ISSN:0975-9646

Karthik et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (4) , 2015, 4145-4147

Comparative study of various Image De-noising Techniques

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***Abstract*— every image captured on a screen has possibilities of having noise, which is undesirable. With the introduction of noise in an image causes distortions in quality of the image. Hence it is important to eliminate noise from an image to retain the original information in the image. There are many types of noise which can be found associated with the captured image. This paper discusses about a few ways of de-noising an image using various algorithms. SAR images are one of the types of images which are highly exposed to all factors of noise.**

***Keywords*— Image noise, Image de-noising, weights.**

I. INTRODUCTION

Images in general are known as a picture which can be represented on screen. These images on a digital screen are very complex and constitute many dots which have its own properties of size and color. These dots are called as Pixels or Picture element.

Images play an extremely important role in our everyday lives from entertainment to work. They are widely used in medical fields like X-Rays, MRI images, scanning which help in determining the medical issues with a person. Any slight error may lead to fatalities. Hence it is extremely crucial to make sure that there are no errors while or after capturing an image in any form. Then it is extensively used in Space research organizations where even a small dot in an image is expected to carry important information. Again if there is any error, then results in financial loss as well. Therefore capturing an image that is error free in today's world is extremely important.

There are chances of introduction of unwanted information into an image is always possible. Noise in an image means an unwanted data, which is captured due to various reasons. Noise in an image causes distortions in the quality of the image. In worst conditions it masks the crucial information. Noises that get induced are from different sources like imperfect instruments and undesirable external conditions. There are different types of noise that get induced in an image. They are Gaussian noise that arise during acquisition, Salt and pepper noise during analog to digital conversion, Shot noise by statistical quantum fluctuations and so on.

Synthetic Aperture Radar (usually abbreviated as SAR) is a technique or a form of obtaining an image of an object or landscapes. SAR images formed may be of 2-dimentional or 3-dimentional. Single radar and antennae are attached to an aircraft of a spacecraft. It radiates a beam, whose wave propagation direction which has a substantial component which is perpendicular to fight's path direction. All he received reflected beam do not reach the receiving antennae. They are received at different time. This is because of the time taken by the beam to travel from and to the aircraft, indirectly indicating the distance between the flight and ground beneath it. When it is carefully designed, the resolution of obtained image would be millionth of a given range.

SAR images are widely used in many areas. SAR images are capable in all weather conditions, day or night. It is used for looking at impact over a region affected by floods. It is also used in forestry for estimating bio-mass and also forest density. SAR images are highly useful in navigations and a moving aircraft.

SAR images are also exposed to noise factors. They're due to radars, antennas receiving unwanted signals, changes in reflected radio waves in terms of intensity and frequency and so on.

Elimination of reasons and factors that induce noise requires perfect and ideal conditions, which is difficult to obtain. Removing noise from an image can be done with certain algorithms and software. Section 1 introduces various types of noises and causes for the same. Section 2 includes the various algorithms and their results with respect to standard images. Finally section 3 gives a comparison between selected algorithms. In the end section 4 specifies the conclusion and best results obtained.

This paper concentrates on giving out the comparison between selected paper [1] to [4] followed by the conclusions, which specifies the best results along with the reason(s).

II. RELATED WORK

A. Two step multi-temporal non-local means for SAR images [1]:

Method based on binary weight and spatial noise:
The key idea of approach of de-noising of an image in [1] is done in two steps. In steps 1, the similarities of two images are identified. This can be done by the weights in normalized map. Temporal average with binary weights, Obtain a first de-noised imaged by the combination of stable pixels while keeping unchanged pixels with the other pixels. This step is mainly w.r.t the stable pixels. In step 2, spatial average, on the improved image obtained from step 1, algorithm specified in [1] is applied. Different pixels have different looks based on the average data taken. Hence

the author has considered taking different looks for the same patch to obtain a de-noised and stable image.
Following Fig 1 shows the flow and steps involved in [1].

Fig. 1 Flow diagram of image de-noising technique mentioned in [1].

B. Image de-noising in wavelet domain [2]: using two Mat labs functions:

In [2], two mat lab functions are used to perform de-noising of a SAR image. First function that is used returns the threshold value that has to be used for image de-noising. In section 3.1 of [2], it is observed that there are two equations given to get the value of '**f**' and '**w**' where 'f' is defined as desired noise-free signal and 'w' is defined as length of noisy observations. The second function, it returns de-noised image matrix from input image matrix by wavelet coefficient threshold with the consideration of only 'haar' wavelet. Haar wavelet is the sequence of rescaled function (square shaped) which forms a wavelet. The threshold technique can be of two types. They are soft and hard threshold. For soft threshold (which a preprocessing step that reduces background, with intensity values below threshold are reduced) equation 10 in section 3.2 is used which considers the absolute value of threshold values. But hard threshold (if the intensity values are more than the threshold values then the values are retained) takes different values. Each wavelet which has amplitude value less than the predefined threshold value, then it will be set to zero, or else kept unchanged.
Following Fig 2 shows the steps involved in [2], which shows using two functions in mat labs.

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Fig. 2 Image de-noising flow diagram as specifies in [2]. Function 1 and function 2 represent mat labs software which is used in [2].

C. SAR image filtering via learned dictionaries and sparse representations [3]:

Method based on multiplicative modal:
In [3], the author in section 3 which concentrates on SAR log-intensity images, has mentioned about the intensity being dependent on two independent variables 'S' and 'X' where S and X are random variables and are said to be radar reflectivity and speckle noise and these random variables are said to be gamma distributed. Following to it the equations 5 is assumed just as any other speckle filter. The author has also told that the better way of dealing this is to define pseudo-additive noise given by equations 6 and 7 in section 3. In section 4 of [3], mentions about filtering SAR intensity images. The process of direct filtering of SAR intensity images is difficult to do because of non-stationary signal dependent noise. For non-homogeneous noise, it was proposed, by local variance stabilization by modifying OMP (stands for OpenMP, a programming platform in C/C++) step.

D. Exploiting patch similarity for SAR image processing [4]:

Non local means:In [4], the author has specified about non-local approaches and mentioned about the various steps involved in de-noising of image. The author has explained that the de-noising occurs in three steps. Step 1, define patch similarity, and identify patches of an image with certain similarity criteria. The similarity between the patches can be obtained by detection approach, informal approach, and geometric approach and so on. These patches are compared with a few which are close to central reference patch and several are selected. These selected patches are then given certain weights.

Step2, estimate properties of Radar: The second step majorly involves in combining these patches based on their selected weights by simple averaging. These estimation steps are to compute the radar properties based on the observations. The most common estimators used as mentioned in [4] are SME/WSME, MLE/WMLE, MMSE, and LMMSE and so on. Finally step 3, Re-project final image, where the second step provides with the various estimations, either for a single pixel, or patch or for the entire stack of patches. These patches estimates on patches are then merged together to get a de-noised image.

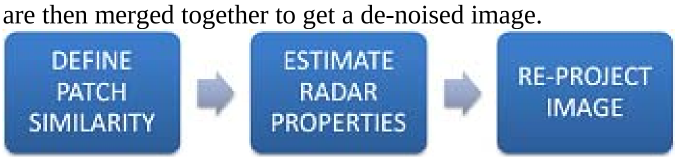

Fig. 1 Image de-noising steps involved in [4].

III. COMPARISON WORK

From the above discussions, we have come across few methods of de-noising a SAR image.

Authors in [1], [4] have considered non-local approaches for de-noising of an image. The initial steps followed in [1] and [4] are the same but have different approach. First in [1], the author has taken weights into consideration for checking the similarity criteria in normalized maps. The pixels which are
not similar are given more weights, because of more noise indicating the sound presence of noise in the image. In [4], the author has classified the similar patches into hard and soft assigned for predictor patch and also have given consideration for pixel wise similarities by various techniques as mentioned earlier. The similar pixels in the compared patches are classified to hard and soft assignment.
Following first step, second step in [1], patch based de-noising occurs in two steps. As mentioned it goes in sequence of temporal average with the consideration of binary weights and finally the spatial average. But in [4], the second step mainly considers the radar properties by the combination of relative weights. This is very interesting as the radar properties are taken into consideration, wherein trying to analyze and eliminate faults caused by radar for giving estimations. Finally in step 3, the re-projection of image space is done to obtain the final de-noised image. The final results in [1] seem to be interesting as the de-

noising of stable pixels work with greater efficiency. But when it comes to unstable pixels, the algorithm isn't very efficient. In [4], according to visual inspections the images showed significant improvement and de-noising and also reducing strong fluctuations.

The procedure used in [2], has been kept simple by using two mat labs functions. This algorithm was tested on 4 different types of noises. They are Gaussian noise, Salt and pepper noise, Poisson noise and Speckle noise. In the paper, only haar wavelet was considered. But it is mentioned that the same algorithm can be used with respect to other types of wavelets also. Based on visual observations, the results were good and effective except salt and pepper noise. The presence of noise was still visible which is a drawback. In [3], filters are used to remove noisy pixels. The author has used soft threshold and fixed dictionaries. The visual observations show no much removal of noise. Hence, the algorithm not being that very efficient in removal of noise.

IV. Conclusion And Result

This paper concludes from the above comparisons made that the non-local approach gives a better de-noised image based on patch similarities and weights assignments based on Exploitation of patch redundancy.

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