Entorpy Efficient Model for SAR Image Using BSF Using Discrete Wavelet Segmentation

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Abstract - In last two decades, demand of the wavelet transform has exponentially increased for many research applications. This dissertation focuses on to design a image de-noising method in wavelet domain for SAR images. The major sad drawback of different existing noise reduction methods [1, 3, and 5] is the loss of information. This research work compares the methods of speckle noise reduction in Synthetic Aperture Radar (SAR) images. Dissertation deals with the various speckle filters which are based on wavelet based de-noising in SAR images. Due to the conventional CFAR algorithm, CFAR with morphological operation and two stage degree detection methods aren't appropriate for high-resolution goal detection of SAR pictures, a new novel fuzzy C-means clustering detection approach primarily based on auto-segmentation proposed in this dissertation. On the primary stage, obtaining the transform image the use of discrete wavelet transform or rework practice to the enter SAR picture, and remove the noise from the enter SAR image, this is also proved or established to be an easy and an effective quantitative description index for measures of complexness of SAR image. Keywords - leaf disease, k-means clustering, Image segmentation, Neural network.

Keyword :- Bivariate Shrinkage, Discrete Fourier Transform, Mean Square Error, Signal to Noise Ratio, Probability Density Function.

I. INTRODUCTION

The (SAR) is incredibly helpful for providing data concerning earth's surface by using the comparative gesture among aerial and its target, generally motion in particular swath. Its numerous applications like remote sensing, resource watching, triangulation, standing and soldierly imposing, great-determination secluded detecting for planning, examine and release, coalface recognition, apparent investigation and spontaneous goal acknowledgment [3].

Figure 1.1 Synthetic Aperture Image

It possesses various benefits over optical satellite imagery like, effective operation is achieved irrespective of the atmospheric condition and might ready to penetrate clouds, forest cover and soil [7]. In spite of these benefits, it's being affected largely by the signal dependent noise referred to as speckle noise that successively affects radiometric resolution [1].

II. LITERATURE SURVEY

This dissertation deals with the study of Synthetic Aperture Radars also abbreviated as SAR systems, which represents the best example of active microwave systems. The initial SAR technology was established in early 1950s. During this era it was demonstrated that the spatial azimuth resolution of the radar system can drastically increased via consistent recording and processing of radar's echoes. The SAR image processing involves changing nature of the image in order to either;

I. Improve its visual information for human interpretation and perception.

II. Make it more suitable for intelligent machine perception.

It requires realizing that both of these aspects represent separate but equally important aspects of SAR image processing. The algorithm which satisfies condition (1) is a procedure to enhance the image but may be worst procedure for satisfying condition (2). Humans like their images to be sharp, clear and detailed but machines prefer their images to be simple and uncluttered.[15]

A. SAR Image Interpretation

SAR images are contains many small dots, or scene elements or pixels. This scene element in the radar images represents the radar back-scatter from captured ground area as shown in Figure 2.1. Back-scatter for a target area at particular wavelength varies with different conditions Viz. scatters size and moisture content in the target areas, polarization of the radio pulses, and there observation angles. Back-scatter will be also different when radio waves of different wavelengths are used.

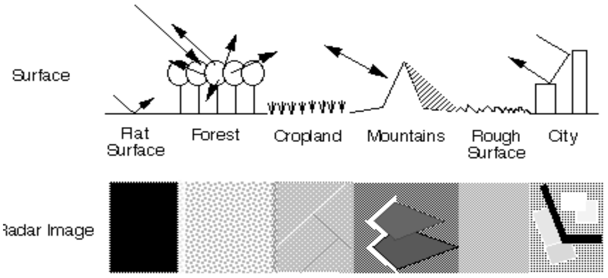


Figure 2.1 Imaging different types of surface with radar [12]

B. Types of Noises Models

The noise in images can be mathematically modeled as either additive or multiplicative noise model.

White Noise **-** In signal processing, white noise is a random signal having equal intensity at different frequencies, giving it a constant power spectral density. ... White noise refers to a statistical model for signals and signal sources, rather than to any specific signal.

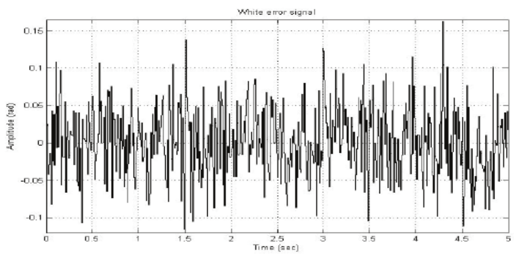


Figure 2.2 White noise

Additive Noise: Usually captured images are corrupted by additive noises modeled with either a Gaussian, uniform, or salt or pepper distribution. Mostly additive noise is Gaussian noise and is easy to model and remove.

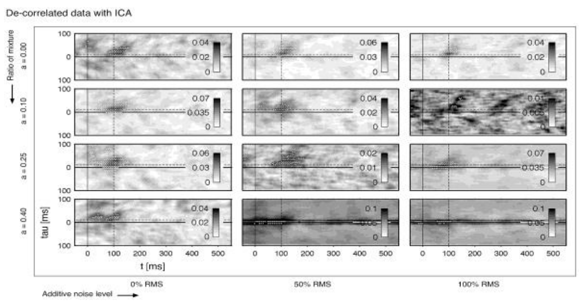
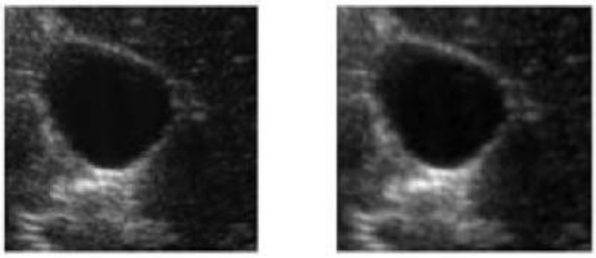


Figure 2.3 additive noises

Multiplicative Noise: Whereas, multiplicative noise is complex to model and it varies with image environment. Multiplicative noise is mostly present in SAR imagery. Synthetic Apertures Radar (SAR) technique is popular because of its usability under various weather conditions, its ability to penetrate through clouds and soil [1, 3]. A SAR image is a mean intensity estimate of the radar reflectivity of the region which is being imaged. Speckle noise in such system is to be referred as the difference between a measurement and the true mean value. Usually in Synthetic Aperture Imagery (SAR) large amount of de-phased echoes due to pulse scattering causes the Speckel noise.



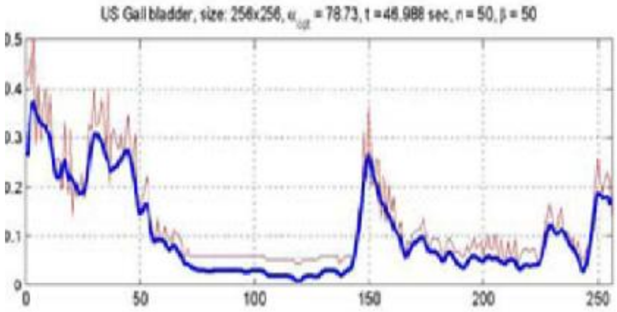


Figure 2.4 *Multiplicative Noise*

The noise in images can be mathematically modeled as either additive or multiplicative noise model.

White Noise **-** In signal processing, white noise is a random signal having equal intensity at different frequencies, giving it a constant power spectral density. ... White noise refers to a statistical model for signals and signal sources, rather than to any specific signal.

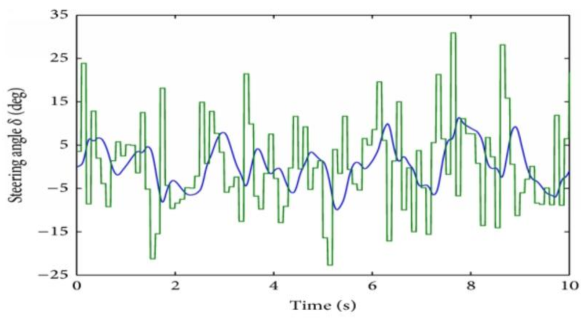


Figure 2.5 White noise

C. Speckle Noise Reduction Methods

The best way of designing the noise reduction filters are;

I. Based on directly filter on the received signals before forming the beam.

II. Or based on a mixing the various existing de-noising process.

In this dissertation we have followed the second way to design a speckle noise reduction method. First various existing noise reduction methods are reviewed sequentially. There are many speckle noise reduction algorithms [1, 2, 28, 30] which were designed by the researchers viz. Mean filter, Median filter, Lee filter, Kuan filter, Frost filter, and Wiener filter. These noise reduction filters are classified as shown in Figure 2.6 as follows.

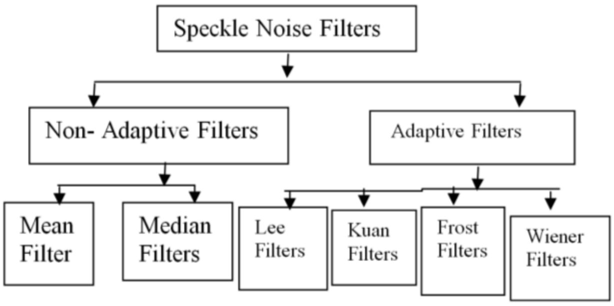


Figure 2.6 Classification of Speckle Reduction methods

III. FILTER REVIEW

A. Mean Filter Review

Mean filter is a spatial domain non-adaptive filter [17], which uses the structuring mask or window for filtering. It is also termed as averaging filter. Since every pixel value is replaced by the mean value of all pixels in neighborhood using the structuring window of $M \times M$ size.

B. Median Filter Review

Median filter is also a spatial domain non-adaptive filter [17]. In case of median filter, the neighboring pixels are sorted according to brightness and the median value in the neighborhood becomes the new value for the central pixel in a M×M.

C. Lee Filter review

J. S. Lee [28], have proposed a noise filtering method by using the of local image statistics. These filters were first proposed in 1981 and then modified in 1986. The basic principle of the filter was estimation of signal using mean square error minimization technique. Filter utilizes the combination of mean filter in homogeneous regions and filtering noisy data in edge regions. Lu, *et al in* 1996 has proposed the modified Lee filter method which performs the speckle noise reduction only in edge regions.

D. Kuan Filter Review

D. T. Kuan, *et al in* 1985 have proposed a smoothing filter for images with signal dependent noise model. Kuan in 1987 have proposed a multiplicative noise model which transforms into a signal dependent additive noise model with addition of minimum mean square error criterion.

E. Wiener Filter

Anilet et al. [2] have stated that Wiener Filter in the wavelet domain performs better than thresholding methods and Wiener Filter in the Fourier domain. The wiener filter is very efficiently used in many applications such as noise reduction and de-blurring.

F. Wavelet shrinkage

According to wavelet analysis, one of the most effective ways to remove speckle without smearing out the sharp edge features of an ideal image is to threshold only the high frequency components while preserving most of the sharp features in the image. The approach is to shrink the detailed coefficients (high frequency components) whose amplitudes are smaller than a certain statistical threshold value to zero while retaining the smoother detailed coefficients to reconstruct the ideal image without much loss in its details. This process is sometimes called wavelet shrinkage since the detailed coefficients are shrunk towards zero.

IV. SPECKLE NOISE REDUCTION METHODS

A. Spatial Domain Methods

The term spatial domain means working on the brightness in the given color space [11]. In this case, the image, it implies working directly with the pixels values or in other words, working directly with the raw data. Let $f(x, y)$ be the original image where f is the gray level value and (x, y) are the image coordinates. An 8 bit image f can take values from $0 - 255$ where 0 represents black, 255 represents white and all the intermediate values represent shades of color. In a color image of size $256\ x\ 256\ x\ 3$, x and y can take values from $(0\ ,0)$ to $(255, 255)$ for RGB each color space as shown in Figure.

$$G(x,y) = T[f(x,y)] \quad \text{Equ.no. 3.1}$$

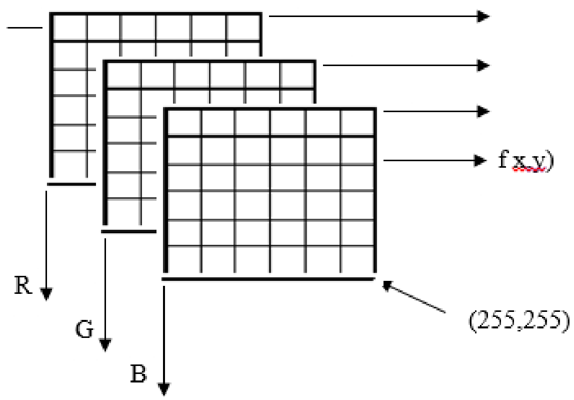


Figure 4.1 Spatial domain representation of color image

B. Linear Averaging Filters

An averaging filter is a low pass filter which eliminates the Gaussian noise present in an SAR image. An low pass filtering mask is generated from the spatial response that would give us the averaging filter operation. An important point to note from spatial response is that here coefficient are shown in 3 x 3 mask although mask size can be MxM with all value 1.

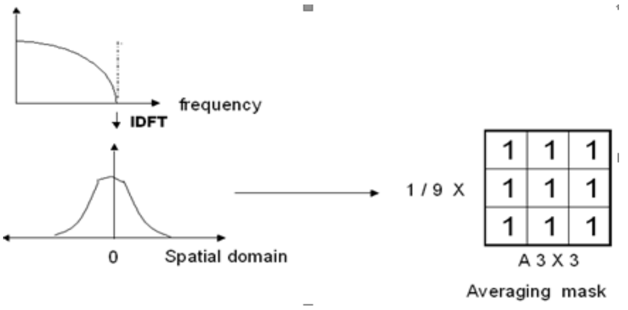


Figure 4.2 Linear Averaging Filters

C. Median filters

Median filters can perform better to reject certain types of noise, for example "shot" or impulse noise in which some individual pixels have extreme values [17].

Compared to the other smoothing filters median filters particularly have following main advantages given as:

- No reduction in contrast across steps, since output values available consist only of those present in the neighbourhood (no averages).
- Since the median is less sensitive than the mean to extreme values (outliers), those extreme values are more effectively removed.

D. Adaptive Weighting Filters

There are many filters which are designed for the Speckle noise reduction in SAR images. These all filters are different than each other in terms of weighting function or in term of threshold selection method. All these methods weights the center pixel value of the filtering mask with a weighting function W, which is calculated adaptively from

the current mask values. these filter are broadly classified as; Lee filter, Kuan filter, Frost filter and Wiener filters. Speckle noise in SAR is by default a multiplicative noise, i.e. it is proportional to the local grey level value of any pixels within image region.[2]

E. Lee Filte

Lee [28, 29] filter are based on the Minimum Mean Square Error (MMSE) filtering technique, which results speckle removed image governed by the weighting function [29] given as;

$$Y_{ij} = \bar{K} + W * (C - \bar{K}) \quad \text{Equ.no.} \quad 3.3$$

Where;

Y_{ij} is the Speckle Removed filtered image

$\bar{K}$ is the mean value of the current pixels within the mask

W is the weighting function or matrix

C is the center pixel value of the current mask position

Where, weighting function W is calculated as;

F. Kuan Filter

The Kuanfilter [18] are modeled as similar to the Lee filters and are widely used for SAR images. these filters are based on the minimum mean square error (MMSE) filtering technique.

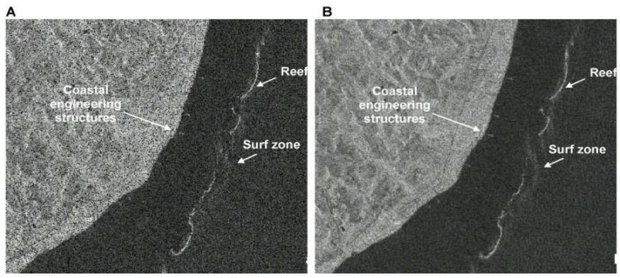


Figure 4.3 Kuan filtering example a) NoisySAR_image_2 b) filtered image

F. Frost Filter:

The Frost filter is an adaptive and exponentially weighted averaging filter based on the coefficient of variation, which is the ratio of the local standard deviation to the local mean of the degraded image [31]. It replaces the pixel of interest with a weighted sum of the values within the moving kernel and the weighting factors decrease with distance and increase with the increase in variance of the kernel.

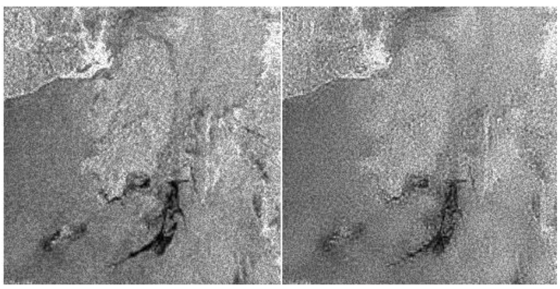


Figure 4.4 Frost filtering example a) NoisySAR_image_2 b) filtered image

V. WAVELET SEGMENTATION OF SAR IMAGE

In this dissertation wavelet image fusion is used for improving the performance of the existing Speckel noise reduction in SAR images. Synthetic aperture radar (SAR) imaging system is usually an observation of the earths' surface.

A. Image Fusion

Land use information is one of the most useful input element in forming policies concerning to economic, environmental issues at national and also at global levels. With the view of these different spectral, temporal and spatial qualified sensors are

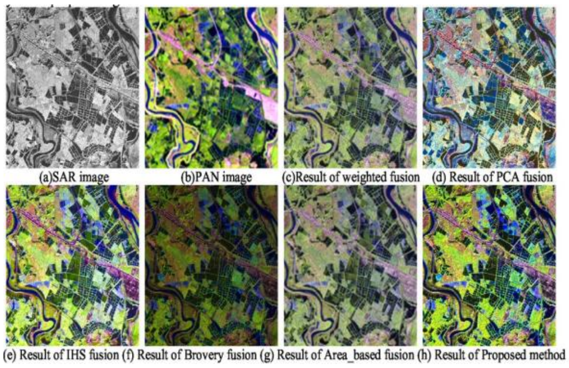


Figure 5.1 Basic Image fusion of SAR Image.

B. Wavelet Based Image Fusion

Fusion methods based on discrete wavelet transform (DWT) technique as shown in Figure 4.4 have become popular due to their multi-resolution characteristic.

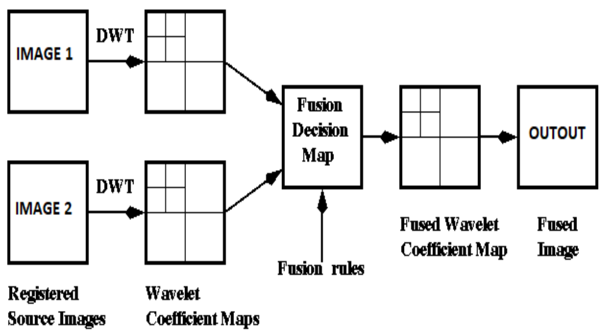


Figure 5.2 Wavelet based image fusion block diagram

VI. BIVARIANT SHRINKAGE FUNCTION

This technique is simple and very effective than existing [6] Speckle reduction techniques in spatial domain. The proposed method is computationally less complex since it uses the simple global thresholding for filtering with Bivariant Shrinkage function. It is intended to provide better filtering compared to other speckle reduction approaches.

A. Proposed Speckle Reduction Filter

In this dissertation a simple Speckle noise reduction filter is designed using simplified Bivariant Shrinkage (BVS) function in wavelet domain and in order to improve the entropy the wavelet fusion is used. The original image is used as reference and the wiener filtered image is used as expanded image in bivariant shrinkage function therefore the filter is simple and fast. in order to improve the entropy the Frost filtered image is fused with bivariant filtered image. The block diagram of the proposed method is shown in the Figure 6.1.

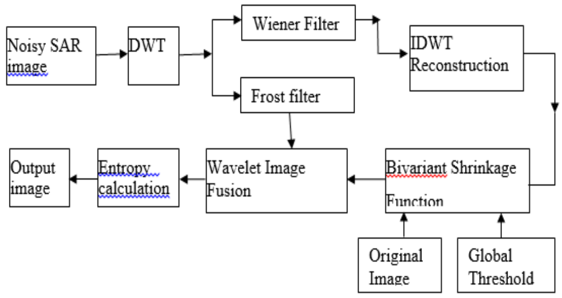


Figure 6.1 Proposed Speclle reduction filter

VII. SIMULATION RESULT

The proposed filtering method takes advantage of Frost filtered image and bivariant Shrinkage function based on global thresholding. The results are presented in three stages as results of Wavelet decompositions, Then in the second stage the results of various wavelet based Speckle filters are presented. Finally the results of Wavelet based fusion and qualitative analysis are presented.

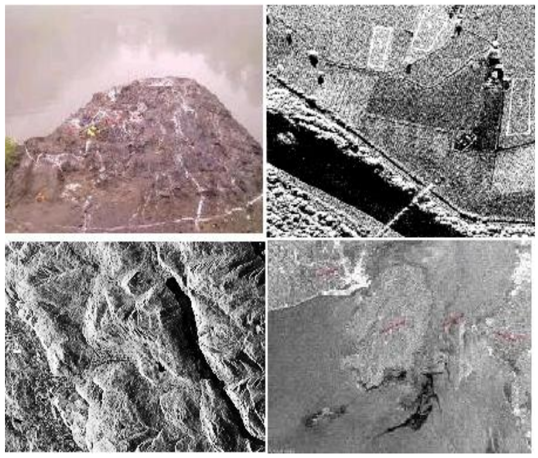
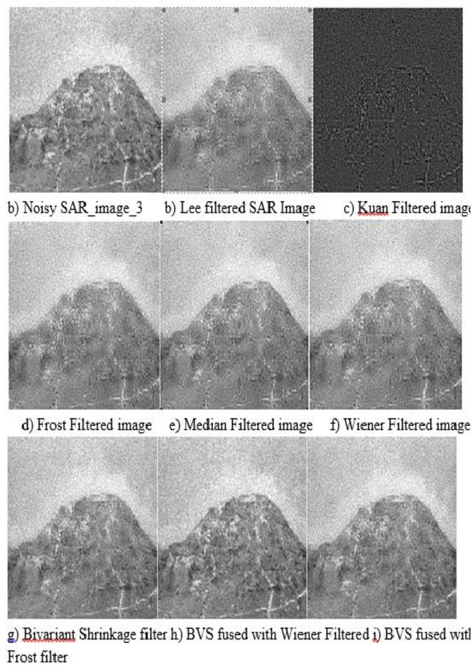
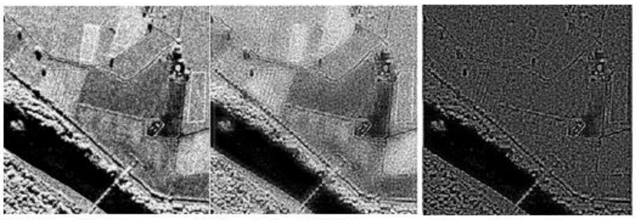


Figure 7.1 Input Image

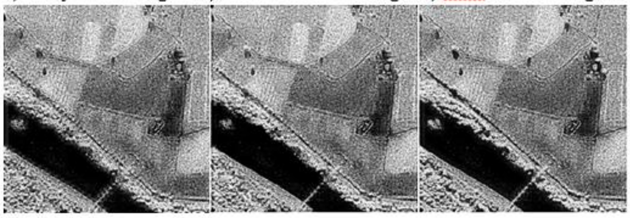
A. Simulation Result 1 :-



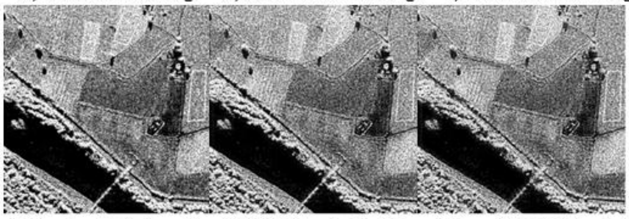
B. Simulation Result 2 :-



b) Noisy SAR1 image b) Lee filtered SAR Image c) Kuan Filtered image



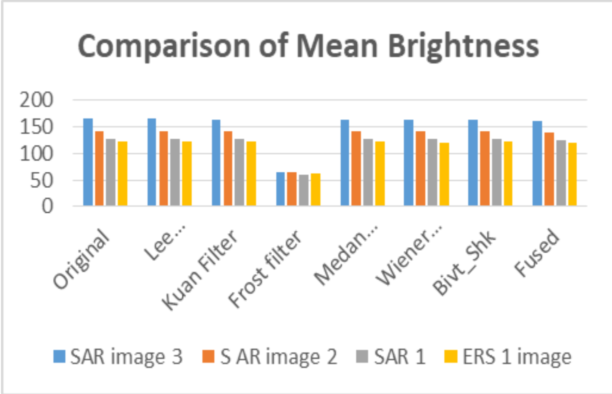
d) Frost Filtered image e) Median Filtered image f) Wiener Filtered image



g) Bivariant Shrinkage filter h) BVS fused with Wiener Filtered i) BVS fused with Frost filter

C. Comparison of Mean Brightness

ERS 1 image	SAR 1	S AR image 2	SAR image 3	Images
121.753	126.72	141.475	163.624	Original
121.493	126.729	141.368	163.801	Lee Filter
121.747	126.698	141.475	163.591	Kuan Filter
62.484	58.497	63.761	63.798	Frost filter
121.724	126.917	141.48	163.552	Medan filter
120.329	125.926	140.9087	162.844	Wiener filter
120.921	126.197	141.1419	163.244	Bivt_Shk
118.2581	123.465	137.8266	159.951	Fused



VIII. CONCLUSIONS

Same analysis can be applied to dual tree complex wavelet transform.The dual tree complex wavelet transform incorporate good properties of fourier transform in wavelet transform. As the name implies 2 wavelet tree are used one generating real part of complex wavelet coefficient tree and other generating imaginary part. This transform provide good basis for multiresolution image denoising and de-blurring.[11]

Bivariate distributions are proposed for wavelet coefficients of natural images in order to characterize the dependencies between a coefficient and its parent. That is more efficient then classical soft thresholding approach. Other simple bivariate shrinkage functions can also be developed, for example, a bivariate hard Threshold with a circular or ellipsoidal dead zone

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