variations in the image by factors such as face appearance, lighting, and pose. The goal of face detection is to detect human faces in still images or videos, in diverse situations. A global overview focuses on a detector which processes images very quickly while achieving high detection rates. In certain applications face detection may require advanced classification methods that would precisely identify the faces even if the face visibility measure is less. This work proposes two methods, first is an edge detection technique. Where it establishes a pheromone matrix that represents the edge information at each pixel based on the routes formed by the Ant Colony Genetic Algorithm (ACOG) dispatched on the image* ***[1, 2]***. *Second one is face detection based on usage of GA for advance classification of cases and objects of the input image. This work is based on preliminary segmentation of images into regions that contain non face objects and face objects. This idea may greatly accelerate the efficiency of face detection.*
Keywords: *ACOG, image, genetic, FRS, Performance*

I. Introduction

Face detection can be observed as a particular case of object-class detection. In object-class detection, the job is to find the locations and sizes of all visual objects in an image that belong to a given class. It can be regarded as a more general case of face localization; in face localization, the task is to find the locations and sizes of a known number of faces. In face detection, the two classes have to be discriminated one is images containing faces" and "images not containing faces". It is easy to get a representative sample of images which contain faces, but much harder to get a representative sample of those which do not. Automatic face detection is a difficult problem which consists in detecting one or many faces in an image or film sequence **[9]**. The complexity resides in the fact that faces are non severe objects. Face appearance may vary between two different persons but also between two photographs of the same person, depending on the lightning conditions, the emotional state of the subject and pose. Face detection can be regarded as a specific case of object-class detection. In object-class detection, the task is to find the locations and sizes of all objects in an image that belong to a given class.

A genetic and ACO Algorithms are based on face detection system. First part is also designed to support for detection of faces in any point of view. The main purpose is to find out whether there is a face in a given image. If it so then the co-ordinates of face should be determined and then GA is proposed to generate a face model from the scratch and optimize it based on a large database of sample digital images **[3, 4, 5 and 11]**. The effectiveness will increase as the GA inputs these target values as dynamic input measurements and fitness function is used to allocate real valued number to a given replica. It is to be suggested that image segmentation and pre-processing techniques would reduce the complexity and thereby accuracy levels can be improved.

In this work genetic algorithm is used for training, which adds false detections into the training set as the training progresses **[6]**. This eliminates the difficult task of manually selecting non-face training examples, which must be chosen to extent the entire space of non-face images. Comparisons with other state-of-art face detection system are presented; the system has better performance in the term of detection, run time, false-positives rate, time, and false-negative rate and accuracy rates . An Ant Colony Genetic Algorithm (ACOG) based algorithm to detect frontal views face in gray scale images. These algorithms and training methods are general, and can be applied to other views of faces as well as to similar object and pattern recognition problems. Training a genetic algorithm for the face detection task is challenging because of difficulty in characterizing prototypical "non-face" images. Unlike in face recognition where the classes to be discriminated are different faces, in face detection, the two classes to be discriminated are "images not containing faces" and "images containing faces **[8]**". It is easy to get a representative sample of images which contain faces, but much harder to get a representative sample of those which do not. The size of training set for the second classes can grow very quickly. Nowadays, many applications are developed to secure access control and financial transactions based on biometrics recognition such as fingerprints, iris pattern and face recognition. Along with the development of these technologies, computer controller plays an important role to making the biometrics recognition more economically feasible in such developments. One of the most common and intuitionist biometrics recognition is face recognition.

1.1 Problem Definition

It describes the break in the existing work and problem formulation. Detecting human faces in images is a challenging problem in computer visualization, and is a hot topic of present work in both commercial and academic institutions throughout the world. Face detection is the most important part of face identification and it is difficult due to varying illumination, pose of head and face expression human face detected in an image can represent the presence of a human in a place **[11]**. Evidently, face detection is the first step towards creating an automated system, which may involve other face processing schemes. Differences between face detection and other face processing have been explained as follows:

- **Face Detection**: To decide if there is any face in an image.
- **Face Localization**: To locate point of a face in image.
- **Face Tracking**: To continuously detect position of a face in an image sequence in real- time.
- **Face Recognition**: To contrast an input image against the database and report if related **[7, 10]**.
- **Face Authentication**: To verify the state of the identity by an individual in a given input image.
- **Facial Recognition:** To identify emotion of a human based on face evaluation.
- **Facial Feature Detection:** To detect occurrence and location of face features **[13]**.

1.2 Applications

Face detection plays an important role in today's world. They have many real world applications like human/computer interface, surveillance, authentication and video indexing. However research in this field is still young. The Face detection system can benefit the areas of: Law Enforcement, Airport Security, Access Control, Driver's Licenses & Passports, Homeland Defense, Customs & Immigration and Scene Analysis. The block diagram of Face Recognition System is shown in Figure 1.

Face Image Acquisition	
Face Image Enhancement	Grey scale conversion Clipping Noise Reduction Edge Detection Filtering
Feature Extraction & Feature Selection (ACO) **[12, 14 and 15]**	
Genetic Algorithm (GA) Recognition	

Figure 1: Block diagram of face recognition system

II. Implementation

ACOG uses genetic programming to enhance the 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: Several methods of edge detection exits in practical. The procedure for determining edges of an image is similar everywhere but the only difference is the use of facades. Different types of facades can be applied such as Prewitt, Sobel and quick mask to obtain the edge of a face image. The performance of different masks has a negligible inconsistency. But in this paper, quick façade has been used as this is smaller than any others. It is also applied in only one direction for an image; on the other hand others are applied in eight direction of an image. So, the quick facade is eight times faster than other facade.

To apply GA for face detection, a pattern of the face image obtained from averaging the gradation level of pixels of a number of similar looking face images of several individuals is constructed. The pattern of the face image is then moved through the whole image to find the location where the most suitable match exists. This process applies GA for the optimization of five parameters such as center position of the pattern image, scaling of the template, rotation of the template and matching rate between the input image and the template image. The algorithm starts with an initial set of random solutions called residents. Each individual in the residents known as genetic material, represents a particular solution of the problem, each genetic material is assigned a fitness value depending on how good its solution to the problem is. After fitness allotment, the natural selection is executed and the survival of the fittest genetic material can prepare to variety for the next generation. A new population is then generated by means of genetic operations; crossover and mutation. This evolution process is iterated until a near optimal solution is obtained or a given number of generations are reached.

2.1 Initialization

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

i. While execution 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 charm 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:

ii. Evaporate a fixed amount of the pheromone on each path.
iii. For each ant perform the “ant-cycle” pheromone update.
iv. Strengthen the best trip with a set number of “exclusive ants” performing the “ant-cycle”

2.2 Initial Residents

Generate randomly new residents of genetic materials of size N: y_1, $y_2 \ldots y_{n.}$ .Assign the cross over probability P_C and the mutation Probability P_M. Evaluate the Fitness function for each genetic material in the residents.

2.3. Fitness Function

To determine where a selected region is a face or not a function need to assign a degree of fitness to each genetic material in every age group as shown in Formula a. The fitness of a genetic material is defined as the function of the difference between the intensity value of the input image and that of the pattern image measured for the expected location of the chromosome. That is for each genetic material n, the fitness function is defined as

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

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.

2.4. Selection

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

2.5 Cross Over

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

2.6. Transformation

Apply the conventional transformation operation to the population with a transformation 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.

Table 1: parameter setting approach

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

Based on pheromone trails the operations are applied to individual(s) selected from the residents with a probability based on fitness.

III. Performance analysis

The performance anaysis of Ant Colony Optimization Genetic Algorithm (ACOG) are displayed in Table 2. Face Recognition system is supported with Platforms Microsoft Windows® 2000, XP, Vista, 7 (32 and 64 bit) Mac OS X (Version 10.5 or later, 64 bit) Linux (32 and 64 bit) Intel Pentium 4-classes, 1 Giga Byte RAM

Table 2 :Results for Ant Colony Optimization Genetic Algorithm(ACOG)

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

3.1 Speed of the Detector

There are several metrics to measure the performance of face detection systems, ranging from detection frame rate, false positive /negative rate, number of classifier, number of features, number of training images, training time, accuracy and memory requirements. In addition, the reported performance also depends on the definition of a “correct” detection result. Several post-processing algorithms have been proposed to accurately locate faces and extract facial features. This method is particularly well adapted to real time applications. In fact, the computed model needs few operations to be applied on an image. Preceding works show that the over and done time for face detection is about 50 seconds. In this approach, the hub was to reduce this time factor and also to increase the true positive rate compared to earlier methods.

3.1.1 Statistical Results

The proposed ACOG detects the face from a database collection of test images of size 320 x 240 resolutions in Intel Dual Core processor of 2.8 GHz Personal computer using MATLAB at an average speed of 5.2 secs. The proposed method recognizes correctly 8 out of 10 test images and yields results better than the Ad boost and Haar Wavelet based Training **[10].** In Figure 2, comparison of the detection algorithms are plotted with test images in x axis and run time (in seconds) in y axis.

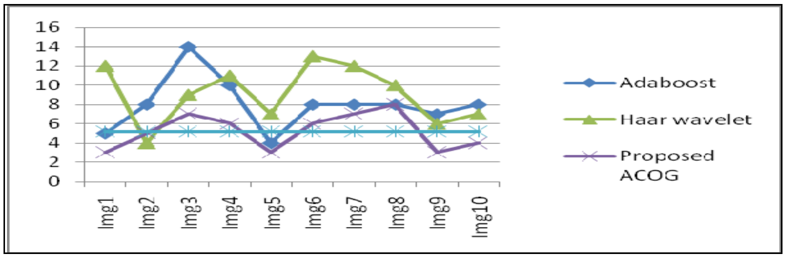

Figure 2: Comparison of the detection algorithms are plotted with test images

IV. Conclusion

In this work, a real time model for Face Recognition System (FRS) using the Soft Computing techniques GA is proposed; with the ACOG for feature Extraction, selection and image Pre-processing techniques. Here the static FRS has been developed and the maximum efficiency is 94 % for FRS by using GA. The competence can be improved than before by using better face scanner module combined with best technique of scaling and well-organized edge detection and feature extraction of the facial image. The efficiency of the FRS by using GA is maximized by clustering the ACO. In future the algorithm may be modified and tested to compensate for different face angle and illumination variations.

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