Improved Mean Shift Based Speckle Filtering in SAR Imagery

Gayathri.R, Dr.R.S.Sabeenian and sugapriya.T
1Associate Professor of ECE Department, Saveetha Engineering College, India
E-mail: gayathri.r@saveetha.ac.in
2Professor of ECE Department, Sona College of Technology, India
E-mail: sabeenian@gmail.com
3M.E Student of ECE Department, Saveetha Engineering College, India
E-mail: sugarajesh7@gmail.com

Abstract:

In this paper a new technique is used for removing the speckle noise from synthetic aperture radar image. The mean shift algorithm is a reference based nonlinear method to remove the speckle noise present in the SAR image. Applying the conventional mean shift algorithm directly to SAR image filtering will change the structural elements of the SAR data. The proposed method is an iterative method to obtain a high quality image with maximum data retention. The mean shift filter minimizes the mean square error and increases the PSNR. This improves the image quality by preserving the edges.

Keywords —SAR, mean shift, speckle noise

I. INTRODUCTION

Synthetic aperture radar (SAR) is used to create images of an object. SAR is mounted on moving flat form such as aircraft or spacecraft. For example to create SAR images radio waves are transmitted to target and each pulse are received and recorded using antenna. The satellite is capturing the images. The SAR images are widely used in remote sensing and mapping of the surface. One of the main problems in SAR images present in the speckle noise. It affects the SAR images. The main aim is reduce the speckle noise. [1] Guided search algorithm is applied to findout the speckled pixel by using gaussian kernel. But some texture information may be lost. [2] The improved sigma filter was reasonably effective in speckle filtering however, deficiencies were discovered in producing biased estimation, Blurring and strong reflected targets. The threshold value is difficult. [3] Pretest based on complex wishart distribution method is involved. The similar region is taken to choose the central pixel and related pixel. Select the homogeneous pixel in large scale area in filtering process. The patch is used to refer the central and its neighbors. The refined algorithm is used to eliminate the redundant operation. But the selection of homogeneous pixel is more complex. Conventional mean shift algorithm techniques such as mean, median, kaun and other adaptive filtering method have been proposed to reduce the speckle noise. But these filters are produce some disadvantages such as bias and blurring. Wavelet-based denoising algorithms applied for speckle filtering in SAR images [5],[6]. The mean shift algorithm have been studied and applied successfully for speckle reduction in SAR images. The mean shift is an iterative process. The mean shift filter is often used as a reference, because it combines an efficient noise reduction, while maintaining the edges, texture and sharpness of the images. The mean shift filtering is more powerful and effective to reduce the speckle noise and edges and texture preservation. The SAR images are subject to several preprocessing steps such as logarithmic transformation, normalization etc. The traditional filters neglect the spatial information and filtering is a linear process not based on the error occurrence in that particular pixel leads data loss or changes.

LITERATURE SURVEY

<table>
<thead>
<tr>
<th>TITLE</th>
<th>METHOD</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Improved sigma filter for speckle filtering of SAR imagery”, Jong-son lee,jen-hung wen, Thomas L.Ainsworth,kun-shen chen,Abel J. IEEE Transaction on geoscience and remote sensing,vol.47,n o.1,Jan 2009.</td>
<td>Target signature preservation technique. Effective to reduce the speckle noise.</td>
<td>Remove the bias</td>
<td>Unfiltered black pixels Blurring</td>
</tr>
</tbody>
</table>
II. “MEAN -SHIFT” FILTERING

The mean shift is a simple non parametric technique for both kernel density estimation and gradient density estimation. It was proposed by Fukunaga and Hostetler in 1975. The mean shift filter can be used for edge-preserved smoothing or for segmentation. Edges and sharp details of an image will estimated along with gradient densities and this will be used as a reference for mean shift filtering. For each pixel of an image, the set of neighboring pixels is determined. Mean shifting will be carried out iteratively based on estimated values and nonlinear operation will be carried out accordingly.

These calculated mean values will serve as the new center for the next iteration [4].

\[
\hat{f}(x) = \frac{1}{n} \sum_{i=1}^{n} k_{H}(x-x_i)
\]

(1)

\[
k_{H}(x) = |H|^{-1/2} k(H^{-1/2}x)
\]

(2)

where \( H \) is a bandwidth matrix chosen proportional to the identity matrix, \( H = h^2 I \).

The mean shift vector [4] is calculated as

\[
m_{h,G}(x) = \frac{\sum_{i=1}^{n} g_{ij} \left\| \frac{x-x_i}{h} \right\|^2}{\sum_{i=1}^{n} g_{ij} \left\| \frac{x-x_i}{h} \right\|^2} - x
\]

(3)

The mean shift is an iterative method in which each step is calculated using equation (3) and added to the center of the window to obtain the mean value. These mean values will serve as the center for the next iteration. This method is an gradient based nonlinear method.

A. Application to image processing

In image processing the spectral information is mostly used and neglects the spatial information. The spatial information is represented by image location. This information is useful calculate the neighboring pixel. The spectral information is range information.it is useful for calculate the bands in satellite images.

The mean shift [4] is defined in the joint spatial-spectral domain.
The hyper spectral image (HSI) is an example of satellite image. It collects the images as a function of wavelength. HSI provides an individualized reflectance or fluorescence spectrum for each pixel in an image. The HSI contain both spatial and spectral domain. The spatial denotes the x and y coordinates and the spectral denotes the wavelength. The input image is a synthetic aperture radar image and added a speckle noise it’s a noisy image. The adaptive filter is used to denoise it and apply the weighted average method. The gradient density estimator is used to preserve the edges and textures. The minimum mean square error is calculated using difference between the original and denoised image.

### III. RESULTS

In this section, results obtained for SAR images. Partition the hyper spectral image into multiple subsets of adjacent bands and fuse bands in each subset. The size of the original image is 300 × 300 pixels. The parameters that have been used to evaluate, the speckle noise reduction performance are: mean square error, signal to noise ratio, peak signal to noise ratio, and structural similarity index module (SSIM). These measurements are performed for SAR image.

- Mean square error indicates the difference between the original image and denoised image.
- Structural similarity index module (SSIM) indicates similarity between the two images.
**TABLE I**

<table>
<thead>
<tr>
<th>Parameter s</th>
<th>Weighed based speckle denoise performance</th>
<th>Kaun based speckle denoise performance</th>
<th>Mean based speckle denoise performance</th>
<th>Median based speckle denoise performance</th>
<th>Mean shift based speckle denoise performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE</td>
<td>539.8079</td>
<td>2.2824e+04</td>
<td>2.2823e+04</td>
<td>2.2823e+04</td>
<td>227.174</td>
</tr>
<tr>
<td>SNR</td>
<td>65.8373</td>
<td>49.5758</td>
<td>49.5759</td>
<td>49.5759</td>
<td>69.5961</td>
</tr>
<tr>
<td>PSNR</td>
<td>20.8084</td>
<td>4.547</td>
<td>4.5471</td>
<td>4.547</td>
<td>24.5672</td>
</tr>
<tr>
<td>SSIM</td>
<td>0.5271</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.7136</td>
</tr>
</tbody>
</table>

Fig.3 Noisy image

Fig.4 Denoised image

Fig.5 Kaun filter denoised image
As a first step, we have compared the performances of different filters (mean, median, kaun and mean shift filter) for different window sizes. The filtered images are presented in Fig6, Fig7, and Fig8, respectively.

In table I, mean square error (MSE), signal to noise ratio (SNR), peak signal to noise ratio (PSNR), and structural similarity index module (SSIM) are presented for the different filter cases. This is a very interesting result. Because the performance of a mean shift filter parameter are very robust for satellite images.

**IV. CONCLUSIONS**

In this paper, mean shift algorithm is applied to reduce the speckle noise in synthetic aperture radar (SAR) imagery. The edges and sharp details of an image will estimated along with gradient densities and this will be used for mean shift filtering. A set of bandwidth parameters is proposed, that improves the mean shift filter performance in speckle noise reduction and textures and edges preservation.

**REFERENCES**


