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Contourlet Transform Based Denoising On Normal Images Using ABC Optimization With Hard Thresholding

Contourlet Transform With ABC Optimization

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Abstract— Digital Images are generally corrupted by noise, Noise is nothing but addition of unwanted information for the Original Image. Removal of the noise is necessary to reduce the minimal damage of the image, improve image details. Contourlet transform is employed with the directional filter bank to capture the discontinuities of line and it gives various directional decomposition.ABC algorithm is bio-inspired algorithm which is derived from intelligent food search nature of the honey bee. ABC as an optimization tool provides a population-based search procedure in which individuals called foods positions are modified by the artificial bees with time and the bee's aim is to discover the places of food sources with high nectar amount and finally the one with the highest nectar. The hard thresholding will kill all the coefficients whose magnitudes are less than the threshold to zero while keeping the remaining coefficients unchanged. Contourlet with image denoising with ABC optimization based hard thresholding it improves the image quality.

Keywords- *component; Contourlet Transform;Laplacian Filter Bank; ABC Optimization;Hard Thresholding*

I. INTRODUCTION

Image denoising has remained a fundamental problem in the field of image processing. Image denoising involves the manipulation of the image data to produce a visually high quality image. The restored image should contain less noise than the observations while still keeping sharp transitions (i.e. edges) Image denoising is to eliminate the noises as well as to conserve the details of an image. Image denoising is a fundamental step in the image processing. Image Denoising is to confiscate the unnecessary noises at the same time it preserves the main characteristic of the information and its enhance the image clarity also. The main focus of an image denosing is to accomplish noise reduction and maintain the quality. Digital images plays an notable task in daily life application such as Natural images such as Lena and cameraman. Corruption may come in many forms such as motion blur, noise and camera mis-focus

Noise can corrupted by different intrinsic and extrinsic conditions. In practical situation its not possible to avoid a noises. Noises may be additive and Multiplicative. Additive noises are always interrupted with natural images. Removing the noise from the image to increase the overall quality of the processed image.

Contourlet is the greatest method for preserving the edges. Contourlets form a multiresolution directional tight frame designed to efficiently approximate images made of smooth regions separated by smooth boundaries. The contourlet transform has a fast implementation based on a Laplacian pyramid decomposition followed by directional filter banks applied on each bandpass sub band. The contourlet transform is shown to be more effective in recovering smooth contours, both visually as well as in PSNR. The contourlet transform is applied for the noisy image to produce decomposed image coefficients. Basically Contourlet transform is a double filter bank structure. It consists of a Laplacian pyramidal filter followed by a directional filter bank. First the Laplacian pyramid (LP) is used to capture the point discontinuities. Then directional filter bank (DFB) used to link point discontinuities into linear structures.

The hard-thresholding function chooses all contourlet coefficients that are greater than the given threshold λ and sets the others to zero. The threshold λ is chosen according to the signal energy.

ABC as an optimization tool provides a population-based search procedure in which individuals called foods positions are modified by the artificial bees with time and the bee's aim is to discover the places of food sources with high nectar amount and finally the one with the highest nectar. Artificial Bee-colony (ABC) to improve the accuracy of denoised image.

II. DENOISING PROCEDURE

The procedure to denoise an image is given as follows:

De-noised image = W−1 [T{W (Original Image + Noise)}
Step 1: Apply forward Contourlet transform to a noisy image to get decomposed image.
Step 2: Apply hard thresholding to decomposed image to remove noise.
Step 3: Apply inverse Contourlet transform to thresholded image to get a denoised image.

Contourlet gives high degree of directionality. It can easily symbolize the curves and lines without discontinuity. The intension of image denoising is to eliminate the noises as well as to conserve the details of an image. Contourlet transform is to preserve the edges and contours. After Hard thresholding function are used, The contourlet transform was proposed as a directional multiresolution image representation that can efficiently capture and represent singularities along smooth object boundaries in normal images, and take inverse transform to reconstruct the original image, Artificial Bee-colony (ABC) to improve the accuracy of denoised image.

A. *Related Work*

Image Denoising is a well-known good model for noise removal and edge preservation[3]. The main aim of denoising is to remove the unwanted noises or signals without losing any information[7]. Image Denoising is a central pre-processing step in image processing to eliminate the noise in order to strengthen and recover small details that may be hidden in the data[9].

A noise can be categorized depending on its source,Contourlet transforms is by introducing basis functions which are local directional, and with multiresolution expansion[13].This representation has two basic building blocks, the Laplacian pyramid (LP) and the Directional Filter Bank (DFB). Laplacian pyramid to capture the point discontinuities, followed by a directional filter bank to connect point discontinuities into linear structures[9].

[3]A hard thresholding function doesn't change rest of coefficients while thresholding reduces its value by absolute threshold value[10]. Small coefficients are dominated by noise, while coefficients have a large coefficients contain more signal information as compared to noise so thresholding[15] functions set the coefficients less than threshold to zero.

Artificial Bee Colony is one of the most recently introduced optimization algorithms. [12]This(ABC) algorithm, which is based on the foraging behavior of honey bees.ABC, a population based algorithm[8], the position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. The number of the employed bees is equal to the number of solutions in the population[15].

B. *Motivation and Justification*

Image Denoising is a well-known good model for noise removal and edge preservation. Contourlet is one of the transformation function. Contourlet is builded by Laplacian Pyramid and Filtering bank. Laplacian Pyramid is used to perceive the line discontinuities and filtering bank is used to tie-up the discontinuities. Edges are clearly discern in contourlet transform. It will speed up the enactment process. It recovers the edges and the shapes. Contourlet gives high degree of directionality. It can easily symbolize the curves and lines without discontinuity. Edges are clearly discern in contourlet transform. It will speed up the enactment process. It recovers the edges and the shapes. Contourlet gives high degree of directionality.

A new approach to denoise Otsu thresholding optimized using ABC algorithm in Contourlet transform domain. Contourlet has high directional sensitivity and are optimally sparse in representing image containing edges.

B. *Organization of the Paper*

The rest of the paper is organized as follows. Methodology includes the outline of the proposed work of Contourlet and Transform, Denoising Procedure are presented in Section II. Experimental results are shown in Section IV. Performance evaluations are discussed in Section IV and Finally Conclusion is shown in Section V.

III. METHODOLOGY

A. *Outline of the Proposed Work*

The input image is added with speckle and salt & pepper noise and applies Contourlet Transform to decompose the image. Then apply Hard Thresholding with ABC Optimization in transforms and noises are removed to obtain the noise free images.

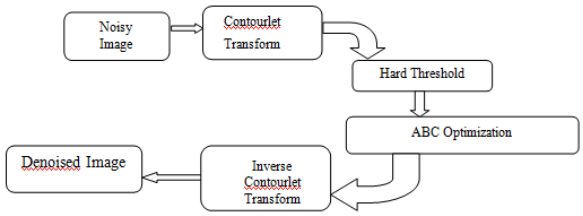

Figure 1.Block Diagram for Contourlet Based ABC with Hard Threshold

B. *Contourlet Transform*

Contourlet with ABC mostly depends on random search which is sufficient for exploration but insufficient for exploitation. Contourlet transform is employed with the directional filter bank to capture the discontinuities of line and it gives various directional decomposition. It identifies an anistropic components. The value of a food source depends on many factors such as its proximity to the nest, its richness or concentration of its energy, and the ease of extracting this energy. ABC as an optimization tool provides a population-based search procedure in which individuals called foods positions are modified by the artificial bees with time and the bee's aim is to discover the places of food sources with high nectar amount and finally the one with the highest nectar.

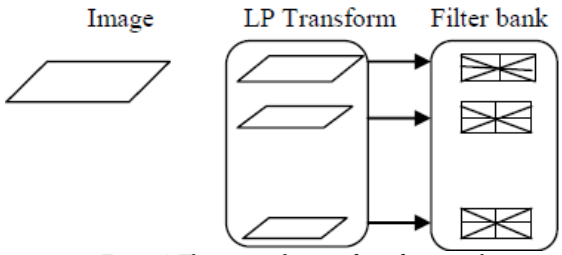

Figure 2.The contourlet transform framework

C. *Hard Thresholding*

Thresholding is a procedure used for signal and image denoising. The hard-thresholding function desires all Shearlet coefficients that are greater than the provide threshold λ and sets the others to zero. The threshold λ is chosen according to the signal energy.These methods are to make a noises free in an image.

$$D(x,y) = \begin{cases} S(x,y) & if\ S(x,y) > T \\ else & 0 \end{cases} \quad (1)$$

Where T is Hard threshold. Let S(x, y) represent the original shearlet coefficient in the point (x, y), denoised coefficient D(x,y) at the position S(x,y) by adjust the pixel values.

D. *ABC Optimization*

In the ABC model, the colony consists of three groups of bees: employed bees, onlookers and scouts. It is assumed that there is only one artificial employed bee for each food source. In other words, the number of employed bees in the colony is equal to the number of food sources around the hive. Employed bees go to their food source and come back to hive and dance on this area. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. Onlookers watch the dances of employed bees and choose food sources depending on dances.

E. Noise Categories

Image noise is an undesirable by-product of image capture that adds spurious and extraneous information. Noise removal algorithm is the process of removing or reducing the noise from the image. The noise removal reduce or remove the visibility of noise by smoothing the entire image leaving areas near contrast boundaries.

i) Gaussian Noise

Gaussian means that each pixel in the noisy image is the sum of the true pixel value and a random Gaussian distributed noise value, which has a bell shaped probability distribution function given by,

$$F(g) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(g-m)^2/2\sigma^2}$$

where g represents the gray level, m is the mean or average of the function, and σ is the standard deviation of the noise.

ii) Poisson Noise

Poisson or shot photon noise is the noise that can reason, when number of photons intellect by the sensor is not ample to give evident numerical information. This noise has root mean square value comparative to square root intensity of the image.

$$p(x) = e^{-\lambda}\lambda^{x} \quad \text{for } \lambda>0 \text{ and } x=0,1,2\ldots.$$

IV. EXPERIMENTAL RESULTS

Experimental results were conducted to denoise Lena,Cameraman images shown in Fig. 2. Noises are Gaussian,Poisson noises are considered. Contourlet Transformation are decomposed level.The hard thresholding has been used.

Figure 3. Original Image for Lena and Cameraman

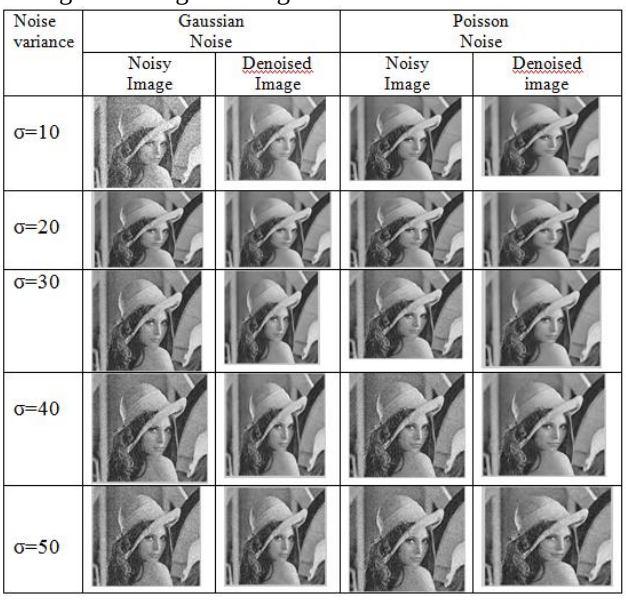

Figure 4.Lena image Contourlet with ABC Using hard threshold

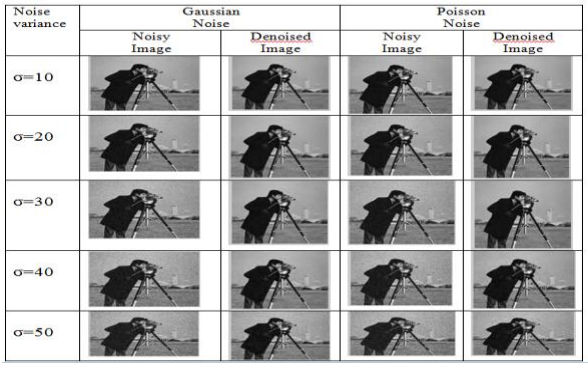

Figure 5.Cameraman image Contourlet with ABC Using hard threshold

A. Performance Metrics

i) PSNR

PSNR is used to appraise the restoration results, which determines how secure the restored image is to the original image.

$$PSNR = 20 * log\log_{10}\frac{maxi}{\sqrt{mse}}$$

ii) MSE

The slighter the MSE the nearer the estimator is to the tangible data. A miniature mean squared error means that the arbitrariness reflects the data more precisely than a superior mean squared error.

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

B. Performance Evaluation

The performance of Contourlet with ABC was evaluated by using MSE, PSNR. The experiments Contourlet with ABC hard thresholding have been tested and their denoised image results are shown in Table I and Table II. Considered all the metrics, it is observed that performs well for two images such as Lena, Cameraman.

Table -1: Normal Image Contourlet With Hard Threshold In Gaussian Noise

Image	Noise variance	Contourlet with ABC (PSNR)	MSE
Lena	10	67.78	4.55
	20	62.02	4.48
	30	58.74	5.76
	40	56.56	6.34
	50	55.09	7.79
Cameraman	10	69.82	3.76
	20	67.63	4.08
	30	61.34	5.32
	40	59.78	5.43
	50	56.56	6.09

Table -2: Normal Image Contourlet With Hard Threshold In Poisson Noise

Normal Image	Noise variance	Contourlet with ABC(PSNR)	MSE
Lena	10	79.19	6.55
	20	75.68	7.08
	30	73.91	6.76
	40	72.76	8.34
	50	72.89	9.79
Cameraman	10	80.03	6.54
	20	76.33	5.59
	30	74.40	7.23
	40	73.02	6.90
	50	71.96	7.92

CONCLUSION

This Paper presents for normal image denoising based on Contourlet with hard threshold is used to remove noise from the image. The normal images are corrupted by Gaussian and Poisson noise. Contourlet With ABC Optimization is one of the method for decomposition is best suited for performance demonstrated that the use of Contourlet With ABC Optimization could offer better results than hard thresholding to improve the best quality of the image.

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