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Digital image compression by using intelligence swarm algorithms

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Abstract

Image compression is one of the most important branches of digital image processing as it is concerned with reducing the size of the captured images to save the space allocated to them on the storage drive and facilitate the process of transferring and sending them. In this paper, we present a new method for compressing digital images depending on two algorithms: the Ant Lion Optimization and the Firefly. The performance of the suggested algorithms is evaluated using the compression ratio; i.e., Ratio of bits before and after compression, (PSNR); i.e., the extent to which the restored image is similar to the original image, and the standard for average squared errors (MSE), meaning the amount of error in the recovered image, where the lowest value of image compression ratio with the highest value for image quality should be obtained with the lowest value of errors. A comparison was made between both methods in order to determine the best of them in conducting the pressure process through the results that will be reviewed.

Key words and phrases: Ant Lion Optimization Algorithm, Firefly algorithm, Image Processing.
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1 Introduction

The importance of image compression has increased as a result of the rapid development of computer capacity. The sophistication that converges in multimedia and the emergence of which has easy access to the Internet for everyone. All these things have made new algorithms need to be better and faster, especially in the image files as storage and data transfer requires a large size and large package width. This may be very expensive. Image compression techniques include reducing the increase in data representation to reduce storage requirements and thus reduce the cost of communications [11]. Intelligent techniques have become more and more used than before, and increasingly in the field of image processing "to find more accurate solutions to image processing problems compared to traditional methods, or at least to find solutions to problems that traditional methods failed to solve" [4]. Techniques that fall under the phrase *soft computing* such as neural networks, genetic algorithm, evolutionary computing, fuzzy logic, and swarm intelligence all provide powerful tools for dealing with optimization problems [15]. The behavior of swarms has impressed many biologists, and has recently expanded to occupy computer scientists, with its intelligence in the style of movement and movement and its often distinguished coordinates between its elements and its adaptation to the conditions surrounding its environment, and that swarm intelligence use to find solutions to problems in a way inspired by the behavior of swarms. The types of swarms include, among other things, bees, ants, fish where these algorithms have been used in many computer applications and have proven efficiency in several aspects including classification and discrimination [8].

2 Previous work

Lu and Deny [15] have developed a method for cross-hybridization between the genetic algorithm and the mean-K method, adding some improvements to the method to get a high compression ratio, and a new method called Algorithm mean-K Genetic Fast (FGKA) was proposed, based on that of Krishn and murty, where the FGKA method treats Global optimization problems The new method is faster than GKA. Al-Husainy [9] applied the Genetic Algorithm (GA) with the Quantization Vector (VQ) and applied it to several examples and it showed good results compared to the traditional method of VQ. Bonyadi and Mohsen adopted one of the loss compression methods, the jpeg method, applying the threshold limit for each storage unit and using

GA to find the threshold mask function. The GLD property was extracted and adopted in the genetic algorithm. The search results measured in PSNR were good compared to jpeg2000.

3 Firefly Algorithm

Proposed by Yang in 2007, it depends on the behavior of the swarms such as "fish, insects and birds" in nature. There are three parameters of the firefly algorithm which are in [12]:

3.1 Intensity of light and gravity

The most important characteristic is the intensity of light and the gravity factor, where gravity is determined by its illumination which in turn is associated with the target function [6]. The luminance I of the firefly at a specific location X can be chosen as $F(x)\alpha I(x)$. However, the gravity (β) must vary with the distance rij between the firefly i and the firefly j [3, 6]. The intensity of the light decreases with the distance from the source, and the light is absorbed by the transmitting medium, so gravity will change with the varying degrees of absorption, meaning that the intensity of light $I(r)$ changes according to the inverse square law as in the following equation [6].

$$I(r) = Is/r^2 .....(1),$$

where Is is the intensity of the light at the source, and r represents the distance between any two Fireflies [6].

3.2 Distance

The distance between any two Fireflies is defined as the Euclidean distance. Let the firefly (i, j) at (xi, xj) be as in equation (2) [6]:

$$r_i, j = \parallel X_i - Y_j \parallel = \sqrt{\sum_{k=1}^{d}}(x_{i,k} - y_{j,k})^2 .....(2),$$

where (xi, k) is the spatial coordinate of the firefly i and dv is the number of dimensions.

3.3 Movement

The firefly i is gravitate to j, which is more luminous and attractive through the following equation [6]:

$$x_i = x_i + \beta e^y r_{j,i}^2 * (x_j - x_i) + (\alpha * (rand - \tfrac{1}{2}), ...(3),$$

where xi represents the position of the firefly i,d α is a parameter of randomness, and $rand$is a random number within the interval [0, 1]

4 Ant Lion Optimization Algorithm

The Ant Lion optimization Algorithm mimics the hunting mechanism of ant lions. The main steps are "random movement, create traps, hunting, and re-building traps are implemented". The mechanism for implementing the algorithm depends on the following steps [5, 13]:
1. The algorithm starts with a random movement according to the following equation:
$X(i) = (0, cumsum(2r(t_1) - 1), cumsum(2r(t_2) - 1), ...cumsum(2r(t_n) - 1).....(4)$,
where Cumsum denote cumulative sum, n stands for the maximum number of iterations, t is a step of random walk, $r(t)$ is a Trapping in ant lion function.
2. Trapping in ant lion's spits
$c_i^t = Antlion_j^t + c^t.....(5)$
and
$d_i^t = Antlion_j^t + d^t, ...(6)$,
where c^t represents the minimum of all variable, d_t is the maximum of all variables t, c_i^t is the minimum of all variables, and d_i^t denotes mtmaximum of all variables.
3. Building trap 4. Sliding ants towards ant lion
$c^t = \frac{c_t}{I}.....(7)$
and
$d^t = \frac{d_t}{I}.....(8)$

5 Flow chart of suggested methods

Figure 1 represents the flowchart of the suggested methods in the image compression process, [3, 13].

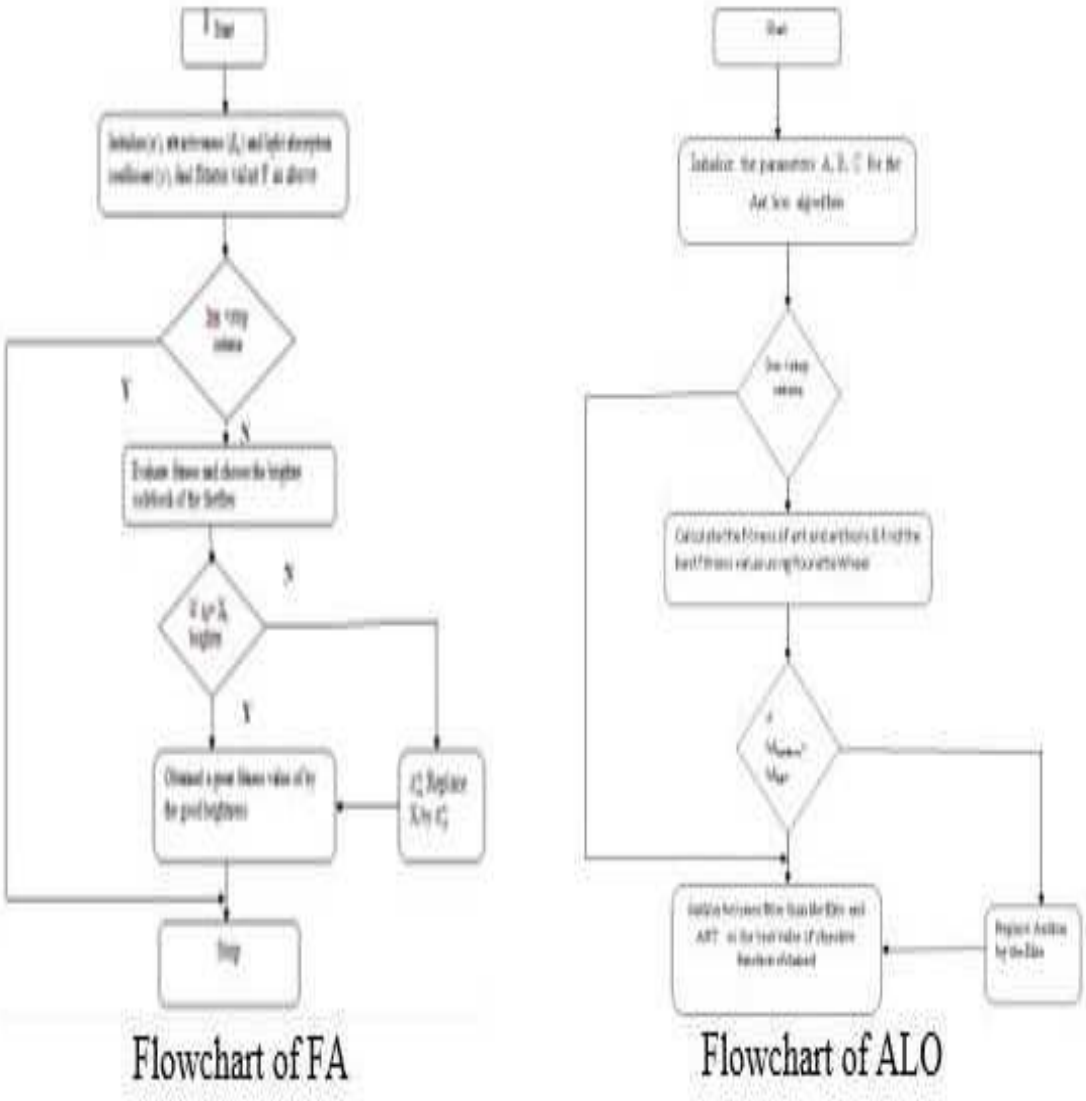

Figure 1: Flowchart of ALO

6 Measures Test The Program

The measure of efficiency was extracted from the fields of digital signal processing and information theory as it was used in order to measure the amounts of error in the reconfigured image and the level of missing information can be expressed as a function of the original - input - and compressed image. There are many measurements [7] that depend on calculating the amount of contrast between different copies of the same image and from these measures, we have:
1- Measure (PSNR): Peak signal-to-noise rate and the equation for this measure is as follows [2]:
$PSNR = 10LOG_{10}\frac{255^2}{\frac{1}{MN}\sum(rij-xij)^2}$.....(9),
where rij is the Enhanced image, xij is the original image, and N, M are the image dimensions
2-Measure MSE: the mean squared error is defined as follows [2]:
$MSE == \frac{1}{n}\sum_{I=1}^{N}(actual - forecast)^2$.....(10),
where n is number of items, $\sum$ stands for the summation notation, Actual is the original or observed y-value, and forecast is the y-value from regression.
3-Measure compression: the following equation is used to measure the compression rate [1]:
Compression rate = (data length after compression obtained)÷ data length before compression $\star$ 100.....(11)

7 Results

The suggested algorithms were applied to a number of images of different sizes and resolutions in order to reach a comparison showing which algorithm are better in performing the image compression process. Image A represents the original image before the compression process, while image B represents the image after the application of the Firefly Algorithm and C represents the image after the application of the Ant Lion Optimization. By noting the first figure, which represents the outcome of applying algorithms to the selected image, we find that the ratio (PSNR) when applying the algorithm (FA) was (22.5009) while it reached (22.8278) when applying the algorithm (ALO), as for the square error ratio (MSE) when applying the algorithm (FA) was (365.5875) while the ratio (339.0776) was when applying the algorithm (ALO), While the number (1019.1278) represented the compression ratio when using the (FA) method, while the compression ratio when using the

(ALO) algorithm was (1053.0321)

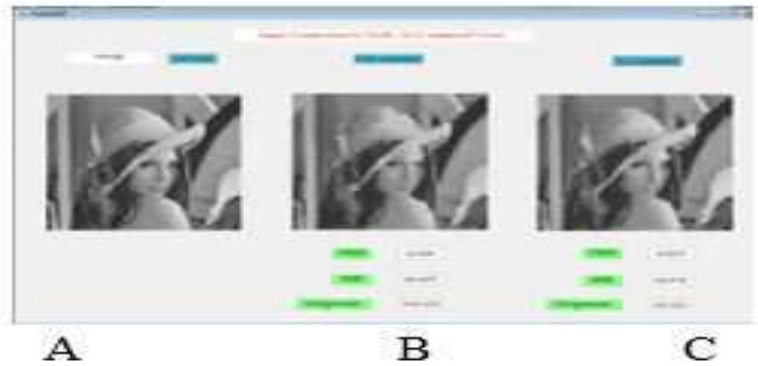

Figure 2:

Through the results that were obtained from the application of the proposed algorithms, and as shown in Figure 3, we find that the ratio of)PSNR(was (15.20), the ratio (MSE) was (1933.39) and the compression ratio (1018.31) when applying the algorithm (FA), Whereas, the results appeared different when applying the (ALO) algorithm, so the ratio (PSNR) equals (15.52), and the ratio (MSE) was (1823.27) and the compression ratio was (1024.43)

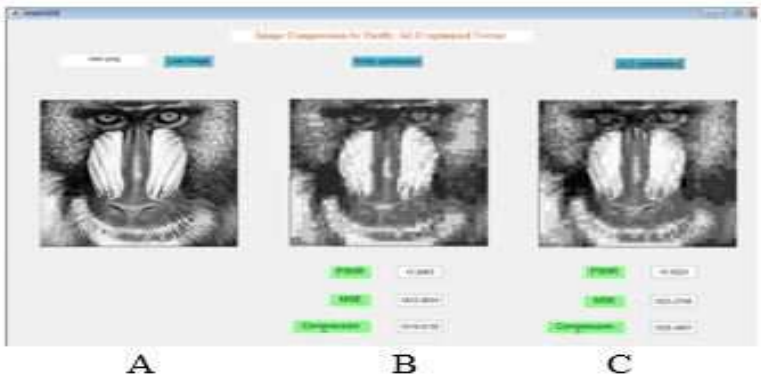

Figure 3:

To ensure the effectiveness of the algorithms in performing the compression process on digital images, the proposed algorithms were applied to a third image and the results were as shown in figure 4, where the ratios (PSNR), (MSE) and compression ratio when applying the algorithm respectively were as follows (96.34) (1507.46) (2049.45) . In the showed The results

are that the ratios for applying the algorithm (ALO) were respectively as follows (96.74) (1377.18) (1075.12)

Figure 4:

8 Comparison of the two methods

The rates shown in the table 1 below represent what was obtained from applying the suggested algorithms by adopting the measures (PSNR), (MSE), and compression ratio to the set of images. Through the results obtained from the application of the proposed algorithms on a selection of different digital images and based on the measurements of the scales that were adopted in this research and as shown in table 2, we find a high efficiency of the two methods in executing image compression. We also note that the algorithm (ALO) was better in performing the compression if compared with the algorithm (FA).
Table 1: Comparison by Measures Rates

Image	FA			ALO		
	PSNR	MSE	COMP.	PSNR	MSE	COMP.
1	22.50	365.58	1019.12	22.82	339.07	1053.03
2	15.20	1933.39	1018.31	15.52	1823.27	1024.43
3	96.34	1507.46	2049.45	96.74	1377.18	1075.12

9 Conclusion

From the results, it became clear to us that the use of the ALO algorithm as an intelligent technique in supervised machine learning is a very powerful technique and best in digital image compression from where quality, speed, and amount of compression.

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