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A proposed CLCOA Technique Based on CLAHE using Cat Optimized Algorithm for Plants Images Enhancement

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ABSTRACT: Image Enhancement is the mainly important with complex methods and techniques in image study. A purpose of image enhancement is for advancing the optical presence for an image, or for supporting an improved convert representation for future mechanized image processing. Various images similar medical, satellite, natural images with equal existent life photographs which have a lowly contrast and noise. This study presents a new enhancement technique based on standard contrast limited adaptive histogram equalization (CLAHE) technique for image enhancement which its name CLCOA. The suggested technique depends on augmentation of swarm intelligence via using Cat Swarm Optimization algorithm (CSOA). The swarm intelligence is used to obtain the optimal structure of CLAHE technique. Tomato plant images have used and applied as dataset because of its important and influence in our life. For fair analysis of two techniques, Absolute Mean Brightness Error (AMBE), peak signal-to-noise ratio (PSNR), entropy and Contrast Gain of fundus images are analyzed by using MATLAB. The results show that performance of the proposed technique reveals the efficiently and robustness. It produced 9.3060, 12.9871db, 5.8213 and 3.4640 as maximum values for four above evaluation measures respectively when compared results of standard technique.

Keywords: CLAHE 2, image enhancement 3, Cat Swarm Optimization algorithm 4, peak signal-to-noise ratio (PSNR)

1. INTRODUCTION

The color image enhancement is a vital task in digital image processing. It is famous which image enhancement as a difficult topic in the subject for medical imaging and slight sense imaging [1]. The goal of image enhancement is for developing the feature for image by various ways e.g. changing intensities, thus that segmentation later can be further effective and develop the diagram presence for image, or to support an enhanced renovate demonstration for coming automatic image processing, instance analysis, detection, segmentation and recognition. Also, it improves analyses background information which is principal to understand object behavior without needing costly human graphic review [2]. Working image enhancement accepting minimal small feature image is a defying problem since these aims. Because of low contrast, it cannot evidently remove items from the black background. Mainly color built modes will decline on this topic if the color of things and that of the background are parallel [3]. A study for existing techniques which founded on the current techniques of image enhancement, that categorized in double wide types: Spatial based domain image enhancement and Frequency based domain image enhancement [4].

Contrast Limited Adaptive Histogram Equalization (CLAHE) is HE a technique which utilizes local contrast enhancement to the local regions for the image [6]. It is a technique applied via scientists publicly, for contrast enhancement of images, mainly in the preprocessing stage. It is famous that CLAHE is utilized for enhancing medical images like X-Ray images with sonography images [7]. As CLAHE not one flattens the histogram then too offers highest entropy while compared through another HE algorithms, this makes it more appropriates- ate for use in medical images, especially for X-Ray images, where the low contrast is a problem. In specific of the searches, it is met which CLAHE is employed for enhancing the contrast of the under- water images [8]. It is indicated by [9] that the CLAHE algorithm

together supports a well contrast and preserves aspects. The investigators said the low contrast problem in underwater images because of the bright interest and they explained the problem by using CLAHE. The researchers preferred a hybrid style which al- lows for procure benefit of together CLAHE and homomorphic filtering (HF) [10]. CLAHE improved to decline the difficulty of image restoration algorithms and also supported an efficient contrast enhancement. Also, CLAHE can be seen in curved track detection enhancement of the facial images to be utilized in deep learning [11] for robust feature detection.

Moreover, its acceptance in the works, CLAHE equally changes on two factors, that are quantity of tiles with clip limit, separately. First factor, the number of tiles, defines the quantity of tiles which the image is separated with contains of two values that are m and n [12]. Later, the image is separated into m x n local regions. Later factor, the clip limit, determines the increase of the noise in image. The clip limit also avoids amount values of the histogram for every tile from superior the ideal clip limit [13]. If these parameters are not certain rightly, this position may control to weak quality images with noise. Meanwhile the productivity of the CLAHE acceptably builds on two factors declared above, other ideal values of these two factors can present increase to an improve contrast enhancement. Moreover, defining the perfect parameters is a time utilizing activates and an automatic parameter recognition technique is wanted. Then, it donates a unique automatic factor selection technique for CLAHE using MOCS [14]. This paper will propose following:

- novel enhancement technique based on standard enhancement technique.
- The proposed technique depends on using (CSOA)
- Evaluate the proposed technique using several measures

The rest of the paper is organized as follows. In Section 2, the review of nature inspired algorithms. In Section 3, the Cat Swarm Optimization is validated by each of its attributes. In Sections 4 and 5 the CLAHE technique and methodology are given respectively. experimental results are identified, section 6 has showed the results that are visually and compared according to the AMBE, PSNR, Entropy with contrast gain. a last conclusion was displayed by section7.

2. LITERATURE REVIEW

The best traditional " typical " nature-inspired types for computation are cellular automata, neural computation, with evolutionary computation. Other current computational systems extracted from natural procedures contain swarm intelligence, artificial immune systems, membrane computing, and amorphous computing [15]. Actually, each main techniques and algorithms are nature-inspired metaheuristic algorithms involving cellular automata, evolutionary computation, swarm intelligence, artificial immune systems, membrane computing, and amorphous computing. Evolutionary computation is a computational paradigm inspired by Darwinian evolution. An artificial evolutionary system is a computational system built on the idea of simulated evolution [16]. It includes a constant- or variable-size population for characters, a fitness criterion, and natively motivated operators which create the following generation from the existing one. The original population is usually produced casually and may be heuristically, with normal machinists are transformation with regrouping [17].

Swarm intelligence, occasionally denoted to as cooperative intelligence, is expressed as the drawback answering behavior which begins from the collaboration for separate agents (e.g., bacteria, ants, termites, bees, spiders, fish, birds) that connect by additional agents by playing on their regional environments [18]. Particle swarm optimization utilizes this scheme for the problem of outcome an optimal solution to an organized problem via a seeking across a (multi-dimensional) result space. Artificial immune systems (a.k.a. immunological computation or immune computing) are computational systems inspired by the natural immune systems of biological organisms. Noticed as an information processing system, the natural immune system of organisms presents several difficult tasks in parallel and distributed computing fashion. These contain separating between self and non self, neutralization of non-self-pathogens (viruses, bacteria, fungi, and parasites), learning, memory, associative retrieval, self-regulation, and fault-tolerance [19].

Membrane computing (or MC) is a topic inside computer science which seeks to determine recent computational examples since the study of biological cells, mainly of the cellular membranes [20]. It is a part of producing a cellular model. Membrane computing deals with distributed and parallel computing models, processing multisets of sign things in a restricted way. Hence, evolution rules accept for developing things to be summarized into compartments described via membranes [21]. The transportations between compartments and with the environment show an important task in the procedures. The numerous kinds of membrane systems are seen as P systems after Gheorghe Păun who primary formulated type 1998 [22].

Lately found various algorithm optimization techniques that imitate animal behavior. Cat Swarm Optimization Algorithm (CSOA) which made by [23]. CSOA has an amount of benefits related to pattern matching difficulties for optimization. CSO algorithm improvement, accepted can generate a quicker time and has an improved accuracy level evaluated for current algorithms [24]. It has a some of behavior cat which divided in two major types. First one is Searching Mode (SM) with the Tracing Mode (TM) has utilized for determining the optimization difficulty. The initial style of the CSO is to define how many cats will be applied by repetition, next utilize the cat in the CSOA to determine a difficulty. It is an evolutionary optimization algorithm which patterns of two main behavioral traits of cats. The

behaviors can be named looking for style (cats travel slowly while relaxing then actuality attentive) with tracing style (cats transfer slowly while relaxing [25]. looking for style have four significant things which are Seeking Memory Pool (SMP), seeking range of the chosen dimension (SRD) (to find a range of selected dimensions), Counts of Dimension to Change (CDC) (to compute elements will modify), and Self-Position Considering (SPC) [26]. The CSO phases are displayed in the Fig.1.

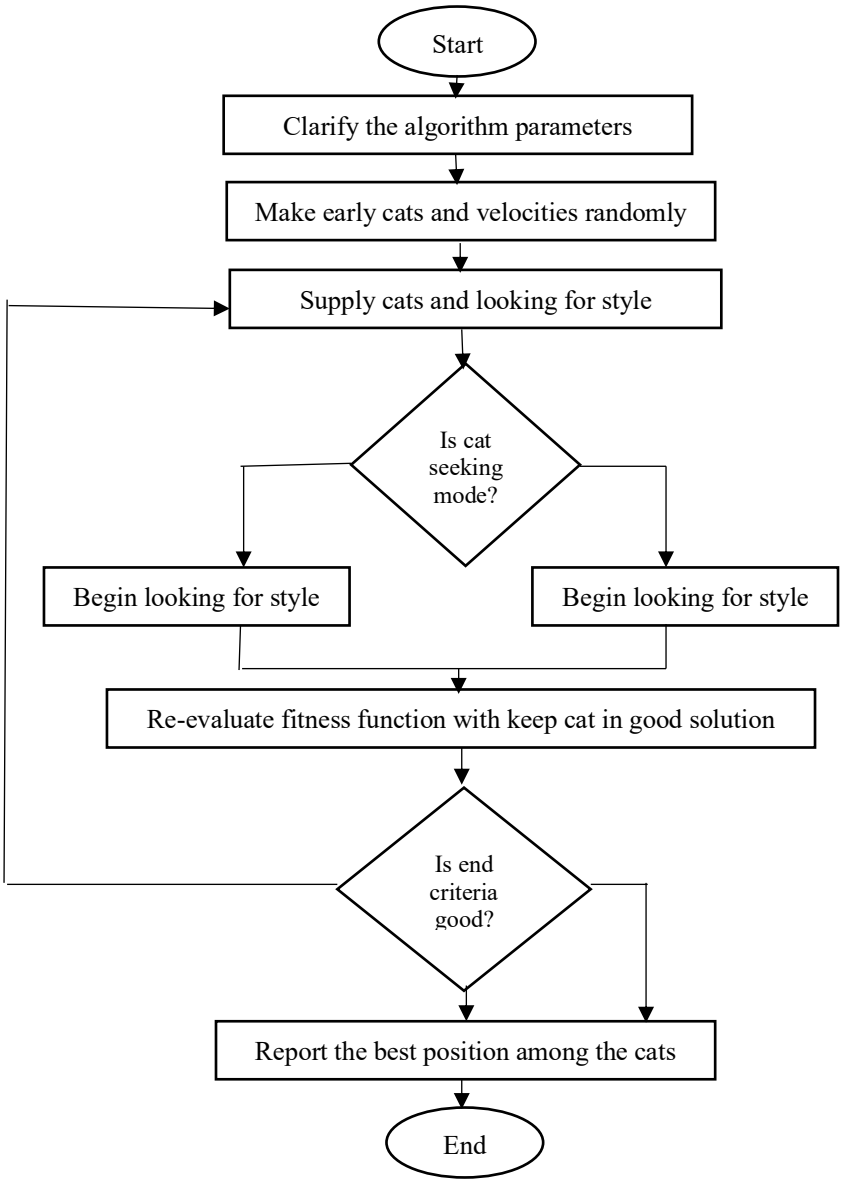

FIGURE 1. – Flow chart of cat optimization algorithm

3. CLAHE TECHNIQUE

Contrast Limited Adaptive Histogram Equalization is applied for enhancing the local contrast which available inside the image giving to the pixel rate allocation of each region [27]. Next the homomorphic filtering algorithm is applied for improving the image feature with decrease the noise in the image. Also, the image texture precision with the details of the feature are achieved, although overwhelming the enhancement for noise. Nearby this image is achieved through growing numerous equal grids of the image termed the region size. The regional structure of the image is separated into three, namely the portions in the corner of the image are evident and the corner region, the edges acceptance these regions are scored with the border region, and the other portions in the center are marked and the inside region [28].

This technique has the capability to reduce the development by cutting the histogram then, the contrast of the image is enhanced. The CLAHE applies on small regions in image in its place of whole image, and later, difficulty rises [29]. These minor parts of an image are named tiles. Each tiles adjust is enhanced so which the histogram for the formed region about matches the histogram formed by the appropriation factor. The difficulty of extreme contrast enhancement can be defeated by using CLAHE namely by giving an edge rate on the histogram [30]. This limit value is named the clip limit

that states the extreme height of a histogram. How to compute the clip limit of a histogram can be expressed by equation (1) below and CLAHE process in Fig. 2.

$$B = M / N (1+a/100 Smax) \quad (1)$$

The M is the amount of pixels in every block, N is the dynamic range in this block, $Smax$ is the maximum grade, with α is the pin element [31].

1- *Divide image components into sub–images of non-overlapping contextual region.*
2- *Calculate histogram of each sub-image based on inherent intensity level.*
3- *Calculate contrast limited histogram of each region base on clip limit.*
4- *Redistribute pixel value above clip limit till none fall above limit.*

FIGURE 2. - Flow chart of proposed algorithm

4. METHODOLOGY

The steps of processing the data followed by proposed technique has expressed. One famous algorithm inspired by nature which name cat optimization algorithm (COA). Details and steps of algorithm are provided in its respective subsection. Lastly, dataset and proposed technique details were addressed respectively.

4.1 PROPOSED TECHNIQUE (CLCOA)

In this study, a proposed a CLAHE image enhancement technique based on cat nature-inspired algorithm for plants images (CLCOA) which uses optimal value for discovering improved enhancement. CLAHE changes in the procedure of histogram delivery in which it usages the cutting histogram for balancing the image. In addition, a gray image's histogram has defined a connection between the gray values of every level for digital image with its frequency of existence. The histogram uses in expressing an amount of pixels in every with all gray levels for image. However, it not uses to epitomizing each image. Fig. 3. explains the (CLCOA) technique steps.

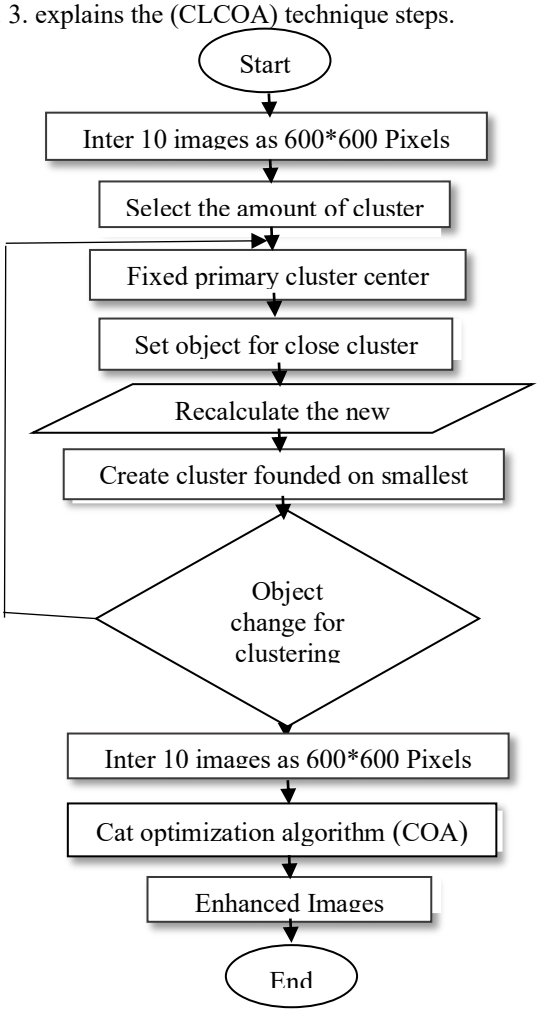

FIGURE 3. - Flow chart of proposed algorithm

4.2 DATASET

Similar humans and animals, plants can also be diseased. The series of plant diseases are widely larger since many plant species are implicated in horticulture, agriculture and forestry. Plant pathology (Phytopathology) is the biological review of the several diseases or infections in plants made by pathogens. Tomato is the second mainly vital vegetable crop after potato in the world. It is an essential point in cooking measures and is the mainly vital processed vegetable. It supports variation to the salads and is a significant source for vitamins A with C.

dataset which used in this study are collected from health center and its medical departments. To evaluate and approve the enhancement techniques on plants images regardless of its type or modality, we considered 10 images of tomato crop images. The image, size is 600*600 pixels and saved in JPEG and RGB color space. The dataset which adopted and used are downloaded from the internet [32]. The experiment results are archived in the software MATLAB R2022b, with windows 10. Some samples of dataset images are showed in Fig. 4.

FIGURE 4. - Samples of dataset

5. EVALUATIONS MEASURES

The comparison of proposed and standard techniques will be drawn by taking the Absolute mean brightness error (AMBE), Peak Signal-to-Noise Ratio (PSNR), Entropy and Contrast Gain respectively.

5.1 ABSOLUTE MEAN BRIGHTNESS ERROR (AMBE)

The purpose for computing AMBE is, how much illumination is preserved in advanced fundus image. It is the whole difference between mean of primary gray fundus image and improved fundus image [33].

$$AMBE = [E(X)-E(Y)] \quad (2)$$

Now, X is input image and Y improved and enhanced image and E (2) denotes mean. AMBE identifies enhanced intensity conservation of the fundus image. It mostly identifies the amount of distortion famous as extreme illumination change.

5.2 PEAK SIGNAL-TO-NOISE RATIO (PSNR)

It denotes area homogeneity for last subdividing. An upper PSNR value presents of improved results of enhanced images. PSNR in calculated in decibels (dB) is calculated by next equations (3).(4): [34]

$$PSNR = 20\log10\,(255/MAE) \quad (3)$$

$$MAE = 1/MN \sum\sum |F(i,j) - f(I,j)| \quad (4)$$

Wherever, 255 is max of pixels' number and MAE is abbreviation of t mean- absolute error. The F (i, j) is a segmented image and f (i, j) - source image that holds M by N pixels. The higher PSNR value represents the better quality of the output image. The PSNR value styles infinity the mean absolute error (MAE) which displays a higher image quality. Oppositely, a minor value of the PSNR involves high statistical variances between images [35]. In image enhancement PSNR values were applied for evaluating the segmented images and results in the numerical evaluation mode.

5.3 ENTROPY

The median information content identified as entropy is utilized to calculate image feature. Higher the value of entropy, further the information satisfies in the image.

$$ENT = \sum I(1)\, logI(1) \quad (5)$$

The ENT (i) denotes entropy, I(l) is density function of image taking l intensity point with L amount of gray points [36].

5.4 CONTRAST GAIN

Contrast gain is the gain showed in the signal of the suggested technique. This rises the accuracy of the signal at the required range [37]. This also increases the signal power. Contrast gain is an important parameter. This parameter expresses the gain of the signal. Now one is the input signal procured primarily for the advance for the underwater images [38].

6. RESULT

A quantitative measurement used to evaluate the performance of our technique. Table 1. compares the AMBE value measures results for two techniques. From Table 1, we observe that CLCOA technique can apply better brightness values from the standard CLAHE technique. however, CLCOA make images with high and good enhancement [39].

Table 1. – AMBE values

Im.no	Standard CLAHE	Proposed Technique
1	8.9342	9.2346
2	8.8842	9.1942
3	9.0002	9.2389
4	9.0076	9.2002
5	9.1698	9.3011
6	9.1978	9.3060
7	9.0342	9.2963
8	9.0142	9.2306
9	8.9302	9.2712
10	9.0042	9.2091

Peak signal-to-noise ratio (PSNR), that is best frequently applied as a measure of quality of reconstruction in image compression and images/videos enhancement [40]. It is approved to evaluate quantitatively and goodness for the outcomes and enhanced images. As displayed in Table 2. below our technique has achieved well level of enhanced matched to another technique.

Table 2. – PSNR values

Im.no	Standard CLAHE	Proposed Technique
1	11.2725	12.8734
2	11.2788	12.1942
3	11.4869	12.7635
4	11.9645	12.8742
5	11.6420	12.3742
6	11.7431	12.0761
7	11.0974	12.9871
8	11.9800	12.9764
9	11.9710	12.8762
10	11.2809	12.8530

From the comparison shown in Tables 3 and 4 respectively, our CLCOA results in the largest entropy and contrast gain when comparing with normal CLAHE technique which that mean produced a better enhanced images. Finally, some samples of enhanced images which produced by CLAHE and CLCOA techniques are showed in Fig. 5.

Table 3. – Entropy values

Im.no	Standard CLAHE	Proposed Technique
1	4.7256	5.0624
2	4.9647	5.2731
3	4.8885	5.2963

4	5.2430	5.8213
5	4.7530	5.1235
6	5.0621	5.4531
7	5.1572	5.7601
8	4.9823	5.2771
9	4.9013	5.5645
10	5.1983	5.3001

Table 4. –Contrast gain values

Im.no	Standard CLAHE	Proposed Technique
1	2.7641	3.3520
2	2.0034	2.6745
3	2.2984	2.7864
4	2.1453	3.1265
5	2.6598	3.2091
6	2.5768	3.2321
7	2.5982	3.1093
8	2.9984	3.3421
9	2.9201	3.3201
10	3.1076	3.4640

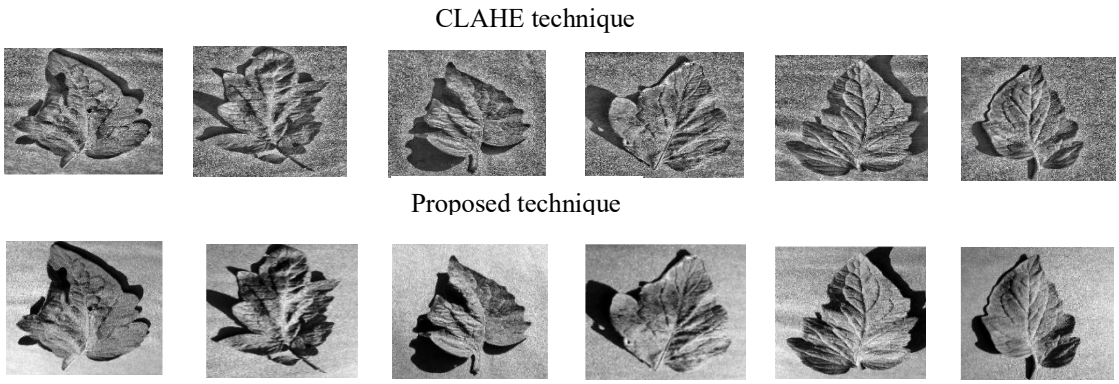

FIGURE 5. - Samples of enhanced images by CLAHE and proposed technique

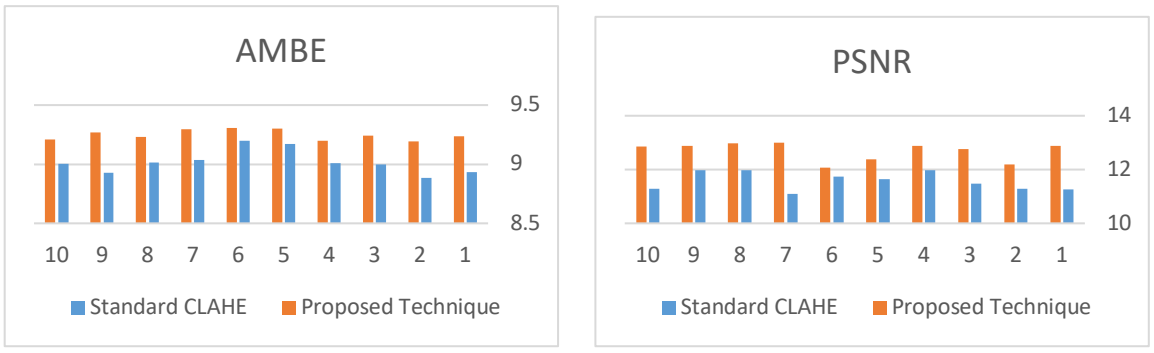

FIGURE 6. - (a) AMBE values for two techniques; (b) PSNR values for two techniques

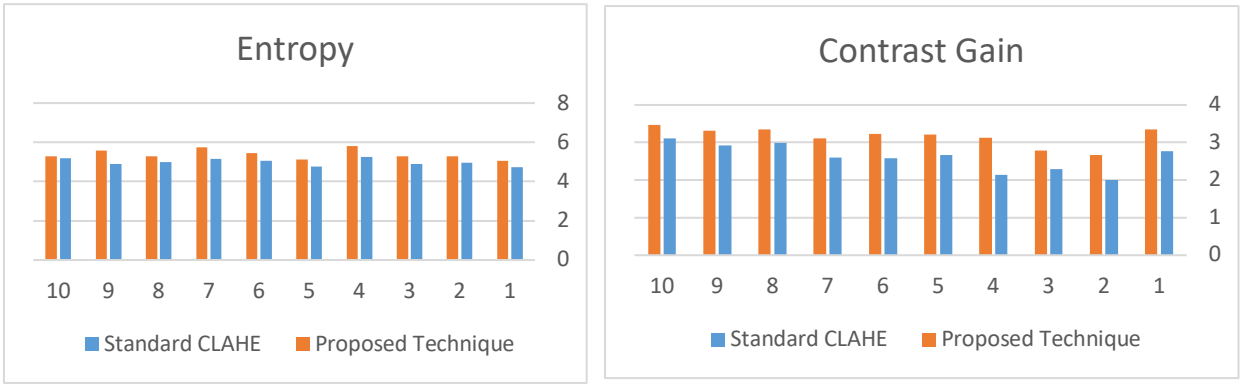

FIGURE 7. - (a) Entropy values for two techniques; (b) contrast gain values for two techniques

In the next Fig. 6, it is observed that the performance of CLCAL was higher in terms of AMBE and PSNR levels. It recorded good and better values for enhanced images. It is observed that the standard CLAHE technique has lower values for all images. In turn, for the entropy and contrast gain measures. The Fig 7 shows the results achieved for the enhancement using 10 images was generated higher entropy and contrast gain values. Finally, the proposed technique obtains the best values in terms of AMBE, PSNR, entropy and contrast gain when it compared with standard technique

7. CONCLUSION

Image pre-processing is extreme needed for a well image evaluation. A reason for color image processing, color image enhancement considers the mainly worried subject as distortion in the color image will influence the future analysis process as segmentation adversely and later this deformation can be separated across enhancement techniques as much as likely. In this paper, a useful image enhancement technique has suggested, where using cat swarm optimization algorithm (CSOA). The use of swarm intelligence whereas enhancing the image and the common of current study emphasis in natural images. Tomato plant images have been used as data set to apply the proposed technique for enhanced images. In addition, a proposed technique has implemented using image processing toolbox in MATLAB. It can be exactly utilized in various little illumination images without any pre-processing and conditions. Experimental results show that the proposed algorithm is tough and successful. It was compared with standard CLAHE technique and the quantitative test AMBE, PSNR, Entropy and Contrast Gain results. The graphic results show the advantage of the proposed technique over the standard technique. In future work, it can use the proposed technique with other types of images. Also. It can use another optimization algorithm for plant image enhancement.

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CONFLICTS OF INTEREST

The author declares no conflict of interest.

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