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Ant Colony Optimization Based Medical Image De-Noising Using Sub Block Scanning Method

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Abstract
Medical image denoising is very important part of digital image processing. It becomes more and more popular day by day. Medical image denoising is fundamental challenge in image processing. Noise occurred in medical images due to many factors. Medical images include x-ray images, Ultrasound images, Magnetic Resonance images (MRI) etc. noise corrupt the medical images and the quality of images degraded. For diagnose to diseases original images are very important. So, there denoising of medical images play very important role for diseases diagnose. There are so many techniques and filters used for image denoising. Still there is need of advancement in image denoising. As we know image denoising is a well know field for the researches to get better PSNR values and implement latest and new methods to denoise image which is fast and accurate. Denoising of images with 3x3 mask with mean and median filters are very well know to us. We are going to propose a noble method to denoise images using ACO based threshold optimization in subblocking technique. Here we will sub divide the main image into several blocks and for each block optimization will be done with ACO (Ant Colony Optimization) to reduce artifacts and noises in present block.
Keywords: ACO (Ant Colony Optimization), Mean and median filter, Sub blocking scanning technique.

1. Introduction

Image denoising is the process in which we take corrupted image applied denoising techniques on that image and create original image. Medical images used to create the images of human body for examine disease and diagnose. Medical images include magnetic resonance images(MRI), X-Ray images, Ultrasound images, Tomographic images etc. In these days widely used images are ultrasound images because these are inexpensive. These images are safe and portable with other like CT and MRI. It is used for visualization of internal organs muscles, their injuries etc. The quality of medical images degraded due to noise. Digital images corrupted by some degree of noise [1] [2] due to presence of corruption present in transmission and acquisition by many effects. There almost all medical images occurs noise. Most medical images received from MRI and CT equipments. Noise reduces the quality of image and visibility of image becomes poor and creates difficulties to diagnosis and treatment. Image denoising is still challenging problem for research. For diagnose the disease original image required. So there is need of image denoising to reduce the noise from image. Different types of noise corrupt the image. Noise occurrence of noise in image depends upon the noise present in signal. So many techniques and filters used for [3]denoise the images. Medical science faces the problem of noise in images. Noise mostly occurs in medical images are Additive White Gaussian noise (AWGN), salt and pepper noise[4], speckle noise[5][6]etc. There frequency components of noise low as well as high. High frequency component can easily remove from corrupted images, while it's difficult to remove low frequency components. Reason behind that real signal and low frequency noise cannot be distinguished easily. Noise occurs due to transmission error[7] and use of imperfect instruments used in image processing. It's very important to denoise the corrupted image before analyze that image. Denoising help the physician to diagnose the exact disease. The main goal of denoising of medical images to got real image for diagnose the[8] disease exactly.

2. Proposed Method

In the present work we are going to propose a noble method to de-noise images using ACO based threshold optimization in sub block scanning technique. Here we will sub divide the main image into several blocks and for each block optimization will be done with ACO (Ant Colony Optimization) to reduce artifacts and noises in present block.

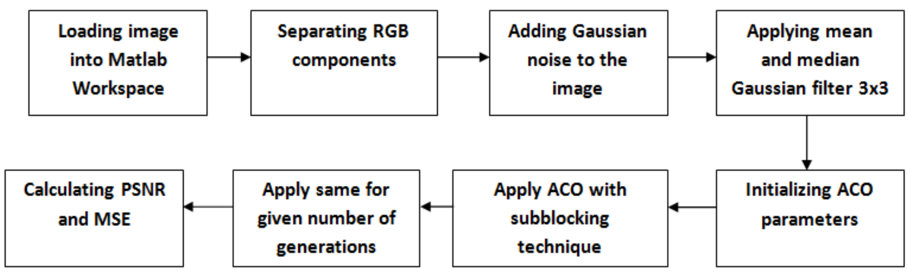


Fig.1 Block diagram of proposed method

3. Present Work

The various steps used in the present medical image denoising system are discussed below.

3.1 Ant colony optimization (ACO)

Ant colony optimization (ACO) is an optimization algorithm inspired by the natural behaviour of ant species that ants deposit pheromone on the ground for foraging. Ant colony optimization (ACO) is a nature-inspired optimization algorithm [9], [10], motivated by the natural phenomenon that ants deposit pheromone on the ground in order to mark some favourable path that should be followed by other members of the colony. The first ACO algorithm, called the ant system, was proposed by Dorigo et al. [11]. Since then, a number of ACO algorithms have been developed , such as the Max-Min ant system and the ant colony system. ACO has been widely applied in various problems. In this paper, ACO is introduced to tackle the noisy medical image problem, where the aim is to extract the noise presented in the image, since it is crucial to understand the image’s content [12]. The proposed approach exploits a number of ants, which move on the image driven by the local variation of the image’s intensity values, to establish a pheromone matrix, which represents the noise information at each pixel location of the image. Swarm intelligence approach in solving complicated optimization problems is relatively new. The main advantage of swarm intelligence approach is that system of simple communicating agents is capable of solving complex problems [13]. Ant Colony Optimization (ACO) being a branch of swarm intelligence is here considered and its use for important biomedical image processing application is investigated. The initial model idea was proposed by Bocchi, Ballerini and Hässler , while population control model was proposed by Fernandes, Ramos and Rosa. Let us here briefly present selected ACO model. Ants are supposed to be moving over the grayscale image. Doing so, each ant can occupy only one cell, moreover only one ant can be in one cell. Each ant has certain associated with it probability to move to unoccupied region and to leave a pheromone trace. If all adjacent cells are occupied by other ants, the ant will stay in its cell. In a course of processing ants [14] can die and can reproduce (that will be discussed latter). During initialization ants are placed on grid in random way. Then ants are moved by iteration. Probability of ant to move and movement direction are chosen by evaluating earlier direction of travel, surrounding ants and pheromone level.

3.2 Subblock scanning:

Sub blocking technique to divide image into several blocks and implement the fittest nutrient results to each block of the image while computing from ACO. There are many algorithms for image denoising and among these, histogram equalization is the most common method used due to its simplicity and effectiveness. In adaptive scanning, for each sub-group, a weight value is set, indicating the probability that this sub-group will become significant. The weighting value depends on three factors: parent significant, children's significant (from the previous coding round), and already scanned (or previous round) neighbours' significant ratings. The relative value of each of the three contributions (which might be zero) is implementation dependent. Once the total significant probability is calculated for each sub-group, the scanning order is rearranged according to the weighting value. As a result, the sub-groups [15] that are most likely to be in significant will be scanned first, whereas the sub-group that is most likely to be significant will be scanned last. In this way, a series of events can be used to predict event. Adaptive scanning can be employed either with simple coding of subgroups or with complex coding. Complex coding of sub-blocks can be employed either with a fixed or adaptive scanning order. The essence of the sub-block coding introduced is that a distinction is made between significant blocks with one significant sub-block and those with more than one significant[16] [17] sub-block. If there is just one significant sub-block in a significant block, then only two bits are needed to identify its relative position within the block. The image sub-blocks are roughly known by segmenting the image into partitions of different configuration, finding the sting density in every partition exploitation edge thresholding, morphological dilation and finding the corner density in every partition. The colour and texture options of the known regions are computed from the histograms of the quantized HSV colour area and grey Level Co- incidence Matrix (GLCM) respectively. A combined colour and texture feature vector is computed for every region. the form options are computed from the sting bar graph Descriptor (EHD). Euclidian distance live is employed for computing the distance between the options of the question and target image. Experimental results show that the planned methodology provides higher retrieving result than retrieval exploitation a number of the present strategies.

3.3 Mean squared error

In statistics, the mean squared error (MSE) of an estimator is one of many ways to quantify the difference between values implied by an estimator and the true values of the quantity being estimated. MSE is a risk function, corresponding to the expected value of the squared error loss or quadratic loss. MSE measures the average of the squares of the "errors." The error is the amount by which the value implied by the estimator differs from the quantity to be estimated. The difference occurs because of randomness or because the estimator doesn't account for information that could produce a more accurate estimate. The MSE is the second moment (about the origin) of the error, and thus incorporates both the variance of the estimator and its bias. For an unbiased estimator, the MSE is the variance of the estimator. Like the variance, MSE has the same units of measurement as the square of the quantity being estimated. In an analogy to standard deviation, taking the square root of MSE yields the root-mean-square error or root-mean-square deviation (RMSE or RMSD), which has the same units as the quantity being estimated; for an unbiased estimator, the RMSE is the square root of the variance, known as the standard deviation. The MSE thus assesses the quality of an estimatoror set of predictions in terms of its variation and degree of bias.

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \qquad (1)$$

3.4 Peak signal to noise ratio(PSNR)

The phrase peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale. The PSNR is most commonly used as a measure of quality of reconstruction of lossy compression codecs (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs it is used as an approximation to human perception of reconstruction quality, therefore in some cases one reconstruction may appear to be closer to the original than another, even though it has a lower PSNR (a higher PSNR would normally indicate that the reconstruction is of higher quality). One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec (or codec type) and same content.

It is most easily defined via the mean squared error (MSE) which for two m×n monochrome images I and K where one of the images is considered a noisy approximation of the other is defined as:

The PSNR is defined as:

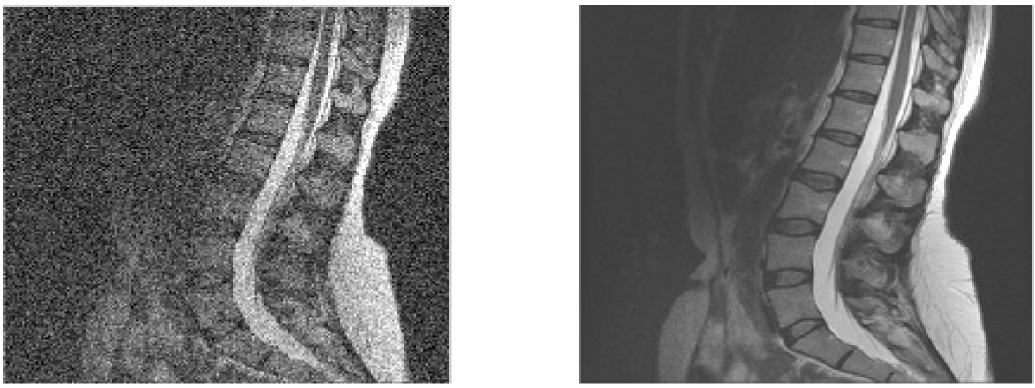
$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \end{aligned} \qquad (2)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. More generally, when samples are represented using linear PCM with B bits per sample, MAX_I is 2^B-1. For color images with three RGB values per pixel, the definition of PSNR is the same except the MSE is the sum over all squared value differences divided by image size and by three.

4. Result and Discussion

4.1 Final Results on MRI spline Image

In this section we discuss the results on MRI spline image . In which we enhanced the MRI spline Medical images include x-ray images, Ultrasound images, Magnetic Resonance images (MRI) etc. noise corrupt the medical images and the quality of images degraded. For diagnose to diseases original images are very important. So, there denoising of medical images play very important role for diseases diagnose.



(a) (b)

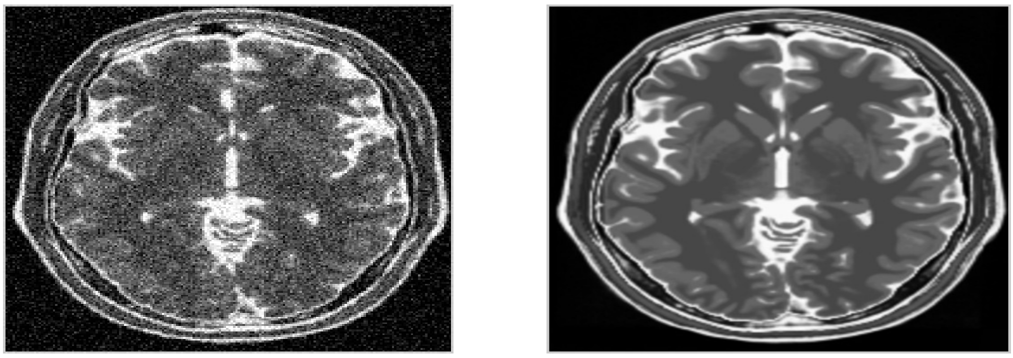
Fig.2 MRI Spline (a) Noisy Image (b) Enhanced image

Table1. Denoising results on Gaussian Noise added MRI SPLINE images.

Medical Image Denoising Method	PSNR(db)									
	σ=5	σ=10	σ=15	σ=20	σ=25	σ=30	σ=35	σ=40	σ=45	σ=50
	MRI SPLINE IMAGE (512X512)									
Adaptive Spatial & Wavelet method	**36.9**	**33.9**	**32.2**	**31.0**	**30.1**	**29.4**	**28.7**	**28.2**	**27.7**	**27.2**
Proposed method	**41.44**	**37.58**	**35.98**	**35.21**	**34.64**	**34.15**	**33.68**	**33.14**	**32.61**	**32.22**

4.2 Final Results on CT BRAIN image

In this section we discuss the results on CT Brain image . In which we enhanced the Medical CT Brain images include x-ray images, Ultrasound images, Magnetic Resonance images (MRI) etc. noise corrupt the medical images and the quality of images degraded. For diagnose to diseases original images are very important. So, there denoising of medical images play very important role for diseases diagnose.



(a) (b)

Fig.3 CT Brain (a) Noisy Image (b) Enhanced image

Table 2. Denoising results on Gaussian Noise added CT Brain images.

Medical Image Denoising Method	PSNR(db)									
	σ=5	σ=10	σ=15	σ=20	σ=25	σ=30	σ=35	σ=40	σ=45	σ=50
	CT BRAIN IMAGE (512X512)									
Adaptive Spatial & Wavelet method	**39.8**	**35.8**	**34.2**	**33.0**	**32.3**	**31.6**	**30.9**	**30.3**	**29.8**	**29.4**
Proposed method	**40.29**	**37.25**	**35.80**	**34.99**	**34.36**	**33.79**	**33.22**	**32.61**	**32.07**	**31.58**

5. Conclusion

In the present work Ant colony optimization based medical image de-noising using sub block scanning method framework, which integrating both ant colony optimization and sub block scanning method using is presented. The major factor in the performance of the proposed method is the application of sub block scanning method and mean and median Gaussian filter, which helps in eliminating the blur effect in medical images. In addition to this, it also helps in preserving the edges. Medical images used to create the images of human body for examine disease and diagnose. Medical images include magnetic resonance images(MRI), X-Ray images, Ultrasound images, Tomographic images etc. It is used for visualization of internal organs muscles, their injuries etc. The quality of medical images degraded due to noise. It may be possible to improve the results further by applying Trivariate Shrinkage Filter (TSF) and the work in this direction is under progress.

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