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A Novel Approach for Face Detection in Complex Background Using Genetic Algorithm

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Abstract*— In this paper, a novel face detection system to detect faces in images. This system is caped with two steps. Initially pre-processing methods are applied on the input image and then our method consists of search procedures which find a face in the image using Genetic Algorithms. For this purpose, we have developed ellipse model to be used as a tool to calculate the fitness for each observation in the search procedure. Head model is approached by a simple ellipse model. The experiments show that our method can locate face an area in the complex background effectively.The proposed method is tested on a number of test images.

I. INTRODUCTION

Face is the most distinctive and widely used key to a person's identity. Face detection have attracted considerable attention in the advancement of human-machine interaction as it provides a natural and efficient way to communicate between humans and machines. The problem of detecting the faces in image sequences has become a popular area of research due to emerging applications in human-computer interface, surveillance systems; secure access control, video conferencing, financial transaction, forensic applications, pedestrian detection, and driver alertness monitoring systems, image database management system and so on.

Various approaches to face detection have been reported in literature over the last few decades, ranging from the geometrical description of salient facial features to the expansion of digitized images of the face on appropriate basis of images [1]. Different techniques have been introduced recently, for example, principal component analysis [2], geometric modeling [3], auto-correlation [4], deformable template [5], neural networks [6], elastic bunch graph matching [7], and color analysis [8] and so on. Face detectors based on Markov random fields and Markov chains [9] make use of the spatial arrangement of pixel gray values. Model based approaches assume that the initial location of the face is known. In this paper, we attempt to develop an automatic face detection system by using Genetic Algorithms which has been well known for its robustness from noise and always converge to its global optimal value. Finding the head is done by using a simple ellipse model

II. METHODOLOGY

Fig 1 shows the outline of the proposed human face detection algorithm. First, it resizes an input image. Second, the image is converted into a gray image. And then, edge of the image is detected using canny edge detector with low threshold value 0.1 and high threshold value 0.3.Finally it is defocused to detect ellipses using GA. Finally, the detected ellipses are judged whether they are facial regions or not. Every time a detected ellipse is considered as a facial region, it is eliminated from the search image.

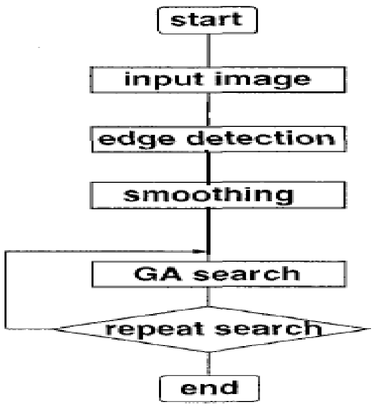

Fig. 1. Outline of proposed algorithm

Preprocessing:

1) RGB to GRAY conversion: The original image is the RGB image. It is converted to gray scale image for further processing. The image is resized to get the size same as original image.
2) Noise Removal: Image is processed for noise removal.
3) Edge Detection: The edges are detected by canny edge detector.
4) Elliptical Object Estimation: The object with the maximum area and closest to ellipse is detected. The detected object is approximated to be the face.

When we output the best ellipse as a genuine ellipse, we output its center, its orientation and the lengths of its two semi-axes, which can be expressed by the parameters x_e, y_e, θ, A,B respectively.

III. GENETIC ALGORITHM

Genetic Algorithms (GAs), based on the simulation of the biological model of evolution and natural genetic systems, are randomized searching methods. They have been found to be robust and efficient way of solving optimization problems. To apply GA for face detection, an ellipse model is constructed. The ellipse model 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 parameters of the ellipse.

The algorithm starts with an initial set of random solutions called the population. Each individual in the population, known as chromosome, represents a particular solution of the problem. Each chromosome is assigned a fitness value

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depending on how good its solution to the problem is. After fitness allotment, the natural selection is executed and the 'survival of the fittest chromosome' can prepare to breed for the next generation. A new population is then generated by means of genetic operations: cross-over and mutation. This evolution process is iterated until a near-optimal solution is obtained or a given number of generations are reached. However, different steps employed for the genetic algorithm are given below.

The fundamental steps employed for the genetic algorithm are as follows.

Step 1 Initialization. Generate an initial population with *M* chromosomes randomly.

Step 2 Evaluations. Evaluate the fitness function for each chromosome in the population.

Step 3 Selection: Use the roulette wheel selection procedure.

Step 4 Cross-over. Produce two off-springs from two chromosomes with better fitness function values.

Step 5 Mutation. Apply the conventional mutation operation to the population with a mutation rate. $M p$

Step 6 Termination test. If a predefined termination condition is satisfied, go to **Step 7**, else go to **Step 2**.

Step 7 Preservation. Keep the best chromosome.

Step 8 Ends.

A. Initialization of the Parent Population

The individual chromosome comprises of five sections:

The chromosome is represented as a binary string of the set {0, 1} of fixed length *N* (here it is 40 bit). A chromosome consists of five optimization parameters:

1. The Xe is x-coordinate of the ellipse.
2. The ye is y- coordinate of the ellipse.
3. A represents length of major axis
4. B represents length of minor axis.
5. θ represents angle of face.

X co-ordinate xe (8-Bits)	Y Co-ordinate ye (8-Bits)	Major axis A (8-bits)	Minor axis B (8 Bits)	Angle Θ (8 Bits)

A population with a set of chromosomes is defined by the strings as :$\{C_j, j=0, 1, ..., M-1\}$ where *M* is the number of the chromosomes or the population size (here it is chosen as 180). The genotype data structure stores an entire population in a matrix of size *MXN*, where *M* is the number of chromosomes in the population and *N* is the length of the genotypic representation of each chromosome. Initially the set of chromosomes in the population are chosen randomly.

B. Selection

Selection operator is a process in which chromosomes are selected into a mating pool according to their fitness function. Good chromosomes that contribute their gene-inherited knowledge to breed for the next generation, are chosen. Here we use conventional elitist selection scheme to select an elitist chromosome with the highest fitness value, which is copied directly into the new population of next generation. The other chromosomes are selected by a roulette-wheel selection process, where the selection probability of each individual is proportional to its fitness value.

C. Cross-Over

A population of 50 most fit individuals is selected from this initial population this fit population is now allowed to crossover. This operator works on a pair of chromosomes and produces two offspring's by combining the partial features of two chromosomes. Crossover can be of different types, single point cross-over, two point cross-over and uniform cross-over operators. The cutting points are selected randomly within the chromosome for exchanging the contents. In this experiment, the cross-over rate was chosen as 0.8 for all cases.

D. Mutation

This operator alters genes with a very low probability. PM For each chromosome, generate a random value between [0, 1]. If the random value is less than, PM then choose a bit at a random location to flip its value from 0 to 1, or 1 to 0. The mutation rate for our method was chosen as 0.2.

IV. Ellipse Model Used for Face Detection

To find a head of person, we used an ellipse model with 5 parameters: two parameters Xe and ye for the center of the ellipse, two principal axes A and B, and orientation theta as shown in Fig. These 5 ellipse parameters are converted into 1 string member of population whose the cost function will be evaluated by the algorithms. By using these 5 parameters and concentrating on the upper-half of the extracted moving person, the head search algorithms is activated.

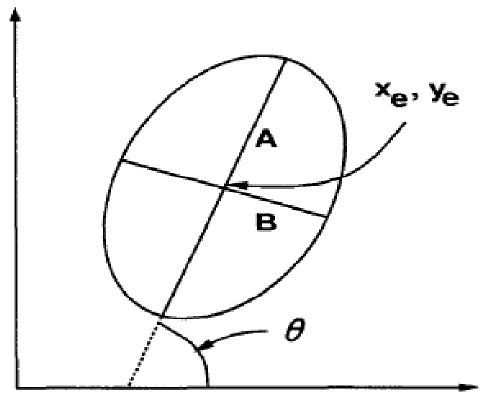

Fig .2.Head Model

For each chromosome fitness is calculated. Fitness function used to calculate the fitness of each chromosome is given below:

$$\gamma = \frac{\sum_{\Omega t} h(x,y)}{le}$$

Where $(x, y) \in \Psi(xe, ye, A, B, \theta)$ and $\Psi(xe, ye, A, B, \theta)$

$$= \frac{((x-xe)\cos\theta + (y-ye)\sin\theta)^2}{A^2} + \frac{(-(x-xe)\sin\theta + (y-ye\ldots}{B^2}$$

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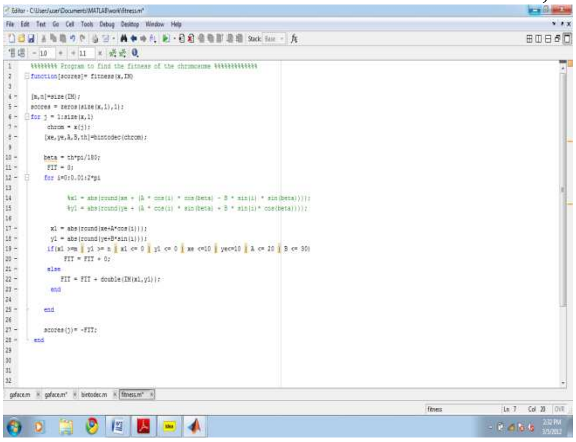

Fig. 3. Code for Fitness function

V. EXPERIMENTAL RESULTS

The simulation is done in MATLAB environment.

In this section, we present some results by computer simulations. The parameter settings are summarized in Table given below:

Population Size	100
Selection Probability	0.6
Crossover	Single Point Crossover
Mutation Probability	0.2
Crossover Probability	0.8
Number Of Generation	150

The matlab code was run for 80 images which contain a single face and 40 images contain multiple faces with dimension of 400 X 400. The code gave exact results for 104 times out of 120 images. Thus efficiency of this algorithm is 86.67 %.

Fig. 4. Input Image

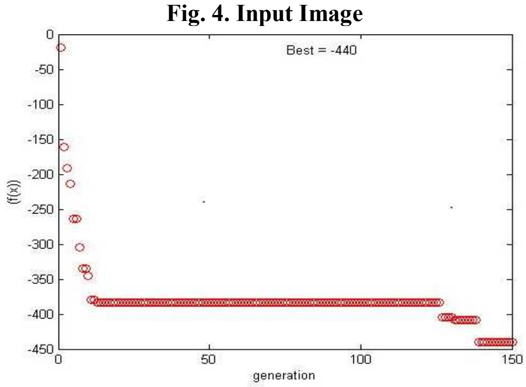

Fig. 5.Graph shows best fitness chromosome for each generation

Fig. 6. Output image

VI. CONCLUSION

We have presented a new model based searching method based on Genetic Algorithms which detects a face. The proposed method gave very good results with a lesser computational costs. The results of the experiments showed that the proposed algorithm can detect ellipses in a reasonable time and, in addition, the algorithm is robust to noise and occlusion.

Thus this model can be further extended in near future to the expression in real time on a live surveillance system analyze. Our future work include Finding a more robust face model that can efficient search side faces in complex background and in various direction .

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