IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SPECKLE NOISE REMOVAL IN IMAGES USING BILATERAL FILTERING AND WAVELET TRANSFORM

N. Durga Rao, Assistant Professor, Department of ECE

Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt, Andhra Pradesh.

SK. APSARUNNISA, UMA NAGA SAI SARASIJA.G, P. ALEKHYA, R. RAJANI

UG Students, Department of ECE

Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt, Andhra Pradesh.

Abstract— Medical images are distorted by several noise forms in image processing. To permit accurate observations for the intended use, it is crucial to make a precise photograph. Eliminating noise from medical pictures is presently a very tough subject in the field of medical image processing. This project seeks to undertake a study of Speckle noise in the medical image and remove the Speckle noise by utilizing Bilateral filtering and Wavelet transform-based techniques. These are used on a variety of medical pictures, including CT, MRI, and X-ray images, to reduce noise while preserving the edges and reducing detail loss. It uses statistical factors to compare the Reconstructed image with the original image. Signal to Noise Ratio, Peak Signal to Noise Ratio, Mean Square Error.

Keywords—Noise, Bilateral Filtering, Signal to Noise Ratio, Peak Signal to Noise Ratio, Mean Square Error.

I INTRODUCTION

For improved analysis and vision, one of the most important tasks in image processing is to the image. The quality of photographs can be lowered by a variety of noises kinds. The noise is primarily caused by the random change of pixel values in different imaging systems and can be described as multiplicative noise. It can be described as pixel values multiplied by random values. Speckle noise is a mathematical model for image denoising.

$$\text{Speckle Noise} = (I*(1+N))$$

where 'I' is called as the original image matrix and 'N' is the Noise, which has a

normal distribution with a mean equals to zero initially. Multiplicative Noise is the Speckle Noise. There are many imaging methods that produce this type of noise, including laser, medical, optical, and medical picture images.This kind of multiplicative noise is produced by multiplying the intensity values of the pixels in the image by random numbers..

Bilateral filtering, the most effective denoising technique, is largely used as a restoration tool for noisy images of all kinds[1]. Comparing the original and restored images in terms of a number of quality performance assessment indices, including Mean Square Error (MSE), Signal to Noise Ratio (SNR), and Peak Signal to Noise Ratio (PSNR). It was created from Wavelet as a multi-scale representation and is a more advanced kind of visual representation at fine scales.

II REVIEW OF LITERATURE

Several scholars presented numerous denoising methods, including Wiener filtering and Wavelet based thresholding. A recently developed non-adaptive multiscale transform, the wavelet transform is mostly used in the field of image processing. To eliminate image noise, such as Gaussian noise, Salt & Pepper noise, and Speckle noise, that was either present during image capture or that was added after transmission.The bilateral filter

performed better than the median filter after denoising for gaussian noise and speckles. The Wavelet transform for images in two and three dimensions was defined by the effectiveness of the Median filter following Salt & Pepper noisy denoising[2,7]. Entropy-based image thresholding for image segmentation reduces image distortion through segmentation; Cross entropy thresholding relies on the Gamma distribution. Both symmetric and nonsymmetric histograms can be represented using the gamma distribution. Using medical images as testing data, the proposed method produces reliable results for both Bi Modal and Multi Modal images.This is more versatile, and experimental thresholding findings on images from medical imaging were promising. According to their knowledge, the authors have categorized the thresholding strategies into six classes, as we have seen. These are the categories:

1. Histogram Shape-based Thresholding
2. Entropy based Thresholding
3. Clustering based Thresholding
4. Attribute Similarity based Thresholding
5. Spatial Thresholding
6. Local Adaptive Thresholding

According to the literature, clustering- and Entropy based thresholding both offer superior performance with respect to other methods.

We have undergone research on Speckle Noise Removal in Images using Bilateral Filtering and Wavelet Transform-based Algorithms.

The core idea of the Median filter is to iteratively replace each entry in the signal with the median of its immediate neighbors. Images with different types of noise such as Gaussian noise, Salt & Pepper noise, and Speckle noise those are either present in the image after capture or introduced into the image during transmission are denoised using median filter techniques. Little signal-to-noise ratios in this filter tend to produce spurious noise edges and break up image edges, and they are unable to suppress medium-tailed (Gaussian) noise distributions. As the initial value is the only entry, it must be repeated along with the last value to generate enough entries to fill the window. To decrease or get rid of speckle noise, two different categories of techniques have been given. The first group includes techniques like multiple-look processing, which combines a number of separate in the process of creating a picture, different polarisation states of the same region can be used to create distinct images or "looks" of the available azimuth spectral bandwidth(synthetic aperture).Because it successfully eliminates Pulse and Spike Noise while preserving step and ramp functions, the median filter performs better than the mean filter in terms of maintaining the edges between two different features (ERDAS Inc., 1999). However, it does not preserve single pixel-wide features, which will be altered if speckle noise is present.

III Proposed Model

The drawback of the existing model is that it cannot suppress medium-tailed (Gaussian) noise distributions and instead tend to break up picture edges and produce spurious noise edges in the case of low signal-to-noise ratios. In our model as we are applying Bilateral filtering and Wavelet transform to produce a noise-free image. Bilateral filtering allows for greater edge preservation at low frequencies and less information loss in the output image than Wavelet transform.

III.1 Algorithm for Denoising

Step 1: Take the input image as original image.

Step 2: Now add Multiplicative Nosie to the original image.

Step 3: Compute PSNR of the noise image.

Step 4: Estimate noise level using a robust median estimator.

Step 5: Apply the bilateral filtering to noisy images.

Step 6: Apply general wavelet decomposition.

Step 7: Now Bayesshrink technique is used to get the finest level of diagonal details.

Step 8: General wavelet reconstruction using discrete harmonic wavelet reconstruction.

Step 9: Observe the restored image.

Step 10: Compare the restored image with the original image and calculate various parameters like MSE, PSNR, and IQI.

Flowchart for denoising

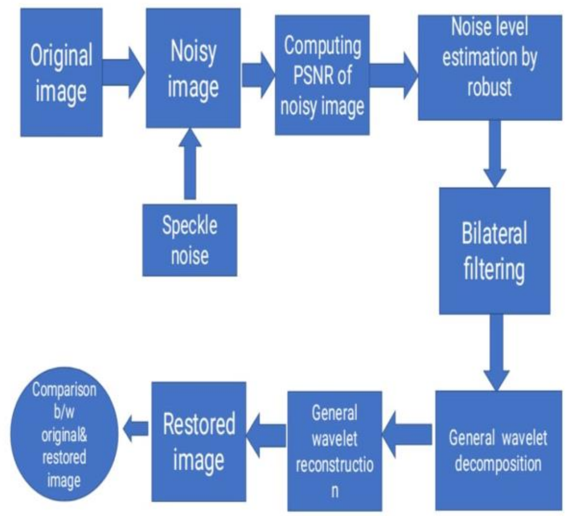


Fig III.1.1: Block diagram of proposed method

Signal to Noise Ratio

The strength of the intended signal in comparison to the background noise is gauged by the signal-to-noise ratio or SNR. Get a grasp of the practical techniques to improve SNR and debunk the myths around SNR calculation.

$$\textbf{SNR} = P_{signal} / P_{noise} \qquad \text{(III.1.1)}$$

where P_{signal} indicates mean of the signal or expected value and P_{noise} is the deviation of the noise.

SNR refers to the amount of noise in an image's output edge as compared to the noise in the original signal level. SNR is a quality statistic that provides a rough estimate of the likelihood of erroneous switching and is used to compare the relative effectiveness of various implementations.

Mean Square Error

The average square of the errors is the MSE. Where error is the discrepancy between the intended quantity and the estimated quantity. The MSE offers a method for picking the ideal estimator. The square root of the MSE is used to calculate the Root Mean Square Deviation, which is another useful statistical indicator for gauging the image's quality. It is desired to have a Mean Square Error of zero (0%).

$$MSE=\Sigma[f(i,j)-F(i,j)]^2/N^2 \qquad \text{(III.1.2)}$$

Peak Signal to Noise Ratio

The Peak Signal to Noise Ratio between the two pictures, measured in decibels, is computed by the PSNR block. This ratio is used to compare the original and compressed images' quality.

With higher PSNR, the quality of the compressed or rebuilt image gets enhanced. Mean-square error and peak signal-to-noise ratio (PSNR) are used to evaluate the effectiveness of picture compression (MSE).The PSNR represents the peak error, whereas the MSE represents the cumulative sum of squared error between the original and compressed image. The error is inversely correlated with the MSE value.

$$PSNR = 10\log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20\log_{10}\left(\frac{MAX_I}{MSE}\right) \quad (III.1.3)$$

The image's MAX_I value is its highest-possible pixel value. This is 255 when pixels are represented with 8 bits per sample. when B bits per sample linear PCM is used to represent samples more generically.

Structural Similarity Index Measure

The SSIM is an index that calculates how similar two photographs are. the SSIM technique for evaluating image quality recently. multiple windows are used to calculate the SSIM. Let's measure the distance between windows f and g. This window has the standard size unit N*N.

SSIM (f,g) =l(f,g) α *c(f,g) β *s(f,g) γ

Where, α>0, β>0

$$SSIM(f,g) = \frac{(2\mu_f\mu_g + c_1)(2\sigma_{fg} + c_2)}{\left(\mu_f^2 + \mu_g^2 + c_1\right)\left(\sigma_f^2 + \sigma_g^2 + c_2\right)} \quad (III.1.4)$$

Image Denoising Techniques

- Bilateral filtering
- Estimation of statistical parameters

The edges of images are preserved by the Bilateral Filter block's filtering. In additional to denoising while protecting edges, separating texture from lighting, and cartooning to emphasise edges, bilateral filtering can be utilised for a variety of purposes. Each pixel in a neighborhood's center is replaced by the filter with an average that was created by combining Gaussian filters for the both space and intensity. Filter coefficients for the block are calculated from:

1. Location in the neighbourhood, specifically (similar to a Gaussian blur filter).

2.Intensity change from the value of the local centre.

III.2 Bilateral Filter

The bilateral filter can be compared to a second Gaussian filter that operates on intensity and modifies the spatial dimension coefficients of a first Gaussian filter. To create an N*N pixel matrix that corresponds to the Neighborhood size, the program stores N-1 lines. Following that, it runs two Gaussian filters through each neighborhood. The spatial and intensity standard deviations are used to determine the filter coefficients.

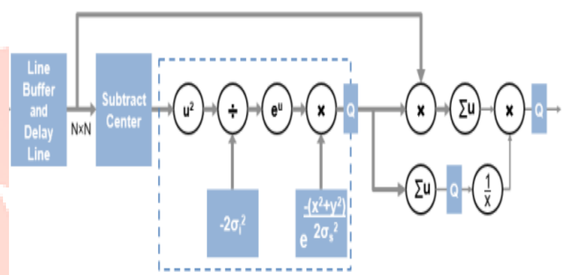


Fig III.2.1: Algorithm of 2-D Bilateral Filter

The neighborhood's centre is rendered with a pixel value of Zero via the Subtract Center operation. A lookup table of precomputed values for each pixel is used to implement the calculation in the dashed area in order to imitate fixed-point or integer data types and to support hardware implementation.u^2 and e^u are always equal to one and are not computed because the center value is always zero. The simulation calculates u^2 and e^u as indicated for input with floating-point precision. The coefficient data type that you chose is used in the dashed region's output. Quantization points are displayed in the Q blocks of the diagram.

After that,the output pixel value is transformed into the output data type you specify. If your colour space does not use the entire range of the data type, you may need to rescale the pixel values because the filter uses the entire range of the data type. Both defects and other discontinuities, as well as fine-scale information included within coherent picture features, are preserved using bilateral filtering. The primary disadvantage of bilateral filtering is its computational cost, which is relatively high compared with that of edge-preserving smoothing.

Algorithm of Image Denoising Using Bilateral Filtering

Step 1: Take the original image.

Step 2: Add speckle noise to the original image

Step 3: Then it stores N-1 lines so that it can form an N * N matrix of pixel matching in Neighborhood size.

Step 4: Apply two Gaussian filters on each of their neighborhood.

Step 5:Filter coefficients are calculated from Spatial and Intensity Standard Deviations.

Step 6: Subtract center operation that produces a pixel value of zero at the center of respective neighborhood.

Step 7: The simulation computes u^2 and e^u, and the output of the dashed region uses the coefficient data type that you have choosen.

Step 8: The final normalization step is implemented. The most important number of bits are used to quantize the coefficient sum.

Step 9: The output data type that we chose is used for the reciprocal values. The simulation then recognises a zero-sum and divides the dividend by eps().

Step 10: It then converts the output pixel value to the output data type that we requested.

Wavelet Deconstruction & Construction:

One of the key advantages of wavelets is that they allow complex information such as images to be deconstructed into elementary forms at multiple places and sizes and afterwards reconstructed with high precision.

IV SOFTWARE REQUIREMENTS

MATLAB

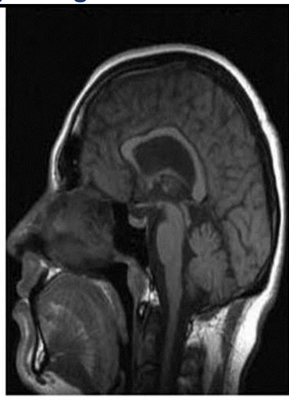
For technical computing, MATLAB is an efficient language. It combines computation, visualisation, and programming in a user-friendly setting where issues and answers are presented using well-known mathematical notation. Examples of typical usage Calculation and math development of algorithms data collection the use of models, simulations, and prototypes exploration, analysis, and visualisation of data visuals used in science and engineering the creation of a graphical user interface for an application.

V RESULTS

The results obtained are performed by Bilateral Filtering and Wavelet Transform and are as follows:

Input Images :

FigV.1: Input Image 1



FigV.2: Input Image 2

Output Images :

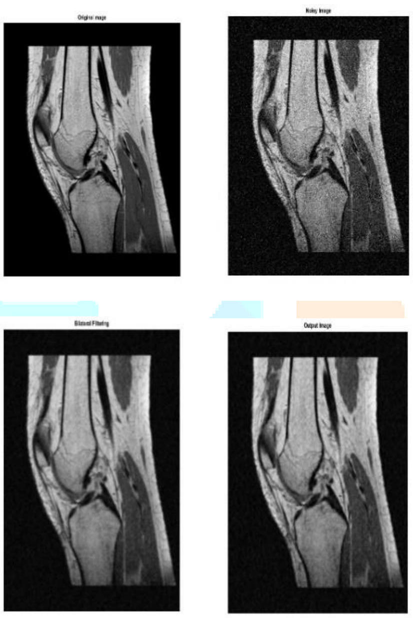
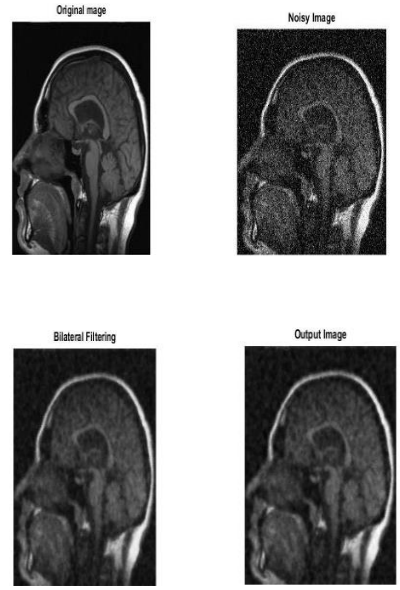
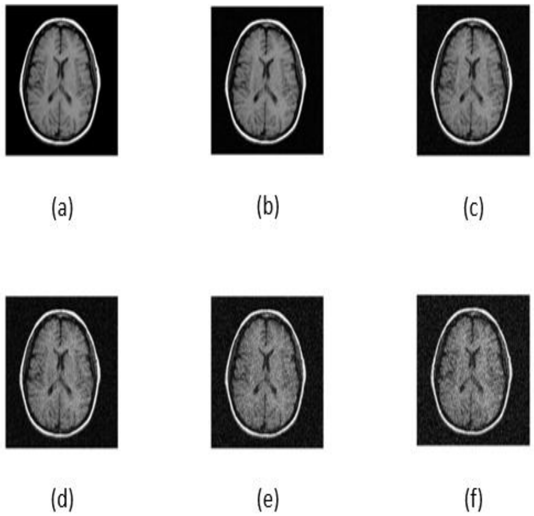


Fig V.3: Input Image, Noisy Image, Bilateral Image, Output Image of VARIANCE 30.



FigV.4:Input-Image,Noisy Image,Bilateral-Image, Output Image of VARIANCE 40.



FigV.5:(a) Original image, (b) Noisy image with var. 10, (c) Noisy image with var. 20,(d) Noisy image with var. 30, (e) Noisy image with var. 40, (f) Noisy image with var. 50.

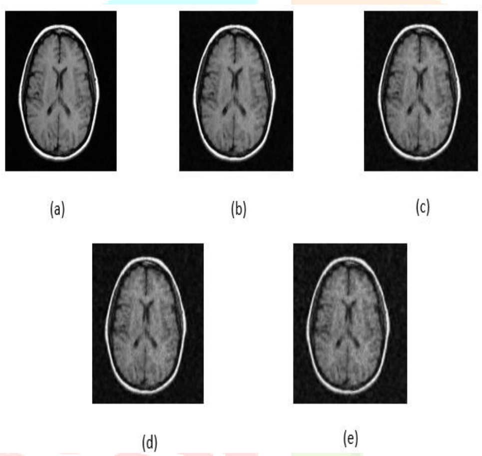


Fig V.6: (a) Output image for var10, (b) Output image for var20, (c) Output image for var30, (d) Output image for var40, (e) Output image for var50.

VI CONCLUSION

Many images, including MEDICAL photographs, Ultrasound images, etc., have been discovered to simulate the real-time noise using the multiplicative noise. The goal of this thesis is to create a denoising technique for multiply corrupted noise. There has been development of a Wavelet domain-based approach with various thresholding methods. A hard and entropy-based thresholding method created in [8] determines the thresholding on the Wavelet coefficient. Using statistical metrics like SSIM, MSE, SNR, and PSNR, the algorithm's performance is assessed after it has been applied to a number of common images. The findings of the experiments show advancements above the current state-of-the-art for denoising, such as bilateral filtering.

S.NO	Statistical Parameter Indices	Noisy Image	Restored Image
Image1	PSNR MSE	29.5823 71.5882	32.7493 34.5261
Image2	PSNR MSE	28.5307 91.2023	34.0973 25.3133
Image3	PSNR MSE	29.2690 76.9434	34.8260 21.4029

Table VI.1: Comparison between original, noisy and restored image of Bilateral filtering with different noise variance.

VII REFERENCES

[1] S. Kumar, P. Kumar, M. Gupta, and A. Nagawat, "Performance comparison of median and wiener filter in image denoising," International Journal of Computer Applications (0975–8887) Volume, 2010.

[2] E. Candes, L. Demanet, D. Donoho, and L. Ying, "Fast discrete curvelet transforms," Multiscale Mod-eling & Simulation, vol. 5, no. 3, pp. 861–899, 2006.

[3] J. Starck, E. Cand`es, and D. Donoho, "The curvelet transform for image denoising," Image Processing, IEEE Transactions on, vol. 11, no. 6, pp. 670–684, 2002. [4] N. R. Pal, "On minimum cross-entropy thresholding," Pattern Recognition, vol. 29, no. 4, pp. 575–580,1996.

[5] A. Al-Ajlan and A. El-Zaart, "Image segmentation using minimum cross-entropy thresholding," in Systems, Man and Cybernetics, 2009. SMC 2009. IEEE International Conference on. IEEE, 2009, pp. 1776–1781.

[6] G. Al-Osaimi and A. El-Zaart, "Minimum cross entropy thresholding for medical image images," in Information and Communication Technologies: From Theory to Applications, 2008. ICTTA 2008. 3rd InternationalConference on. IEEE, 2008, pp. 1–6.

[7] E. Cands, L. Demanet, D. Donoho, and L. Ying, "Fast discrete curvelet transforms," 2005.

[8] M. Sezgin et al., "Survey over image thresholding techniques and quantitative performance evaluation," Journal of Electronic imaging, vol. 13, no. 1, pp. 146–168, 2004.

[9] J. Kittler and J. Illingworth, "Minimum error thresholding," Pattern recognition, vol. 19, no. 1, pp. 41–47, 1986.

[10] J. Kapur, P. K. Sahoo, and A. Wong, "A new method for gray-level picture thresholding using the entropy of the histogram," Computer vision, graphics, and image processing, vol. 29, no. 3, pp. 273– 285, 1985.

[11] C. Li and P. Tam, "An iterative algorithm for minimum cross entropy thresholding," Pattern Recognition Letters, vol. 19, no. 8, pp. 771–776, 1998.

[12] J. Sauvola and M. Pietik¨ainen, "Adaptive document image binarization," Pattern Recognition, vol. 33, no. 2, pp. 225–236, 2000.

[13] M. Sezgin and R. Ta¸saltın, "A new dichotomization technique to multilevel thresholding devoted to inspection applications," Pattern Recognition Letters, vol. 21, no. 2, pp. 151–161, 2000. 51 BIBLIOGRAPHY 52

[14] J.-S. Chang, H.-Y. M. Liao, M.-K. Hor, J.-W. Hsieh, and M.-Y. Chern, "New automatic multi-level thresholding technique for segmentation of thermal images," Image and vision computing, vol. 15, no. 1,pp. 23–34, 1997.