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An Enhancement Visual Quality of Medical Images Based on hybrid Genetic –Bat Algorithm

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تحسين جودة الصور الطبية البصرية بناءً على خوارزمية جينية هجينة (بات)

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الجامعة المستنصرية

ABSTRACT

Image denoising is one of the most significant tasks in medical image processing due to the important information obtained from these images. This paper proposed a method to denoise medical images by the use of a hybrid algorithm based on the Genetic Algorithm (GA) and Bat Algorithm (BA). which are nature-inspired algorithms used for improvement purposes. Medical images can be often affected by different types of noises that decrease the precision of any automatic analysis system. Therefore, the noise reduction methods are frequently utilized for increasing Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index Module (SSIM), and decreasing the Mean Square Error (MSE) of images to optimize the originality. Poisson noise and Gaussian noise corrupted the used medical data, separately. The noise level to medical images was added noise variance from 0.1 to 0.3 to compare the performance of the de-noising techniques. In the study, we apply different types of noise like Poisson noise and Gaussian noise to medical images for making these images noisy. The hybrid GA -BA method was applied on medical noisy images to eliminate noise and the performances have been determined by the statistical metrics such as PSNR, MSE, where it gives a PSNR 60.22dB, 58.15 dB and MSE 0.00128, 0.00160 for x-ray and CT images on order

تعد عملية ازالة الضوضاء من الصور من أبرز المهام في مجال معالجة الصور الطبية بسبب المعلومات المهمة المستخلصة من هذه الصور والتي تخص الجسم البشري حيث يعمل تقليل الضوضاء على تحسين الجودة المرئية للصورة. في هذه البحث تم اقتراح طريقة لتقليل الضوضاء على الصور الطبية باستخدام الخوارزمية هجينة (Genetic -Bat) وهي خوارزميات مستوحاة من الطبيعة تعرف بمقدرتها على إنشاء حل أمثل من بين مجموعة من الحلول غير المثلى لأغراض التحسين. غالبًا ما تتأثر الصور الطبية بأنواع لذلك تُستخدم طرق تقليل الضوضاء دائما .تحليل آلي مختلفة من الضوضاء التي تقلل من دقة أي نظام وتقليل SSIM ومقياس مؤشر التشابه الهيكلي PSNRلزيادة مقياس نسبة ذروة الإشارة إلى الضوضاء .

تعرضت البيانات الطبية المستخدمة لضوضاء . للصور لتحسين الأصالةMSEمتوسط الخطأ التربيعي بشكل منفصل. تم إضافة مستويات مختلفة من الضوضاء إلى الصور Gaussian وضوضاء Poisson الطبية بزيادة تباين الضوضاء من ٠.١ إلى ٠.٣ لمقارنة أداء تقنيات إزالة الضوضاء. في هذه الدراسة على الصور الطبية Gaussian وضوضاء Poissonنطبق أنواعًا مختلفة من الضوضاء مثل ضوضاء لجعل هذه الصورnoisy.

لإزالة الضوضاء من الصور الطبية أفضل اداء Genetic -Batاعطت الخوارزمية الهجينة المقترحة (حيث MSE، PSNRمقارنة مع طرق تقليل الضوضاء الاخرى. من خلال المعلمات الإحصائية مثل ٥٨ ديسيبل ,٦٠ ديسيبل و ١٥, مساويه قدرها ٢٢(PSNR)اعطت قيم لنسبه لإشارة الى الضوضاء ٠ لصور الأشعة السينية وصور الرنين المغناطيسي على التوالي.,٠ و ٠٠١٦٠, مساوي ٠٠١٢٨MSEو

Keyword:
Hybrid Genetic- Bat algorithm, Denoising, Medical image, Genetic algorithm,

INTRODUCTION

The researches in the domain of medical image processing are one of the maximum challenging fields in recent years, this is because of the increased spread of diseases [1]. Medical imaging is diagnostic tool and the technique creating visual representations of the interior of a body without opening up the body surgically, for diagnosis and medical intervention, an indispensable all hospitals the world [2]. The imaging helps determines whether surgery would be an effective treatment option to locate tumors for treatment and removal. For example, computer-tomography(CT)is very helpful for imaging bodily structures and dense tissues, while magnetic resonance imaging (MRI) and ultrasound (US) are powerful tools for the visualization of soft tissue [3][4]. Because of the widespread use of medical imaging, the quality of digital medical images becomes an important issue. To achieve the best possible diagnoses useful for physicians to contribute in providing an accurate diagnosis of patient [4]. Data sets collected by different types of sensors are usually contaminated by different types of noises, lighting conditions, problems with the data acquisition process, images may have low quality [5]. Moreover, noise can occur by transmission errors and compression. While the technologies for acquiring digital medical images continue to improve, resulting in images of higher resolution and quality, noise remains and low contrast is the problem for many medical images [6]. Removing noise in these digital images remains one of the major challenges in the study of medical imaging. noise leads to information loss of an image in addition to quality degradation. Therefore, the problem of recovering an original image from a noisy image has received ever-increasing attention in recent years

can be achieved by image denoising [7]. The objectives of this study focus on the set filters chosen by hybrid GA-BA for denoising and enhance visual quality and saving medical image edge and building the adaptive model related to kinds the different of medical images. A comparison is made to the advanced algorithms/techniques performance with the existing ones by peak signal-to-noise ratio (PSNR), structural similarity index measure (SSIM), and Mean Square Error (MSE). The remainder of the paper is structured as follows: The second portion featured the related works review, as well as a brief discussion of noise. Then the work methodology, the genetic algorithm, and the Bat algorithm. And discuss the results and conclusion were presented in the remaining sections.

2. RELATED WORK

We present some contributions have been achieved by researchers in the field of de-noising of the medical image, Saraiva, A., et al. [8],2019, introduced the technique of genetic algorithm optimization. Through this method, best filtration can be obtained and artifacts can be reduced and preserving the structure through noise attenuation. The algorithm structure works in two major stages, the first stage: is to filter with BM4D, ellipsoid filter, and 3d medium filter. the second stage is formed by the application of mutation operators in the previously recovered image, by means of intensity change techniques, medium filter, and Gaussian filter. In the end, and offer an efficiency of the method adopted as a filter with good application results. B. Baron Sam et al. [9], 2019 proposed to utilize a blend of filters; Anisotropic Filtering, Kalman Filter, and Kirsch Filter to reduce the Gaussian noise from the CT images. The filtered output images were then assessed by the method of the firefly algorithm for the exact image details. Gave the proposed method the de-noised image. V. Anoop and P. R. Bipin [10],2020 presented a method Enhanced grasshopper optimization algorithm (EGOA) is used to optimize the BF parameters. To simulate the medical MR images (with different variances), the salt and pepper impulse and Rician noises are added. The EGOA is applied to the noisy image in searching regions of window size, spatial and intensity domain to obtain the filter parameters optimally. the PSNR was used as a fitness value. The proposed denoising method's results were compared to those of other previously used BFs, such as the genetic algorithm (GA) and the gravitational search algorithm (GSA). Rawat, Shubhankar, et al. [11] In 2021, complex-valued CNN-based deep learning model with residual learning for medical image denoising, has been proposed and implemented, termed as CVMIDNet. CVMIDNet was implemented using a

complex-valued convolutional layer, to remove Gaussian noise from chest X-ray images. A merging layer was used to convert the complex valued feature cube to a real-valued output image. To assess the denoising performance of CVMIDNet, standard image quality metrics, namely, peak signal to noise ratio and the structural similarity index. It was observed that proposed method CVMIDNet good gave results

3. Sources of Noise and Mathematical Representation of Noise

Due to processes of different acquisition, storage, transmission, and display devices, Medical images are generally of low contrast and get various types of noise. Noise is an important factor that influences image quality [12]. As noise is a random process it is not possible to predict its values Exactly, but it is possible to determine its statistical properties. the poor quality of the results indicates that a better understanding of the noise properties is required. Poisson noise and Additive white Gaussian noise, and mathematical formula are illustrated below Gaussian noise correspondingly distributed over signal, i.e. Which means every pixel in the noisy image is the sum of the random Gaussian distributed noise value and the true pixel value with a given distribution is given by equation.1 [13]

$$F_{awgn} = f(x,y) + N(x,y) \quad 1$$

Where N represent random variable having Gaussian probability distribution and a bell-shaped function of a probability distribution that is given in equation .2

$$F(\mathbf{a}) = \frac{1}{\sqrt{2\pi\sigma^2}}\, e^{-(\mathbf{a}-m)^2/2\sigma^2} \quad \mathbf{2}$$

Where a refers to the grayscale, m refers to the average or mean of the function and σ refers to noise standard deviation.

4. PROPOSED ALGORITHM

This work applies the Genetic -Bat Algorithm (GBA) as a denoising method of medical images for many kinds of noise and this technique is compared with Gaussian filter, Bat algorithm, median filter, wiener filter, bilateral filter. In work proposes (GBA) to denoise the medical image achieved by the first step, generation of the initial random population by applying different filters having different characteristics. Calculation the fitness function (PSNR) for each particle from the population to measure the quality of the solution. Then, it choice the global best and local best of participation. A new generation is

obtained in each iteration. The genetic algorithm is applied to modify the existing population Basically; GA starts to process with several possible solutions which are provided from a randomly generated initial population. It uses some operators such as selection, crossover, and mutation for finding the optimal solution. After that, Bat algorithm update the new population and generate new solutions by adjusting frequency and updating velocities and locations according to the equations of the bat algorithm. then the global best and local best of participation are selected, then the population is updated based on GBA and updating the global and local best enhancement image, see algorithm 1 and Figure 1.

4.1 Genetic Algorithm

A genetic algorithm is a randomized search and optimization algorithm which is inspired natural and genetics. GA is one of the best know techniques of Evolutionary Algorithms [14]. In this algorithm, the process of searching is simply needed A method of representing a solution such that GA can search the space of all possible solutions finding the best answer to every iteration. And method of measuring the quality of any proposed solution, this called the fitness function [15]. The maximum important operator in the genetic algorithm is the crossover operator, which can product a new population through a combination of chromosomes dependent their selection. The parents selected for crossover, transfer their genes on to each other to create new offspring. Crossover can remove genetic variation in the population. Furthermore, another operator in the genetic algorithm is the mutation operator that can products multiple optimal solutions [16]. In mutation, it is possible to remove a single from the subset or produce a new one that is added to the population [17].

4.2 Bat Algorithm

The bat algorithm is a metaheuristic algorithm inspired by nature commonly utilized to tackle real-world global optimization problems. This technique is based on the way bats look for food using echolocation The majority of bats can make use of their sophisticated hearing ability [19] [18]. That is, The Bat uses sound to locate items rather than sight. Bats use echolocation to locate food and avoid colliding with trees at night. Echolocation is a technique that includes producing a sound and analyzing its echoes to determine what things are nearby[20][21][4]. Three rules govern the implementation of the Bat: First and foremost, all Bats use echolocation to determine the distance to a specific spot. Second, bats fly randomly with a predetermined frequency and at a certain

velocity toward the designated spot. The loudness and wavelength, on the other hand, can change. Thus, bats modify their wavelengths automatically in response to their target. Thirdly, the author reasoned that loudness is varied by varying it

from maximum to minimum rather than by varying it in any other way, as shown in equation (3), equation (4), and equation (5) [22].

$$ft = fmin + (fmax - fmin) \times \beta \quad (3)$$

$$v_i^{(t+1)} = v_i^t + (x_i^t - x_{Gbest})ft \quad (4)$$

$$x_i^{(t+1)} = x_i^t + v_i^{t+1} \quad (5)$$

Where $\beta \in [0,1]$ is a random vector drawn from a uniform distribution, f denotes the frequency of each Bat, $xGbest$ here is the current global best solution (location), vi represent the velocity, xi represents the practical, by using equation (4) and equation (5), the position and velocity updates of ith bat can be calculated. Based upon the prey's bulk and location, the wavelength, and loudness A differ. xi and vi can be initialized through the use of certain initial random values. The particles' position coordinates were utilized for calculating the function of fitness f as input values. The best value of fitness in all bats is referred to as $xGbestbat$. A positive value represents differences between $xi(t)$ and $xGbestbat$, meaning $xGbestbat$ bat can process more properties than i_{th} Bat. This difference is summed up with the preceding velocity to accelerate the motion of ith Bat towards the $xGbestbat$ [23] [24].

Algorithm (1) of the Genetic- Bat algorithm of Denoising of medical image explained in the following steps:

Input: Noisy image
Output: Denoised image

Step1: The parameter PSNR is determined as the fitness function
Step2: Initialize population by applying a number of filters with different parameters on the input image
Step3: The parameter of bat frequency is defined and create zeros velocity of each particle
Step4: Compute the fitness of each particle according to PSNR performance
Step5: Determine the best global image and local best of the image where the best image achieves a high PSNR value
Step6: For itr= 1 to max iteration
Step7: compute each image's fitness (PSNR) of image
Step8: From the current population, the two-maximum fitness of the image is selected
Step9: Crossover the two images based on the single-point crossover to produce an offspring
Step10: Replace the image's two minimum fitness by the two new images
Step11: Compute the best local of the new population
Step12: update the best global
Step13: For i= 1 to size of the population
Step14: Compute velocity
Velocity{i+1} = Velocity{i} + (current image - best global image) * frequency
Step15: Update the population
new image = current image + velocity {i+1}
End for
Step16: Compute the best local of the new population
Step17: Update the best global
Step18: If the fitness of the best global image < fitness of the best local image, then
best global image = best local image
End for
Step19: Output the best global image.

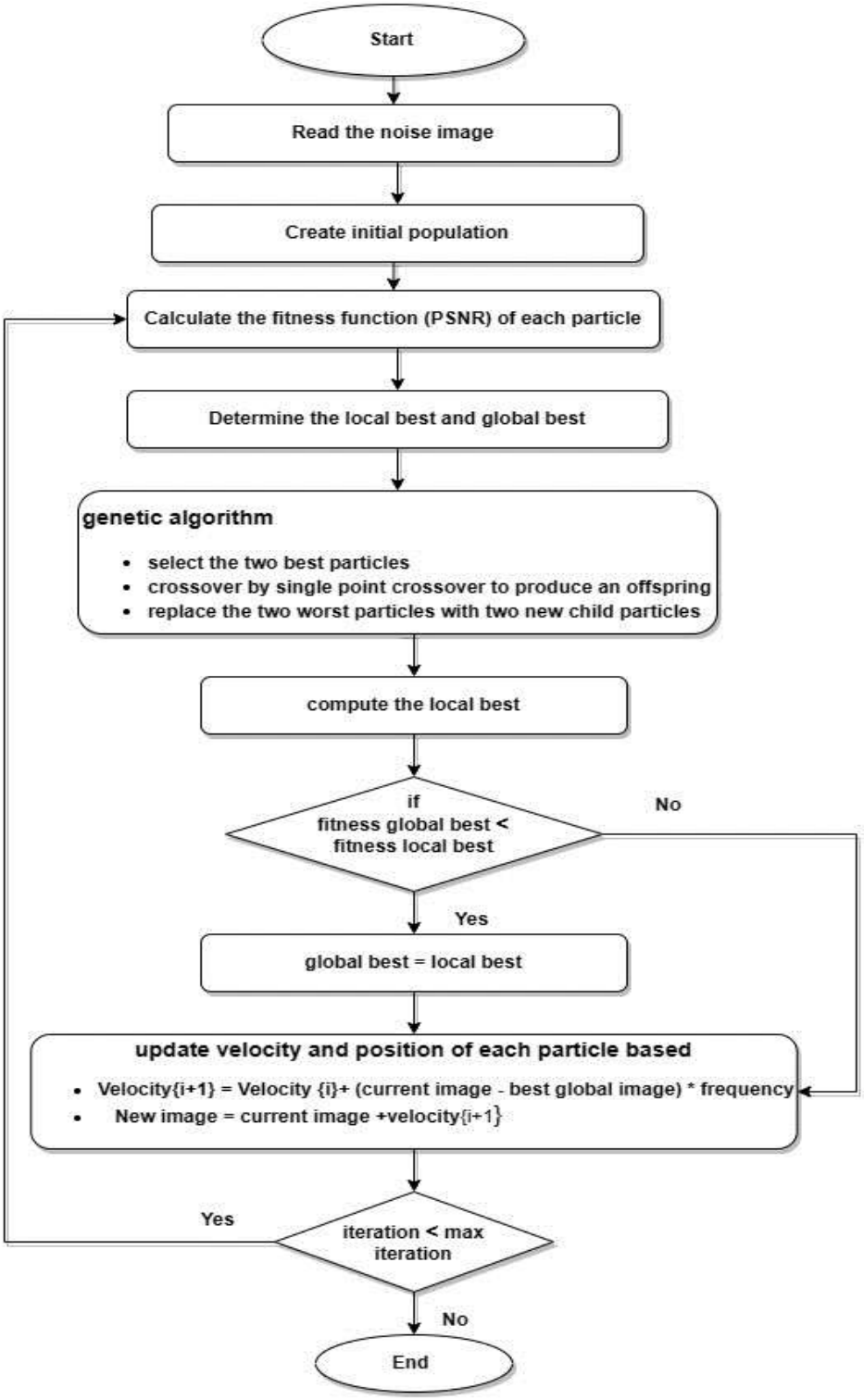
Start
Read the noise image
Create initial population
Calculate the fitness function (PSNR) of each particle
Determine the local best and global best
genetic algorithm
select the two best particles
crossover by single point crossover to produce an offspring
replace the two worst particles with two new child particles
compute the local best
if fitness global best < fitness local best
No
Yes
global best = local best
update velocity and position of each particle based
Velocity{i+1} = Velocity {i}+ (current image - best global image) * frequency
New image = current image +velocity{i+1}
Yes
iteration < max iteration
No
End

Figure1: The Flowchart of Denoise of the proposed method (Genetic -Bat algorithm).

5.SIMULINK RESULT AND DISCUSSION

In this work, apply the number of filters and implemented us (MATLAB R2020a) and two varieties of noise are tested: Poisson noise and Gaussian noise. The denoising from the image using Genetic-Bat algorithm, Gaussian filter, bilateral filter, Bat algorithm, wiener filter, and median filter. The work test on some medical digital images of different types like-ray, CT. The results of our proposed technique that use the Genetic-Bat algorithm for image de-noising have been compared with Bat algorithm, bilateral filter, median filter, Wiener filter, and Gaussian filter with different kinds of noise, see Figure 2, Figure 3.

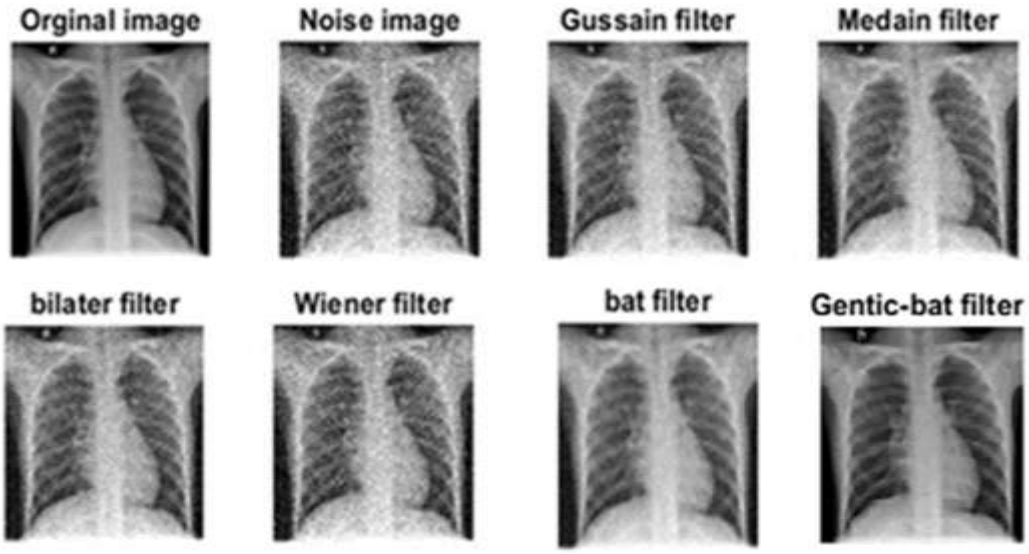

Figure2: Display denoising Poisson noise from x-ray images.

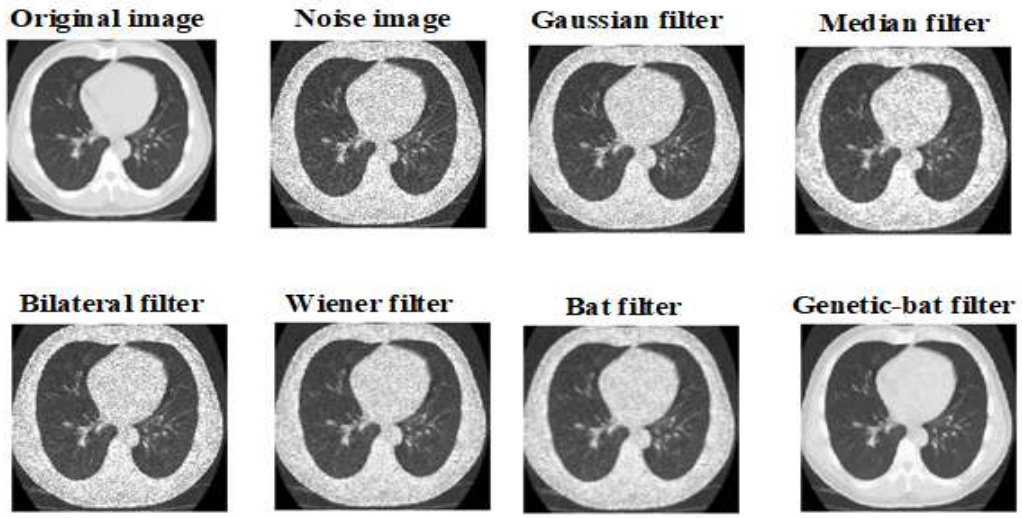

Figure3: shows denoising Gaussian noise from The CT image

This section clarifies the results achieved when this proposed method is used, verifies, and provides a comparison to the denoising process of the proposed method with other traditional filters. The experimental results were applied on X-ray images and CT images. This section uses statistical parameters metrics such as (SSIM, MSE, and PSNR) for illustrate the proposed technique's comparison with a number of filters with different kinds of noise.

The experiment follows these steps: first, medical images are selected from the database, and Poisson noise, Gaussian noise are added to the image. The noise variance level ranging from 0.1 to 0.3 is added to the x-ray and CT image. The medical image in which Poisson noise, Gaussian noise was used to corrupt it with noise variance from 0.1 to 0.3 is denoised by using the proposed technique (Genetic-Bat). Then, filtering the same noise corrupted image by applying Gaussian filter, Bat algorithm, bilateral filter, wiener filter, median filter to give a comparison. and to evaluating the proposed method performance PSNR, MSE, and SSIM values are used as a quality performance metric. Table 1, shows the PSNR, MSE, and SSIM values for removing Poisson.

Table 1: Denoising results for Poisson Noise removal.

Filter	PSNR	MES	SSIM
Gaussian	32.25366609	39.40705872	0.840341332
Bilateral	33.95793741	26.14942932	0.885989919
Wiener	33.70527675	27.82941437	0.868269226
Bat	43.84002	4.0923614	0.9687088
Genetic -Bat	60.22821	0.001284	0.998621
Median	32.10406888	40.15629578	0.836699168

Removing Poisson Noise by the use of the technique of genetic and bat algorithm would provide optimum for remove noise. Table 2 tabulated the PSNR value, MES value, and SSIM value which are gotten for denoised and noised medical images that Gaussian Noise corrupt. For each method that is tested, the results showed that this method produces the highest PSNR, MSE, and SSIM values when comparing to other filtering methods at several noise levels.

Table 2: Denoising results for Gaussian Noise removal from CT.

	Level noise 0.1			Level noise 0.3		
Filter	PSNR	MES	SSIM	PSNR	MES	SSIM
Gaussian	18.7415	436.66	0.3659	11.0151	2612.75	0.33219
Bilateral	18.5802	452.31	0.3564	10.9648	2642.57	0.32371
Wiener	19.3239	382.34	0.4283	11.1092	2555.21	0.35435
Bat	43.4200	7.49511	0.83128	31.93341	41.41024	0.795139

Genetic–Bat	58.1583	0.00160	0.99821	46.3646	
0.080841	0.89959				
Median	19.1902	392.70	0.41985	11.0505	2588.82
	0.34914				

Tables 1,2 contain the tabulation to the results related to denoising medical images, the result concluded that this proposed technique presents optimum results in each aspect when removed Poisson Noise and Gaussian noise from image medical with preserving the structure of image.

6.CONCLUSIONS

This paper presented an overview of the Quantitative and statistical measures as well as image visual quality are used to measure the proposed denoising algorithms' performance. In this paper, we provided an excellent technique through the application of a hybrid of two algorithms (Genetic algorithm) and (Bat algorithm) as denoising the medical image. In this study, Poisson noise and Gaussian noise are used to corrupt the medical images with the noise variances of 0.1and 0.3 then the proposed method was used to denoise these images. A comparison is made to the result with Gaussian filter, Median filter, Bat filter, Wiener filter, bilateral filter. Finally, the results of the proposed algorithm are optimum results, when compared with the other traditional filters that were used to denoise from medical images. The output from the proposed method contains a higher SSIM value higher PSNR value comparing to the other techniques that were used. The results of the simulation also revealed that the Genetic –Bat algorithm presented better and more efficient performance at a higher level of noise variance Furthermore, this method proves that it is better best to maintain the medical images' structure. The PSNR values were obtained at 60.228 dB and 58.15 dB for x-ray and CT images. In the future, this Expansion the dataset to comprise the other types of medical images such as MRI and ultrasound images. also, expand to using other types of noise, and using the proposed algorithm in other image processing applications such as image segmentation, classification, image compression.

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