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Using Original and Hybrid Artificial Bees Colony Algorithm to Represent Images

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Abstract

Artificial bee colony is one of the artificial intelligence methods. Bees, in general, have amazing ability to build mathematical models to solve some problems in computer science and find the best solution.
Thus, The current research aims to use artificial bees colony algorithm and three hybrid methods to represent gray level images. The hybrid methods gave best results value in the case that the colony size was small (Colony size=10 or 14), While all methods gave the same results in case of increasing the colony size (Colony size=18).

Keywords: *Artificial Bee Colony Algorithm, Insert one-bit, Inverse sections, Three replacement positions.*

I. Introduction

Artificial Bee Colony method is used to solve the difficult optimization problem. It presented by Karaboga in 2005[1]. The algorithm were formed by observing behavior of real bees during the search for nectar resources. Creating a flow of data around a hive is a bee behavior that involves the basics of swarm intelligence[2].

In this research, a simplified explanation of the artificial bee colony algorithm will be given, then the algorithm will be applied and three hybrid methods on represented grayscale images.

II. Proposed Algorithm

2.1 Artificial Bee Colony (ABC) Algorithm:

ABC algorithm based on the intelligence model of the behavior of the swarm in search of food. Used to find the best possible solutions to solve problems and be affected by the behavior of natural bees[3]. Initially, bees communicate directly with one another. Each one performs group simple local moves thus builds a solution. This operation is repetitive. after the first step completed, best solutions detected are saved. The second step begins, bees are increasingly building solutions to the problem. At the end of each replication, one or more of the best partial solutions are retained. The analyst decision maker prescribes the total number of iterations[4]. ABC includes four phases:

1. Initialization Phase:

In this phase, the food source is generated randomly. This represents the number of employed bees or number of onlooker bees. The initial food sources are randomly produced using equation (1) [5] [6]:

$$x_i^j = x_{min}^j + rand[0,1]\left(x_{max}^j - x_{min}^j\right), \quad ---(1)$$

2. Employed Bees Phase:

In the employed bees' phase, each employed bee finds a new food source vi in the neighbor hood of its current source xi . The new food source is calculated using equation (2):

$$v_{ij} = x_{ij} + \emptyset_{ij}\left(x_{ij} - x_{kj}\right), \quad ---(2)$$

After that, the employed bee is comparatively superior and preserves the best resulting solutions[7] [8]. After

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production of the new food source vij, its fitness is calculated by using equation (3):

$$fit_i(x_{ij}) = \begin{cases} \frac{1}{1+fit_i(x_{ij})} & if\ f_i(x_{ij}) \geq 0 \\ 1+abs\left(f_i(x_{ij})\right) & if\ f_i(x_{ij}) < 0 \end{cases}, \quad ---(3)$$

3. Onlooker Bee Phase:

Employed bee share with onlooker bees in nectar and information food source. Then calculate probability chooses using one method of selection such as roulette wheel selection[8] [9]. The probability value, can be found by using equation (4) [10]:

$$p_i = \frac{fit_i(x_{ij})}{\sum_{n=1}^{SN} fit_n(x_{ij})}, \quad ---(4)$$

4. Scout Bee Phase:

This type of bees is chosen food source randomly. Determine the abandoned food source, if exists, and replace it with a new randomly produced solution xi for the scout using the equation (1). Save the best food source position[11].

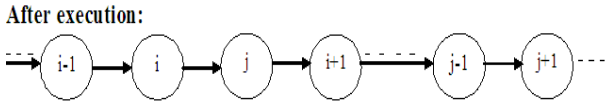

Figure 1. Insert one bit before and after execution

2. Inverse sections operation:

The chromosome is divided into two sections, all genes in each section are copied and then inversely placed in the same section of the child. The position of section point is to choose randomly. This operation is illustrated in Figure 2 [13][14].

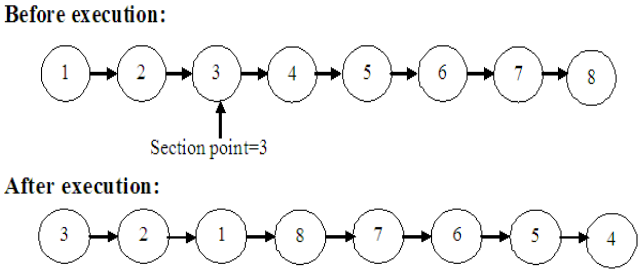

Figure 2. Inverse sections before and after execution

3. Three replacement positions operation:

Three genes are chosen randomly (i ,j and k) which shall take different positions its necessarily successive i < j < k, The gene of the position i becomes in the position j, the gene of the position j becomes in the position k and the gene of the position k becomes in the position i. This operation is illustrated in Figure 3 [14].

2.2. Proposed Methods:

The current research use artificial bees colony algorithm and three hybrid methods to represent gray level images. These hybrids methods are:

1. Insert one-bit operation:

This method can be executed to all population by choosing two different positions from a job permutation randomly. The second selected site is to be inserted after the first site, The rest of the sites change. This operation is illustrated in Figure 1 [12].

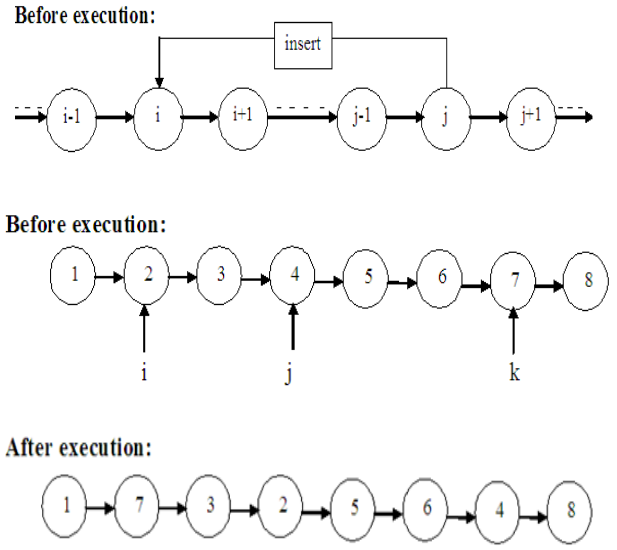

Figure 3. Three replacement positions before and after execution

2.3. Original ABC algorithm and Suggested methods:

Step 1: Initialization Phase
Step 2: If we need to execute ABC algorithm go to step 3 else Execute one of the suggested methods to the population:(Insert one-bit operation or Inverse sections operation or Three replacement positions operation)
Step 3: Repeat
Step 4:Employed Bee Phase
Step 5: Onlooker Bee Phase
Step 6: Scout Bee Phase
Step 7: Memorize the best solution achieved so far
Step 8: Continue until the termination criteria is satisfied or Maximum Cycle Number (MCN) has been achieved
Step 9: End [8] [15] [16].

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In this research the:
Image name=image 1 or image 2 or image 3
The colony size=10 or 14 or 18
Number of representation=9
Maximum cycle number (MCN)=100

2.4. Flowchart of ABC algorithm and Suggested methods:

Flowchart of ABC algorithm and suggested methods shown in Figure 4 [17] [18] [19]:

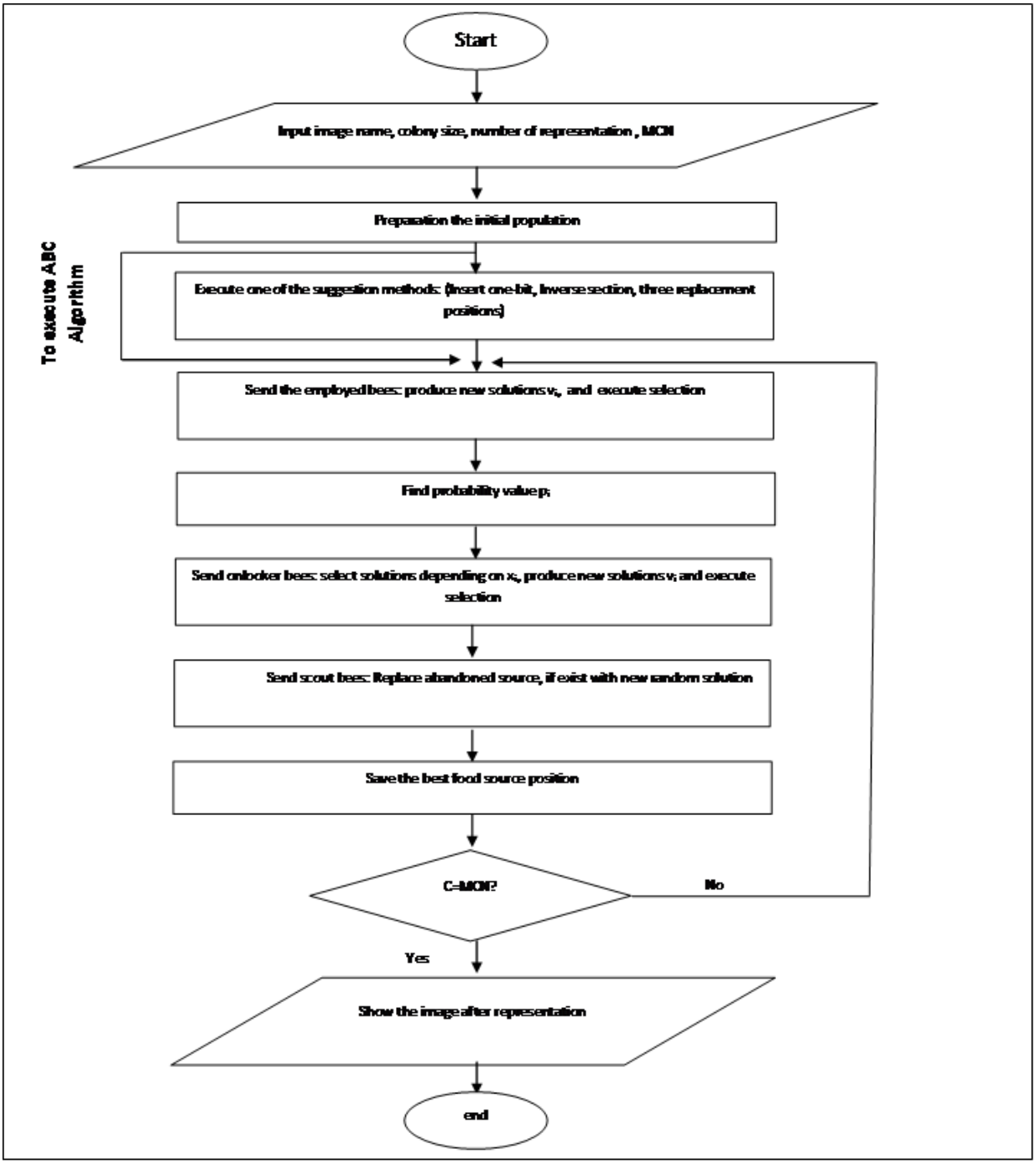

Figure 4. The Flowchart of ABC Algorithm and Suggested Methods

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III. Results and Discussion:

In this research, the ABC algorithm and suggested methods (Insert one-bit operation, Inverse sections operation and Three replacement positions operation) have been applied in three gray level images (image 1, image 2 and image 3), as it is shown in Figure (5-7).

Table 1 represents the results of execution ABC algorithm and suggested methods. The hybrid methods gave best results value in the case that the colony size was small (Colony size=10 or 14), While all methods gave the same results in case of increasing the colony size (Colony size=18). And the rate of execution is also computed using equation (5):

rate=result/number of representation*100 --- (5)

rate=5/9*100

The graph of ABC and suggested methods are shown in Figure(8-10).

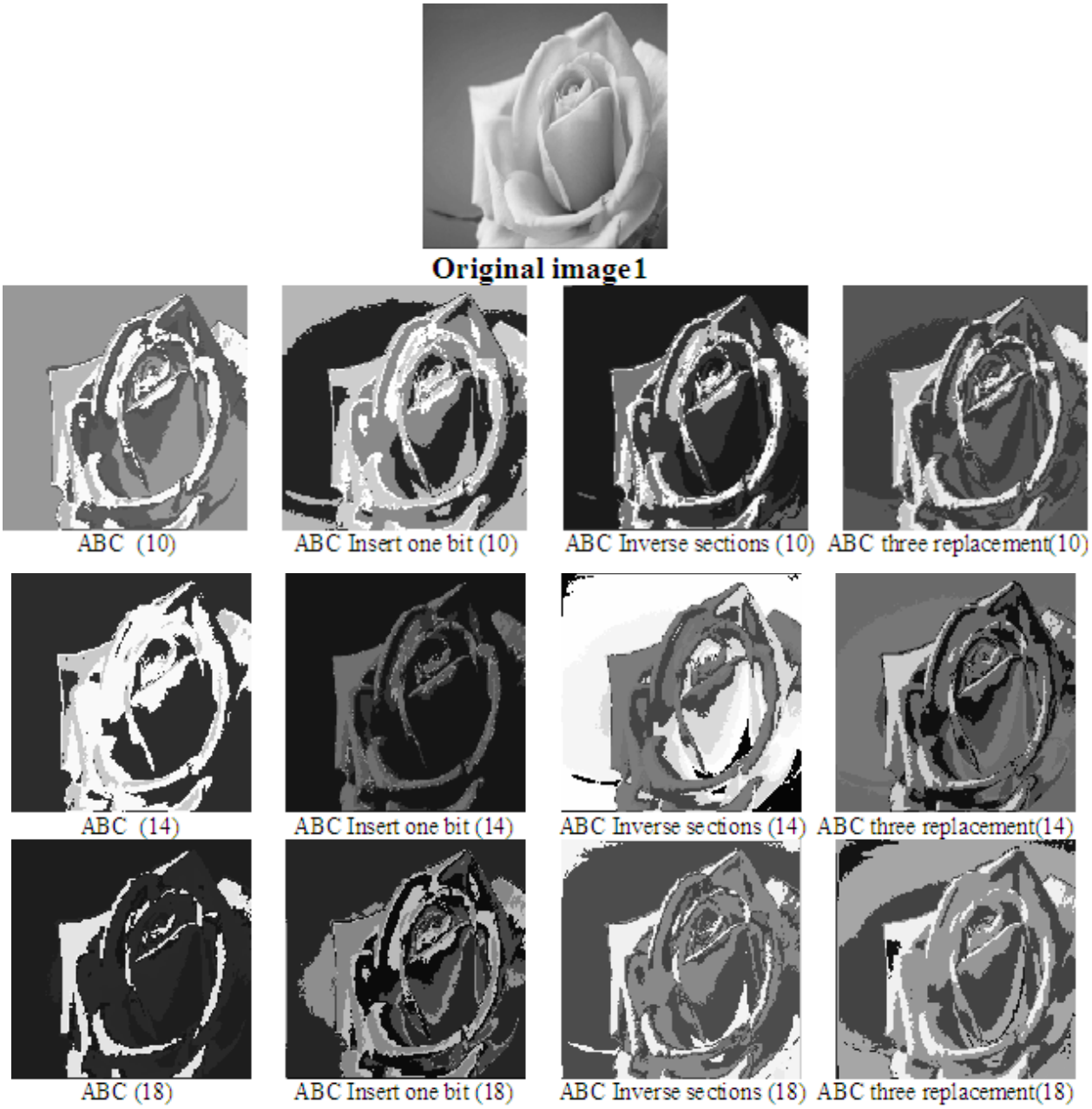

Figure 5. Execution ABC algorithm and suggest methods to image1

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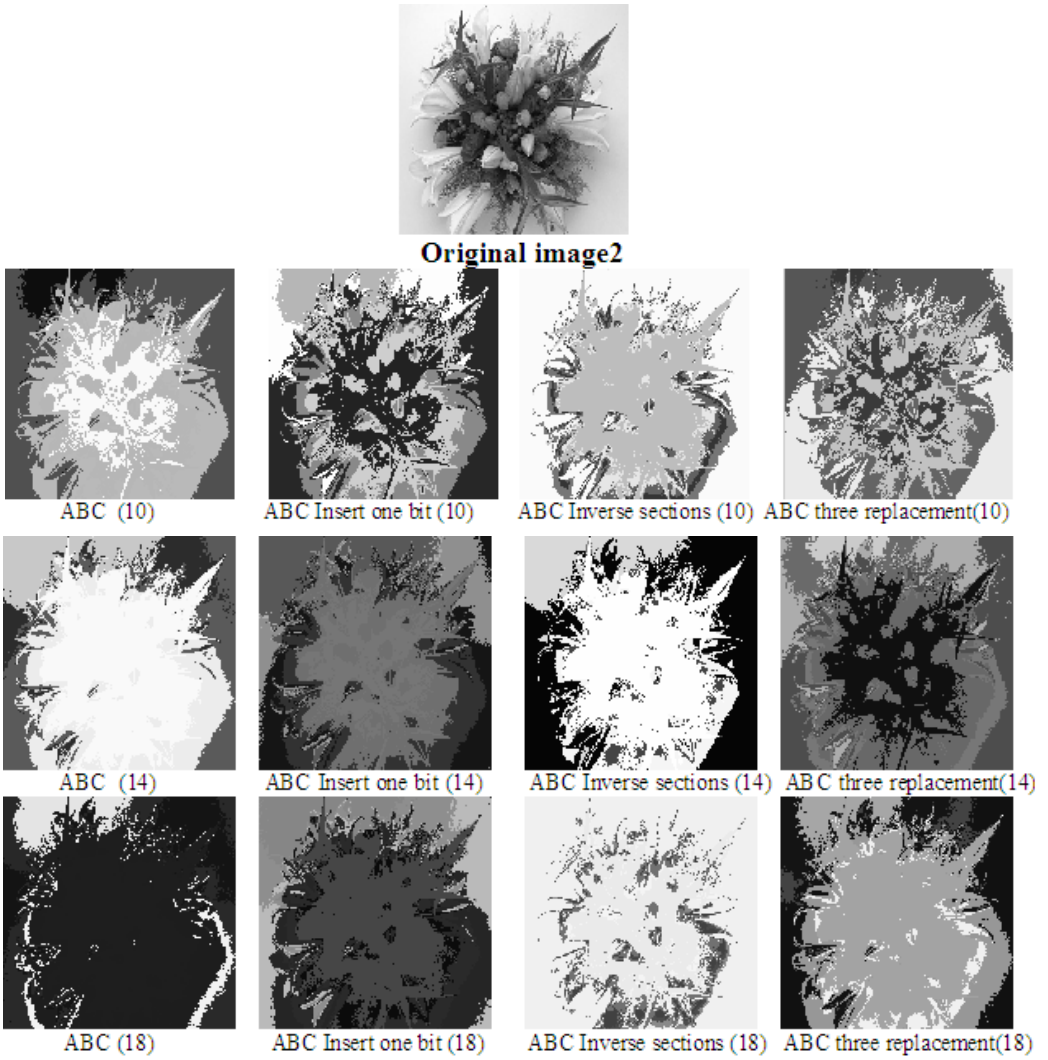
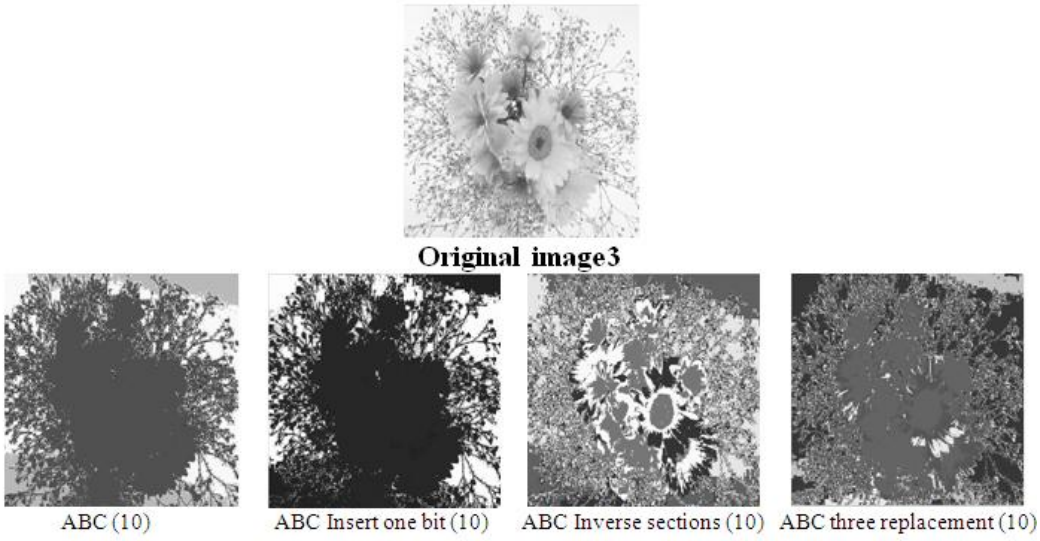


Figure 6. Execution ABC algorithm and suggest methods to image2



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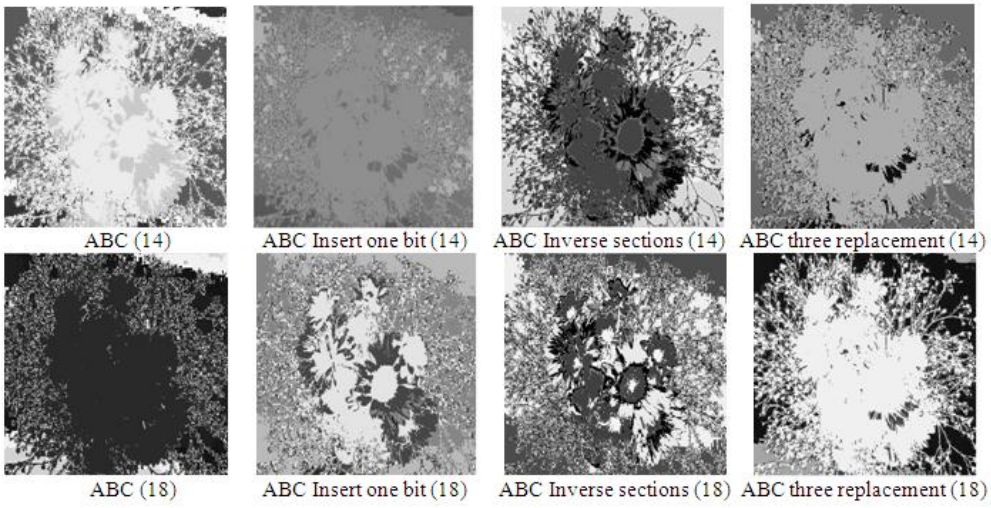

Figure 7. Execution ABC algorithm and suggest methods to image3

Table -1- Display the Results of Execution the ABC Algorithm and Suggestion Methods

Image Name	Colony Size	ABC	ABC rate	ABC Insert one-bit	ABC Insert one-bit rate	ABC Inverse sections	ABC Inverse sections rate	ABC Three replacement	ABC Three replacement rate
Image1	10	5	55.5	6	66.6	7	77.7	7	77.7
	14	5	55.5	6	66.6	7	77.7	6	66.6
	18	7	77.7	7	77.7	7	77.7	7	77.7
Image2	10	5	55.5	6	66.6	6	66.6	6	66.6
	14	5	55.5	7	77.7	6	66.6	7	77.7
	18	7	77.7	7	77.7	7	77.7	7	77.7
Image3	10	4	44.4	6	66.6	5	55.5	6	66.6
	14	5	55.5	6	66.6	6	66.6	6	66.6
	18	7	77.7	7	77.7	7	77.7	7	77.7

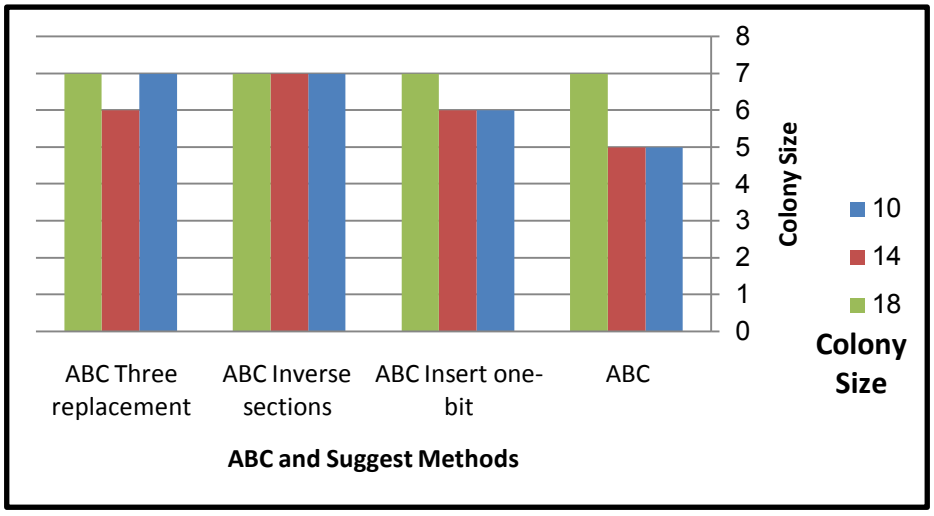

Figure 8. Graph of ABC Algorithm and Suggest Methods from Image1

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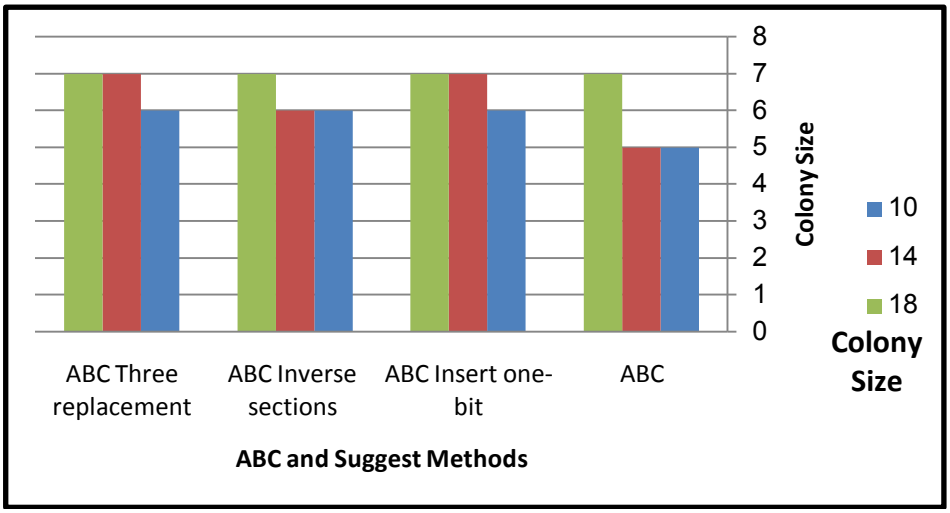

Figure (9) Graph of ABC Algorithm and Suggest Methods from Image2

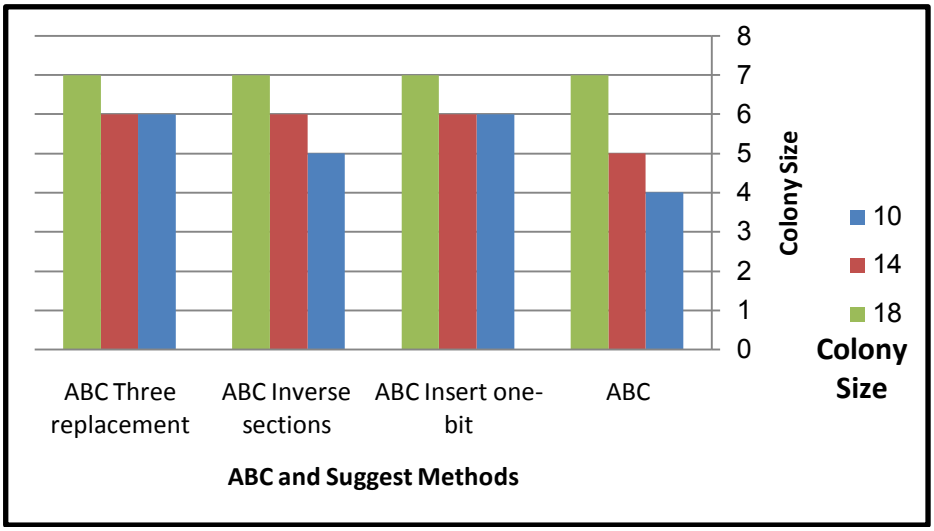

Figure 10. Graph of ABC Algorithm and Suggest Methods from Image3

IV.CONCLUSION

The ABC algorithm is an optimization algorithm used to find the best possible solutions to the problem. It is easy, fast and efficient method compared to other methods.

In this research, ABC algorithm and suggestion methods (Insert one-bit operation, Inverse sections operation and Three replacement positions operation) was used to represent three gray level images. Suggested methods gave good result to represent images better than ABC algorithm when the colony size is small When the colony size increases all methods gave the same result to represent images.

In the future it is possible to apply this research on color images and get better results.

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