Ant Colony Optimization Based Medical Image Enhancement

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Abstract: Medical imaging plays an important role in monitoring the patient's health condition and providing an effective treatment. However, the existence of several objects overlapping in an image and the close proximity of adjacent pixels values in medical images make the diagnostic process a difficult task. In order to overcome the above stated limitations, a new algorithm is proposed which will utilize to ant colony optimization to enhance the results further. Ant colony optimization has ability to find optimistic adjustment factor for better fuzzy based enhancement. Therefore has provided more optimistic results than available methods. Also to reduce ringing artifacts further gradient smoothing is used. The main scope of this work is to apply proposed technique for colored medical images.

Keywords: Image enhancement, ant colony optimization, medical images, gradient smoothing, color images.

I. INTRODUCTION OF IMAGE ENHANCEMENT

Image Enhancementis actually a easiest and appealing section of digital image processing. Image Enhancement is strategy applied to enhance the entire superiority of the corrupted photographs can be attained by using Enhancement mechanisms .So that the human eye can effortlessly detect the important thing options that come with the pictures. It's applied to eradicate the improper artifacts from the images like sound or enhance the photo and it in order to recognize principal characteristics and then it seems improved. It's a person section of digital picture processing. To create a visual present more beneficial to see and examination, it retrieve the photo characteristics such as for instance edges or boundaries. It enlarges the energetic range of gathered features. It generally does not boost the inbuilt material of data.

II. ENHANCEMENT TECHNIQUES

Enhancement techniques can be mostly divided into two parts [1]

a. Spatial Domain Method: It straight work on pixel. In spatial domain practices [1], we straight handle the picture pixels. The pixel prices are controlled to attain preferred enhancement. In volume domain strategies, the picture is first moved directly into volume domain. It means that, the Fourier Convert of the picture is computed first. All of the improvement procedures are executed on the Fourier convert of the picture and then your Inverse Fourier convert is completed to obtain the resultant image. These improvement procedures are executed in order to modify the picture perfection, comparison or the circulation of the gray levels. As a consequence the pixel value (intensities) of the output picture will be altered according to the change function applied on the input values.

The procedure can be composed as $g(i,j) = T[f(i,j)]$, where g is the outcome, f is the input and **T** is a process on f defined above a few neighborhood of (i,j).This technique is using the Eq. (1.1) [35].

$$g(i,j) = f(i,j) * h(i,j) \qquad (1.1)$$

The outcome of this change is mapped to the gray scale selection as we are working here just with gray scale digital images. Therefore, the email address details are mapped back in the range [0, L-1], where L=2k , e being the amount of portions in the picture being considered. Therefore, for example, for an 8-bit picture the range of pixel prices will be [0, 255]. I'll consider just dull level images. Exactly the same principle can be expanded for the colour photographs too. A digital dull picture may have pixel prices in the range of 0 to 255.

Figure 1: Showing the effect of Image Enhancement

Many different, often primary and heuristic methods [2] are used to improve images in some sense. The issue is, of course, not properly identified, as there's no goal calculate for picture quality. Here, we discuss several dishes that have demonstrated to be useful both for the human observer and/or for machine recognition. These methods are extremely

problem-oriented: a way that performs great in one event might be entirely limited for still another problem. In that report simple picture improvement methods have already been mentioned using their mathmatical understanding. This report can offer an overview of underlying ideas, along with calculations frequently used for image enhancement.

b. Frequency Domain Method: Frequency domain method process on the Fourier Transform. Frequency domain image development is clear-cut. The volume filters recognized a picture in the volume domain. This class filter strategy is very simple [2]

l. Change the image to the Fourier domain.

2. Multiply the picture or image by the filter.

3. Get the inverse change of the image

III. ANT COLONY OPTIMIZATION

(ACO) is definitely an algorithm on the cornerstone of the organic conduct of the true bugs to acquire the quickest journey from the source to the food. It utilizes the effectiveness of the true bugs while searching for the food. It's been seen that the bugs deposit a level of pheromone on the path while touring from the home to the foods and vice versa. In this way the bugs that follow small journey are estimated to come right back early in your day and ergo pheromone deposition on small journey reaches a faster rate. ACO methods could possibly be employed in the device redirecting problems to acquire the quickest path. In a way redirecting situation, some artificial bugs (packets) are simulated from the source to the strain (destination). The forward bugs will make still still another node arbitrarily for the very first time finding the knowledge from the redirecting eating desk and the bugs which are efficient in attaining the place may replacing the pheromone deposit at the ends visited. Ant colony optimization escalates the scalability and alarm working period. ACO utilizes the strong mobility and optimization ease of the ant colony to acquire the utmost way concerning the alarm nodes.

IV. EDGE DETECTION

Edges contain vital data in picture and edge identification can be viewed as a low level procedure in picture preparing. Among various techniques produced for this reason customary strategies are straightforward and rather proficient. In Swarm Intelligent strategies created in a decade ago, ACO is more able in this procedure. This paper utilizes conventional edge location administrators, for example, Sobel and Canny as contribution to ACO and turns general procedure versatile to application. Size lattice or edge picture can be utilized for starting pheromone and subterranean insect conveyance. Picture size diminishment is proposed as a productive smoothing strategy. A couple of parameters, for example, territory and width of voyaged way by ants are changed over into guidelines in pheromone redesign process. All principles are standardized and last esteem is gained by averaging [5].

Edge discovery of pictures is a crucial assignment in PC vision and picture handling. Edge recognition is dependably concentrate on center in the field of medicinal picture handling and investigation. It is important stride in restorative picture handling. Edge discovery of commotion free pictures is similarly less muddled, however in most sensible cases the photos range unit corrupted by clamor. Edges in photographs give low-level signs, which could be used in more elevated amount forms, similar to question discovery, acknowledgment, and grouping, moreover as movement location, picture coordinating, and trailing. Edges and surfaces in picture are run of the mill tests of high-recurrence data. High-pass channels deduct low-recurrence picture data and in this way upgrade high-recurrence data like edges. Numerous ways to deal with picture elucidation measure bolstered edges.

A. Pollination based optimization (PBO) algorithm.

In this, The examples of medicinal pictures (MRI) with determination 128×128 is given as information and yield as edges of picture is delivered. All pictures are dark scaled and we changed over all specimens to same size (128×128). In this firstly include dot clamor then channel this picture by utilizing respective channel to make picture commotion free. A respective channel safeguards sharp edges by deliberately circling through every pixel and changing weights to the neighboring pixels in like manner. It amplifies the idea of Gaussian smoothing by weighting the channel coefficients with their comparing relative pixel intensities. An audit study is led where numerous strategies have been created for the same reason. In this work, wavelets with higher request will be given as contribution to ACO. At that point improvement calculation ACO will be connected. Thus the smoothness of power of pictures and the thickness of edges will characterize the adequacy of this technique.

V. IMAGE SMOOTHING

Image Smoothing is a critical picture preparing operation. Smoothing operation is important to lessen clamors and to obscure the false/stray form sections so as to improve the general visual nature of the debased picture. With a specific end goal to clean a picture and improve its components, either spatial or recurrence space procedures can be utilized. The recurrence space smoothing utilizes sifting as a part of the Fourier area. Spatial area systems, then again, ordinarily utilize direct or nonlinear spatial operations. Numerous productive systems have been created in spatial space. The least difficult smoothing strategy utilizes (unweighted) averaging over a predefined neighborhood.

This decreases commotion essentially, however in the meantime it obscures the edges of items. Along these lines, the general picture quality falls apart. This occasionally break down the picture quality. Moreover, the quantity of cycles required for various operations, e.g. edge location, is heuristic in nature. Human intercession is likewise required for end of the calculation and to judge the picture quality. Something else, the clamor cleaning may get to be inadequate or there

might be over the top pointless emphasess. Some smoothing calculation which actualizes both isotropic and anisotropic are examined under dissemination forms. The isotropic dissemination helps in safeguarding the rooftop edges and evacuating commotions, while the anisotropic dispersion makes consideration of honing of stride edges and decreasing of low dim varieties inside areas. A locale geography record directs the dissemination forms. To keep the impact of neighbors on the calculation of weights limited just inside a size of 3 x 3 of the focal pixel, we consider the contrast between the focal pixel and a neighboring pixel as the angle at the area of the neighboring pixel. For the main issue, we take the typical inclination. Every inclination at a point decides the heaviness of the pixel by then utilizing a polynomial capacity, for example, that for low angles, weights are high and the other way around. For programmed end of the smoothing calculation, characterize a picture quality file (IQI) which gives an appraisal of the normal difference (regarding foundation) per pixel in the picture. The viability of the calculation, alongwith its correlation with Gaussian smoothing, has been exhibited on both manufactured and genuine has been demonstrated on both synthetic and real images.

A. Gaussian Smoothing

The Gaussian smoothing administrator is a 2-D convolution administrator that is utilized to `blur' pictures and expel detail and commotion. The possibility of Gaussian smoothing is to utilize this 2-D appropriation as a `point-spread' capacity, and this is accomplished by convolution. In principle, the Gaussian circulation is non-zero all around, which would require a vastly extensive convolution piece, however by and by it is successfully zero more than around three standard deviations from the mean, thus we can truncate the portion now. Once a reasonable bit has been computed, then the Gaussian smoothing can be performed utilizing standard convolution techniques. The convolution can in truth be performed decently fast following the condition for the 2-D isotropic Gaussian appeared above is distinct into x and y segments. Along these lines the 2-D convolution can be performed by first convolving with a 1-D Gaussian in the x course, and afterward convolving with another 1-D Gaussian in the y bearing. The Gaussian is in truth the main totally circularly symmetric administrator which can be decayed in such a way. The y part is precisely the same yet is situated vertically.

B. Edge Preserved Filtering

Run of the mill edge saved sifting incorporates two sorts: Kuwahara separating and specific cover sifting. The fundamental procedure of them is portrayed as takes after: Firstly, some distinctive formats are made in view of the inside pixel. Also, the mean quality and the standard deviation of the pixels in various layouts are ascertained. At long last, the dark estimation of the middle pixel is characterized as the mean worth in the layout where the standard deviation is the minimum. The Kuwahara sifting chooses one format from 4 square windows. While the particular veil sifting picks one format district from 9 windows, which incorporate 4 pentagon, 4 hexagon and 1 square .The impact of protecting points of interest of the specific cover separating is superior to that of the Kuwahara sifting, on the grounds that the previous has all the more fine window decision. Through the investigation of these calculations, we find that the picture points of interest can be saved from selecting an appropriate format as indicated by the guideline of minimizing the standard deviation. At the point when the layout is chosen, we can utilize other smoothing calculations with better smoothing impacts. For instance, considering that the medium separating can safeguard points of interest more successfully than mean channel does and that it is more compelling for salt and pepper clamor, we can take the medium dark worth in the layout window where the standard deviation is the minimum as the dim quality on the middle pixel. Thus we can expel salt and pepper commotion all the more adequately.

C. Optimization-Based Image Filtering

A progression of methodologies streamline a quadratic cost work and fathom a straight framework, which is proportional to verifiably sifting a picture by a converse grid. In picture division and colorization , the affinities of this grid are Gaussian elements of the shading likenesses. In picture tangling, a tangling Laplacian network is intended to uphold the alpha matte as a nearby direct change of the picture hues. This grid is additionally relevant in dimness evacuation [12]. The weighted minimum squares (WLS) channel in [11] modifies the framework affinities as indicated by the picture inclinations and produces a corona free disintegration of the information picture. In spite of the fact that these streamlining based methodologies frequently create amazing results, fathoming the relating direct framework is tedious. It has been found that the improvement based channels are firmly identified with the unequivocal channels.

D. Robust Smoothing Filter

Strong smoothing channel is a straightforward and quick nonlinear channel. It can evacuate salt and pepper clamor with lower thickness successfully. Since it receives the technique of losing the capacity of smoothing to protect edges, it can save more edge points of interest than the medium separating can do. The procedure can be depicted as takes after:

(1) Calculate the most extreme and the base of the dark qualities in the layout window aside from the inside pixel.

(2) Compare the dim quality on the middle pixel with the greatest and the base.

(3) If the dim quality is bigger than the most extreme , the greatest is yield; If the dark worth is littler than the base, the base is yield; If the dim worth is between them, the dim worth is yield. With a specific end goal to safeguard more subtle elements, then embrace the same thought in hearty smoothing separating as in the versatile medium sifting. It can diminish the picture bending by constant the dark onv„middle level‟ pixels.

E. Gradient Weighting Filter

The gradient-dependent weighting filter are primarily in light of the accompanying guideline: in a discrete picture, the distinction of the dim qualities on pixels in external zone is bigger than that in inward region. In same territory, the change on focus pixels is littler than that tense pixels. The dim slope is immediate proportion to the dark contrast in region. That is, the place the dim change is slower, the slope is littler. A capacity whose quality lessens with the expansion of the slope is embraced, and it is picked as the heaviness of the window. Along these lines, the smoothing commitment is primarily originating from the same zone. As needs be the edge and the subtle element can't be lost obviously after picture smoothing. In planning inclination chose channels, force and exponential capacity are frequently picked as weighting capacity. Particularly when the force is equivalent to −1, the sifting is called angle proportional weighting separating. At the point when the capacity is the exponential one, the sifting is called versatile separating. When we extricate lines from remote detecting pictures, the versatile separating is frequently received in preprocessing to understand the point of commotion evacuation and edge upgrade.

F. Guided Image Filter

Guided image filter [7] is an unequivocal picture channel, got from a neighborhood straight model; it creates the sifting yield by considering the substance of a direction picture, which can be the info picture itself or another diverse picture. Also, the guided channel has a quick and non-rough direct time calculation, whose computational multifaceted nature is autonomous of the sifting piece size. The guided channel yield is locally a direct change of the direction picture. This channel has the edge-saving smoothing property like the two-sided channel, yet does not experience the ill effects of the angle inversion ancient rarities. It is likewise identified with the tangling Laplacian grid, so is a more bland idea and is relevant in different applications past the extent of "smoothing". In addition, the guided channel has an O(N) time (in the quantity of pixels N) precise calculation for both dim scale and shading pictures. Tests demonstrate that the guided channel performs extremely well as far as both quality and effectiveness in an incredible assortment of uses, for example, clamor lessening, subtle element smoothing/improvement, HDR pressure, picture tangling/feathering, dimness evacuation, and joint up examining.

G. Gradient Based Smoothing

Gradient-based methods for orientation estimation involve two essential steps:
(1) finite differences in the *x* and *y* directions and
(2) smoothing.

Smoothing of the image preceding figuring the slope is for the most part an absolute necessity, for motivations behind forestalling expansive spikes in the subordinate because of sharp edges and spurious clamor. Smoothing of the inclination vectors (in their multiplied stage representation) is likewise regularly utilized either as a prefiltering venture for subsampling or essentially for reasons for locally homogenizing the stream of the introduction vectors. vectors.

VI. LITERATURE SURVEY

Hamid Hassanpour et al. (2015) [1] talked about a plate formed veil whose size fits that of the first info picture is decided for morphological operations. A while later, the proposed channel from the Top-Hat changes is connected to the picture, utilizing the picked cover as a part of a multi-step process. At every progression, the span of the cover is expanded. Therefore, an improved picture is accommodated every veil size. The quantity of required strides and the last upgraded picture are resolved taking into account the Contrast Improvement Ratio (CIR) measure. Undoubtedly, this methodology applies a shedding procedure on the pictures, in which one or a few articles in the picture are conspicuously showed utilizing morphological channel, thus give a fitting picture to investigation.

Bhandari et al. (2015) [2] clarified fundamental arrangement for an enhanced and simple methodology for upgrade of dim and low complexity satellite picture in view of knee capacity and gamma adjustment utilizing discrete wavelet change with particular worth disintegration (DWT–SVD) has been anticipated quality change of highlight. The technique breaks down the info picture into four recurrence subbands by utilizing DWT and evaluations the particular quality network of the low–low sub band picture, and afterward figure the knee exchange capacity utilizing gamma adjustment for further change of the LL segment. A short time later, prepared LL band picture experiences IDWT together with the natural LH, HL, and HH subbands to produce an appropriate enhanced picture.

Atta et al. (2015) [3] has proposed an adjustment of the low complexity improvement strategies that depend on the particular worth deterioration (SVD) for safeguarding the mean power of a given picture. With the proposed strategy, the weighted total of particular lattices of the info picture and its worldwide histogram adjustment (GHE) picture is ascertained to get the solitary worth grid of the leveled picture. Reproduction results demonstrate that the proposed technique safeguards the picture shine all the more precisely and upgrades it with generally irrelevant visual curios. It outflanks the traditional picture leveling, for example, GHE and neighborhood histogram balance (LHE), and additionally the SVD strategies that in view of scaling its solitary worth both subjectively and quantitatively. 2015) [4] proposed a completely modernized liver division process implying that the procedure distinguished the wanted Area of Interest itself. The execution of k-means and stage accumulation, and arranged cross breed k-means and stage gathering was assessed on various CT photographs to section the liver area. The procedure was assisted connected to different modalities with different infections, which will be valuable in surgeries. Additionally shaded photographs might be utilized and usage can be completed in 3-D. The execution of the arranged calculation was dictated by the choice of preparatory centroids notwithstanding on legitimate accumulation of an engineering component.

Dibya Jyoti Bora et al. (2014) [5] In portable workstation viewpoint, picture division is constantly chosen as a huge study theme by scientists. In view of its critical standard in picture control, there for the most part emerges the need of a superior picture division strategy. Grouping is certainly an unsupervised study utilizing its interest as a part of basically every field of study and designing. A few specialists utilized grouping as a part of picture division process. In any case, regardless there requires change of such methodologies. In this report, a story system for bunching focused picture division is propose.

Ghosh et al. (2014) [6] examined the capacity of another advancement calculation. The Cuckoo Search calculation in tuning the picture upgrade capacities for crest execution. The assessment has been directed in contrast with two of the old improvement calculation helped upgrade, to be specific, Genetic Algorithms and Particle Swarm Optimization and prior improvement systems Histogram Equalization and Linear Contrast Stretch procedures. Results have been acclimatized in this paper and conclusions have been drawn keeping the wellness of picture and number of edges in enhanced picture as the standard. The outcomes have outlined the capacity of Cuckoo hunt calculation in improving the upgrade capacities.

Gupta, et al. (2014) [7] proposed a misty allotment and most extre me entropy focused multilevel thresholding approach. The principle focus of multilevel thresholding is dependably to isolate your lives a photograph into numerous classes. This was focused on acquiring the appropriate costs of various edges in a way that entropy of questionable parcels in a photograph is liable to be expanded. For the motivation behind why that GSA, ABC, PSO and GA are abused to expand entropy predicated on indistinct segment strategy to find extraordinary multilevel edges. Their new advantages uncovered that GSA works superior to anything different three meta heuristic strategies with regards to entropy, calculation time and soundness.

Mathew et al. (2013) [8] has examined another satellite picture determination and shine improvement method in view of the discrete wavelet change (DWT) and particular worth disintegration (SVD) has been proposed. Satellite pictures are utilized as a part of numerous applications, for example, geosciences studies, space science, and land data frameworks. The strategy decays the info picture into the four recurrence sub-groups by utilizing DWT and appraisals the solitary quality network of the low–low sub band picture, and, then, it remakes the enhanced picture by applying opposite DWT. The method likewise assesses the solitary quality grid of the low–low sub band of histogram balanced picture and standardize both particular worth networks to get brilliance upgraded picture.
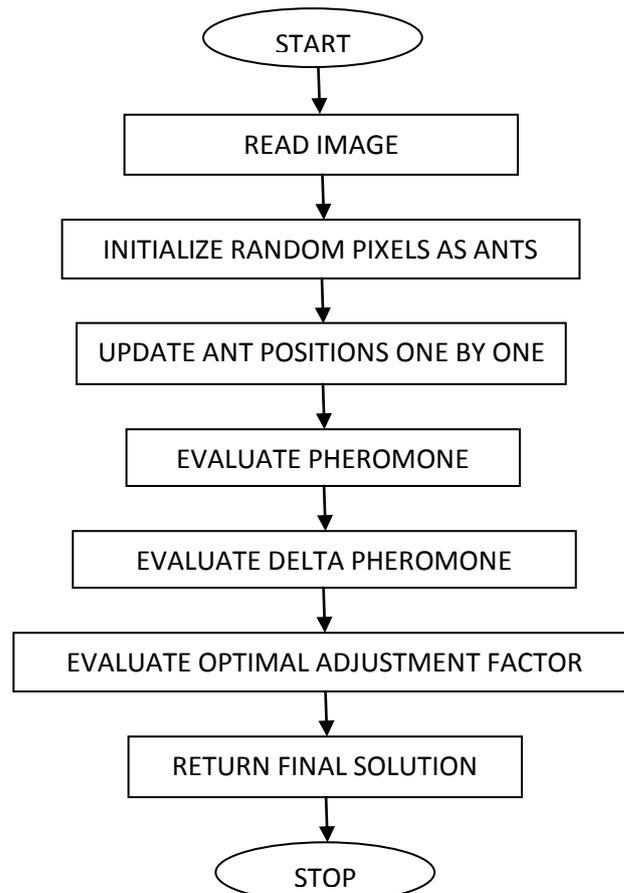
VII. PROPOSED METHODOLOGY

Figure 2: Flow Chart Of Proposed Methodology

Step 1: Start the algorithm.
Step 2: Firstly take any input color medical image.
Step 3: Then apply Ant Colony Optimization technique as a proposed method. After that initialize random pixels as ants.

Step 4: After then update ants position one by one.
Step 5: Evaluate pheromones in it.
Step 6: Then Evaluate delta pheromones in it.
Step 7: Evaluate optimistic adjustment factor for morphological transforms to enhance the contrast of color medical images by using use ant colony optimization.
Step 8: Return to the final solution.
Step 9: Stop the algorithm.

VIII.   RESULTS AND DISCUSSION

| (a) Input image 7 | (b)Existing Result | (c)Proposed Result |

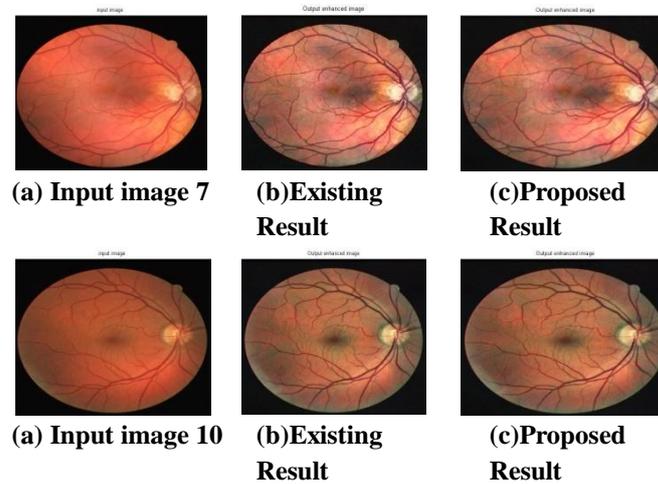| (a) Input image 10 | (b)Existing Result | (c)Proposed Result |

Figure 3: Experimental Results

IX.   PERFORMANCE EVALUATION

This section contains the comparison table and graphs of the existing and proposed techniques. Some well-known image performance evaluation parameters for digital images have been selected to prove that the performance of the proposed algorithm is quite better than the existing method.

A. RMSE

Root-mean-square error is a measure of the differences between values predicted by a model or an estimator and the values actually observed. It can be explained as:

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

The values of Root Mean square error are shown below in the comparison Table 1.

As RMSE need to be minimized; so the main goal is to decrease the RMSE as much as possible. Table5.4 has clearly shown that the RMSE is minimum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

This table has shown the results of existing algorithm as well as proposed algorithm.

Table 1: Root mean square error comparison table

Input Image	Existing Result	Proposed Result
1	0.4587	0.3058
2	0.2921	0.1947
3	0.2706	0.1804
4	0.2993	0.1995
5	0.4216	0.2811
6	0.4850	0.3233
7	0.2938	0.1959
8	0.4122	0.2748
9	0.3277	0.2184
10	0.3540	0.2360
11	0.2818	0.1879
12	0.4158	0.2772

13	0.3287	0.2191
14	0.3909	0.2606
15	0.2620	0.1746

Figure 4 has shown the quantized analysis of the Root Mean Square Error of different images by Existing value in(Blue line) & proposed values in(Red lines).). It is very clear from the plot that there is value of RMSE is minimum in every case with the use of proposed method over other methods. This represents improvement in the objective quality of the image.

This RMSE graph proves that the values of proposed algorithm is low than the existing algorithm. so the proposed work results are much better than the existing results.
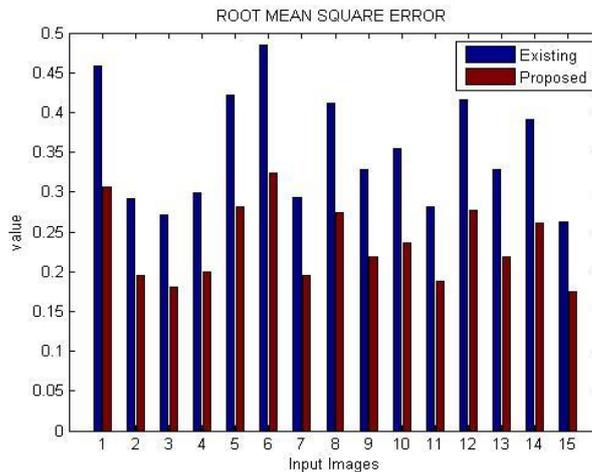

Figure 4: Root Mean square error graph

B. BER

It is defined as the rate at which errors occur in a transmission system. This can be directly translated into the number of errors that occur in a string of a stated number of bits. The definition of bit error rate can be translated into a simple formula:

$$BER = \frac{Number\ of\ errors}{Total\ number\ of\ bits\ sent} \quad (4)$$

The values of Bit error rate are shown below in the comparison Table 3

Table 3: Bit error rate comparison table

Input Image	Existing Result	Proposed Result
1	0.0182	0.0171
2	0.0170	0.0160
3	0.0168	0.0159
4	0.0171	0.0161
5	0.0180	0.0169
6	0.0184	0.0173
7	0.0170	0.0161
8	0.0179	0.0168
9	0.0173	0.0163
10	0.0175	0.0165
11	0.0169	0.0160
12	0.0179	0.0169
13	0.0173	0.0163
14	0.0178	0.0167
15	0.0167	0.0158

Figure 5: has shown the quantized analysis of the Bit Error Rate. It is very clear from the plot that the value of BER is getting reduced in every case with the use of proposed method over other methods. This represents improvement in the objective quality of the image. This BER graph proves that the values of proposed results are much better than the existing results.
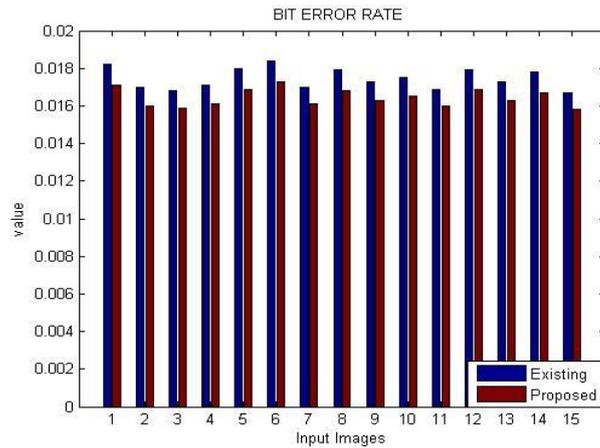
Figure 5: Bit error rate graph

C. Entropy

Discrete entropy is used to measure the content of an image .Higher the value of discrete entropy indicates then richer the details in an image. Discrete entropy can be calculated by using Eq. (5).

$$H = - \sum_{s=0}^{255} j(s) \log_2 j(s) \quad (5)$$

Table 5.6: Entropy comparison table

Input Image	Existing Result	Proposed Result
1	5.4788	6.2897
2	6.6000	7.4109
3	6.6158	7.4267
4	6.2638	7.0748
5	5.6042	6.4151
6	5.4290	6.2399
7	6.3120	7.1229
8	5.6722	6.4832
9	6.1097	6.9207
10	6.0642	6.8752
11	6.6302	7.4412
12	5.6376	6.4485
13	6.2205	7.0314
14	5.6776	6.4885
15	6.6020	7.4129

Figure 6 has shown the quantized analysis of the entropy of different images by Existing value in (Blue line) & proposed values in (Red lines). It is very clear from the graph that there is increase in entropy value of color medical images with the use of proposed method over existing methods. This increase represents improvement in the contrast of the image.
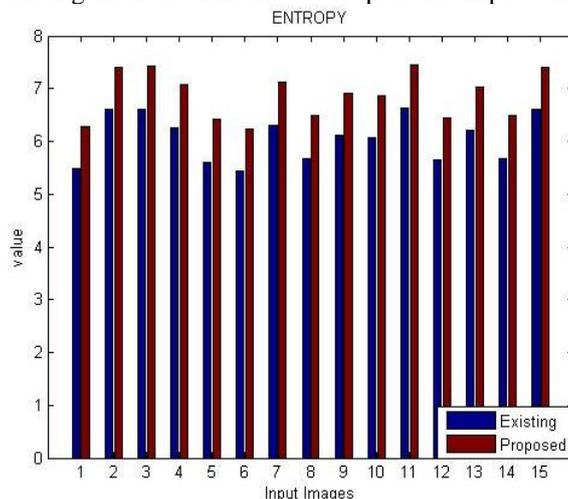

Figure 6: Entropy graph

Therefore the proposed work results are much better than the existing results.

X. CONCLUSION

In order to overcome the above stated limitations, a new algorithm is proposed which will utilize to ant colony optimization to enhance the results further. Ant colony optimization has ability to find optimistic adjustment factor for better fuzzy based enhancement. Therefore will provide more optimistic results than available methods. Also to reduce ringing artifacts further gradient smoothing will be used. The main scope of this work is to apply proposed technique for colored medical images. The proposed technique is designed and implemented in the MATLAB 2013 tool. The comparisons have clearly demonstrate that proposed technique outperforms over the available methods. This work has not considered the effect of noise on images, so in near future we will work for noisy images.

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