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Image Enhancement of Gray Scale Images Using Improved Cuckoo Search

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Abstract

Image enhancement is the advanced approach for the improvement of an image. Multifarious techniques are available for image enhancement which improves the quality of an image. To enhance the image, meta- heuristic calculation has been demonstrated. This paper involves the image enhancement using one of the Meta heuristic algorithms, which is improved cuckoo search algorithm and used to achieve the highly effective results. The proposed method implemented on gray scale images and qualitative and quantitative correlation between existing and proposed work has also been done for image enhancement

Keywords: Cuckoo Search, Digital Image Processing, Image Enhancement, Meta-heuristics, Gauss Distribution, Qualitative Metrics

1 INTRODUCTION

Image enhancement is the most significant area in the digital image processing. This is the essential procedure of picture control. Picture upgrade implies the system of improving the visual appearance of a picture with the goal that resultant picture is increasingly precise and far reaching when contrasted with the first one, just as, is proper for human and machine discernment [13,14,21]. Main goal of this procedure is to modify certain traits of the picture in order to make picture appropriate for investigation and for specific application. This procedure is

subject to the spectator's conduct that makes a decision about the nature of the picture. It is done to upgrade the visual intrigue of the picture. It performs tasks like changing low difference picture to high complexity picture, altering brilliance of the image.

2 Cuckoo Search Algorithm (CS)

There are three principles as first, Eggs are laid by cuckoo at once and these eggs are placed it in an arbitrarily chosen home. Also, just eggs fulfilling the standard capacity will be taken to the consequent emphasis. Third, tally of existing host homes is kept consistent. Likelihood of identification of egg by have winged creature is taken as irregular variable in the interim [1].Quality of eggs is dictated by utilizing a wellness work [16].

Different advances were made in this field of meta-heuristic calculations to improve the current methods. It was seen that with the improvement in the calculation, proficiency of the upgrade method additionally improved which in the long run delivered a superior accentuated and upgraded picture. Cuckoo search discovers its applications in different areas, for example, in restorative imaging, unique mark investigation [5].Cuckoo Search has been affirmed to perform better both GA and PSO [11] in accomplishing the streamlined outcome in lesser time.

Thus, meta-heuristics give a lot of research to complete in field of picture upgrade that can be utilized to produce pictures with better and enhanced parameters and simultaneously improves the nature of the image [15]. Prime aim of this exploration is to develop an effective calculation that advance the parameters of the picture well and simultaneously improve the quality, complexity of the picture.

3 PROBLEM FORMULATION

3.1 Gaps in Existing Literature

State of art techniques i.e. Spatial and Frequency domain methods suffered from some problems like high complexity, uncertainty, difficult to control and lack of robustness. Biggest problem was that there were idiosyncratic in nature and required humanoid judgment to evaluate the quality of the image. Hence, various meta-heuristic algorithms were proposed which eliminate

the requirement of human judgment for evaluating the quality and performance of enhancement process. But there are certain limitations of each of the algorithms. These are listed as:

1. Genetic Algorithms defined the fitness function to objectively outline the superiority of the image but only operations were to be performed were cross-over and mutation to find determine the value of parameters and find out the global optimal solution. But GA guarantees local optimization but not the global optimization. Also result of each iteration depends on previous iteration solution, hence poor selection of the results may lead to poor results of enhancement. Moreover, GA is very time consuming.

2. PSO proved to be superior to GAs also has certain limitations as sometimes, state of particles can become un-exact and uncontrolled. This hampers the ability of the algorithm to arrive at global convergence. It requires the number of parameters to be optimized such as velocity in search space, step size etc.

3. Differential Evolution and Firefly algorithm also suffered from similar problems

4. Cuckoo Search Algorithm was proved to produce far better results than GA and PSO but also suffers from problem as it does not guarantee the global optimum. Cuckoo search algorithm use Levy Flight Distribution characterized by random walk and use fixed step size to determine the populace for the next iteration. With such random walk, fast convergence cannot be always guaranteed.

5. In the CS, there does not occur any information interchange among the individuals and search process is entirely independent.

6. Levy flights do not show ergodicity property.

3.2 Problem Definition

Motivation-There are many techniques of image enhancement which quantify the performance evaluation in a subjective way. Meta-heuristic algorithms eliminate this problem by making the transformation process objective. They use fitness function to evaluate the quality of the image.

GA, PSO and Cuckoo Search Algorithm use fitness function as objective metric of quality evaluation. But none of the method provides fast computation and high rate of convergence.

Cuckoo search algorithm suffers from certain problems of low convergence and precision. It makes the use of Levy Flight Distribution which performs random walk and such search is performed independently. Also Levy Flight distribution has infinite mean and variance.[16,20] At higher steps, solution expands very much which sometimes violate boundary condition. Search relies heavily on random walk, hence fast convergence is not guaranteed.[15] Hence problem is to increase the convergence rate and precision of Cuckoo Search Algorithm and at the same time, decrease the computation time so that better image results are generated.

3.3 Objectives

1. To study various meta-heuristic algorithms for image enhancement.
2. To study the performance of existing Cuckoo Search algorithm and determine the various parameters on which it can be gauzed
3. To propose the improved Cuckoo search Algorithm which use Gauss distribution instead of Levy Flight distribution as compared to original method.
4. To compare the proposed method with the existing technique on basis of parameters such as: value of fitness function, edgels, entropy value and computation time.
5. To calculate Feature Similarity Index Metric as measure of image quality assessment and compare its value with previous technique.

3.4 Methodology

In this research work, an improved version of improved Cuckoo Search Algorithm is proposed that attempts to improve all the related parameters of the existing algorithm and at the same time tries to improve the overall brightness, texture and contrast of the image. Algorithm is mainly governed by nature and way of solutions it generate in each iteration. Original algorithm manipulates flight behavior by using levy flight distribution to generate solution for subsequent iterations while proposed method makes the use of Gauss distribution whose mean and variance

can be controlled so that solutions do not go out of bound from the given range and at the same time tries to control precision of the values generated.

4 Proposed Method

Follow the following steps for proposed work :

1. First absolute populace of nests is instated and afterward each nest utilizing these four limitations p,q,r,k of change work is introduced that should be streamlined.
2. Each nest compares to an improved picture that fulfills the fitness function.
3. Only eggs or parameters fulfilling the fitness function will be taken to the consequent emphasis.
4. New nests are made at new position utilizing Gauss appropriation as characterized by condition (5) and (6)
5. Fitness of all nests is determined utilizing wellness work characterized in condition (4) and best home and best wellness is recorded as bestnest and Fbest.
6. Fitness of new nests is processed and contrasted and Fbest and Fitness with greatest worth is held as best worth.
7. And at last, upgraded picture is acquired utilizing best arrangement of parameters which relate to the best arrangement.
8. Post handling and perception is preformed to acquire the last upgraded picture.

The central point that should be instated to suitable qualities are number of nest (n), nest dispose of likelihood (pd), most extreme number of cycle (niter_max), window size for computation of nearby mean and difference. Fundamental goal is that estimation of wellness/target work must be boosted and simultaneously improve the general difference and brilliance of the image.Figure 3.1 given underneath speaks to the flowchart portraying every one of the means followed in the proposed improved cuckoo scan calculation for picture upgrade.

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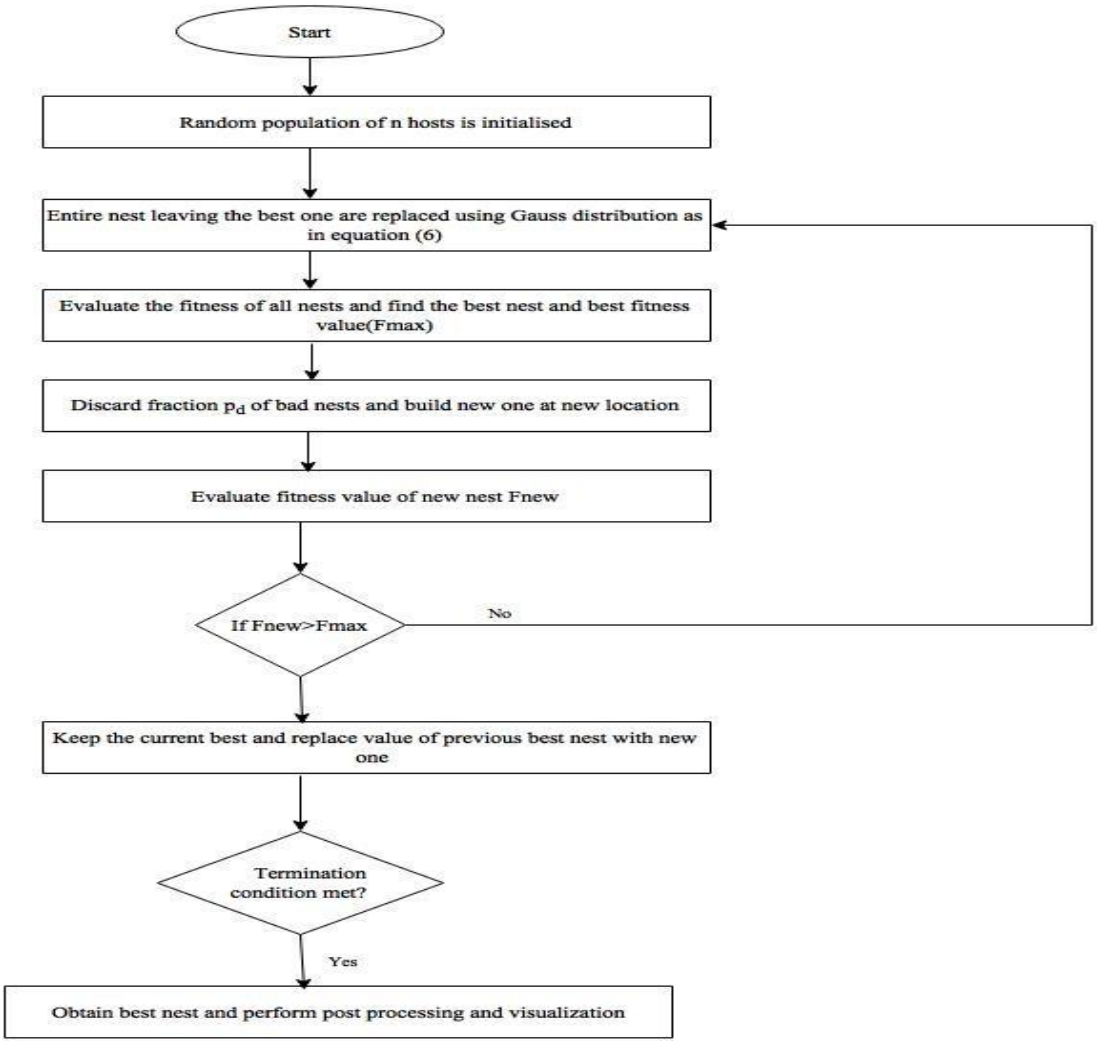

Figure 4.1 Flowchart of proposed algorithm

5 EXPERIMENTAL RESULTS AND COMPARISON

The proposed strategy was executed on certain pictures utilizing MATLAB [22]. The fundamental motivation of the proposed swork is to enhance the quality of an image as per edgels and entropy which establishes the wellness work. Expanded the edgels put high accentuation on the edges. Results acquired from the proposed strategy are made a decision against unique calculation .

The major factors used in improved algorithm are defined as:Total number of nests=15, nest discard probability p_d = 0.35, number of rounds=40.Window size for 2.Local mean and variance

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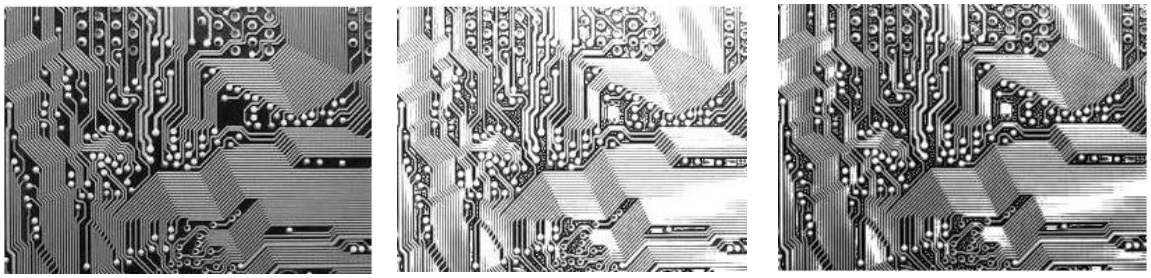
are computed using this window size. Main objective is that value of fitness/objective function has to be maximized and at the same time emphasize the general contrast and brightness of the image.

Results are classified into two categories-Qualitative and Quantitative Analysis. Qualitative analysis shows original image and image enhanced using original and proposed algorithm. Quantitative analysis represents the values of all performance metrics considered. Comparison of all values of parameters with existing algorithm is also done. Qualitative analysis represents images along with their enhancement results using existing as well as proposed technique.

As shown in the below provided figures, outcomes of various images from original and proposed method are evaluated and compared. Results clearly show that proposed approach results are much better than exiting algorithm.

5.1 Qualitative Results

Reenactment results (utilizing MATLAB instrument) of pictures utilizing unique and proposed calculation are spoken to beneath. Four pictures are utilized to show subjective examination of results. Figure 5.1-5.5 represents to the first picture, picture upgraded utilizing Cuckoo Search Algorithm and picture upgraded utilizing Improved Cuckoo Search Algorithm.



(a) Input Image (b) Improved Image with CS (c) Enhanced Image with Improved CS

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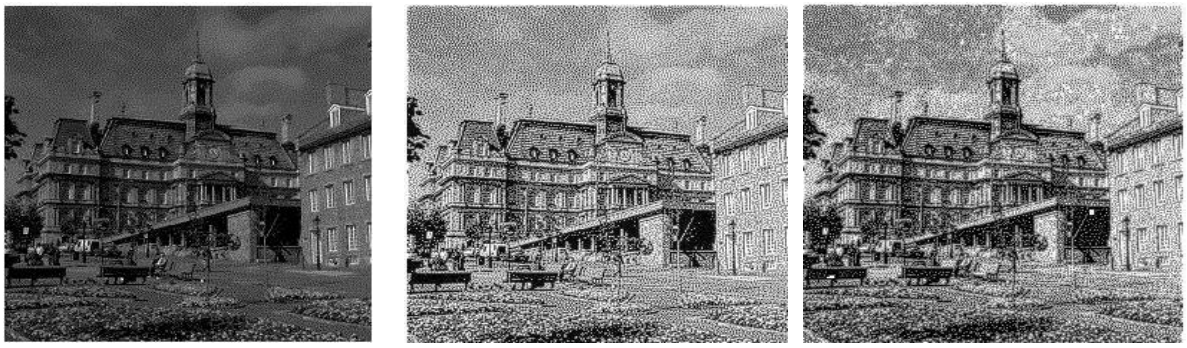
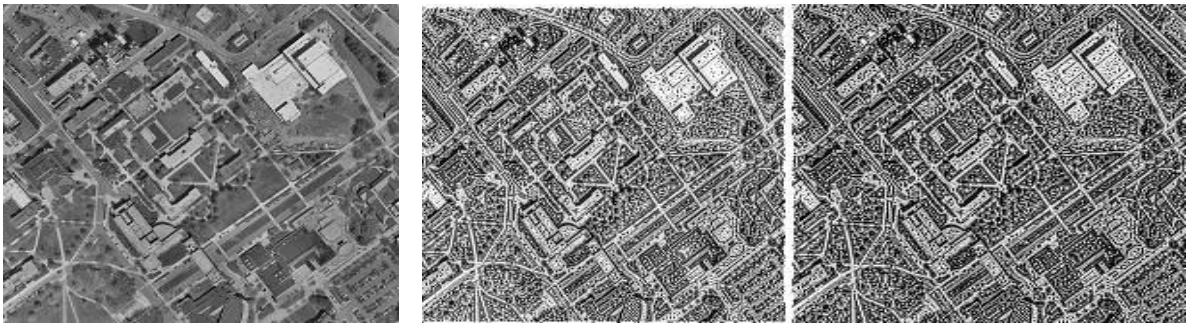


a) Input Image (b) Improved Image with CS (c)Enhanced Image with improved CS

(a)Input Image (b) Improved Image with CS (c) Enhanced Image with Improved CS



(a)Input Image (b)Improved Image with CS (c) Enhanced Image with Improved CS

Fig.5.1 Visual results of proposed method

Four images namely Circuit, Building, Forest, Land images are taken for qualitative analysis. It is clear from the visual analysis that results obtained using proposed technique are better than those obtained by existing technique.

5.2 Quantitative Results

Quantitative outcomes depend on estimations of execution measurements considered for the assessment of unique and proposed procedure. Table 5.1 given beneath shows the estimation of the considerable number of parameters registered for utilizing unique just as proposed calculation on the above pictures. Results unmistakably shows that qualities acquired utilizing proposed Algorithm are superior to those got by unique calculation.

Input Images	**Parameters**	**Existing Approach**	**Proposed Approach**
Image 1	Original Fitness	3.235	3.235
	Fitness of improved Image	6.1120	11.0756
	Computation Time	23.41	21.56
	Existing Entropy	7.7792	7.7792
	Enhanced Entropy	6.7044	15.0324
	RMSE	1.4256	1.2203
	PSNR	45.0794	50.2365
	BER	0.02244	0.0216
Image 2	Existing Fitness	3.952	3.8952
	Fitness of improved Image	8.7081	12.8142
	Computation Time	33.68	32.32
	Existing Entropy	5.7562	5.7526
	Enhanced Entropy	14.3885	15.5123
	RMSE	1.0033	1.0388
	PSNR	48.124	50.27
	BER	0.208	0.091

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Image 3	Existing Fitness	5.596	5.596
	Fitness of Enhanced Image	12.0856	14.7958
	Computation Time	22.58	22.66
	Existing Entropy	7.4625	7.4625
	Enhanced Entropy	14.4756	15.5196
	RMSE	1.6621	0.2170
	PSNR	43.717	66.4023
	BER	0.022	0.005
Image 4	Original Fitness	5.4025	5.4025
	Fitness of Enhanced Image	6.9125	9.0198
	Computation Time	18.36	18.25
	Original Entropy	7.3256	7.3256
	Enhanced Entropy	15.0525	15.4789
	RMSE	2.6728	2.2635
	PSNR	39.5822	51.0231
	BER	0.023	0.009

Table 5.1 Parameters Values with Original and Proposed Method

5.3 Graphical Comparison between existing and proposed research work

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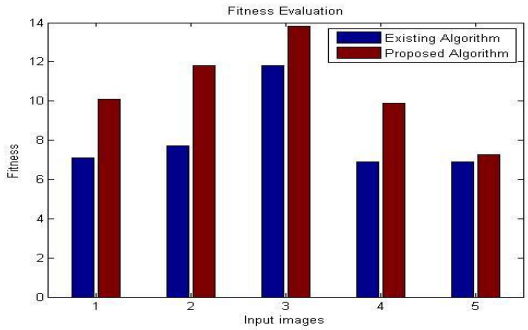
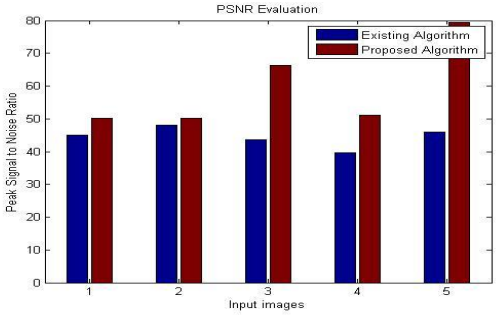
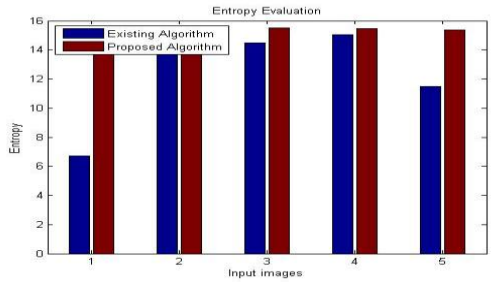


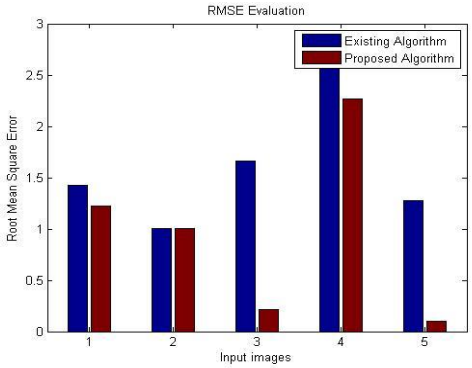
a) Fitness Value of Existing and Proposed Approach for multifarious images



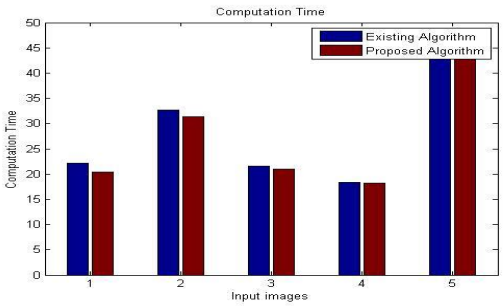
e) PSNR value of multifarious images using Existing and Proposed Approach



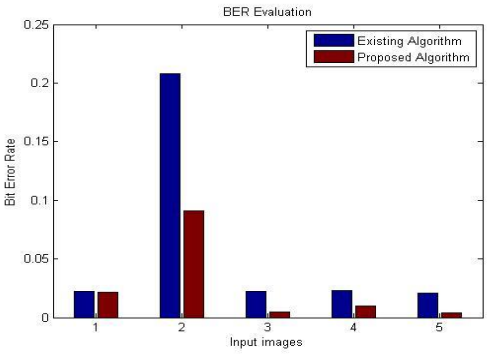
b) Entropy of various images using Existing and Proposed Approach



d) RMSE results of multifarious images using Existing and Proposed Approach



c) Computation Time for multifarious images using Existing and Proposed Approach



f) BER values of multifarious images using Existing and Proposed Approach

Figure 5. 2 Graphical representation of proposed work

6 CONCLUSION

Picture improvement is the technique which expects to upgrade or underline the significant qualities of the picture. Spatial and recurrence area techniques are two fundamental classes of picture upgrade. HE and LCS are customary strategies and experience the ill effects of flighty difference issue. Recurrence area strategies abuse recurrence spectra of the picture to improve it. Be that as it may, both spatial and recurrence area techniques are abstract in nature and require human translator to assess the picture quality. At that point to make this procedure objective, meta-heuristic calculations were presented. These calculations endeavor to characterize a target work that assesses the picture differentiation and surface scientifically. Genetic algorithms were the first to be used for this purpose. GAs are evolutionary algorithm but suffers from low convergence. PSO tried to solve the problem of GA but also has a limitation that it can become uncontrolled. Cuckoo Search algorithm poses a problem that true convergence to optimal solution cannot be guaranteed. So to overcome the limitation of Cuckoo Search algorithm, improved version of cuckoo search algorithm is proposed in this paper that makes use of Gauss distribution instead of Levy Flight distribution to generate optimized results. As Gauss distribution is controlled by its mean and variance, unpredictability of solutions can be controlled. Experimental results have shown that proposed technique produce better results both qualitative and quantitative. Comparison with existing technique is also done on the basis of some performance metrics.

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