
An analysis of a un decimated BM3D de-speckling method for monochrome images

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ABSTRACT:

In microwave or synthetic aperture radar or radar image formation, a speckle noise is generally added. This noise is available in coherent imaging systems like radar image capturing, medical image capturing, etc. De-speckling methods are used to de-speckle the available speckle noise from these speckled systems. In optical image formation, other noises are added. An un-decimated block matching 3D (BM3D) method is a state of art technique in de-speckling area. In this paper, an analysis has been done on optical or satellite images with un-decimated BM3D method. Different quality parameters are evaluated and compared for different speckle noise variances by considering the Sentinel-2 satellite sub band images as radar image.

Keywords: BM3D, monochrome image, de-speckling, optical image and colour band.

I. INTRODUCTION

Microwave images are popular in taking the images at bad environmental situations and at day and nights. In this radar image process of capturing or image formation, a noise is generally added called as speckle noise. Due to this unavoidable noise the quality of the image is degraded and the important features are disturbed. To get back the original image of the scene, a good de-speckling method [1] has to be used. In this process, spatial domain filters like lee, map and wiener filters and frequency domain filters like wavelet, ridgelet, curvelet, bandlet, contourlet transforms are generally used [2-3]. A BM3D technique has become popular in removing the speckle noise in last decade. An un-decimated BM3D algorithm is giving good and reasonable results in recent years. A de-speckled image can be used for applications like ground water monitoring, agriculture advising, disaster management, forest deformation, glacier analysis, etc. Here, a question arises. Can a de-speckling technique is used for an optical image, by considering the optical sub band as radar image. This paper gives answer for that.

II. PROPOSED METHOD

A BM3D method is good for de-noising of satellite images. In BM3D, wavelet decomposition and reconstruction are used. A 512*512 image is converted into 256*256 image in decomposition of sub bands and 256*256 image is converted into 2737

512*512 image in reconstruction. In this process of reconstruction the originality is missed, it is because of compatibility of the sizes of images. This can be avoided by using un-decimated BM3D method [4]. This method has given very good results for de-speckling analysis. In the figure 1, it is clearly shown the process of the method of image de-speckling. This method is used for speckled image. The block size, threshold values, wavelet type and type of filter play the major role in the process. Haar wavelet is used in the wavelets [5-6]. Different sub bands of wavelet are having different visual information. Threshold in these sub bands play the most important role. Block size of 32 is considered. Wavelet theory is used two times in the technique. Wiener filter is used in filter section. A bunch of blocks of size 32 is arranged in one dimension and finally forms a 3 dimensional image. Actually this is not a 3 dimensional, but this blocks arrangement process looks like 3 dimension. That's the reason it is said to be 3D algorithm. By having un-decimation along with 3 dimensional arrangements, it is named as un-decimated 3D algorithm [7].

Different quality parameters like equivalent number of looks of an image (ENL), speckle suppression index of method used (SSI), speckle suppression and mean preservation index of method used (SMPI), correlation coefficient between images (CC), edge saving index in horizontal direction (ESIH), edge saving index in vertical direction (ESIV), mean square error of final image (MSE), peak signal to noise ratio of the final image (PSNR), overall edge preserving index (EPI) or edge saving index (ESI) and computational time for the process (CT) are calculated and compared for two speckle noise variances. These values play a vital role in de-speckling process. These de-speckled images can be used for classification purpose and validation can be done for accuracy and kappa calculations.

The differences in the optical images or radar images can't be understood with naked eye [8]. It can be possible with statistical approach. This de-speckling method can be used at the time of image formation and it is possible at initial levels of image formation [9-10]. Now, this method has been tested at last level of image of geo tiff format of the image. This method can be done for the sizes of 256*256, 512*512 and 1024*1024. This method is tested on regular mono chromo images like red, green and blue sub bands of 11 bands of sentinel image. This can

also be used for adjacent sub bands of above said

bands.

III. RESULTS AND DISCUSSIONS

The de-speckling method has been verified with different variances (0.25 & 0.1) for monochrome images. The monochrome images that considered are red colour band, green colour band, blue colour band and grey colour image of original optical image. Environment for Visualizing Images (ENVI) software is used for sub band division and addition and matrix laboratory (MATLAB) software is used for de-speckling technique. The satellite or optical image is having 7585*7591pixels in its representation. MATLAB can't run that big sized image, ENVI can.

Figure 2(a) is the original optical image of size 512*512. This is collected from sentinel-2 achieve of earth explorer website. Figure 2(b) is the grey colour image of the optical image. These two images can give more visual details compared to other panchromatic images. Figure 2(c) is the de-speckled image after considering the red colour band panchromatic image for de-speckling method. Figure 2(d) is the de-speckled image after considering the green colour band panchromatic image for de-speckling method. Figure 2(e) is the de-speckled image after considering the blue colour band panchromatic image for de-speckling method. Figure 2(f) is the de-speckled image after considering the grey colour image for de-speckling method. These images are the outputs of images containing noise variance of 0.25. This noise has been added to monochrome images before de-speckling process. For different noise variance values, the parameters are evaluated and compared. Table 1 to table 4 are showing the quality parameters for various noise values.

Different quality parameters like ENL, SSI, SMPI, CC, ESIH, ESIV, MSE, PSNR, EPI and CT are calculated for two set of images. Each set contains de-speckling of red colour band de-speckling, green colour band de-speckling, blue colour band de-speckling and grey colour image de-speckling of original optical image. It is given the statistical approach to analyse the de-speckling of the bands with given de-speckling method. ENL is more in green band de-speckling. Because this band contains very less visual information, it is good to use for next steps. SSI and SMPI are related to speckle reduction measurements. SSI and SMPI values are more for red and blue bands. More visual information is available in these bands and better to have high value at these bands. Good effort in this issue. The obtained CC values are really appreciated. CC value is more for red and blue bands. More visual information is available in these bands and better to have high value at these bands. ESIH is high and same in all the bands and better than ESIV. Generally horizontal information is more important to human eyes than vertical information. Good effort in this issue. MSE and PSNR values are reasonably good and same in all the bands. The obtained PSNR values are really prised. EPI values are not good in number. It may be due less resolution image. CT is more and almost all same for all the bands. De-speckling is not meant for colour images. So, grey colour image of RGB colour image has been tested. Grey colour image has given almost all average of all the three bands.

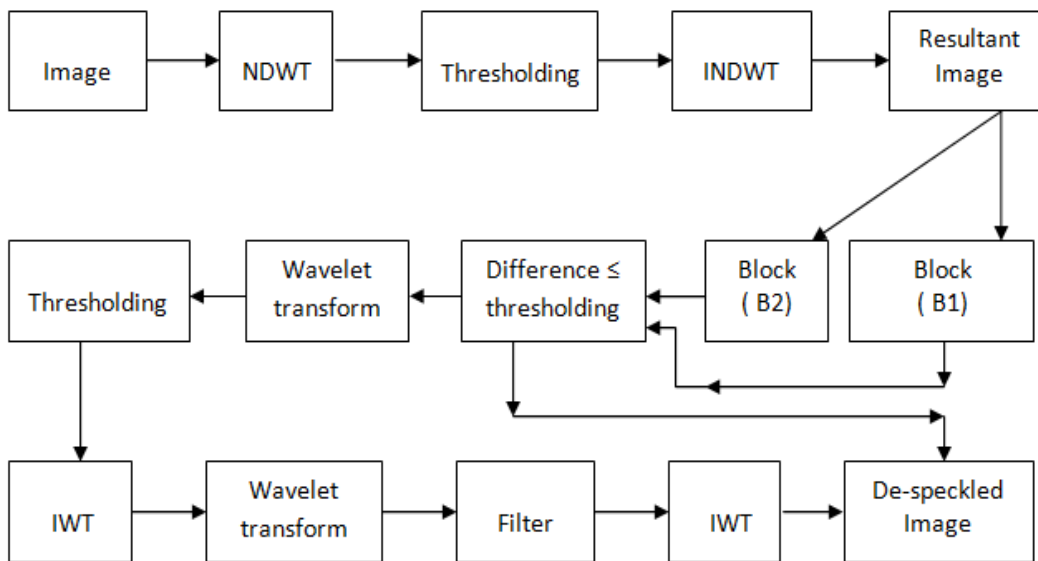


Figure 1: Proposed method

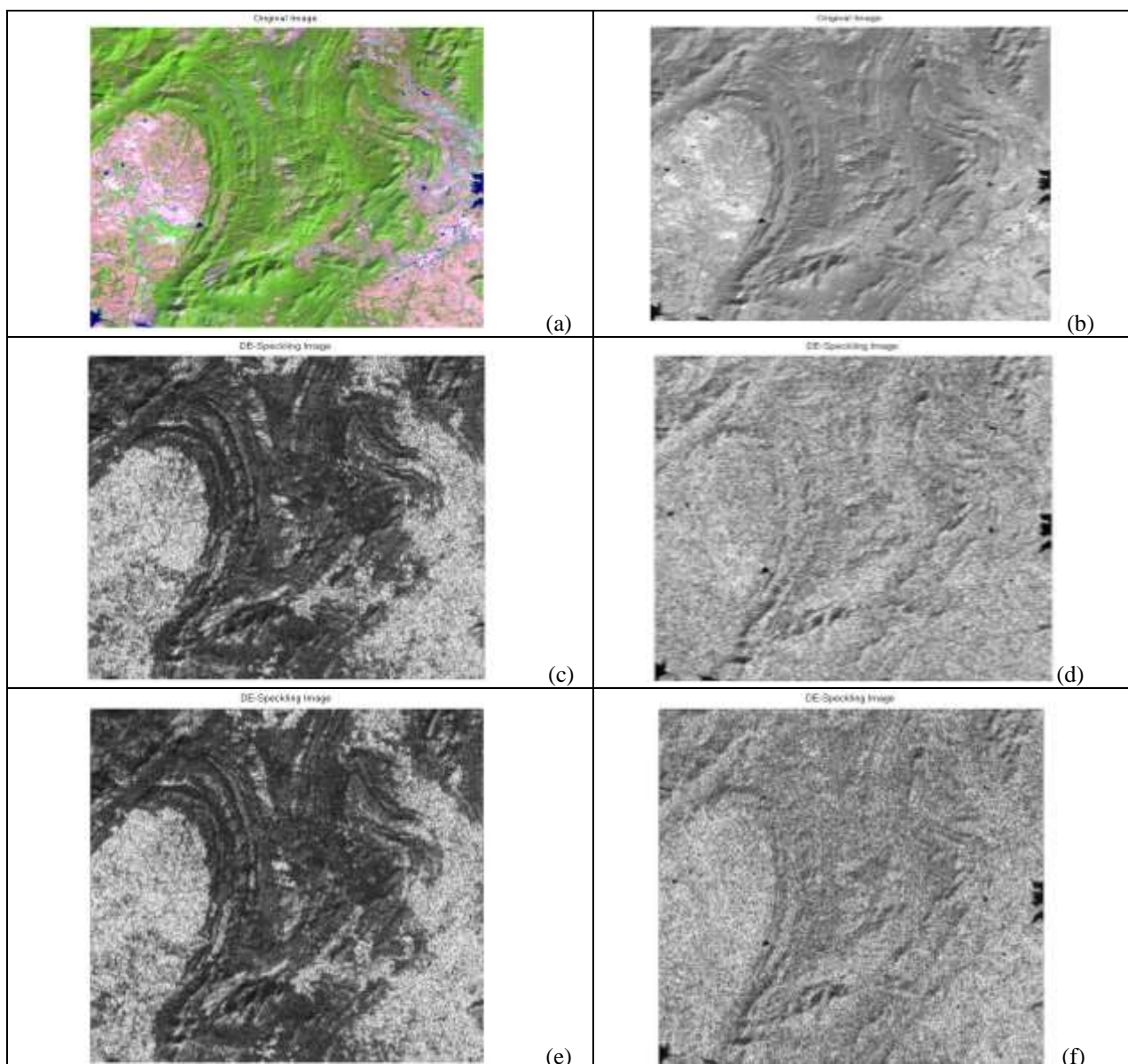


Figure 2: (a) Original Optical Image (b) Grey Image of the Optical Image (c) De-speckled Image with Red Panchromatic Image (V=0.25) (d) De-speckled Image with Green Panchromatic Image (V=0.25) (e) De-speckled Image with Blue Panchromatic Image (V=0.25) and (f) De-speckled Image with Grey Image of the Optical Image (V=0.25).

Table 1: Comparison of different quality parameters of de-speckling method for different monochrome images (V=0.25)

	RED	GREEN	BLUE	GRAY
ENL	1.223160	9.961071	1.265484	10.563566
SSI	0.065192	0.036346	0.065138	0.039047
SMPI	0.812408	0.331568	0.827002	0.356342
CC	0.988545	0.960317	0.988259	0.963290
ESIH	0.694283	0.690001	0.694205	0.689658
ESIV	0.420569	0.430305	0.418537	0.430057
MSE	67.348639	101.223666	68.831743	90.728620
PSNR	29.847515	28.077982	29.752915	28.553360
EPI	0.170256	0.459674	0.921316	0.586118
CT	412.827371	410.251966	419.556321	437.506615

Table 2: Comparison of different quality parameters of de-speckling method for different monochrome images (V=0.2)

	RED	GREEN	BLUE	GRAY
ENL	1.113160	8.961071	1.065484	9.763566
SSI	0.068492	0.046346	0.064138	0.038447
SMPI	0.812488	0.332168	0.832002	0.346342
CC	0.993545	0.960197	0.949259	0.971290
ESIH	0.695183	0.690046	0.6911905	0.684458
ESIV	0.424569	0.449305	0.414937	0.415057
MSE	67.344839	101.2249666	68.831443	90.728720
PSNR	29.844515	28.487982	29.755915	28.583360
EPI	0.181256	0.448774	0.924116	0.575118
CT	412.818571	408.251486	409.556441	434.666615

Table 3: Comparison of different quality parameters of de-speckling method for different monochrome images (V=0.1)

	RED	GREEN	BLUE	GRAY
ENL	0.897557	7.843664	0.897557	6.299499
SSI	0.065164	0.034450	0.065164	0.037298
SMPI	0.870737	0.392845	0.870737	0.376141
CC	0.993161	0.974225	0.993161	0.976964
ESIH	0.705200	0.699264	0.705200	0.699422
ESIV	0.403735	0.417017	0.403735	0.421141
MSE	45.510267	58.874695	45.510267	49.879395
PSNR	31.549709	30.431516	31.549709	31.151591
EPI	0.416910	0.604721	0.416910	0.575119
CT	399.601407	406.331070	435.609231	408.404028

Table 4: Comparison of different quality parameters of de-speckling method for different monochrome images (V=0.05)

	RED	GREEN	BLUE	GRAY
ENL	0.894857	7.844464	0.899557	6.299499
SSI	0.066164	0.041450	0.071164	0.037698
SMPI	0.878737	0.392452	0.884537	0.382141
CC	0.994261	0.974925	0.945261	0.976964
ESIH	0.704100	0.694524	0.709900	0.687422
ESIV	0.4035475	0.417447	0.403735	0.422241
MSE	43.450267	58.454695	45.970267	49.898395
PSNR	32.785709	31.871516	32.549459	32.145791
EPI	0.441210	0.604221	0.486210	0.574819
CT	384.451407	406.345070	425.45231	401.445828

IV. CONCLUSION

The paper has been given the statistical approach to un-decimated BM3D transformation as de-speckling method for de-speckling of different mono chrome images. It has been considered the noise variance from 0.25 to 0.05 for speckling purpose. It is a trial and error process of using de-speckling method for optical images. The de-speckling method is generally meant for microwave images. It has been successfully executed and given the good results even for optical images, if they have been converted into mono chrome images. The mono chromatic images like red, green and blue bands and grey colour images have been tested for de-speckling. All the quality parameters like ENL, SSI, SMPI, CC, ESIH, ESIV, MSE, PSNR, EPI and CT have been

calculated for four images of two sets. Generally ENL is calculated for microwave or radar images. This value is generally high for radar images.

Except EPI, all other results are good. The lesser value of EPI may be due to low resolution of the images taken. It is also an important feature that an image should have. The computational time may be more but it is not major factor to discuss about a de-speckling method. It is concluded that the given de-speckling is good to use for any mono chromatic images. But, this analysis has been done for less number of images, so to give the final conclusion it has to be tested for more images of more varieties.

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