An Effective Model for Face Detection Using R, G, B Color Segmentation with Genetic Algorithm

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Abstract Face detection is a grave concern in digital image processing and automatic face recognition system. This research work proposed a complete mechanism for face detection using R, G, B color segmentation and search optimization scheme with Genetic Algorithm, also refer a discrete technique that is appropriate for combinatorial problems. In this paper we tried to build an R, G, B color range that will shelter a skin part from an image and handover a best fitted solution as fitness function for GA to perform further operation to detect images in complex background. In this paper our tryout are to enrich detection accuracy in lesser computational time. The evaluation shows that this algorithm is capable to detect the face from complex background conditions and for side faces too. This algorithm is tested on a wide number of test images. All the simulation has been done on MATLAB.

Keywords Face recognition and detection · Fitness function · Genetic algorithm (Search optimization scheme)

1 Introduction

Face detection is the foremost problem in digital image processing. In some Automatic Face Recognition (ASR) systems, it can be debated that the system user will cooperate to provide a face image with a side faces pose. However it is not practical to assume that user will always have control over the multifaceted background and surrounding conditions (e.g. lighting) during the face verification system. So detection of a face before trying to recognize saves lot of human work. In static image based automatic recognition system (ARS) try to find a portion of

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the entire face by removing the background area and hairs that are not essential for recognition system most of the background and other areas of an individual's head such as hair that are not necessary for the face recognition.

In human-computer interaction (HCI) face detection have found considerable attention it also provides an efficient way to communicate b/w humans and computer. Detection of face from an image sequence is also a challenging problem in HCI surveillance systems; video conferencing, secure access control, forensic applications [1]. Knowledge based face detection approach for face detection using skin color segmentation with color models (RGB, YCbCr and HSV) with threshold helps to remove non skin part from a static image [2]. Face detection using GA and back propagation Neural Network (NN) where NN used for feature extraction and classification is carried out using GA [3]. Human face detection use adaptive and non-adaptive RGB color space to detect feature like eye and lips [4]. Video based face detection with skin segmentation where face is identified from a video [5]. Real time face detection of profile faces using genetic algorithm to augment the coordinates of rotation angel of profile face using flipping scheme [6]. Proposed Eigen face technique was used to determine the fitness of the face regions and limited the searching space to the eyes and determines existence of the different facial features [7]. In this paper we key objectives is to build a face detection model by using R, G and color space with help of Genetic Algorithm The rest of paper described as follows: (1) Proposed methodology 2.1.2. Genetic Algorithm 2.2.1. Proposed fitness algorithm, (2) Experimental results, (3) Discussion, (4) Conclusion and future work.

2 Methodology

2.1 R, G and B Color Space for Skin Detection (Background)

The apparent human color fluctuates as a function of the relative path to the illumination. Using normalize color histogram it is easy to collect skin pixel and intensity of color be changed on dividing by luminance [8]. The RGB model is characterized by a 3-D dice with (red, green and blue) colors. Main purpose of RGB color model is to represent an image in electronic form. RGB color model don't usage a palette. RGB color model are widely used in video camera and color monitors (Figs. 1 and 2).

2.1.1 Genetic Algorithm: (Background)

Genetic algorithm is a well-known serial search optimization strategy based on principal of natural selection. In GA decision variable of search operation encoded

Fig. 1 RGB colorspace

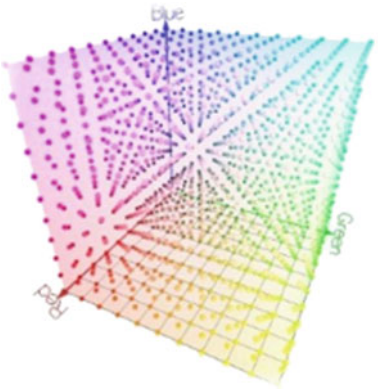
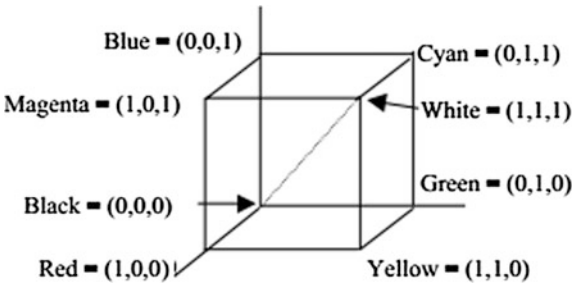


Fig. 2 RGB color cube



into a finite length of string and candidate solution to the search problem are referred as a chromosomes for example in popular travelling salesman problem chromosomes represent route and city is represented by genes. GA is also helpful to solve both constrained and unconstrained problem which is rely on natural selection as well as simulation of biological model. GA is best suited for addressing the problems of mixed integer programming, where some components are constrained to be integer-valued. We can also differ Genetic Algorithm from a classical derivative-based optimization algorithm in two main ways (Table 1).

GA first selects a random population where the population size, which is a user-defined parameter, is an important factor which result performance of Genetic Algorithm.

Selection: Genetic algorithm takes a list of parameters which can be used drive an evaluation procedure. This list of parameters typically represented as a simple

Table 1 Difference between GA and classical derived based optimization

Genetic algorithm	Classical algorithm
Generate a population of points at each repetition, and best point approaches an optimal solution	Generate a single point at each repetition
Generate a single point at each repetition	Next point is selected by deterministic computation

string of data called chromosomes. Using any generic operator e.g. selection, cross-over, mutation, a pair of individual are selected for to endure based on higher fitness value.

Cross-over: The population of most fitted individual images is selected from the initial population. Here two individual are selected randomly with a probability p_c which is called cross-over probability. A uniform number is generated and if $r < p_c$. Then two randomly selected individual endure recombination. Otherwise two off-springs are simply copies of their parents. Cross-over outcomes two new child chromosomes which further added to the second generation pool. The ranges are selected randomly with in the chromosomes for exchanging the contents.

Mutation (Re-placement): in this step new individual chromosomes accidentally mutated with probability of mutation p_m which generates a random vale range b/w [0, 1] for each chromosomes. If this random value is less than PM then chose a bit at random position. The aim of mutation is to generate next generation which is better than first and cross-over selected. It generates until an individual is produced which gives a final solution.

2.2 Methods

In proposed work first we use 100 images covering all types of fair person, dark, normal etc. our aim was to proposed a suitable R, G, B range for skin part in image. Once an input image pass from pixel looping it will detect only the defined range part and eliminate rest of part from an image, because R, G, B values for skin part will be diverse from tiring part in an image as well as from background also. By spending lots of time with math simulation we came with some range for a skin part in image which is shown in (Table 2).

Table 1 show that for a skin part, intensity of green color is lesser as compare to red and blue as well as red intensity is higher than from both green and blue. So there are several possibilities to think and calculate a suitable skin part in an image. Our tryout were to find detect appropriate range for skin part and we came with five assumption.

In image (1) values of R, G, B for skin part is taken from 1 to 95 chosen experimentally and observed values are

Table 2 Range of R, G and B for skin part in image

Type person	R	G	B
Extra fair person	210–250	155–210	90–180
Fair person	180–230	130–170	90–140
Normal	150–200	110–170	70–80
Dark	140–180	90–130	60–80
Extra dark	70–100	40–70	30–50

- Value of R > 95 && Value of G > 40 && Value of B > 20…….. (I)
- Maximum of (R, G, B) – Minimum of (R, G, B) > 15……..(II)
- (R-G) >20 where R > G && R >B……..(III)
- (R-B)>28 where R>G && R>B……..…….(IV)
- (B+G-R)>12……..……..…..(V)

We calculated these ranges by using each image and enchanting R, G, B values that lies on face part and with some mathematics equations build a relationship of R, G, and B value for a skin part in an image. We tabled value of R, G and B color for a skin part in image.

2.2.1 Proposed Face Detection Algorithm Based on R, G and B Color Segmentation

1. Read an image file (I)
2. Calculate R, G, and B from the input file.
3. Calculate Rows and Columns.
4. K=size(I,1-2)
5. Perform pixel wise looping for input image I.
6. For i=1 to size(I,1)
7. For j=1 to size(I,2) //scan each pixel for an input image//
8. If (R>95 && G>40 && B>20)
   If Maximum of (R, G, B) – Minimum of (R, G, B) >15
   If (R-G)>20 where R>G && R>B
   If (R-B)>28 where R>G && R>B
   If (B+G-R)>12
   Set k=1

In proposed face detection algorithm our tryout was to detect a face through intensity of R, G and B color which falls on face regions. This algorithm is pretty straight forward to understand because in this algorithm we just pass an input images from proposed range and the detected the skin appearance where these ranges exists.

Experiment results shows that defined R, G and B ranges efficiently detecting skin part from image we test this algorithm on 110 images and found correct 78 correct detected faces. This algorithm came with one drawback of detecting extra dark person images. When we input an extra dark person it fails because for an extra dark person value of these R, G and B ranges are not satisfying.

2.2.2 Proposed Algorithm for R, G, and B Color Using Genetic Algorithm

GA takes an initial population which is a user defined function. In this case we are using GA to find accurate value b/w certain range that we are assigning with fitness function, once we gave fitness function that is also refer as a problem statement where we try to find our best result. By running each input range of R, G and B distinctly we found that our last calculated range is showing better results as compare to rest four. For GA MATLAB gives an easy toolbox to operate (Fig. 3).

ALGORITHM FOR GA WITH BEST SUITED FITNESS FUNCTION

Step 1: Read an image file (I)
Step 2: Calculate R, G, and .B from the input file.
Step 3: Calculate Rows and Columns.
Step 4: K=size (I, 1-2)
Step 5: Perform pixel wise looping for input image I.
for i=1 to size (I, 1); for j=1 to size (I, 2)
Step 6: If (abs (B+G) - R) > input)) //set a fitness function for GA; Evaluation starts //
Step 7: Option structure for GA
g= gaoptimset ('Generations', 20, 'Display', 'iter')
// create a list of parameters with valid value //
Step 8: m= ga ('best suited range as input ', '12', '20', g)

Moreover, Instead of covering all R, G and B ranges we took best suited range and now keeping best suited range in hand we starts evaluation of GA. Objection function with input refer as a fitness function or a problem statement for Genetic Algorithm. Without passing the actual value of selected range we pass an input. Genetic algorithm starts evaluation by selecting random generations and perform several step mutation, cross-over and provide a best value for this specified range e.g. here we put the input values between a range instead of a fix value so in this range GA detect best suited value for this range and enrich the detection accuracy. We can also pass multiple ranges for GA but it will directly imitate computational time.

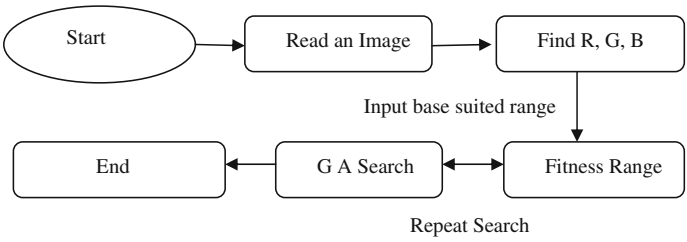


Fig. 3 Proposed methodology for GA

3 Experimental Set up and Results

Here, we intended to show the outcomes of our novel face detection approach by using GA and R, G and B color segmentation. We test our algorithm on MATLAB environment using a local database of images which consists 110 types of different images. First we will see the outcome from R, G and B color range algorithm which we proposed for face detection.

3.1 Input Images

(See Fig. 4).

3.2 Output Given by R, G and B Range Algorithm

By giving input images for first algorithm it seems to be good but not so much efficient because in image 4, 5 and 6 we found some bad result covering less part of skin and more part than face. We achieve good 80 % detection rate by using these projected range algorithm. Using this methodology of range algorithm we achieve good rate in respect of fair person and normal person too & it fails on extra dark person e.g. fourth image. Furthermore we will assign our best suited range for GA as a fitness function and try to treasure some GA operation that can detect faces more accurately. Here rectangle labeling is done on detected part only (Fig. 5).

Fig. 4 Input images

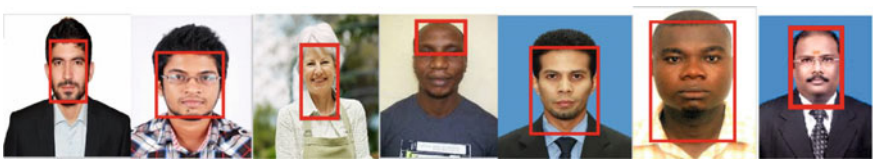


Fig. 5 Output images by skin detection using RGB range

3.3 Results Using Ga with R, G and B Color Range

GA creates a sequence of new population and uses individuals in the current generations to create next population by scoring each member of the current population using their fitness function. Here table shows fitness count for each generation with best and mean fitness count. Table also shows that fitness value is more than generations.

In our case we gave a best suited range to GA as a fitness function and trying to find more accuracy for compare to previous work. In GA we also defined some parameters like number of iterations that we want and a certain range by which GA rings his search with aim of finding best suited number.

Generations	f-count	Best f(x)	Mean f(x)	Stall generations
1	40	9	14.52	0
2	60	9	11.43	1
3	80	9	10.75	2
4	100	9	9.953	3
5	120	9	9.953	4
6	140	9	9	5
7	160	9	9	6
8	180	9	9	7
9	200	9	9	8
10	220	9	9	9
11	240	9	9	10
12	260	9	9	11
13	280	9	9	12
14	300	9	9	13
15	320	9	9	14

3.4 Outcome Given by GA

Here results demonstrate that unlike R, G and B color algorithm here we found good detection rate in less computational time. GA takes best suited range with some user definite values by which it generate its best suited result for a particular image. Results also clearly show the faces of dark person exactly and also for next two images in which our defined range was unable to cover exactly (Fig. 6).

Fig. 6 Output images by proposed range with Genetic algorithm

4 Conclusion

In this manuscript our key objective is to build a complete mechanism for face detection that exists in complex background using RGB color model and Genetic algorithm. Results show that proposed algorithm gives precise outcomes in lesser computational time. Result of this paper also showed that GA can be used in many computer visions where our goal is to produce good solution from many outcomes and for human faces. GA is best which gives good approximation in lesser computational time. Our simulation was implemented on MATLAB. Using proposed work we got 92 % accurate results. In future optimization work can also be presented by using PSO (Particle swarm optimization) which comes from agent oriented prototype and allows greater assortment and assessment over a single population.

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