TEST Engineering & Management
November-December 2019
ISSN: 0193-4120 Page No. 4612 - 4617

A Stipulated boundary exposure Access in Retinal Image using Genetic and Canny Algorithm

Gowri Jayaraman

Dr. GowriJayaraman(Assistant Professor), Department of Software Systems, Sri Krishna Arts and Science College, Coimbatore, Tamilnadu, India.(Email: gowrivgr@yahoo.com)

Article Info
Volume 81
Page Number: 4612 - 4617
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *23 December 2019*

Abstract:

The retinal blood nerve vessel detail suggests many helpful factors in the diagnosis of diseases like retinopathy, drusen and coloboma. Stature Canny Genetic Algorithms mimic the survival of the fittest between individuals over a consecutive generation for solving a challenging problem. This manuscript is proposed as a primer for the Stature Canny Genetic algorithm, which portrays how to paradigm a Genetic Algorithm (GA) and the strands of GA concepts. Genetic Algorithms merge the superior details hidden in a solution, with the good details of another solution, to produce new solutions with good details inherited from both the parents, that outcome unavoidably leading towards optimality. Canny edge detection applies a multi-stage technique to sense a broad range of edges in digital images. The intended approach may be useful, when a vast achievement of boundary exposure is obtainable. This has been fruitfully applied to an extensive range of real-world applications.

Keywords: *Canny edge detection, Edge detection, Genetic clustering, Image segmentation.*

I.INTRODUCTION

The principle of boundary exposure in all its purposes is to drastically condense the quantity of information in an image and it shields the structural possessions to be used in advanced digital image processing. Edge distinguish boundaries and consequently solve the problem of fundamental importance in digital image processing.Since edge detection is for object detection, it is significant to have a good knowledge ofedgedetection algorithms. Presently there are an enormous great number of image edge detection algorithms available, which are more responsive to positive types of edges in an image. The variables included in the option of an edge detection operator are Edge direction, Noise environment, and Edge structure. There are many techniques to build an edge detection operation. The most ordinary technique for edge detection is to compute the differentiation of an image.The first orderderivativesinan image are calculatedusingthegradient,and thesecond order derivativesareidentified using the Laplacian. Another edge detection technique employs Hilbert Transform. The outcome of the canny operator is determined by factors like the width of the Gaussian method applied for smoothing, and the upper and lower thresholds used for tracking. There are lots of edge detectors are available in which user must select a best one. Now a days this concept is used in computer and machine vision.

The Canny technique discovers edge through observation of local maxima in the gradient of the image. The gradient of the image is found using the first order derivative of a Gaussian kernel. This process applies two threshold values, which are used to sense powerful and feeble edges. The process recognizes the feeble edges in the output only if they are connected to powerful edges. In this scheme, there is less possibility of the problem caused by noise, and it provides the additional possibility of sensing true feeble edges. The Canny method relates to two thresholds of the gradient which are far above the ground threshold for short edge sensitivity and near ground threshold for big edge sensitivity. The parameter optimization is made in all aspects of canny algorithms. The main drawback is the calculation of Gradient computation to produce the point of view of the suppression. The major difficulty because of multifarious calculation is time being burnt up. Diabetes constructs flagging of the blood vessels in the body. The minute weak retinal blood vessels are mainly vulnerable. When somebody has diabetes, gradually the blood vessels in the retina turn into thicker and the blood flowing in the blood vessels slows down. Diabetic retinopathy absorbs modified retinal blood vessels that can be the root to bleed or leak fluid, disfiguring vision. Diabetic retinopathy is the mainly familiar cause of visualization loss among people with diabetes and an important reason of blindness with adults. Diabetic retinopathy influences blood vessels in the thin skinned tissue called the retina that lines the back of the eye. The Genetic programming employed to encode a computer program in an artificial chromosome (Fig. 1.) and to estimate its fitness with a high opinion to the predefined function. The DNA molecule is wrapped up into threadlike structures which are known as chromosomes [1]. Each chromosome is composed up of DNA tightly coiled several times around proteins which is known as histones.

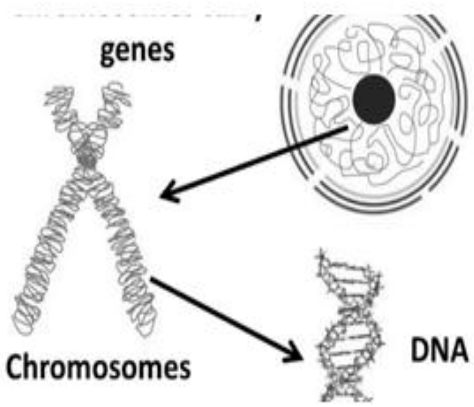

Fig. 1. Chromosome structure

II.RELATED WORKS

Salesh proposed top-hat functions which are applied to find the retinal blood vessels, but the complicatedness of this function is that the pixel values in the output image which is calculated by using the opening function [11]. Prageethet. al. used a Graphical User Interface (GUI) system which is created for the exposure of RNFL fault from the edges of the fundus retinal image inwards. Yanniset. al.proposed a scheme which is innovative in the logic that it handles proficiently links and splits that are joined in angiograms. Nanayakkaraet. al. presented the recent finding of diabetic retinopathy had been done by the diverse machine learning techniques such as Convolution neural network (CNN), artificial neural network (ANN) etc [3]. Aratiet. al. have used the SUSAN edge exposure operator which is to relate a tiny area of neighboring pixels with identical brightness for a center pixel. Sumeetet. al. proposed algorithm which utilizes hierarchical breakdown using Quadtrees and post-filtration of edges using a finite difference operator. Xioalu Zhu et. al. proposed a method to detect straight lines in retinal images that technique has been extended to identify circles and more parameterized geometrical figures [9]. VijayaSaradhiet. al. created a Color normalization which is a noteworthy preprocessing activity for that scheme, since the involvement ofb component to pure white pixels is zero, therefore establishing a strong gradient within the Optic Disc area. HanizaYazidet. al. recommended the Cotton wool spots and exudates which are the central lesions for diabetic retinopathy recognition. The lesions edge extraction is a crucial task in the segmentation process [8]. AmiraSoltaniet. al. presented Laplace operator which offered a remarkably obvious picture, so, the optic nerve's contour is barely sense ability and the form of the optical disk is hardly visible.

III.PROPOSED METHOD (STATURE CANNY GENETIC ALGORITHM- SCGA)

A. Databases

This algorithm is applied to the familiar database DRIVE, which consists of 40 images. All the images collected from 400 diabetic patients in the Netherlands and their ages were above 50 years. Each image in this dataset is 584 X 565 pixel resolutions and in TIF format. The set of 40 retinal images has been split into training and a test set, each consisting of 20 retinal images. For the training retinal images, single person edge detection result is available, whereas for the test retinal images, two persons' edge detection results are available. First one is used as the gold standard, and the other one is used to compare computer-generated edge detection with an autonomous human observer [2]. Another Database STARE encompasses 20 retinal color images which were captured with a TopCon TRV-50 fundus camera at 35° FOV. These retinal images are digitized to 700 × 605 resolutions. STARE database encloses two sets of manual edge detection made by two human observers. CHASE_DB1 database set contains 28 retinal images of JPG type.

B. Preprocessing

The First step of this algorithm is used to enhance the image. Mask processing is applied to the retinal images. In this, a new pixel value is calculated from the pixel values of the original image and its neighborhood. After applying the mask, the output image size is same as the input image size. In this work, sharpening filter is applied, which detected the pixel of high contrast by computing intensity differences in local image regions. The sharpening filter uses the following equation (Eq. 1).

$$\nabla^2 f = [f(x+1, y) + f(x-1, y) + f(x, y-1) - 4 f(x, y)] \quad (1)$$

where, f (x, y) is the input image.

C. Genetic Clustering

Genetic Algorithms (GA) were formerly driven by the Darwinian principle of evolution over and done with genetic [5]. A Genetic Algorithm applies a highly theoretical form of development processes to go forward to get answers to specific problems. Further, all Genetic Algorithms functions on a population of artificial chromosomes. Genetic Algorithms were first proposed and brought forward by a person called John Holland [4]. He found high-quality solutions to a problem that we're working towards the obstinate. Holland's Schema Theorem and the linked building block Theorem offer an abstract and academic basis for the intention of efficient Genetic Algorithms. According to that effective population, two-point crossover and Centre Inverse Mutation are carried out in this algorithm. GA is constructed as follows (Eq. 2):

$$m(H,t+1) \geq m(H,t)(f(H))/favg[1-pc \quad (\delta(H))/(l-1) \quad - O(H)pm] \quad (2)$$

where t is the generation, m (H, t+1) and m (H, t) are schemata number H,f(H) is the average aptitude value of the string,favg is the total population's average aptitude value, l is the total string length, δ(H) is the schemata length, O(H)

November-December 2019
ISSN: 0193-4120 Page No. 4612 - 4617

is the schemata order, pc and pm are the probability of crossover and mutation respectively [10]. In SCGA, the crossover operator is one that merges two chromosomes to fabricate a fresh chromosome. The plan behind the crossover is that the fresh chromosome is enhanced more than both of the parents if it includes the unique factor of each of the parents [6]. The crossover happens during development, based on a user's describable crossover probability. Two-point crossover approach is seemed to be an optimal in this application (Fig. 2).

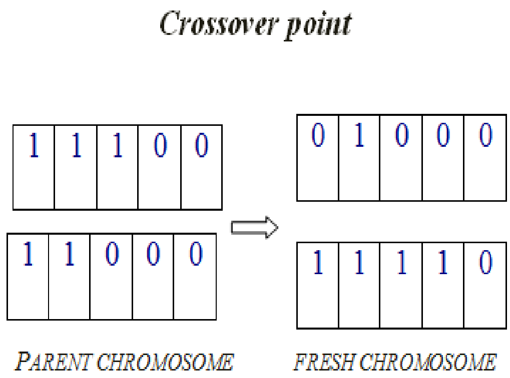

Fig. 2. Two-point crossover approach

The mutation operator has the responsibility of recovering the misplaced genetic resources as well as for haphazardly distressing genetic details [7]. The mutation operator is observed as a backdrop operator to preserve a genetic multiplicity in the population. In SCGA, the Centre Inverse Mutation (CIM) is the main process in the mutation operator which is shown below (Fig. 3.):

Fig. 3. Centre Inverse Mutation

Finally, as a result, this field rises rapidly and the procedure has been fruitfully applied to an extensive choice of realistic troubles in image analysis, data mining and pattern matching (Fig. 4). Composite dispatching Rules (CDR) apply to chromosome representation.

Genetic Algorithm Steps:

Choose the initial population with important factors
Calculate the fitness of every individual in the population
Do
Choose best-position individuals to reproduce
Strain new generation through two-point crossover pc and mutation p_m and give birthto offspring
Estimate the individual fitnesses of the offspring
Swap bad ranked part of the population with offspring
Until the terminating condition reached.

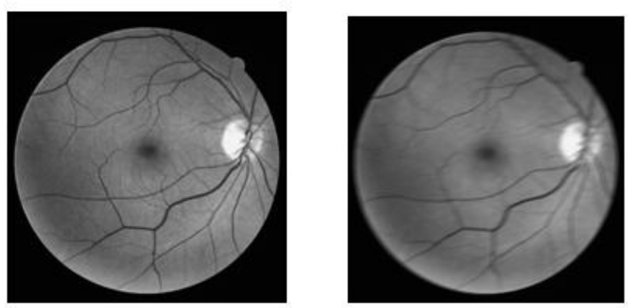

Fig. 4 (Retina). Preprocessed image Clustered image

D. Canny Operator with σ

Edge begins with the small sensitivity outcome and then rises to comprise connected edge pixels from the high compassion outcome, which supports the filling up of holes in the sensed edges. It is the best edge detection method as it offers better detection, understandable response, and good localization. It is generally employed in current image processing methods with additional improvements (Fig. 5).

Algorithm steps:

- Blurring the image to take away the noise.
- The edges have been spotted where the gradients of the image have great magnitudes.
- The magnitude of the gradient is |G|=|Gx|+|Gy|
- Only local maxima are hit as edges.
- Potential edges are resolute by a threshold.Theta = invtan (Gy / Gx)

The canny edge detector is created by using a first order derivative of the Gaussian function. This Gaussian function applies a circular symmetry operation and the canny operator exploits symmetry on edge and, in particular, dissymmetry on vertical edge direction (Eq. 3).The two-dimensional Gaussian function is

$$G(x, y) = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{x^2+y^2}{2\sigma^2}\right) \qquad (3)$$

In this formula, σ is a distribution factor of Gaussian function, x and y are pixel values. The canny edge detection results in a rate for the first derivative in both the horizontal and the vertical directions (Eq. 4).

$$G = \sqrt{Gx^2 + \mathrm{Gy}^2} \qquad (4)$$

In this equation, Gx is the first derivative in the horizontal direction and Gy is the first derivative in the vertical direction. There are certain restrictions in canny methods which are: - the Gaussian smoothing operation blurs the edges out, making those edges harder to detect, and the corner pixels look in the wrong direction if the nearer pixels leave unwrapped ended edges and misplaced connections. Various canny edge detection algorithms are available, but the basic and built-in Matlab canny edge detection algorithm has been used. This function changes the intensity value rapidly and also has two criteria which point to the first derivative of the intensity being superior in magnitude and also point to the second derivative of the intensity being a zero intersection.

November-December 2019
ISSN: 0193-4120 Page No. 4612 - 4617

Using Sobel operator itself, anyone can derive the canny operator and its resultant value. In research, most of the researchers use the canny operator to derive their expected result. To identify sudden edges, depth discontinuity, surface color discontinuity and illumination discontinuity in the digital image canny edge detection operator is used. Rapid changes in the digital image are collected as edges. This is verified if the pixel point is a local maximum in the gradient direction, choosing only one maximum across the width of the edge, and needing the scrutiny of interpolated pixels. Gaussian, gradient, suppression, linking and thresholding are the key factors in the canny edge detection algorithm. Also, it is very important for the process of segmentation.

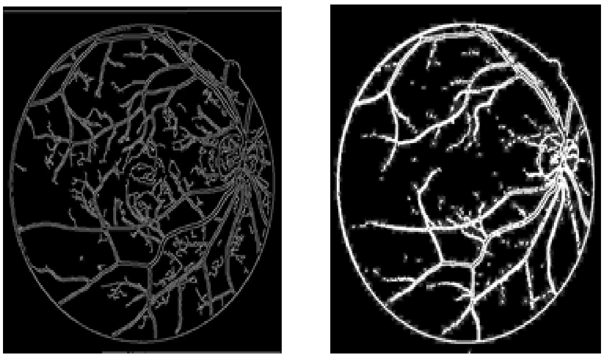

Fig. 5.(Retina). Without ClusteringWith Clustering

E. Post processing

In this step, Wiener filter is used to reduce the amount of noise in a binary image which is received from the previous step. The main aim of this step is to remove noise in the retinal blood vessel image. The equation used here is.

$$b(n1,n2)= \mu+ \frac{\sigma^2-v^2}{\sigma^2} (a(n1,n2) - \mu) \qquad (5)$$

where a and b are the current pixel and new pixel value,μ is the local mean, σ is the local variance and v is the noise variance. The above equation (Eq. 5) is applied iteratively to get a desired result. After applying wiener filter to the above resultant Genetic clustered image, the overall outcome is shown here (Fig. 6.).

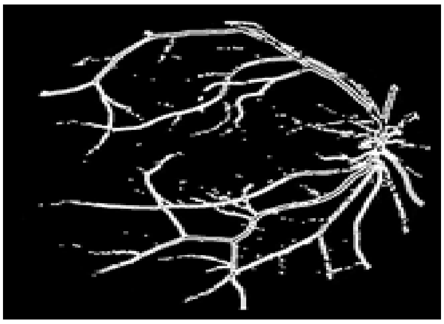

Fig. 6.(Retina). Post processed image

IV.EXPERIMENT AND RESULTS

In this article different edge detection methods were considered and estimated. Among all, the best are listed and tabulated below. İt has noticed that canny edge detector offers better result as judged against others like Sobel, Prewitt, LOG detector with a few positive points. The visual impact of the invention gave a positive outlook about the proposed system (Fig. 7). Huge efforts were taken to develop this upshot in a well-organized manner. Initial settings made in the genetic process were: maximum generation value as 150, population size as 10, chromosome as 8, crossover rate as 0.6 and mutation rate as 0.3. When the generation reached 100, the crossover value was reset to 0.3 and mutation rate value was reset to 0.2.

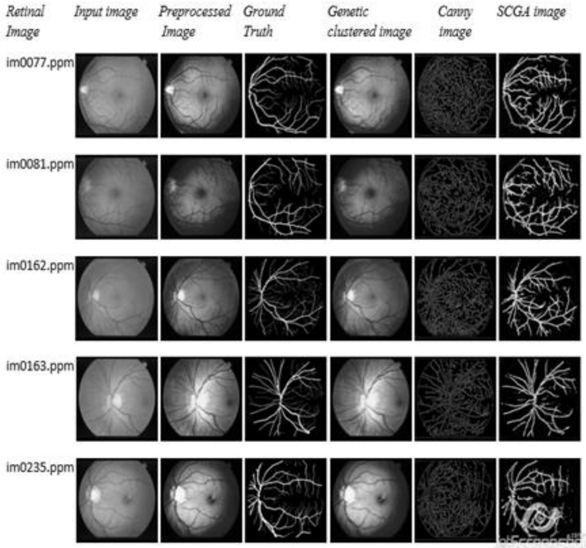

Fig. 7. SCGA results in STARE Database

As many possible images with various edge information and regions were tested using proposed Stature Canny Genetic Algorithm, and the output images were observed with correct edge information and regions. Good results were obtained when the intensity values of the histogram were evenly distributed (Fig. 8). The fitness function to estimate each possible clarification is based on three principles: - increase in the quantity of edge pixels located appropriately in the image, decrease in the number of small regions, and the quantity of endpoint edge pixels in the image. In the table below, it is noticed that the fitness values increased during iteration and finally reached the saturation point (Table 1).

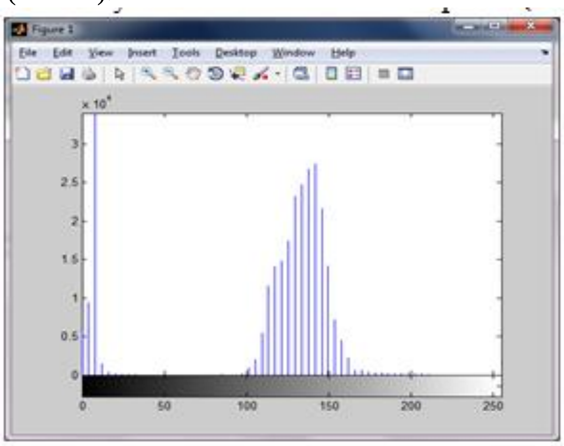

Fig. 8. Histogram for 16_test.tif

November-December 2019
ISSN: 0193-4120 Page No. 4612 - 4617

Table 1. Proposed Algorithm Fitness Result

Image	Fitness value variation in every Generation				
16_test	115204609.52	115974330.11	116221608.17	116319558.22	116344260.56
11_test	60952373.81	61483345.63	61600222.85	61600222.85	61600222.85
04_test	47844257.32	47877726.61	48173875.20	48648262.05	48664576.00
18_test	45877181.43	47392749.64	47444931.50	47472898.09	47472898.09
33_test	119378856.97	119979611.49	120245781.58	120693647.94	120749927.80

All edge detection operation finally, concludes using precision and recall value. There are various segmentation datasets available. Usually, this chromosome must take the values between -1 to +1. The collection of 100 test images in Retinal Database has a lot of color intensity value and dramatically changing edge factor. To the maximum, all the images are taken and construct the following results in a successful manner. The true results are divided into True positives and True negatives among a total number of pixels examined. The false results are inversely proportionate to true results. The Recall is the proportion of the number of related pixels recovered to the total number of related information in the ground truth image (Eq. 6). Recall also known as a true positive rate or Sensitivity. The true positive gives the properly sensed retinal blood vessels; true negative gives the incorrectly sensed retinal blood vessels [12]. False positive gives the properly sensed retinal non-blood vessel points, whereas false negative gives incorrectly sensed retinal non-blood vessel points.

Recall=(True positive)/(True positive+False negative)(6)

The False positive Rate (FPR) is the proportion of the number of unrelated pixels recovered to the total number of related information in the ground truth image (Eq. 7). False positive Rate also known as fall-out.

FPR= (False positive)/(False positive+True negative)(7)

The Accuracy is the proposition of sum of true positive and true negative to the total sum of true positive, false negative, true negative and false positive [13].

The Specificity is calculated by subtracting the false positive rate from the value one. Specificity is also called the true negative rate (Eq. 8).

Specificity = 1- FPR (8)

The value of Recall must be high in enhanced retinal blood vessel detection results. The results of the experiment conducted are shown below (Table 2, 3).

Table 2.Performance in 40 DRIVE retinal images for the proposed method

Routine	Recall	FPR	Accuracy
Proposed	0.7981	0.0373	94.608
Genetic+ Canny with σ	0.7224	0.0345	94.312
Genetic+ Canny	0.713	0.0373	94.17
Canny	0.672	0.0291	93.01
Sobel	0.434	0.0176	89.3

Table 3.Performance in 20 STARE retinal images for the proposed method

Routine	Recall	FPR	Accuracy
Proposed	0.7814	0.0386	94.46
Genetic+Canny with σ	0.772	0.0356	93.05
Genetic + Canny	0.761	0.0343	92.89
Canny	0.698	0.0295	92.01
Sobel	0.513	0.027	91.4

Recall, Specificity and Accuracy graphical representations are shown below (Fig. 9, 10). This shows the comparison result of five various algorithms. The proposed algorithm is nearer to human edge representation. CHASE_DB1 database graphical representations are present in Fig. 11.

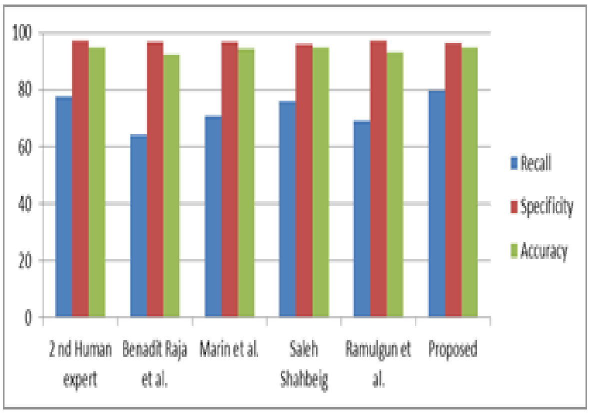

Fig. 9. Comparison with various Algorithms on DRIVE

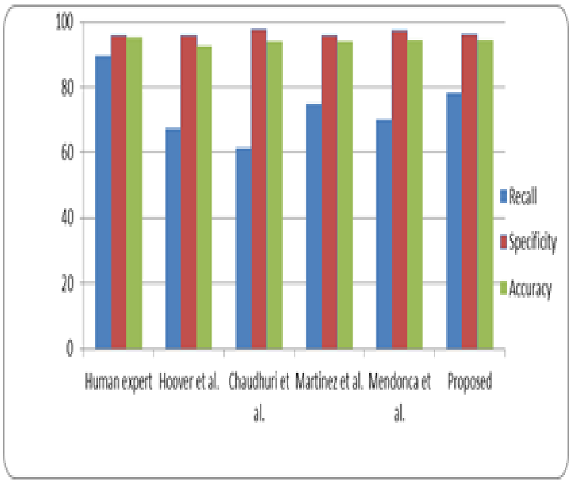

Fig. 10. Comparison with various Algorithms on STARE

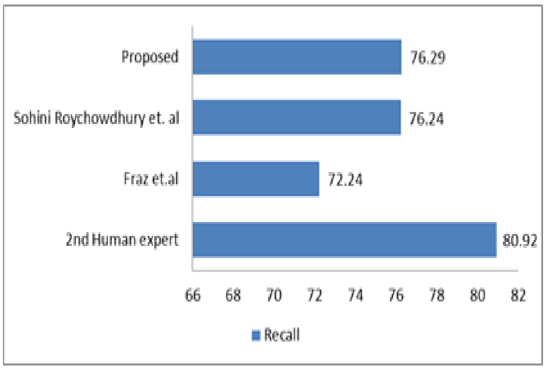

Fig. 11. Recall on CHASE_DB1

V. CONCLUSION

In this work projected a very straightforward and small but a very well-organized, a Stature Canny Genetic algorithm which imparts the knowledge of artificial intelligence and digital image processing. The displayed outcome has shown the exactness of the edge detection using Genetic and a canny algorithm when compared to the other techniques. It is considered an optimal edge detection method, as a lot of work and improvement of this Genetic algorithm have taken place. Also here this algorithm achieves an F-measure value on BSDS300 of 0.65. For DRIVE dataset, this algorithm achieves 96.68% accuracy.For STARE dataset, this algorithm achieves 96.46% accuracy. For CHASE_DB1 dataset, this algorithm achieves Recall, specificity and accuracy values as76.29 %, 97.03 % and 94.1 % respectively. Recall and specificity values are improved compare to all other algorithms. More improvements are possible in the canny algorithm so as to sense edges in the color image without changing to a gray image. The enhanced canny algorithm can also be used for repeated extraction of moving an object.

The routine of the canny algorithm deals mostly with varying constraints. The varying constraints are the standard deviation for the Gaussian filter and their threshold values. Also, the dimension of the Gaussian filter is prescribed by the larger value and the bigger size. In particular, the bigger size constructs more noise that is essential for images which are affected by noise.

REFERENCES

1. Alander J T. An Indexed Bibliography of Genetic Algorithms in Pattern Recognition. Report 94-1-PATTERN University of Vaasa 2001.
2. Bandyopadhyay S, Maulik U, Mukhopadhyay A. “Multiobjective Genetic Clustering for Pixel Classification in Remote Sensing Imagery”, IEEE Transactions on Geoscience and Remote Sensing, Vol. 45, Issue 5, pp. 1506 - 1511, DOI: 10.1109/TGRS.2007.892604, 2007.
3. Changbin Yin, Huihui Li, Shanshan Li, LidongXu. Genetic dissection on rice grain shape by the two-dimensional image analysis. Theoretical and Applied Genetics, DOI: 10.1007/s00122-015-2560-7,2015.
4. Fu W, Johnston M, Zhang M. Genetic programming for edge detection based on the accuracy of eachtraining image. Proc 24th Aust Joint ConfArtifIntell 2011; 301–310.
5. Harith Al-Sahaf, Mengjie Zhang, Mark Johnston. “Binary Image Classification: A Genetic Programming Approach to the Problem of Limited Training Instances” , Evolutionary Computation, Vol.24, Issue 1, pp. 143 – 182, DOI: 10.1162/EVCO_a_00146, 2016.
6. Jinxia Yu, ZixingCai, ZhuohuaDuan. “Improved method for the feature extraction of laser scanner using genetic clustering”, Journal of Systems Engineering and Electronics, Vol. 19, Issue. 2, pp. 280 - 285, DOI: 10.1016/S1004-4132(08)60079-1, 2008.
7. John McCall. “Genetic algorithms for modelling and optimization”, Journal of Computational and Applied Mathematics, Vol. 184, pp. 205–222, 2005.
8. Krawiec K. Genetic programming basedconstructionoffeaturesformachine learning and knowledge discovery tasks. Genetic Program Evol Mach 2002;3: no. 4, 329–343.
9. Lakshmi S, Sankaranarayanan V. A study of Edge Detection Techniquesfor SegmentationComputingApproaches.IJCASpecialIssueonComputerAidedSoft Computing Techniques for Imaging and Biomedical Applications, CASCT 2010; 35-40.
10. NeshatianK, and Zhang M. Unsupervised elimination of redundant features using genetic programming. Proc 22nd Aust Joint ConfArtifIntell 2009; 432–442.
11. SalehShahbeig. “Automatic and quick blood vessels extraction algorithm in retinal images”, IET Image Processing, Vol. 7, Issue 4, pp. 392–400, 2013.
12. Verma A, Archana. A Survey on Image Contrast Enhancement Using Genetic Algorithm. International Journal of Scientific and Research Publications 2012; 2: no. 7, 2-6.
13. Zhong Q, Zhou P, Yao Q, Mao K. A novel segmentation algorithm for clustered slender-particle. Comput Electron Agric 2009;69:118–127.