SPECKLE NOISE REDUCTION USING BILATERAL FILTER

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ABSTRACT

Despite the progress in digital imaging, many image modalities produce images with noise affecting both the visual quality and hindering quantitative image analysis. So, the research in the area of image denoising is highly active. Among a great variety of image restoration and denoising methods the nonlinear diffusion represents a simple yet efficient approach. We use LBPD and bilateral filter for speckle noise reduction. We use LBP which scans the whole image using pixel by pixel, output is used by LBPD to reduce speckle noise. The main goal of the speckle noise reduction is to satisfy the important factors during image enhancement: edge preservation, speckle noise removal, better smoothing of an image. In this proposed work we try to explore the bilateral filter to preserve the edges after speckle noise reduction using LBPD method. It has been observed that combination of LBPD based method and bilateral filtering does perform better than the existing techniques. The experimental results are evaluated both in terms of PSNR metric and visual quality.

Keywords: Anisotropic Diffusion(AD), Local Binary Pattern (LBP), Local Binary Pattern Diffusion (LBPD), Mean Square Error(MSE), Peak Signal to Noise Ratio (PSNR).

I. INTRODUCTION

The noise affects the quality of image as well as its hindering quantitative analysis so research in this area is very highly active. The non linear diffusion is quite simple approach and which is very efficient although. There are many methods of image restoration and denoising. Different kinds of noise like Gaussian noise, salt and pepper noise are present in images which distort the images. They have their own properties. Some are additive noise and some are multiplicative. Multiplicative noise are difficult to remove from image so various filters are used to remove noise but at the cost of edge blurring so we have used bilateral filter approach. Some suitable PSNR value is selected to compare result of developed algorithm with some appropriate algorithm. The bilateral based method for speckle noise reduction and performance of LBPD based method is calculated in terms of PSNR. It is noticed that the combination of bilateral filter and LBPD based method does perform better than existing techniques.

II. LITERATURE REVIEW

C. Tomasi, R. Manduchi Bilateral filtering smooths images while preserving edges, by means of a nonlinear combination of nearby image values. The method is noniterative, local, and simple. It combines gray levels or colors based on both their geometric closeness and their photometric similarity, and prefers near values to distant values in both domain and range.

S.Sudha, G.R. Suresh and R.Suknesh "Speckle Noise Reduction In Ultrasound images by Wavelet Thresholding Based on Weighted Variance", acknowledges that in medical image processing, image de-noising is very important task. A wavelet based thresholding technique has been used for noise suppression in an ultrasound images or medical imaging, various quantitative and qualitative compressions are taken. The results which is obtained by the purposed are compared with the results achieved from the other speckle noise reduction techniques demonstrate its higher performance for the speckle reduction. They purposed a novel thresholding algorithm for de-noising the speckle noise in ultrasound by using wavelets. The purposed thresholding technique outperforms all the standard speckle filters, Wiener filter, Visu shrink and Bayes shrink methods. However, by inspection it is evident that the de-noised image with removing a substantial amount of noise doesn't suffers with no degradation in sharpness and details.

V.S. Frost, J.A.Stiles, K.S.Shanmugam, J.C.Holtzman "A model for Radar Image and its Application to Adaptive Digital Filtering for Multiplicative Noise", a model for the radar imaging process is derived in this paper and a method for smoothing noisy radar images is also presented. The imaging model shows that the radar image is corrupted by multiplicative noise. The model leads to the functional form of an optimum (minimum MSE) filter for smoothing radar images. By using locally estimated parameter values the filter is made adaptive so that it provides minimum MSE estimates inside homogeneous areas of an image while preserving the edge structure. In addition to its use for smoothing noisy radar images, the filter can also be used for processing other images that are degraded by a multiplicative noise process. With the increasing availability of digital radar imagery, digital image processing techniques will be called upon to improve both the quantity and quality of the extracted information.

III. OBJECTIVE

The objective of the research work is development of local binary pattern and anisotropic diffusion based model in MATLAB environment for noise reduction of an image by using bilateral filtering approach. The model is developed as simulator that account for detection of noise of any image that converts the image into gray levels ranging from 0 to 255. The developed model is anticipated to have the following capabilities:

- It accepts different tiff format images that can be gray images.
- It has the feature to compare the PSNR of output image with traditional techniques.
- It has capability to reduce the noise.
- It has ability to refine the edges by bilateral filtering.

IV. METHODOLOGY

To accomplish the task of noise reduction we have used local binary pattern, anisotropic diffusion and bilateral filter method. Explanation of the above methods is described as under:

4.1 Local Binary Pattern (LBP): It is a type of feature used for classification in computer vision.

- Divide the examined window into cells.
- For each pixel in a cell, compare the pixel to each of its 8 neighbors. Follow the pixel along a circle.
- Where the centre pixel value is greater than the neighbor's value write"1"otherwise write "0".This gives 8 digit binary number

- Compute the histogram, over the cell of the frequency of each number occurring.
- Optionally normalize the histogram.
- Concatenate histogram of all cells. This gives the feature vector for the window.

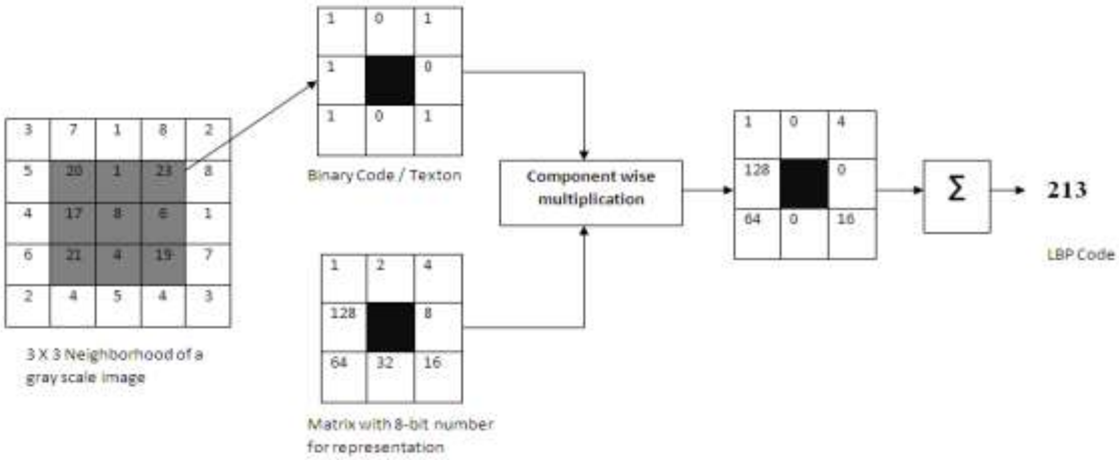


Fig 1: Example Of Obtaining LBP For 3x3 Neighborhood

4.2 Anisotropic diffusion: It is one of the denoising method to remove noise. The diffusion process is mathematically described as

$$\frac{\partial}{\partial t} I(x,y,t) = \nabla.(c(x,y,t)\nabla I) \quad (1)$$

where I(x,y,t) is the image, t is the iteration steps and c(x,y,t) is the so called diffusion function and is monotonically decreasing function of the image gradient magnitude. Perona and Mallik suggested two diffusivity functions

$$C_1(x,y,t)=\exp[-[\frac{\nabla I(x,y,t)}{k}]2] \quad (2)$$

$$C_2(x,y,t)=\frac{1}{1+[\frac{\nabla I(x,y,t)}{k}]2} \quad (3)$$

where k is referred to as a diffusion constant. Depending on the choice of the diffusivity function, equation (3) covers a variety of filters. The discrete diffusion structure is

$$I_{ij}^{n+1} = I_{ij}^{n} + (\nabla t).[C_N(\nabla_N I_{ij}^n).\nabla_N I_{ij}^n + C_S(\nabla_S I_{ij}^n).\nabla_S I_{ij}^n + C_W(\nabla_W I_{ij}^n).\nabla_W I_{ij}^n + C_E(\nabla_E I_{ij}^n).\nabla_E I_{ij}^n] \quad (4)$$

The letter N, S, E and W (north, south, east and west) describe the direction of the local gradient and the local gradient is calculated using nearest-neighbour differences.

$$\nabla_N I_{i,j} = I_{i-1,j} - I_{i,j}$$

$$\nabla_S I_{i,j} = I_{i+1,j} - I_{i,j}$$

$$\nabla_E I_{i,j} = I_{i,j+1} - I_{i,j}$$

$$\nabla_W I_{i,j} = I_{i,j-1} - I_{i,j} \quad (5)$$

4.3 Bilateral Filter: A Bilateral filter is non linear, edge preserving and noise reducing smoothing filter for images. The intensity values at each pixel in an image are replaced by a weighted average of intensity values from nearby pixels. This weight can be based on Gaussian distribution. Crucially the weight does not only on Euclidean distance of pixels but also on the radiometric difference (e.g. range of differences, such as color intensity, depth distance etc). This preserves sharp edges by systematically looping through each pixel and adjusting weights to the adjacent pixels accordingly.

The bilateral filter is defined as:

$$: I^{filtered} = \sum_{x_i \epsilon \Omega} I(x_i f_r(\|I(x_i) - I(x)\|) g_s(\|x_i - x\|) \quad (6)$$

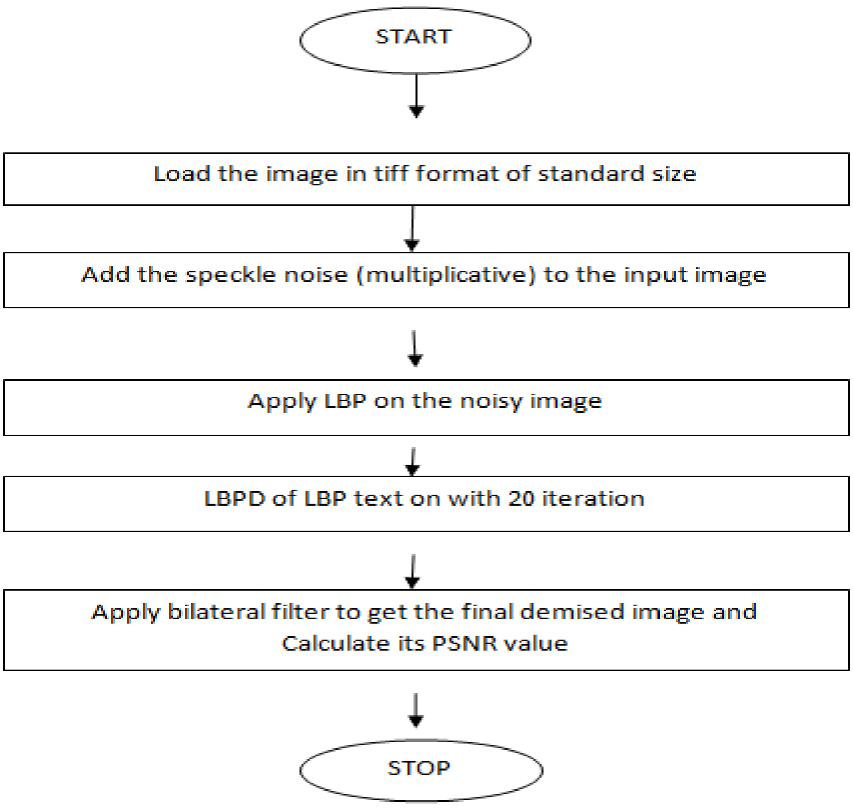
Where:

- $I^{filtered}$ Is the filtered image;
- I Is the original image to be filtered;
- x are the coordinates of the current pixel to be filtered;
- Ω is the window centered in x
- f_r is the range kernel for smoothing difference in intensities;
- g_s is the spatial kernel for smoothing difference in coordinates;

V. IMPLEMENTATION

This algorithm approach for noise reduction requires the image to be scanned pixel by pixel. Firstly we have load the image in tiff format & then we have added speckle noise i.e multiplicative noise to input image. Apply local binary pattern approach on noisy image to calculate value of pixels. An isotropic diffusion method is applied on LBP textons to remove noise with 20 iterations. To preserve edges apply bilateral filter approach. The explanation of algorithm is shown in terms of flow chart

Flowchart



Flowchart For Image Denoising Algorithm Using Proposed Algorithm

VI. RESULTS

The results are analyzed both qualitatively and quantitatively. For quantitative analysis two parameters are used MSE, PSNR are calculated for all the standard images with their noisy and denoised counterparts, respectively. The explanation of algorithm is being done in term of flowchart which is shown in previous chapter.

In the images shown below in Fig 2 we have Leena of size 512 X 512 with speckle noise density 0.02, 0.04, 0.06, 0.08 in first row and in second row we have resultant images after removing noise with proposed algorithm. PSNR of resultant images are shown in tables.

Fig 2: The First Row: Leena Image with Speckle Noise with Noise Density Level D = 0.02, 0.04, 0.06, 0.08; Second Row: Corresponding Results of Bilateral Filter

In the images shown below in Fig 3 we have Cameraman of size 512 X 512 with speckle noise density 0.02, 0.04, 0.06, 0.08 in first row and in second row we have resultant images after removing noise with proposed algorithm. PSNR of resultant images are shown in tables.

Fig 3 The First Row: Cameraman Image With Speckle Noise With Noise Density Level D = 0.02, 0.04, 0.06, 0.08; Second Row: Corresponding Results Of Bilateral Filter

In the images shown below in Fig 4 we have Mangril of size 512 X 512 with speckle noise density 0.02, 0.04, 0.06, 0.08 in first row and in second row we have resultant images after removing noise with proposed algorithm. PSNR of resultant images are shown in tables.

Fig 4 The First Row: Mangril Image With Speckle Noise With Noise Density Level D = 0.02, 0.04, 0.06, 0.08; Second Row: Corresponding Results Of Bilateral Filter

In the images shown below in Fig 5 we have Pirate of size 512 X 512 with speckle noise density 0.02, 0.04, 0.06, 0.08 in first row and in second row we have resultant images after removing noise with proposed algorithm. PSNR of resultant images are shown in tables.

Fig 5 The First Row: Pirate Image With Speckle Noise With Noise Density Level D = 0.02, 0.04, 0.06, 0.08; Second Row: Corresponding Results Of Bilateral Filter

In the above figures we have shown all the resultant images with our proposed work and the resultant PSNR values of anisotropic diffusion shown in table I shown below:

Table I

Comparison Of Psnr Of Different Images With Anisotropic Diffusion

PSNR \ σ^2	0.02	0.04	0.06	0.08
Leena	34.33	30.61	29.55	29.02
Cameraman	32.65	29.88	29.32	29.05
Mangril	31.13	29.51	28.83	28.50
Pirate	32.81	30.61	29.87	29.42

Table II

Comparison Of Psnr Of Different Images With Bilateral Filter

PSNR \ σ^2	0.02	0.04	0.06	0.08
Leena	29.06	29.28	20.22	18.4
Cameraman	24.57	21.93	19.52	17.87
Mangril	19.66	19.04	17.95	16.98
Pirate	22.65	21.23	19.44	18.02

VII. CONCLUSION

In this thesis work we have studied some of the traditional techniques for speckle noise reduction bilateral filtering and also LBPD based techniques studied and implemented. The main goal of the speckle noise reduction is to satisfy the important factors during image enhancement: edge preservation, speckle noise removal, better smoothing of an image. In this thesis work we try to explore the bilateral based method for speckle noise reduction and performance of LBPD based method in terms of PSNR and visual results. It has been observed that combination of LBPD based method and bilateral filtering does perform better than the existing techniques.

VIII. FUTURE SCOPE

In future work we suggest a modification to the proposed combination of LBPD based method and bilateral filtering to remove some artifacts in an image. Also this method is further implemented with curvelet transform, undecimated wavelet transform for speckle noise reduction. Our future research will focus on finding the proper PSNR value for LBPD coefficients.

REFERENCES

[1] C. Tomasi, R.Manduchi, "Bilateral filtering for gray and color images", *proceedings of 1998 IEEE International conference on Computer vision*, Bombay, India.

[2] D.Heric, B.Potocnik, "Image Enhancement By Using Directional Wavelet Transform", *28th Int. Conf. Information Technology Interfaces ITI,* June 19-22, 2006, Page(s):201-206.

[3] D.L.Donoho, "De-noising by Soft Thresholding, *IEEE transaction on Information Theory*", Vol 41, 1995, Page(s) 613-627.

[4] D.T. Kaun, Sowchauk, T.C.Strand, P.Chavel, "Adaptive Noise Smoothing Filters for Signal Dependent Noise", *IEEE Transaction on Pattern Analysis and Machine Intelligence,* Vol. PMAI-7, 1985,Page(s):165-177.

[5] He Qing-Hang,Zhang Zhen-xi,Li Zheng, Xu Zheng-hong, "The Processing of the Degraded Medical Image's Image Enhancement", *Proceedings of the 2005 IEEE Engineering In Medicine and Biology 27th Annual Conference,* Jan. 2006, 17-18, Page(S):3383 – 3385.

[6] M.L.Mittal, V.K Singh, R.Krishnan, "Wavelet Transform Based Techinque For Speckle Noise Suppression and Data Compression for Sar Images", *Fifth International Symposium on Signal Processing and its Application,* Vol.2, Aug. 1999, Page(s):781-784.

[7] M.R.Zamen and C.R.Moloney, "A Compression of Adaptive Filters for Edge Preserving Smoothing of Speckle Noise", *1993 IEEE International Conference on Advance Computing* on Vol. 2, Aug. 1999, Page(s): 781-784.

[8] Mukesh C.Motwani, Mukesh C. Gadiya, Rakhi C. Motwani, "Survey of Image Denoising Techinques"

[9] S.Sudha, G.R Suresh and R.Suknesh, "Speckle Noise Reduction in Ultrasound images By Wavelet Thresholding Based on Weighted Variance", *International Journal of Computer Theory and Eng*

[10] V.S.Frost, J.A.Stiles, K.S.Shanmugam, J.C.Holtzman,"A Model for Radar Image and it's Application to Adaptive Digital Filtering for Multiplicative Noise", *IEEE Transaction on Pattern Analysis and Machine Intelligence,* Vol. PMAI-4, 1982, Page(s):175-186.

[11] Yongjian Yu and Scott T.Action, "Speckle Reducing Anisotropic Diffusion", *IEEE Transactions on Image Processing",* Vol. 11, Sept.2000, Page(s): 1260-1270.