Research Article

Synthetic Aperture Radar Remote Sensing images change detection based on SWT and DWT with Fuzzy C Means clustering

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Abstract: The collection of techniques involved in monitoring objects on the Earth's surface without any physical contact is called remote sensing. It is well- known fact that the speckle noise is existed in SAR images. After the minimization of speckle noise, discrete wavelet (DWT) fusion is exploited for further image segmentation. As it is very familiar that more image information could be brought up by using image fusion process. Filter coefficients have been chosen in the DWT (Discrete Wavelet Transform) filter bank to perform DWT and SWT. The change detection in remote sensing images is the process of detecting changes that take place between two SAR (Synthetic Aperture Radar) images gathered at dissimilar periods of the instance from same geographical area. The two or more SAR images obtained from the identical region at diverse time points are detected in terms of changes in accordance with the ground. Thus, the change detection mechanism is being widely employed in the field of military reconnaissance, natural calamity evaluation, and observing on marine oil spill, forest fire and urban expansion. In this paper Stationary Wavelet Transform (SWT) and Discrete Wavelet Transform techniques have been employed for the fusion process and the fused image is segmented. Fuzzy C – Means clustering is used for segmentation and the segmented image is compared with the ground truth image. The performance of this method is measured in terms of measuring parameters accuracy, FDR, sensitivity etc.,

Keywords: SAR, Remote Sensing, DCT, DWT, SWT, FCM, Accuracy and FDR

1. Introduction

SAR images are quite varied from those attained from Infrared or Optical sensors [1-2]. Molecular resonances are accountable for optical sensors for object reflectivity. In the microwave region, geometric and dielectric properties are accountable for backscattering [3]. Dielectric features include sensitivity, which highlights on the morphological configuration of the considered domain and it also emphasizes the ground conductivity that could offer the data on vegetation, which is significant in forestry and agricultural applications.

A significant feature of SAR information [4-5] results from the propagating nature of the microwave. Owing to their extensive wavelength, they are capable of penetrating the vegetation and even the earth up to a particular depth. The resolution is computed in a SAR [6-11] system by exploiting the width and pulse length of the beam that originates from the antenna. Pulse length portrays the range resolution while propagating the energy (the greater the wavelength, the shorter is the resolution) and the azimuth resolution is determined by the beam width. The azimuth, as well as the range resolutions, are almost proportional to distance of the antenna.

2. Methodology

Two fusion techniques have been implemented in this paper.

2.1 Stationary Wavelet Transform (SWT):

The discrete cosine transform (DCT) is used to separate the image in to 8×8 blocks. The discrete cosine transform is used to decompose the spatial frequency of image in terms of various cosines.

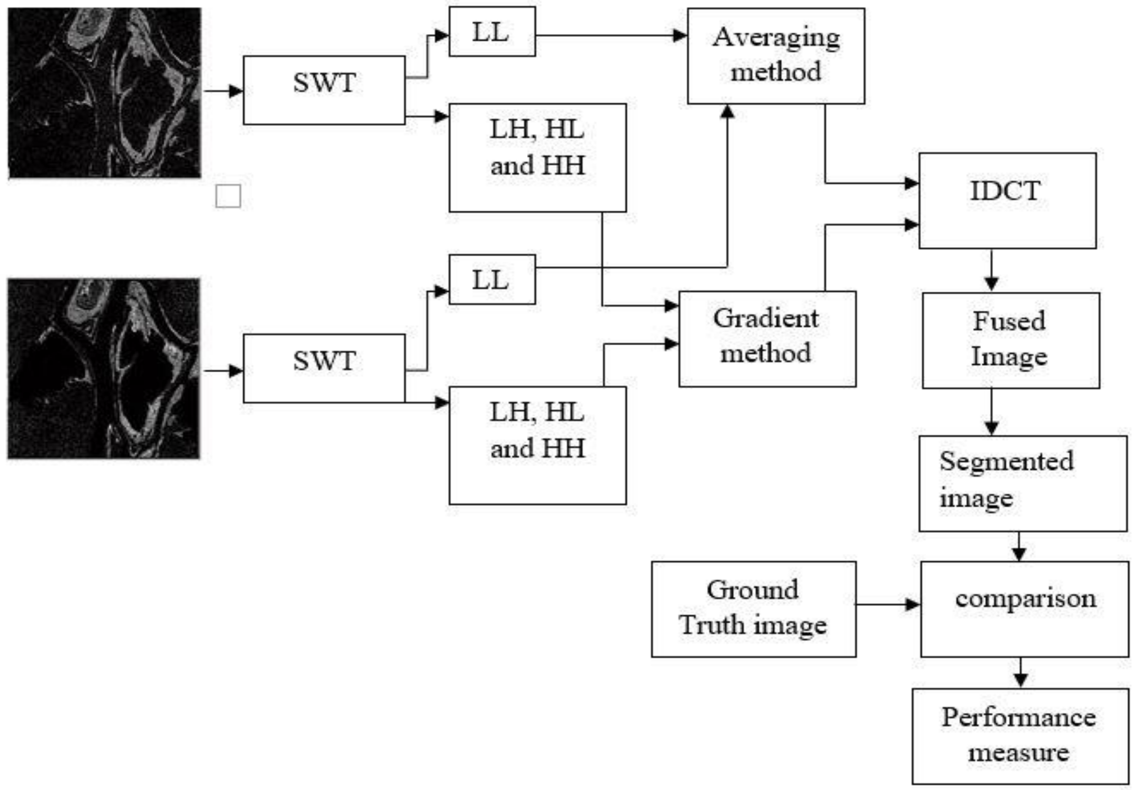


Fig 1. SWT based image fusion

As illustrated in fig.1 SWT is applied to two images i.e., image 1 and image 2. After processing ISWT the fused image will be segmented. Fuzzy C-Means clustering technique has been implemented for segmenting the changed regions and unchanged regions. The image fusion technique based on SWT is to perform a decomposition on each input image and the coefficients are separately fused by using certain fusion rule. Finally, the fused image is obtained by performing the inverse discrete cosine transform (ISWT) for the combined high and low frequency coefficients.

2.2 Discrete Wavelet Transform

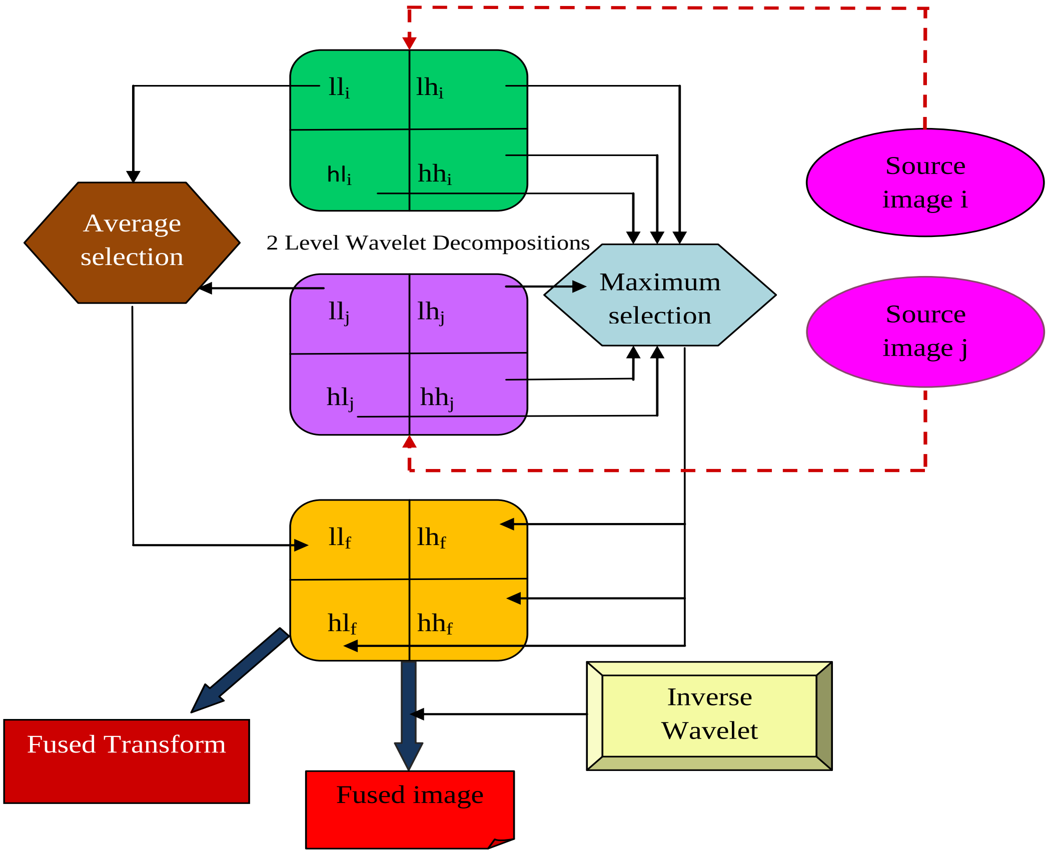


Fig.2. Overall Architecture of DWT-based Image Fusion Model

Fig. 2 specifies the overall architecture of the DWT-based image fusion model having two source images along with the average selection and maximum selection processes. The overall procedures included in DWT-based image fusion model are explained in the following steps.

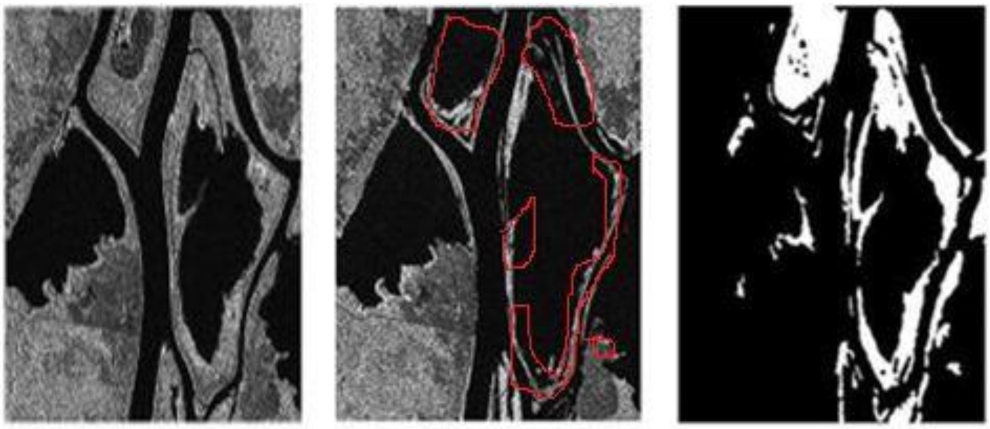
- Attain the 2 source images i and j for fusion procedure.

Perform wavelet decomposition to the input images i and j and consequently, the high frequency(lh),(hl) and (hh) as well as low-frequency components(ll) are attained

- Compute the average selection procedure, in which the low-frequency images are given to the average selection.
- Compute minimum or maximum selection model, in which a selection procedure is performed to each corresponding pixel of the input images i and j. Furthermore, the pixel having low of high intensity is selected respectively.
- Execute inverse DWT on fusedll_f,lh_f, $hl_f$and hh_f coefficients for obtaining the fused intensity image.
- Eventually, the novel intensity coordinate of the image is obtained.

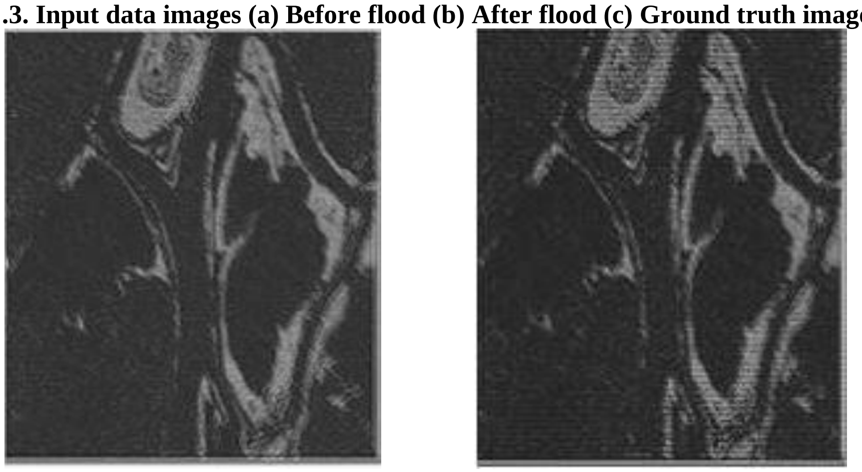
3. Results and Discussions

Two multi temporal images have been taken for this fusion process .These two images are applied as input to DCT process and multiple wavelts have been used for image fusion. Satellite images with SAR, sensors have been taken into account. Ottawa data set is taken as data set to validate the proposed methodology. As illustrated in fig.3 two images are processed for fusion, fig 3. (a) represents the image before flood occurs and fig 3 (b) represents the image after the flood is occurred and red colour shows the affected areas. Here the need of fusion is for further processing of these images such as clustering and change detection applications.



(a) Before flood (b) After flood (c) Ground truth image

Fig .3. Input data images (a) Before flood (b) After flood (c) Ground truth image



(a) **(b)**

(c) **(d)**

Fig .4. Fused image a) SWT_Fuse b) DWT_Fuse c) SWT_FCM d) DWT_FCM

The fusion process using SWT is implemented by using discrete cosine transform (DCT) from and the resulting fused images is shown in fig 4. (a). The fusion process using DWT is implemented by using discrete cosine transform (DCT) from and the resulting fused images is shown in fig 4. (b). After fusion image is segmented by using fuzzy c- means clustering which is shown in fig 4. (c) and fig 4 (d). The Segmented image is compared with the ground truth image and the performance of SWT_FCM and DWT_FCM is illustrated in fig 4. (c) and fig 4 (d) respectively. The performance is measured in terms of accuracy, sensitivity, precision and False Detection Rate (FDR).

Measure	SWT_FCM	DWT_FCM
accuracy	0.9746	0.9852
sensitivity	0.8887	0.8254
specificity	0.9761	0.9578
precision	0.0511	0.0422
FPR	0.0123	0.0210
FNR	0.1012	0.1001
FDR	0.9271	0.9147
NPV	0.9758	0.9689
MCC	0.2502	0.1958
F1-score	0.1012	0.1112

Table 1: Performance analysis of the DWT_FCM and SWT_FCM

4. Conclusion

In this paper change detection in SAR images has been implemented through image fusion-based DWT, SWT and FCM clustering. DCT has been employed for fusion of two SAR images to extract the spatial information and spectral information from the two remote sensing images. Clustering has been performed based on soft fuzzy FCM clustering technique. The segmented image is compared with the ground truth image to compare the performance of SWT_FCM and DWT_FCM. The implemented method is given good accuracy and small FDR.

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