Iraqi Journal of Statistical Science (17) 2010
The Second Scientific Conference of Mathematics-Statistics& Information
pp [91-108]

Civil Components Recognition Based on Proposed Hybrid Technique

Nidhal H.Al-Assady* **Khalil I.Al-Saif**** **Fawziya M.Ramo*****

ABSTRACT

The straight lines exist richly in civil objects which are usually man made like buildings, read,…ect. Depending on this fact search strategy was constructed. New method has been used to detecte straight line, it is Baron's Method (BM), after using and checking the results we adopted the (BM) method in this search. Some development are performed on the (BM) method and we called it Developed Baron method (DBM). Hybrid has been done between (DBM) and genetic algorithm (GA) to get efficient results (execution and precision), this method is being called Genetic Developed Baron Method(GDBM).The two methods have been applied. The accuracy and execution time for each method is calculated. The experiments show that the proposed hybrid method in this search is relatively fast and it achieves high performance, it produces (90%) recognition rate.

الملخص

ان الخطوط المستقيمة تتوافر بكثرة في المكونات المدنية التي تكون عادة من صنع الانسان مثل الابنية والطرق ... الخ وبالاعتماد على هذه الحقيقة تم بناء ستراتيجية البحث.تم استخدام طريقة جديدة لاكتشاف الخط المستقيم وهي طريقة Baron's Method (BM) وبعد اختبار النتائج تم اعتماد طريقة (BM) في البحث. بعض التطويرات تم اجراؤها على الطريقة وتمت تسميتها Developed Baron Method (DBM) . ثم تم اجراء تهجين بين (DBM) والخوارزمية الجينية (GA) للحصول على افضل النتائج من حيث التنفيذ والدقة واطلق على هذه الطريقة Genetic Developed Baron Method (GDBM) تم تطبيق الطريقتين وحساب الدقة ووقت التنفيذ لكل طريقة ومقارنة النتائج ومناقشتها واظهرت النتائج ان سرعة الطريقة الهجينية المقترحة في هذا البحث مقبولة وتحقق اداء عاليا واعطت نسبة تمييز للصور تصل الى 90 %.

1- Introduction

recognition of civil objects in natural-scene images entails three related components: (1) localization, (2) detection and finally, (3) recognition of objects. A number of factors contribute to the difficulty of this problem including variations in camera quality and position, wide-ranging illumination conditions, and extreme scene diversity, civil objects (including building, road,

*Prof./ College of computers & Mathematics Science
**Assistant Prof. ./ College of computers & Mathematics Science
***Lecture/ College of computers & Mathematics Science
Received:1/7 /2009 Accepted: 6 /12 / 2009

bridge, etc.) are characterized primarily by geometric regularities, and that artificial structures are rigid[6].

The object features of interest include the geometric properties, histogram features, and color features, after extracting the features of interest, could analyze the image, features extraction is part of the data reduction process and is followed by feature analysis. One of the important aspects of feature analysis is to determine exactly which features are important [8].

S.Noronha and R.Nevatia have proposed an approach of describing a system that detects and constructs 3-D models for rectilinear buildings with either flat or symmetric gable roofs from multiple aerial images. The perceptual grouping process used to generate the hypotheses is a hierarchical one: line pairs are grouped to form parallels or L- junctions which are then used to form U-shapes which are finally used to generate rectangular roof components the features are matched at each level in the hierarchy [5].

Miguel Angel and Domenec Puig have proposed a pixel-based texture classifier based on the integration of multiple textures feature extraction methods. Experimental results with natural textured images show that this technique produces better quantitative and qualitative results than traditional techniques based on the utilization of specific families of texture methods [3].

"The Optimization of Edge and Line detections for forest image analysis", was suggested by Zhiling Long and Joseph Picone to design an objective metric to evaluate the performance of edge and line detectors and then optimized the performance of our image analysis system using this metric. Our best system resulted in an error rate of 29%, and hand an acceptable insertion rate [10].

2 - Image Texture

There is no strict definition of the image texture, it is easily perceived by humans, and it believed to be a rich source of visual information –about the nature and three-dimensional shape of physical objects [1].

Texture often refers to homogenous patterns or spatial arrangements of pixels that regional intensity or color alone does not sufficiently describe. Texture describes the content of many real-world images, such as fabrics, clouds, trees, bricks, etc [9]. There are three main categories of utilization of texture analysis. These are: texture segmentation, texture classification, texture synthesis. A brief description of these different utilizations is given below [2]:

A. Texture Segmentation

The problem of trying to find different textures in one image. This is a difficult problem because one usually does not know how many different textures there are in an image, and what kind of textures, etc. But this knowledge is not necessary if there is a way to tell two textures are different.

B. Texture Classification

Texture Classification involves deciding in which texture category a given texture belongs. In order to do this, the different texture categories need to

be known; e.g., rock, grass, fabric, and clouds. Pattern recognition classifiers techniques can be used to classify the textures.

C. Texture Synthesis

the problem of synthesizing a new texture, from a given texture, that, when perceived by a human observer, appears to be generated by the same underlying stochastic process. Image synthesis can, for example, be used for image de-noising and image compression.

3- Line Detection

The edge and line detection operators presented here present the various types of operators in use today. Many are implemented with convolution masks, and most are based on discrete approximations to differential operators. Differential operations measure the rate of change in a function, in this case, the image brightness function. A large change in image brightness over a short spatial distance indicates the presence of an edge. Some edge detection operators return orientation information (information about the direction of the edge), whereas others only return information about the existence of an edge at each point [8].

Edge detection methods are used as a first step in the line detection process. Edge detection is also used to find complex object boundaries by marking potential edge points corresponding to places in an image where rapid changes in brightness occur. After these edge points have been marked, they can be merged to form lines and object outlines [8].

4- Artificial Intelligence (AI)

Artificial Intelligence (AI) is exciting new effort to make computers think. Machines with minds, in the full and literal sense [7].

The fact that many artificial intelligence methods are derived from processes within nature or within human thinking makes them, in some way, familiar to persons applying them on their tasks. Artificial intelligence techniques that deal with the unknown or unpredictable consist of neural network, expert system and genetic algorithms.

Genetic algorithms try to make our understanding of evolutionary processes available to computational problems. They enable a system to be-self-optimizing [4]. Genetic algorithms are general-purpose search algorithms based upon the principles of evolution observed in nature. Genetic algorithms combine selection, crossover, and mutation operators with the goal of finding the best solution to a problem. Genetic algorithms search for this optimal solution until a specified termination criterion is met.

The solution to a problem is called a chromosome. A chromosome is made up of a collection of genes which are simply the parameters to be optimized. A genetic algorithm creates an initial population (a collection of chromosomes), evaluates this population, and then evolves the population through multiple generations in the search for a good solution for the problem at hand.

5- The Proposed System for Civil Objects Recognition (COR)

A hybrid algorithm has been proposed in this search in order to extract the characteristics of some areas in a digital image. This algorithm involved the ability to find out some of the sites that are of civil nature (buildings, bridges, roads.. etc.) Previous studies have shown that these parts are rich of straight lines. Accordingly the proposed algorithm depend on segmenting the image into multiple slices since each slice represents one texture of that image and then those textures that contain high amount of straight lines are looked for. Both traditional and new algorithms have been used in order to find out the straight lines inside the image. Some of these methods were in direction of the genetic algorithm which have been recently used in solving complicated scientific problems.

We first describe the broad structure of the proposed (COR) system, Figure (1) shows the main components of the system and the process flow among them.

A pre-processor needed in order to prepare the color image for texture analysis stage this operation includes convert color image to gray level image and normalize image's dimensions by (300×300). The second step is the analysis of image texture based on fractal dimension. The third step is image segmentation depending on its texture's The fourth step feature extraction is represented by straight line detection. This feature has been depended to recognize civil object and finally display image's results.

5.1 Texture Analysis Stage

In this stage, analyzing image texture has been performed by calculating fractal dimension for each pixel by using 2D Variation Method that explains in the following steps :

1- Specifying window with [r,r] dimension with initial value r=3
2- Applying the flying window method (the movement of window on each pixel) to calculate the FD for each pixel.
3- Calculating N(r) which represent the difference between maximum and minimum values of gray level of the current window.
4- Calculating sumN (represents summation of log N (r)).
5- Calculating sumr (represents summation of log (1/r)) .
6- Increasing the size of the window by 2 for each directions (row and column).
7- Repeat steps from 2 to 6 until r=17, where r increases as [3,5,7.., 17]
8- Using the equation (1) to calculate the fractal dimension for each pixel :-

$$S=\frac{SumN}{Sumr}=\frac{\sum \log N(r)}{\sum \log(1/r)} \quad \text{.....(1)}$$

S: Fractal Dimension

As a final result, two dimension matrix has been obtained (its dimension equal image's dimensions), and its value represents fractal dimension for each pixel.

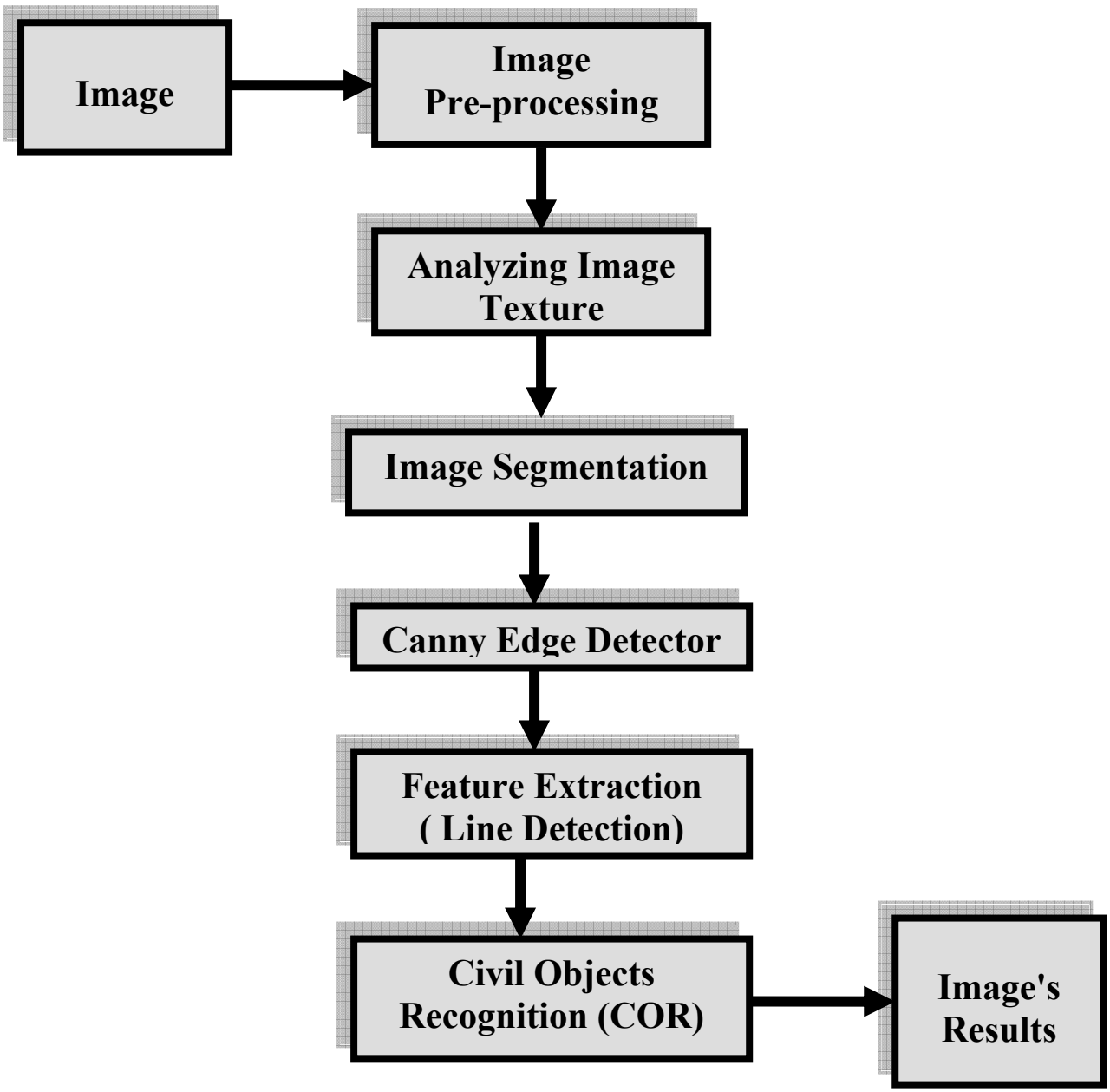


Figure (1):The Proposed Method for Civil Objects Recognition (COR)

5.2 Segmentation Stage

Segmentation of texture's image is necessary in this stage to separate the image to a number of textures. The Region Growing method, the area increases gradually whenever a pixel similar to a seed value is found out. The threshold value which has been decided according to the ratio of similarity is two degrees after the comma.

This texture (slices) has been combined in three dimension matrix as show in figure (4), the value of matrix represents the value of the fractal dimension (texture value) as counted in [3], the first and second dimension represent the image's dimension and the third dimension represents the number of the texture available at the original image. A number of slices is built up at this step (as each slice represents one of the image's textures) which represents the group of the image pixels that possess the symmetric values of the fractal dimension. An accredited value of zero as a background for these textures get a better texture explanation which can be clearly seen in figure(4).

5.3 Feature Extraction

Mathematical features extraction has been adopted to detect straight line in a slice in order to recognize Finding civil objects (civil object has many of straight lines). As pre-processing to slice, the edges of the texture's were being detected to facilitate the process of detecting the straight lines in a texture without getting into the details of the texture itself. The newest method (rarely used) has been applied which is represented by Baron's development method (DBM), and the second method is intelligent method using genetic algorithm (GA).

5.3.1 Baron's Method (BM)

Baron's Method is one of the newest straight line detection method, it supposes that there are straight lines in each place in search space. The correspondence between image's pixels and fanciful line's pixel (in polar space) has been calculated. If the correspondence is high that indicated to find Straight line in location (p,θ) and the converting to Cartesian and found (x,y) that equivalents (P, θ) in polar space [11]. This method has a good property, represented by accuracy of the straight lines number and the accuracy to find locations of these lines. At the same time it is suffering from a number of weak points. We can specify them as follows :

1. The method hasn't any ability to detect vertical straight line in search space.
2. The line detected in this method consists of a number of pixels which are more than correct number of pixels that make actual line.

5.3.2 Developed Baron Method (DBM)

Some development and modification has been performed to the previous method to process a weak point and obtained better results and more accuracy; I

called it Developed Baron method (DBM), which consists of the following steps:-

1-The value of P and θ would be specified as :

$$0 \le p \le (lx^2 + ly^2)^{\frac{1}{2}} \quad , \quad -\pi \le \theta \le +\pi$$

lx, ly : represent matrix dimensions

2- Calculate the function based on equation (2) :

$$Z(P, \theta) = \sum_{i=1}^{n} \frac{1}{(1+di)} \rightarrow \max_{p,\theta} \quad \ldots\ldots(2)$$

Where

n : represents number of white pixels.
p : represents the P.
θ : represents the θ .
di : Eclides distance .

2-1 Find p_o value wherever :

2-1-1 IF $\theta = -\pi$ ***, or*** $\theta = 0$ ***, or*** $\theta = +\pi$

Then $x_o = p, \quad y_o = y_i$

Else

2-1-2 If $\theta = \pi/2$ ***then*** $x_o = xi, \quad y_o = y_i$

Otherwise

$$x_o = x_i \sin^2\theta - y_i \sin\theta\cos\theta + p\cos\theta \quad \ldots\ldots\ldots 3$$

$$y_o = y_i \cos^2\theta - x_i \sin\theta\cos\theta - p\frac{\cos^2\theta}{\sin\theta} + \frac{p}{\sin\theta} \ldots\ldots\ldots 4$$

2-2 $di = \sqrt{(x_i - x_o)^2 + (y_i - y_o)^2}$, $d_i = p_i - p_o$ ……5

where :

p_i : is the position vector of actual line.
p_o : is the position vector of fanciful line.

2-3 check if $d_i = 0$ or $acc \le 1/(1+d_i) \le 1$ (acc is accuracy rate)
then newsum= oldsum + $1/(1+d_i)$

2-4 Repeat steps (from step ***2-1***) for all θ values and find maximum value of function .

3- Repeat steps (from step ***2-1***) for all P values.

The additional steps that develop the Baron Method are :

1- The step (2-1-2) gives the ability of detecting vertical straight line ,by checking θ value ($\theta = \pi/2$) and find values of x_o, y_o (location of vertical line)
2- The step (2-3) gives the ability of obtaining a better corresponding rate (between actual line and fanciful line) by checking (di) value ,when di=0, this means that prefect corresponding has been done for pixel

otherwise ,when di≠0 the corresponding has been checked if it is around the specific user value this means that correspondence has been done, otherwise pixel will be ignored .

5.3.3 Genetic Developed Baron Method (GDBM)

The Developed Baron method offers relatively accurate numbers of lines after having a suitable decision on the ratio of the symmetric pixels and this depends on the trial and error procedure being used. Notice that the execution of this method takes time. In order to get more efficient execution the GA has been used since the genetic algorithm is considered as one of the means for achieving optimal output for finding out the optimal solution or the nearest to the optimal as well as the ability to deal with research of huge and complicated area.

According to what have been mentioned above we arrived at a solution where we can hybridize the DBM with GA and because this method offers relatively good and accurate results as well as the objective function enables us to use it in the genetic algorithm. The following are the steps that specify the genetic algorithm elements used with the GDBM method and the Figure (2) shows a flowchart..

1- Creating Initial Population

The population consists of a number of individuals detected by the algorithm designer and according to the nature of the problem. In this work population has been detected by 50 individuals. (chromosome). The chromosome consists of a number of values (genes) whose numbers (length of the chromosome) are detected according to the problem. The chromosome, in this work, has been represented by the following Figure:

Chromosome :

P	θ

The figure of the chromosome in this work consists of two genes(P gene , θ gene), where the range of P gene is between (0-142) and the range of θ gene is between (0-180) degree .

2- Encode

The chromosome which explained in the previous step represented by a binary encode. Each gene takes 9 bit to accommodate a maximum value for P and θ (the maximum value of θ=180 and the maximum value of P =142).

3-Evaluation of the Chromosome

In the genetic algorithm the chromosome is evaluated by the fitness value in order to check the kind of the solution, therefore, each chromosome (which is born in an initial population or through the antecedent generations) has a fitness value related to the objective function .In this work, individual is evaluated by the number of the pixels. Individual with high pixels will get high

corresponding, whenever the number of pixels increases we will get the best result ,which means that the objective function is a maximum function and thus the fitness is equal to the objective function as follows:-

$$\text{Fitness value} = \text{objective value} = Z(P, \theta) = \sum_{i=1}^{n} \frac{1}{(1+di)} \quad \rightarrow \max_{p,\theta} \quad \ldots\ldots (6)$$

fitness degree depending on threshold is specified by a user. This value is different from one image to another. The principle of trial and error is being used to detect this value until we arrive at the best decisions.

4- Selection

The Elitism method has been used to select a number of the current population individuals to represent the parents of antecedent generation. The selection from the individuals to represents the parents is depend on the value of the fitness function for every individual. In this work a number of good chromosome has been copied to antecedent generation, the number has been specified by five chromosomes (best chromosome has been copied to antecedent). The rest of the parent are selected by the Roulette Wheel Selection method.

5- Crossover

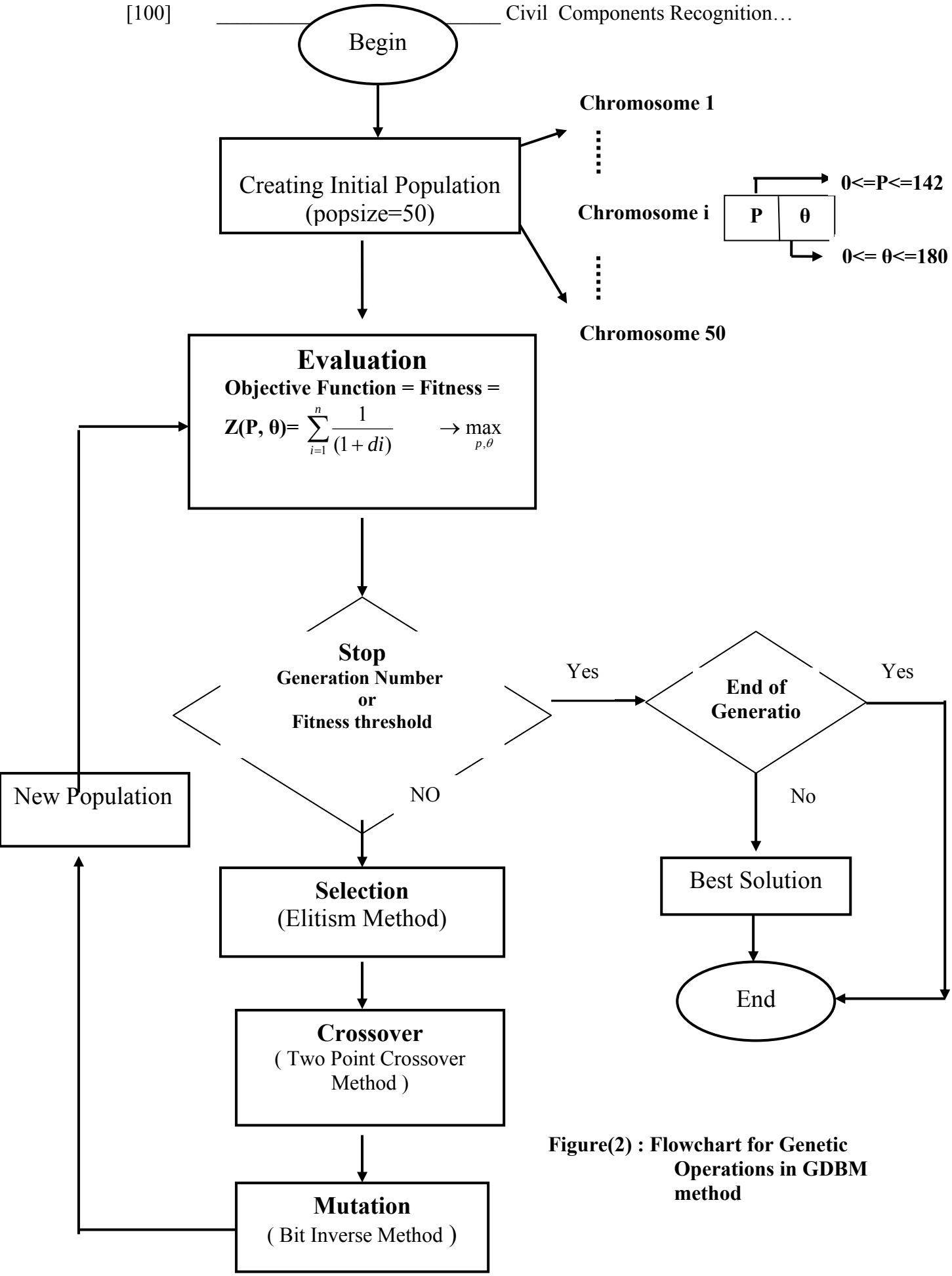
Crossover between parent has been done to produce a new generation that represents the beginning of antecedent genetic cycle. Two-point crossover has been used to suitable chromosomes length ,the two point position are located randomly and the crossover ratio was decided to be (0.9) .

6-Mutation

Mutation has been applied to get a chromosome that possesses new characteristics which have not been formed before from the previous generation, in order to extend the possible soloution area. The flip bit mutation method has been used, the mutation ratio was decided to be (0.3).

7-Stop Criterion

The stop criterion in the GA decides whether the algorithm continues researching or stop. The stop criterion is depend on two approaches: generations number and fitness threshold. Each fitness value for chromosome is compared with a fitness threshold and according to the result of comparison the number of the straight lines in the image is specified, when specific number of straight lines are detected, stop the algorithm.



Figure(2) : Flowchart for Genetic Operations in GDBM method

5.3 Algorithm Evaluation

To evaluate the proposed algorithm the average precision is calculated using the following equations:

$$\text{average precision} = \frac{\sum_{i=1}^{n} precision_i}{n} \quad \text{, number of slices that contain lines} \qquad \ldots\ldots\ldots \textbf{(7)}$$

$$precision_i = \frac{(Detected\_lines)_i}{Slice_i\_lines} \quad , \quad 1 \le i \le n \qquad \textbf{.....} \quad \textbf{(8)}$$

The equation (8) calculates slice's accuracy that contains straight lines, the term ($slice_i$ _lines) represents the actual number of straight line existence in slice i, while the term (detected_lines) represents the number of detected straight lines in slice i ,and n represents a number of slices that contain straight lines.

The equation (7) calculates slice's accuracy average of image by dividing the summation of accuracy rate for all slices on slices number.

6.3.2 Line Detection Methods

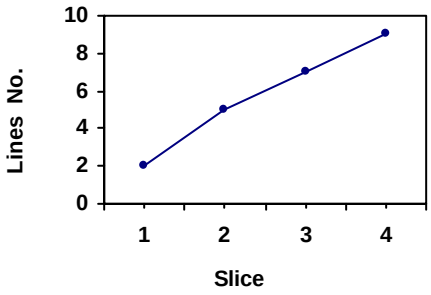
The line detection based on (DBM,GDBM) is carried out for the same sample (the slices are obtained from previous step). A threshold of (50 pixels) for the pixels number is used to indicate a straight line. Table(1) shows the obtained results for slices 6,7,8,and 9.

Table (1) : Line Detection methods results

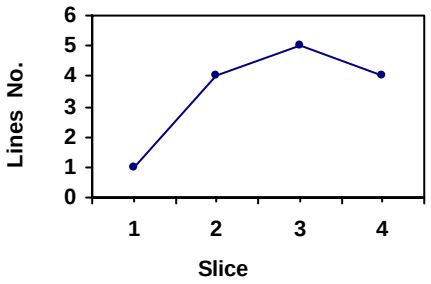
Slice No.	Methods	Detected Lines No.
Slice 6	DBM	2
	GDBM	1
	Actual Line No.	1
Slice 7	DBM	5
	GDBM	4
	Actual Line No.	3
Slice 8	DBM	7
	GDBM	5
	Actual Line No.	5
Slice 9	DBM	7
	GDBM	4
	Actual Line No.	5

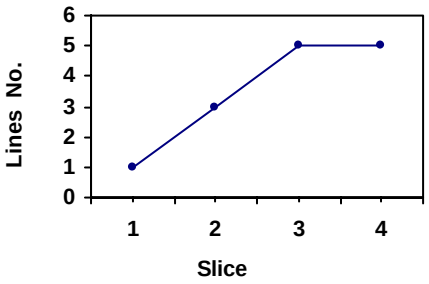
It is clear from the Table(1), that the two methods are association by detected lines in the same slices. The table also shows that the number of straight lines that are detected using (DBM,GDBM) methods are closed to actual lines number.

The comparison between DBM,GDBM and actual lines number is shown in Figure (3) graphs a,b,c respectively, we notice that a graph b is a little bit closed to graph c and it could be considered the optimal result.



a) Result of perform DBM





(b) Result of perform GDBM **(c) Actual lines No. for each slice**

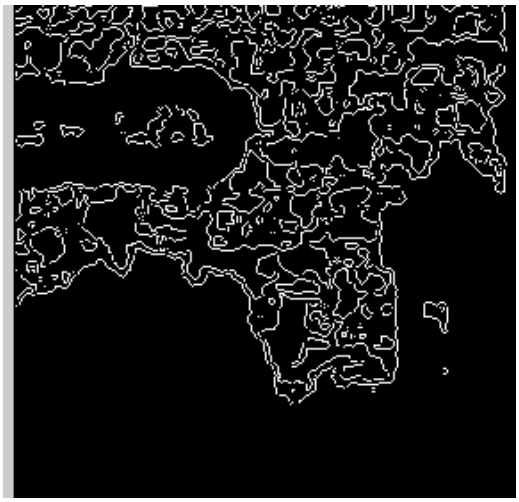
Figure (3) : Results of DBM, and GDBM & Actual lines No. for each slice for image1

6-4 Evaluation Execution time

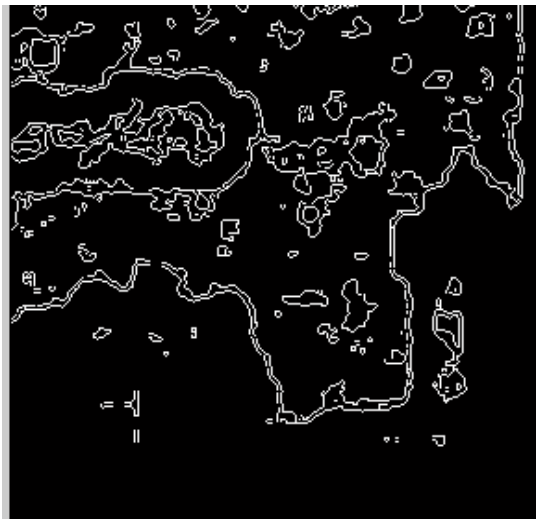
The execution time of straight line detection using the proposed hybrid technique and DBM method for the same image sample are carried out (all slices that are obtained after Canny edge detector step), the execution time for GDBM method is in the range of (20-800) second ,and the execution time for DBM is in the range of (40-999) second .

Notice that GDBM combined the benefit of the accurate result with acceptable execution rate, therefore this method represents the best compared to another two methods. To give more details about the results applied methods, detected lines will be redrawn again at each slice. These can be clearly seen in Figures (4), (5).

1-Results of performance DBM

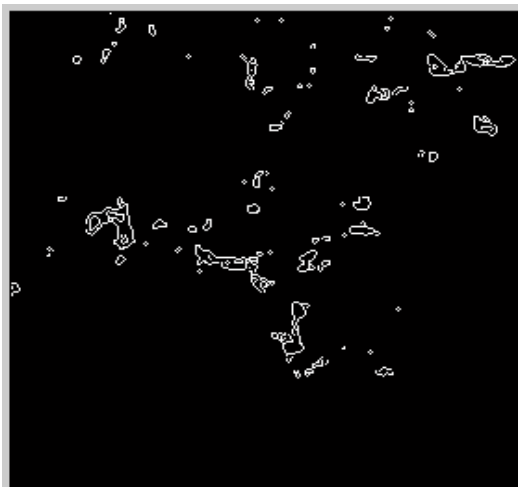


Slice 1

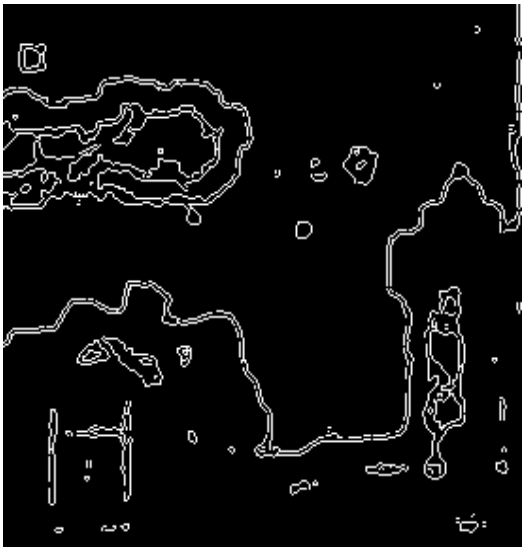


Slice 2

Slice 3

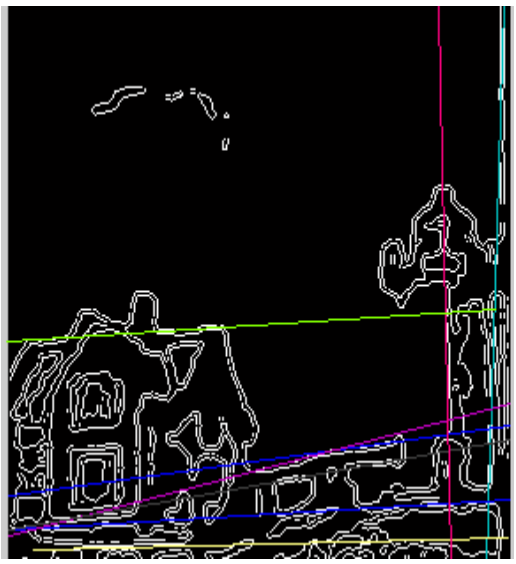


Slice 4

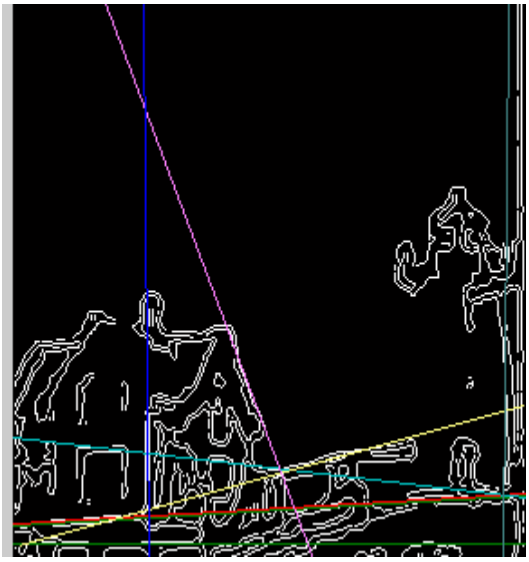


Slice 5

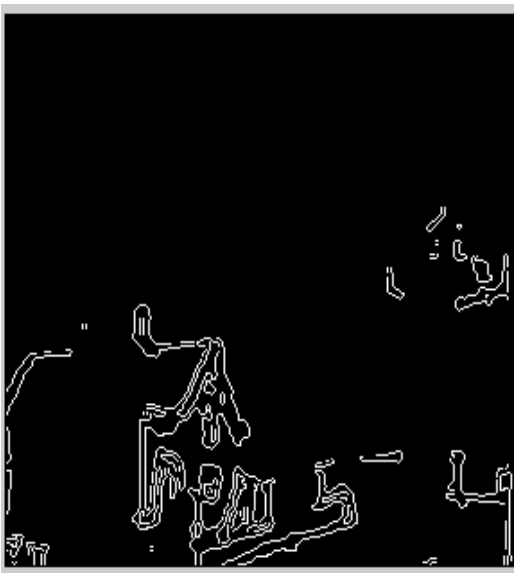
Slice 6



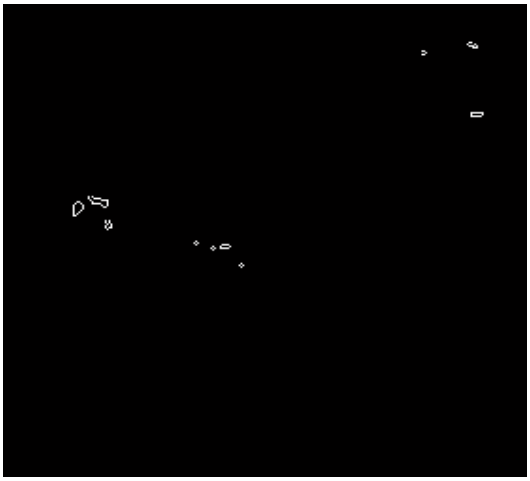
Slice 7



Slice 8



Slice 9



Slice 10

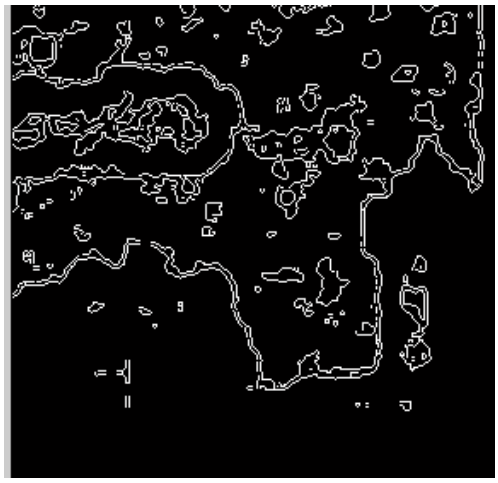
Slice 11

Slice 12

Figure (4) : Results of DBM for image1

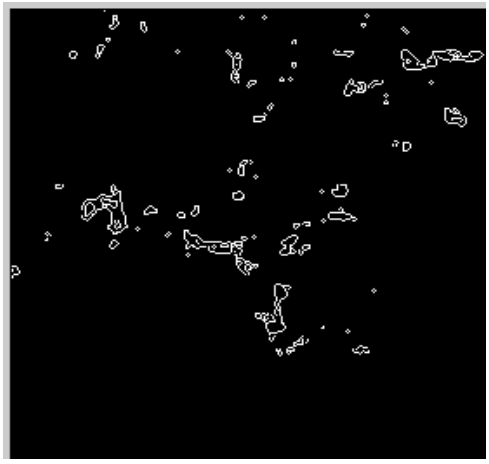
1-Results of performance GDBM

Slice 1

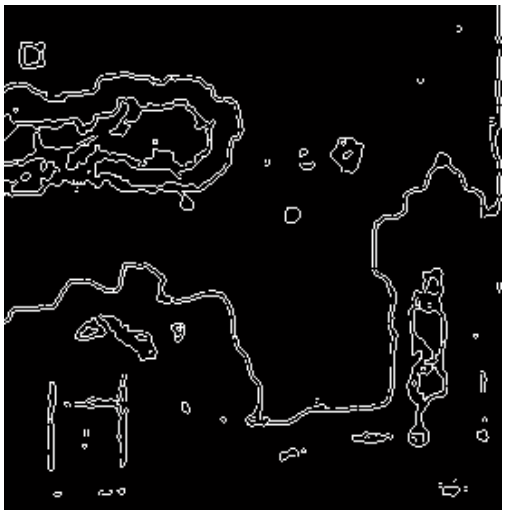


Slice 2

Slice 3

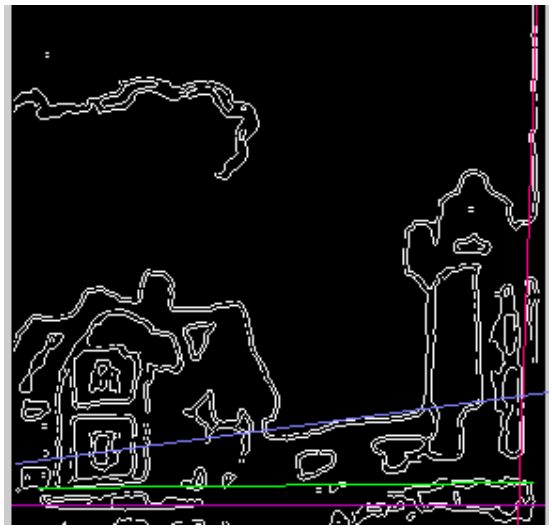


Slice 4

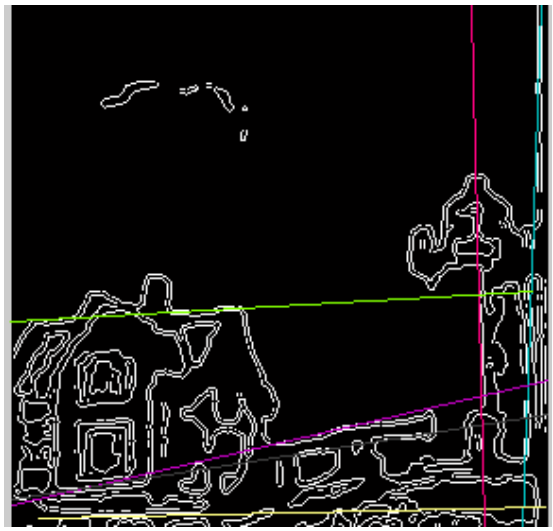


Slice 5

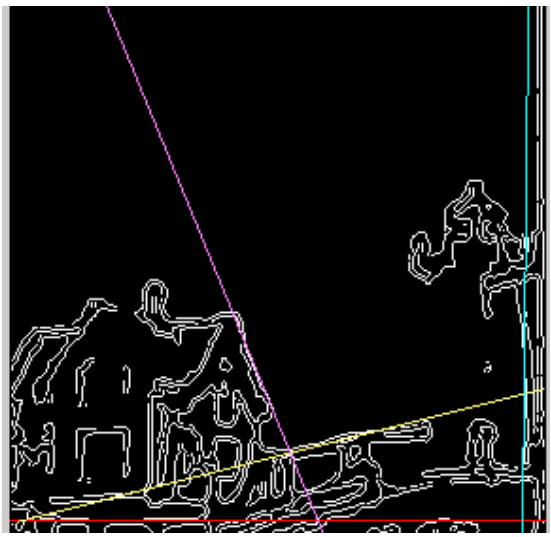
Slice 6



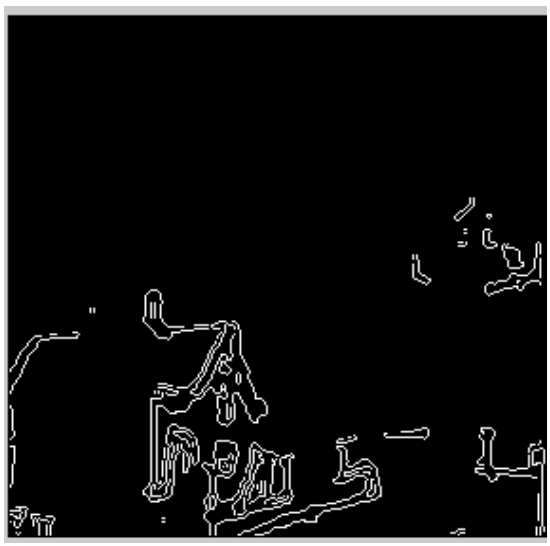
Slice 7



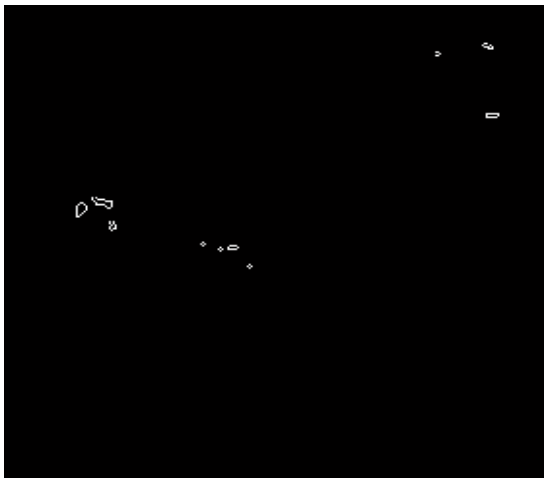
Slice 8



Slice 9



Slice 10



Slice 11

Slice 12

Figure (5) : Results of GDBM for image1

CONCLUSIONS

In this search we have proposed hybrid system for computerized civil objects recognition based on one of the Intelligence techniques (GA). Artificial vision aims to replace the human vision in various areas. Image analysis and interpretation represent an essential phase in the chain of the vision process by computer. Analysis of the civil object recognition based on proposed hybrid technique revealed a Number of interesting conclusions. These conclusions are:

1-Texture image analysis gives an efficient step to make the idea of searching for straight lines in an image.
2-Applying Baron's method gives another approach to detect straight line in digital images, applying some modification gave positive effect on the results and get high correspondence between detection line and actual line.
3-The Hybrid between Baron's Development Method and Genetic algorithm produces efficient results and high performance (acceptable execution time and 95% precision).
4-Using FD in texture analysis image that contains natural parts gave high efficiency specially in segmentation process.

Future Works

- Applying the techniques used in this thesis with hybridized Neural Network techniques to get high performance
- Applying Neural Network with multi previously recognition civil objects make the object classification much easier.
- Using the GDBM method in medical fields.

[1] Andrzej Materka and Michal Strzelecki, 1998,"Texture Analysis Methods-A Review", Technical University of Electronics, COST B11 report, Brussles.

[2] Eva M.van Rikxoort ,2005, " Content-Based Image Retrieval : Utilizing color, texture, and shape",Ms.C in Artificial Intelligence, Redbud University Nijmegen.

[3] Miguel Angel Garcia, Domenec Puig, 2002,"Improving Texture Pattern Recognition by Integration of Multiple Texture Feature Extraction Methods," icpr, p.307, 16th International Conference on Pattern Recognition (ICPR'02) - Volume 3.

[4] Nada Nimat, 2005," Design Hybrid Intelligent System for Transitional Bladder Cell Carcinoma Diagnosis", Ph.D. thesis, Department of computer science, College of computers & mathematical Sciences, university of mosul.

[5] Noronha S., and Nevatia R., 2001, "Detection and Modeling of Buildings from Multiple Aerial Images," IEEE Trans. Pattern Analysis and Machine Intelligence (PAMI), vol. 23, no. 5, pp. 501-518.

[6] Sinisa Todorovic and Michael C.Nechyba, 2004, " Detection of Artificial structures in Natural – Scene Images Using Dynamic Trees", ICPP,PP.34-39, 17th international conference on pattern recognition (ICPP'04),vol.1.

[7] Stuart J.Russell and Peter Norvig, 2003, " Artificial Intelligence a Modern Approach ", 2nd edition , Prentice Hall.

[8] Umbaugh, S. E., 1998, " Computer Vision and Image Processing", A practical Approach Using CVIP tools, Prentice Hall PTR.

[9] Ying Liu, Si Wu, Xiaofang Zhou, 2003," Texture Segmentation Based on Features in Wavelet Domain for Image Retrieval", Visual communication and Image processing, Vol.5150, No.87, pp. 2026-2034 .

[10] Zahiling Long, Joseph Picone, 2000, " The optimization of edge and line detectors for forest image analysis", Orlando: International Institute of Informatics and Systemics: PP :171-176.

[11] Zhab Baron Lic ,1996, "Algorithms of Line detection", Rapport technique EPM, Ecole Polytechnique de montreal, 20 pages.