Improved the Performance of Brightness Preserving DWT and SVD based Image Enhancement for Color Images

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Abstract- Image enhancement has a considerable arrangement within view based applications. Recently significant work is done and results performed in digital image enhancement. This paper states a modification of the low contrast improvement approaches which are good singular value decomposition (SVD) regarding retaining the particular signify settings of a given image. Although SVD-based approaches enhance over the contrast illustrations or photos by means of scaling its singular value matrix, they could not produce satisfactory results for some low contrast image. The whole objective of this research work is to boost the image improvement procedure further. The novel method could be capable of enhance the accuracy rate of image enhancement in which it will utilize cuckoo search algorithm as well as the use of swarm intelligence while enhancing the image to enhance the results further. In this we have used Ant Colony Optimization (ACO) and Particle swarm Optimization (PSO) with Cuckoo search algorithm to enhance results as well as Cuckoo search has ability to find optimistic adjustment factor. Therefore it will provide more optimistic results also to preserve edges further by using trilateral filter. It has been found that image enhancement using cuckoo search is better than SVD, ACO and PSO. This paper finally winds up the several boundaries regarding earlier approaches.

Keywords: Image enhancement, Singular Value Decomposition, Particle Swarm Optimization, Ant Colony Optimization, Cuckoo Search.

1   INTRODUCTION

Image Enhancement is essentially a simplest and attractive part of digital image processing. Image enhancement is process used to boost the general superiority in the corrupted images may be attained utilizing enhancement mechanisms .So which the eye can smoothly notice important object top features of the images. It is really helpful to remove the inappropriate artifacts in the pictures like noise or brighten the photograph plus it to identify main features after which it appears enhanced. It is actually an individual part of digital image processing. To develop a graphic display more employed to visualize and examination, it recovers the image features like edges or boundaries. It enlarges the dynamic selection of composed characteristics. This doesn't improve the inherent content of information.

Fig. 1.Image Enhancement [9]

1.1Need of image enhancement

The idea of image enhancement is always to increase the image top quality therefore the processed image surpasses the key image to obtain a particular software or list of ambitions [1].. Graphic editing encompasses this functions associated with transforming images, if they tend to be digital camera images, standard photochemical images, or designs. Standard analog impression editing is referred to as image editing designs having just about any standard artwork channel. Graphic software programs, which can be broadly arranged into vector visuals writers, raster visuals writers, and also 3D modelers, are classified as the major equipment having which often the end user may adjust, increase, and also modify pictures [22].

1.2 Singular Value Decomposition (SVD)

This approach has been considered to increase the low compare picture and overcome the limitations from the histogram equalization techniques. The singular value equalization (SVE) method is begun on equalizing the single value matrices by SVD. SVD of an image, that can be translated as a matrix is:

$$B = U_Q \, \Sigma_Q \, V^{'}_{\,Q}$$

Wherever U_Q and V_Q are orthogonal square matrices respectively and Σ_Q matrix products set simple values on the key diagonal. The concept of utilizing SVD for image equalization arises from that recognized certain fact that Σ_B products the particular level data of specific image [18]

1.3 Discrete Wavelet Transformation-Singular value Decomposition (DWT-SVD)

The 2-D wavelet decomposition of a graphic is conducted by making use of 1-D DWT across columns. That approach decomposes a reduced distinction feedback image in to the four subscription parts namely LL, LH, HL, HH by utilizing DWT and estimates the Single value matrix of the low-low subscription band image. DWT-SVD approach reconstructs the increased image during the Inverse DWT [18].

1.4 OPTIMIZATION TECHNIQUES

Computational intelligence (CI) is usually about the most approaches associated with Artificial intelligence (AI). CI is primarily adapted to optimize the complicated problems. Optimization is used to determine the greatest solution out of the solution space. Numerical function optimization acts a crucial role in optimizing the target function. Several of the marketing algorithms employed for optimizing the numerical functions is usually categorized into evolutionary computing plus metaheuristic methods. (Swarm Intelligence (SI), Genetic Algorithm (GA) comes within evolutionary computing plus Simulated Annealing (SA), Tabu searches (TS) plus hill climbing comes within metaheuristic methods. [21]. Some of the optimization algorithms are discussed below:

1.4.1 Ant Colony Optimization

ACO offers been made to be a population mainly structured Meta heuristic that is effectively placed on to a number of NP-hard combinatorial problems. The true ACO could be the most current procedures for expected search engine marketing methods. The principle theory will be its roundabout population conversation amongst individuals on the population involving fabricated ants. The central part of ant's activities is the contact between your ants through compound pheromone tracks, which allows those to find direct pathways amongst their particular home plus meal resources. The purpose of pheromone is actually to influence another ant ahead of the aim tips. This step connected with authentic would like cities exploited. The ACO is actually features about three major stages; initialization, pheromone change plus resolution stage. A number of these stages of development help to make an overall research to entire optimum. First of the 1st iteration, many ants research with little thought to your most effective answer connected with affirmed trouble in the possible resolution area, plus outdated would like types is actually made with initialization period. Following of which, level of Pheromone is perfectly up to date. Inside a better solution level, fresh would like community is actually made predicated in the perfect resolution through the old would like colony. Then, the perfect choices connected with a couple of cities will be compared. For the ending connected with the 1st iteration, achievable resolution area is actually lessened having a vector of which tutorials this bounds connected with research area regarding the time of your ACO program. Highest solution is and then reviewed in the lessened research area throughout the algorithm formula improvement. The ACO reaches to the international best when ants acquire ways in the restricted space. [19]

1.4.2 Particle Swarm Optimization

Particle Swarm Optimization (PSO) is one of the recent heuristic algorithms that may be put on nonlinear and non on going marketing problems. That is a population-based stochastic search engine marketing way of continuous nonlinear functions. PSO was made in 1995 through Dr. Adam Kennedy, a social psychologist, and also Medical expert. Russell Eberhart, a power engineer. PSO term points out to a relatively novel category of algorithms that'll be used to find greatest (or in close proximity to optimal) ways of numerical and qualitative problems. That truly is easily carried out in many coding dialects and has exhibited both quite effective and fast when located on the diverse group of marketing problems. PSO was discovered during ruse of an simplified bird flocking model. Dr. Kennedy and Dr. Eberhart explained in Particle swarm search engine marketing has root base in two main feature methodologies. Probably more visible are it ties to manufactured life (A-life) generally, also to parrot flocking, seafood training, and swarming theory specifically. The coders of PSO discussed in Molecule swarm search engine optimization as produced by Kennedy and Eberhart are made up a simple strategy, and paradigms might be located set up in a few lines of computer code. It requires only ancient numerical providers, and it is also computationally affordable in conditions of both storage space requirements and quickness. [19]

1.4.3 Cuckoo Search Algorithm

For ease in detailing our new Cuckoo Research, we have now utilized the pursuing three idealized guidelines:

1) Each cuckoo lays one egg at exactly the same time, and eliminates its egg in arbitrarily preferred nest;

2) The most effective nests with high quality of eggs can take around to another years;

3) The quantity of available quantity nests is set, and the egg placed with a cuckoo is learned by the number bird with a possibility pa ∈ [0, 1]. In this case, the number bird may both chuck the egg out or depart the nest, and create a brand-new nest [4].
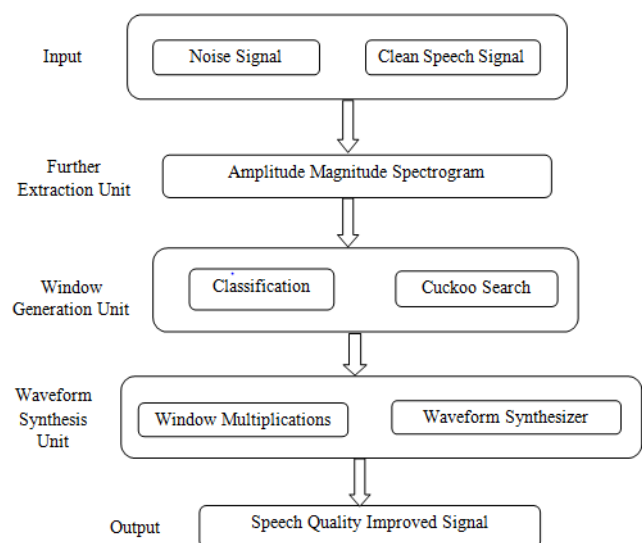

Fig.2. Block diagram of Cuckoo Search [8]

Cuckoo Search Algorithm Cuckoo Search (CS) is one of the latest search engine optimization formulas and was made from the inspiration that the obligate brood parasitism of some cuckoo types arranged their eggs in the nests of other variety birds which are of other varieties. In Cuckoo Research, three idealized guidelines are believed which says that all cuckoo rests one egg at any moment, and eliminate its egg in arbitrarily opted for nest. The 2nd principle boasts that best nests with good quality of ova may bring over to another generations and the 3rd one says that just how many accessible variety nests is set, and the egg established by using a cuckoo is available out by the variety rooster with a possibility in the runs 0 to at least one 1. In cases like this, the variety chicken may often toss the egg out or reject the house, and create a new nest. It could be believed that the clear cheaper nest is changed by new nests [4]. For maximization problem, the traditional or exercise of a remedy may only be proportionate to the worthiness of desire to function. The algorithm is based on the obligate brood parasitic action of some cuckoo varieties with the Levy flight tendencies of some birds and berries lures. The approach found in that benefit sound damping and presentation development method includes three key models particularly; Feature extraction product, perfect screen generation product and waveform synthesis device. Originally, the original and sound presentation indicate is provided as input to get features and eventually, perfect screen is developed with the use of cuckoo search. Subsequently, in the waveform synthesis product, blocked waveforms are windowed and then multiplied by the perfect screen value and summed up to achieve the increased quality signal. The block diagram of the suggested method is disclosed in fig 2.

For simplicity, that previous prediction may be approximated by the portion pa of the d nests are modified by new nests (with new individual judgments alternatives). For maximization problem, the typical or exercise of a remedy may only be proportional to the worthiness of desire to function. Other types of exercise may be acknowledged in the same solution to the exercise function in hereditary algorithms. For straightforwardness, we're able to utilize the chasing easy representations that every egg in a home shows a remedy, and a cuckoo egg stand for a brand new option, the goal is to utilize the completely new and probably better alternatives (cuckoos) to improve a not-so great option in the nests. Naturally, that algorithm may be widened to the more difficult event everywhere each home has multiple eggs representing several solutions. As a result of this provides work, we will utilize the best methodology wherever each home has only a straightforward egg [8].

1.5 Trilateral Filter

Single-pass nonlinear filter systems for edge-preserving smoothing and along with image depth removal for M sizing signs in computer design, image handling and computer eyesight applications. Nothing like bilateral filtration systems or may be anisotropic diffusion methods that gentle towards piecewise constant alternatives, the trilateral filtration offers better sound reduction greater outlier removal in high-gradient locations, and yes it mimics the edge-limited smoothing patterns associated with shock-forming PDEs

simply by place region finding with a straightforward min-max stack. However the trilateral filtration system needs only one user-set parameter, filter systems an input sign in single cross, as well as doesn't performs iterative solver if needed simply by many PDE methods. Like the bilateral filtration system, the trilateral purification effortlessly gets to M-dimensional impulses, nevertheless furthermore, it offers improved productivity for most aesthetic applications including appearance-preserving comparison reduction harm to portrait digital photography and denoising polygonal meshes. Trilateral filter is a recently reported filtering technology which can preserve edges and remove noise as well as the benefits of trilateral filter, which not only enhance image contrast and avoid "halos" but also preserve edges and texture [25].

The brand new trilateral filter shown here combines two revised bilateral filtration systems with a new image-stack system for fast region finding to avoid these problems. It is innovative efforts are usually:

1. Tilting: It is filter property windows is definitely manipulated and also curved with the bilaterally smoothed photograph gradient vector $H\varphi$ to hold loss on high-gradient places [23].

2. . Versatile Region-Growing: The neighborhood area and also domain names on auto-pilot adapts to be able to local image characteristics to be able to even reliable achievable place concentrating on the same smoothed gradient strategy [23].

3. One Parameter: Although trilateral filtration uses 7 interior guidelines (sc, scq, sr, srq, fq, R, b), all can be produced from an individual user-supplied value scq [23].

2. RELATED WORK

Atta et al. (2015) [1] offered a alteration of the low distinction improvement methods that will derive with the single worth decomposition (SVD) suitable for keeping the exact imply intensity of a picture While using the planned method, this measured sum of single matrices with the suggestions picture as well as world-wide histogram equalization (GHE) picture is worked out to discover the single worthy of matrix with the equalized image. Bhandari et al. (2015) [2] explained basic policy for an enhanced and effortless approach intended pertaining to enlargement regarding darkish plus low kind the comparison satellite TV for pc image based on knee operate in addition to gamma static a static correction utilizing underneath the radar wavelet adjust having single value decomposition (DWT–SVD) may be thought out meant for quality improvement associated with credit. Pathak (2015) et al. [3] proposed image enhancement may be used to increase a digital good quality regarding image. It is really employed to help the stream-lined good quality regarding graphic which is too adapted to increase negative good quality regarding graphic into very good image. This kind of component recommends combo of global and local method for distinction graphic improvement. Global contrast graphic augmentation enhances reduced difference regarding graphic in the around the globe way. This kind of overall enhancement avoids noises along with other phoning items of an stimulating image. In global variations graphic enhancement when higher evaluation

occurs. Ghosh et al. (2014) [4] discussed the capacity for a new marketing criteria. The actual Cuckoo Find protocol all through tuning the actual impression development features pertaining to peak performance. The actual evaluate has long been carried out in relation to a pair of using the previous optimization protocol helped improvement, exclusively, Ancestral Algorithms plus Particle Swarm Marketing and sooner improvement methods Histogram Equalization plus Linear Big difference Grow methods. Jiezhang Cheng et al. (2014) [5]researched the pictures connected with outdoors displays received throughout haze, haze along with other local weather a short time usually have terrible distinction along with coloring reliability. Within this information, in order to efficiently enhance the degraded reflection throughout haze superior, decline the effect of the haze in order to outdoors targeted visitors online video media supervision methods, we considered the picture corrosion motive along with unclear process connected with photo throughout haze. Agarwal et al. (2014) [6] have researched in health care image handling; lower assessment image studies is a challenging problem. Minimal variance digital images lower the ability for audience in learning the image. Histogram established techniques are being used to increase an evaluation of most kind of health care images. They would actually request those form of health care images. These varieties of procedures are used to determine particular regions of many forms of cancer regions together with low-dose CT images, they are used to raise little anatomies similar to blood vessels, bronchi nodules, inhaling and exhaling along with breathing out phrases along with lung fissures. The very best procedure used in variance advancement will be Histogram Equalization (HE). Negi (2014) et al. [7] summarized Image Enhancement is primary events in Picture control. During this procedure, the main picture is ready meaning that the ensuing picture is more appealing than the main intended for certain applications. Preprocessing a picture consist of eliminating disturbance, limit or maybe limit enhancing, intelligent advantage analysis, smart compare modification and also segmentation. Picture enlargement can be a summary control strategy simply. A picture enlargement strategy familiar with method graphics can be amazing for the certain nevertheless precisely the same consequence is commonly not necessarily okay enough intended for another. Picture enhancement can be an affordable method i.e. it does not connect any extra facts to help the main image. Amira Bouaziz et al. (2014) [8] proposed the grade of finger print images strongly influences any fingerprint biometric system. To enable you to care for poor fingerprint images and overcome the limitations of conventional enhancement techniques, a cuckoo-search based formula for fingerprint image compare enhancement is proposed during this paper. The formula combines the by using cuckoo seek out both off white level mapping method of contrast augmentation, and the latest objective are being a fantastic metric for global fingerprint image augmentation. Therefore, the projected algorithm has proved to be extremely powerful for fingerprint image quality improvement for further control .Mathew et al. (2013) [9] offers a brand new satellite TV for pc photograph decision and as well perfection progress method in line with the

discrete wavelet alter (DWT) and as well singular worth decomposition (SVD) is still planned. Satellite TV pictures included in a great deal of apps as an illustration geosciences reports, astronomy, and as well geographical information programs. The particular method additionally quotes the particular fresh worth matrix while using the low–low striped bass speaker wedding band associated with histogram equalized photograph and alters equally fresh worth matrices to acquire perfection superior graphic. The particular method is actually balanced with conventional photograph equalization techniques for illustration common recurrent histogram equalization and as well community histogram equalization. Gupta et al. (2013) [10] defined the many existing steps for that improvement linked with darker photographs; it is often detected in case the photographs possess a number of notable place, then items will become more smart as soon as utilizing the people techniques. The design offers appeared using this obtainable downside. Around this informative article be offers improved this parameter utilized previous.
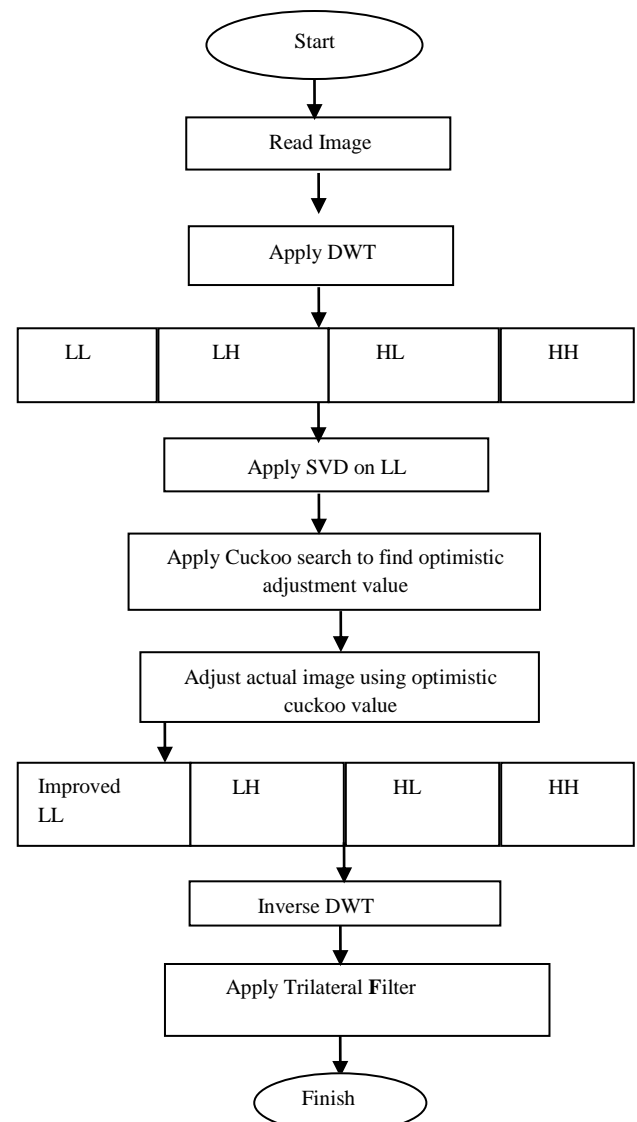
3. METHODOLOGY

Fig.3. Flowchart of the proposed technique

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1. Select any input Image of size M*N from computer storage.
2. Implement 2D-DWT on input image that will split an image into four sub images namely LL, LH, HL and HH.
3. Apply SVD on LL sub band of DWT to improve the mean illumination of the actual image.
4. Apply cuckoo search to find the optimistic adjustment value.
5. Then actual image is adjusted by utilizing optimistic cuckoo value.
6. The new improved LL sub band image is obtained by inverse SVD.
7. Rebuild the decomposed image using inverse DWT.
8. At last step, the trilateral image filter is applied on image to conserve the edges.

4. RESULTS

For experimentation and implementation the proposed technique is evaluated using MATLAB tool u2013a. The evaluation of proposed technique is done on the origin of following parameters i.e. Entropy, peak signal to noise ratio (PSNR), and mean square error (MSE), based on different images.

Moundou   4(a)   Output   SVD   (b)

Output ACO(c)   Output PSO (d)
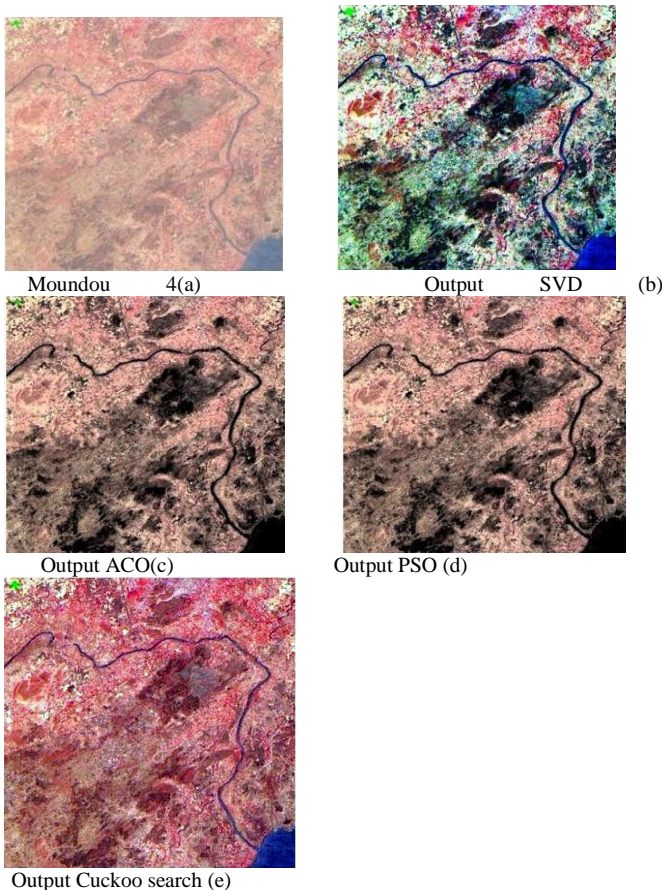

Output Cuckoo search (e)

Fig.4. Evaluation on Image Moundou

Figure 4(a) Moundou image showing the remote sensing image. Image (b) shows the O/P enhanced image using SVD, Image (c) shows the improved image using ACO, Image (d) shows the further improved image using PSO. Image (e) shows the O/P result of cuckoo search. Overall results indicate that the spatial resolution of proposed image is comparatively more than other techniques.

Great Barrier Reef 5(a)   Output SVD (b)

Output ACO(c)   Output PSO (d)
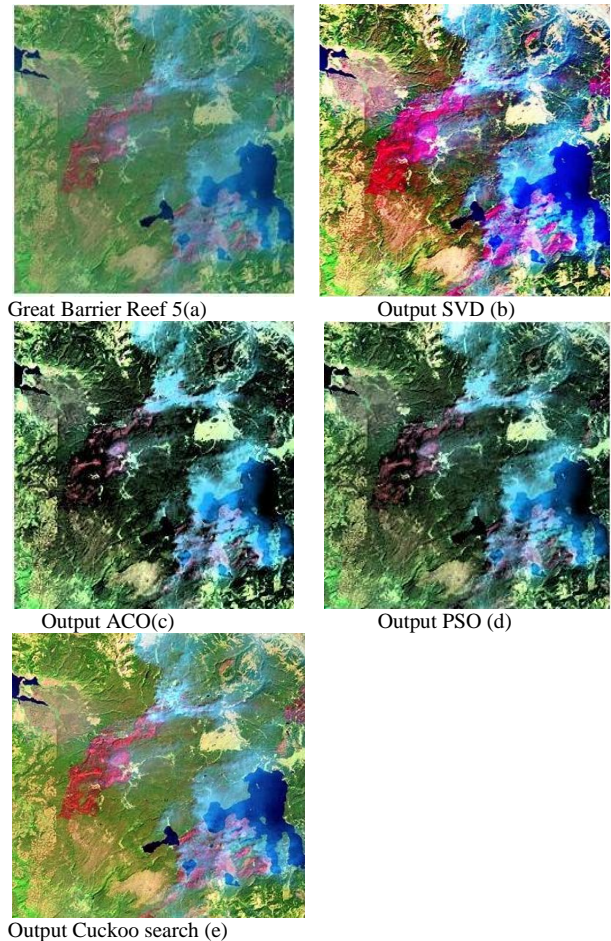

Output Cuckoo search (e)

Fig.5. Evaluation on Image Great Barrier Reef

As shown in above figure of Great Barrier Reef, the figure (a) is the original image. This is remote sensing image with low brightness. The (b), (c) and (d) are the result image after using SVD, ACO and PSO respectively. Figure (e) is output image after Cuckoo search technique i.e. proposed technique which represent more enhanced image.

1. Entropy

Discrete entropy is employed to determine the content of an image .Higher the value of discrete entropy shows richer the information within an image. Discrete entropy can be calculated by using Equation (1).

$$H = -\sum_{s=0}^{255} j(s) \log_2 j(s) \qquad (1)$$

Here j(s) is the universal normalized histogram of the processed image [1].

Table1. Comparison table of Entropy

IMAGES	SVD	ACO	PSO	Cuckoo search
Moundou	6.7873	5.1993	5.1077	7.2859
Great Barrier Reef	6.8301	4.1974	4.1013	7.5628
Africa	6.5782	4.1948	6.1089	7.6278
Aleutian Clouds	6.7307	6.1910	5.1042	7.6732
Andes	6.8409	6.1935	5.1024	7.5084
Araca River	6.8531	4.2005	5.0994	7.6086
Atlas Mountains	6.8339	6.1963	6.0991	7.6448
Bogda Mountains	6.7433	5.2042	6.0985	7.5594
Broutona	6.8652	6.2698	6.1025	7.4330
Colorado's Fire Zone	6.8129	6.1948	4.1014	7.4297

Table 1 demonstrates results of entropy values on given images by various methods. Depending on results of Table, a careful examination of this entropy values indicates that our method (CS) creates rather superior normal entropy value through that regarding SVD, ACO along with PSO. Cuckoo search entropy which gives more enhancement in images due to increase entropy. Proposed algorithm has outperformed over available techniques in terms of entropy. As from table1 it is evaluated that mean improvement in entropy in case of CS is 0.787, 2.301 and 2.402 as compared to SVD, ACO and PSO respectively.
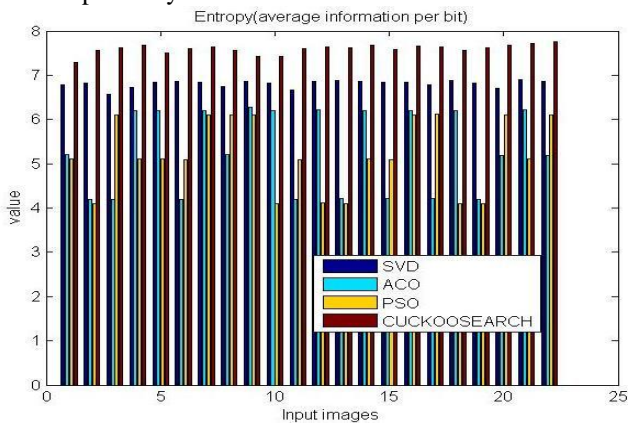

Fig.6. Comparison Graph of Entropy Value

In this graph, it has shown higher value of proposed entropy i.e. lesser in other techniques. The following enhance shows enhancement in the objective quality of the image.

2. PSNR - Peak square noise ratio is the proportion between maximum possible value of the transmission and the power of the corrupting noise. It is measured in decibels (db). It could be explained as:

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \qquad (2)$$

Here, MAX_I is the utmost possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. Mean square error (MSE) is defined as where M*N is the size of the original image. MSE is representing the MSE between the given input image and the original image. Higher the PSNR value is, better the reconstructed image [24].

The values of Peak signal to noise ratio are revealed below in the comparison Table

Table 2. Comparison table of PSNR

IMAGES	SVD	ACO	PSO	Cuckoo search
Moundou	37.2556	36.9944	36.9944	39.2666
Great Barrier Reef	37.1655	37.1405	37.0685	42.3452
Africa	36.6174	36.9944	36.9944	45.4467
Aleutian Clouds	36.8284	36.9944	36.9944	44.1445
Andes	37.1975	36.9947	36.9944	44.4175
Araca River	37.2063	37.5239	37.4431	43.2155
Atlas Mountains	37.1612	36.9968	36.9947	41.1817
Bogda Mountains	36.8326	37.0788	37.0058	45.4619
Broutona	37.3485	37.9968	37.1522	41.0499
Colorado's Fire Zone	37.1215	37.2483	37.0803	45.9126

From the table 2 it is shown that the values of PSNR of different remote sensing images. Here we compare PSNR value of different techniques. As the PSNR is higher the quality of image is good. PSNR of cuckoo search i.e. proposed technique gives higher value than SVD, ACO and PSO techniques. As result we get more enhanced image using proposed technique. CS has outperformed over available techniques in terms of PSNR. As from Table 2 it is evaluated that mean improvement in PSNR in case of CS is 6.813, 6.794 and 6.895 as compared to SVD, ACO and PSO respectively.
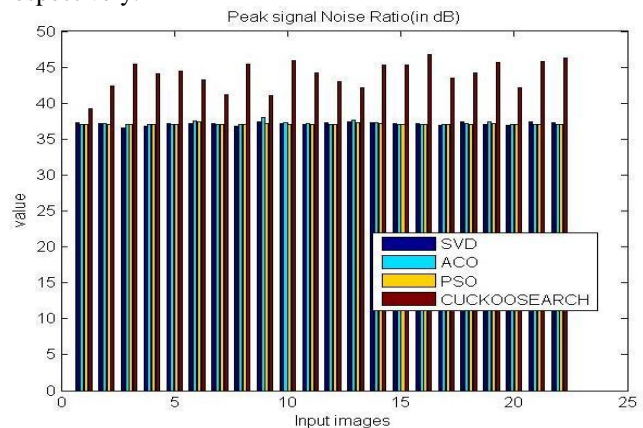

Fig.7.Comparison Graph for PSNR Value

Figure 7from the plot there is increase in PSNR value of images with the use of Cuckoo Search over other methods. This increase represents improvement in the objective quality of the image.

3. MSE – Mean square error is to compute an error signal by subtracting the test signal from the reference, and then computing the average energy of the error signal. It can be explained as:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(f(i,j) - f'(i,j))^2 \qquad (3)$$

Where f (i, j) and f′(i, j) denotes intensity at location (i, j) in the input and processed image respectively [24].
The values of Mean square error are shown below in the comparison Table

Table 3.Comparison table of MSE

IMAGES	SVD	ACO	PSO	Cuckoo search
Moundou	0.9247	1.034	1.027	0.5063
Great Barrier Reef	0.9506	0.9572	0.9780	0.2013
Africa	1.1196	1.0123	1.076	0.1795
Aleutian Clouds	1.0510	1.0193	1.134	0.1263
Andes	0.9410	0.9999	1.022	0.2082
Araca River	0.9385	0.8533	0.8742	0.1347
Atlas Mountains	0.9513	0.9993	0.9999	0.2192
Bogda Mountains	1.0497	0.9750	0.9966	0.1412
Broutona	0.8994	0.9993	0.9538	0.3200
Colorado's Fire Zone	0.9626	0.9268	0.9746	0.2691

Table 3 is demonstrating the quantized investigation of the mean square error. As mean square error must be reduced which means algorithm is displaying the greater results than the available methods as mean square error is less in every case. CS has outperformed over available techniques in terms of MSE. As from Table 3 it is evaluated that mean improvement in MSE in case of CS is 0.672, 0.694 and 0.721as compared to SVD, ACO and PSO respectively.
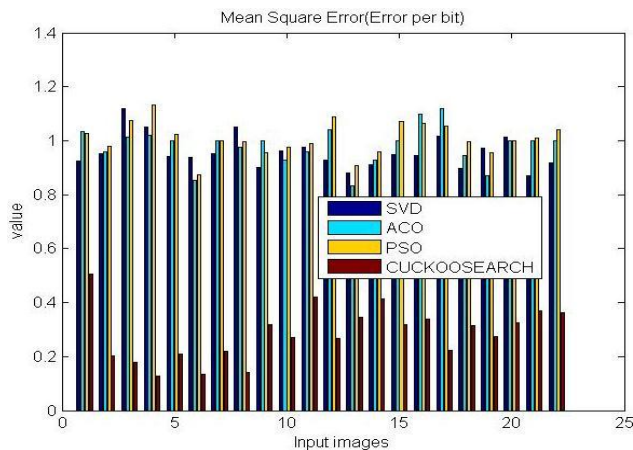

Fig.8.Comparison Graph for MSE Value

Figure 8 from the plot there is decrease in MSE value of images with the use of Cuckoo search method over other methods. This decrease represents improvement in the objective quality of the image.

5.CONCLUSION AND FUTURE SCOPE

The work has provided a good investigation on several image improvement techniques. This work usually means that many upgrades are required for throughout possible techniques to regulate distinct images. The work indicates that the absolutely no technique will work for any type of images i.e. it can significantly preserve the natural appearance of an input image. In the existing method, the effect of noise and edge preservation and use of swarm intelligence while enhancing the image is ignored and the majority of existing research focus in natural images. To get rid of this concern these studies features a revised approach. The reason for these studies tasks will be to boost the style enhancement process further. The newest approach is capable to boost the accuracy rate of image expansion in joyful manner by utilizing cuckoo search to find optimistic adjustment factor for DWT and SVD. The different images have been precisely taken for research purpose. Also distinct parameters has been considered to evaluate great and bad the proposed technique i.e. cuckoo search .The comparison between the earlier as well as the proposed strategy possesses clearly demonstrated the proposed method outperforms above the available methods. This research work has not yet deemed the particular hybridization inside unclear structured strategy together with swarm intellect procedure so they can improve the outcome further. Throughout future we will improve the accessible method in such a way that it can handle climate changed for the degraded images for instance foggy, obscure, dusty damp as well as dark.

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