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Survey Paper on Despeckling of SAR Images on Different Transform Domain

Akanksha Namdeo[1], Anish Vishwakarma[2], Neelmani Chhedaiya[3]

[1]M. Tech Scholar, Digital Electronics, RCET, Bhilai, India

[2]Assistant Professor (ET & T), RCET, Bhilai, India

[3]Assistant Professor (ET & T), RCET, Bhilai, India

Abstract: ***In this paper we have study about despeckling of Synthetic Aperture Radar (SAR) images. SAR images have much more disturbance or we can say it is Noisy. So, it is important to remove the noise from these images. In this paper we study about different transform domain despeckling. By studying this paper it is easy to choose which type of the technique is better for despekling likewise for which purpose we want which type of despeckling that helps more. In this we discuss about curvelet, contourlet, wavelet and wavelet with neighboring coefficient transform.***

Keywords: SAR, Despeckling, Wavelet, Curvelet. Contourlet.

1.Introduction

Radar has long been used for military and non-military purposes in a wide variety of applications such as imaging, guidance, remote sensing and global positioning. Synthetic Aperture Radar (SAR) images are inherently affected by multiplicative speckle noise, due to the coherent nature of scattering phenomena. Synthetic aperture radar (SAR) satellites have provided a wealth of information on such diverse ocean phenomena as surface waves, internal waves, currents, upwelling, shoals, sea ice, wind, and rainfall. The influence of man in the form of offshore facilities, ship transits, and other ocean-related events and artifacts is also observed using fine resolution SAR. The Speckle in the SAR images reduces the detection ability of targets and is not favorable to the image understanding. Thus, the despeckling has become an important issue in SAR image processing.

Recent years, wavelet theory has become one of the main tools of the signal processing. Its analysis capacity for the time domain and frequency domain of the signal and optimal approximation to one-dimensional bounded variable function classes is the main reason that wavelet develops so rapidly.

SPECKLE NOISE MODEL

Speckle noise in SAR images is usually modeled as a stationary multiplicative noise with unit mean and variance. A simple model for speckle noisy image has a multiplicative is represented by

$$f(x, y) = S(x, y).N(x,y) \quad (1)$$

By applying logarithmic operator to both sides of eqn (1), the following expression is obtained

$$\ln(Y) = \ln(S) + \ln(N) \quad (2)$$

Equation (2) can be written as

$$y(x, y) = s(x, y) + e(x, y) \quad (3)$$

Where y(x,y), s(x,y) and e(x,y) represent the logarithmically transformed noisy data, signal and speckle noise respectively. This nonlinear transform totally changes the statistics of speckle noise. Pixels of log-transformed images are mutually independent and this makes less difficult to extract information from speckled images.

2.Comparison On Different Domains

a)Curvelet Transform

Curvelet transform (CT) is proposed by Candes and Donoho in 1999, its essence is derived from the ridge-wave theory. In the foundation of single ridge-wave or local ridge wave transform, Curvelet transform is constructed to express the objects which have curved singular boundary, curvelet combines advantages of ridge wave which is suitable for expressing the points character and wavelet which is suitable for expressing the points character and take full advantage of multi scale analysis, it is suitable for large class of image processing problems.

The Curvelet transform of function is written as,

$$C(j,l.k) = \langle f, \emptyset_{ij,l,k} \rangle$$

Among which, *ij*, *l*, *k* j is Curvelet coefficient, *j*, *l*, *k* are the parameters of scale. Direction and position respectively. Wrapping round origin is the core ofv wrapped based curvelet. It realizes one to one through the periodization technology in the affine region.

b)Contourlet Transform

The contourlet transform consists of two major stages: the subband decomposition and the directional transform. At the first stage, Laplace Pyramid (LP) is used to decompose the image into subbands, and then the second one is a Directional Filter Bank **(**DFB) which is used to analyze each detail image.

The contourlet transform was proposed as a directional multiresolution image representation that can efficiently capture and represent singularities along smooth object boundaries in natural images. Its efficient filter bank construction as well as low redundancy makes it an attractive computational framework for various image processing applications. However, a major drawback of the original contourlet construction is that its basis images are not localized in the frequency domain.

A despecckling technique has been proposed, based on the use of a homomorphic framework with a stage of a filter being replaced by the contourlet thresholding. The despeckled images from such method possess good qualities.

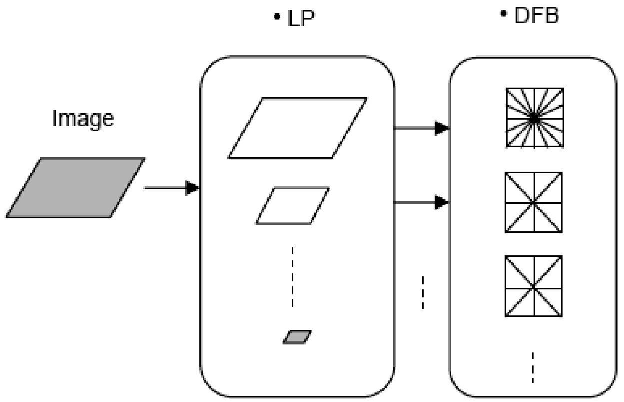

Figure 1: A flow graph of the contourlet transform. Image is first decomposed into subbands by LP and then each detail image is analyzed by DFB.

c) Wavelet Transform

In this paper they introduced new wavelet based algorithm for speckle reduction of synthetic aperture radar images, which uses combination of undecimated wavelet transformation, wiener filter (which is an adaptive filter) and mean filter. Furthermore instead of using existing thresholding techniques such as sure shrinkage, Bayesian shrinkage, universal thresholding, normal thresholding, visu thresholding, soft and hard thresholding, They use brute force thresholding, which iteratively run the whole algorithm for each possible candidate value of threshold and saves each result in array and finally selects the value for threshold that gives best possible results. That is why it is slow as compared to existing thresholding techniques but gives best results under the given algorithm for speckle reduction.

d) Wavelet Transform Using Neighbouring Wavelet Coefficients

The basic idea of the wavelet speckle suppression filter is:
1) Decompose a SAR image into the wavelet subspaces images with a pyramidal structure.
2) Reduce the amplitude of each pixel in the detail images of each subspaces by using the soft or hard thresholding.
3) Reconstruct an output image from the modified subspaces images.

Under the two-dimensional wavelet transformation, at every decomposition level, four frequency subbands can be obtained, namely, LL, LH, HL, and HH. The next level should be applied to the low frequency subband LL only. The denoising is done only on the detail wavelet coefficients of LH, HL, and HH, which capture the horizontal, vertical and diagonal features in the images, respectively. Then we can utilize this nature of the detail images for identifying edges. In this paper, we study SAR image despeckle by incorporating neighbouring wavelet coefficients. By using this method we can learn from the experimental results that their proposed algorithm gives better results than the conventional wavelet thresholding algorithm. It should be note that in this paper they only investigate the relationship of the neighbouring wavelet coefficients at the same wavelet decomposition level.

3.Conclusion

Curvelet transform illustrates that the curvelet based despeckling algorithm using Particle Swarm optimization (PSO) performs much better in several aspects than other wavelet based method and filtering technique. The results using real SAR images show that this transform method can reduce the speckle to a great extent while preserving texture and strong radiometric scatter points. Aiso curvelet transform has Poor performance in smooth areas, produce curve let-like artifacts and not efficient if noise is more.

Using Contourlet transform it has despeckled images that possess good qualities. Because the mean of log-transformed speckle noise does not equal to zero, thus a d.c correction is required to avoid extra distortion in the restored image. It should be noted that the proposed technique is accomplished with acceptable computational complexity. It deals effectively with piecewise smooth images with smooth contours, edges, boundaries and can capture the intrinsic geometrical structure of an image.

In Wavelet Transform Artifacts are introduced if the selection of threshold of the wavelet is not proper. It Supports MRA, provides both time & frequency information.

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