# Land Cover Change Detection in SAR Images Based on DWT Fusion and Contourlet Fusion

Rimple Thomas, Neethu Francis

**Abstract—** A change detection approach for SAR images based on contourlet image fusion and fuzzy clustering .In this method difference image is generated from log ratio and mean ratio images by image fusion technique. In order to restrain the background information and enhance the information of changed regions in the fused difference image, wavelet fusion rules and contourlet fusion rules based on an average operator and minimum local area energy are chosen to fuse the wavelet coefficients for a low-frequency band and a High-frequency band, respectively. A reformulated fuzzy local-information- means clustering algorithm is proposed for classifying changed and unchanged regions in the fused difference image. We have verified the goodness of the proposed fusion algorithm by well-known image fusion measures, entropy, area and also calculate the percentage correct classification. It was found that performance of proposed fusion method is better than wavelet transform.

**Index Terms—** change detection, Contourlet, DWT, fuzzy clustering, image fusion, PCC, RFLICM

## 1. INTRODUCTION

Several regions around the world are undergoing rapid changes in Land Cover. Remote sensing provides a good source of data from which updated land-cover information can be extracted efficiently and cheaply. Change detection has a major application of remotely sensed data because of repetitive coverage at short intervals and consistent image quality. Land Cover (LC) changes are fundamental for a better understanding the relationships and interactions between humans and the natural environment. Change Detection Analysis has broad range of methods used to recognize, label, and count variances between images of the same scene at different times or under different conditions[1].The major applications include medical diagnosis [2]-[3],remote sensing[4][5],video surveillance [7]-[8].for remote sensing application the major data sources are synthetic aperture radar images [9].SAR images are independent of atmospheric and sunlight conditions.so SAR images are more suitable for change detection.

Change detection in SAR images can be divided into three steps: 1.image pre-processing, 2.difference image between the images and 3.analysis of the difference image. The first step include registration, geometric corrections, and noise reduction .In second step, two registered images are compared pixel by pixel.

In the third step, changes are usually detected by applying a decision threshold to the difference image.

The performance of change detection in SAR images mainly depends on the quality of the difference image and the accuracy of the classification method. Two main approaches to change detection: Unsupervised (no ground truth), supervised (ground truth). In supervised technique, a set of training patterns are required, it is little difficult. It is exclusive in the following two traits: 1.creating difference images by combining a mean-ratio image and a log ratio image. 2. Using RFLICM clustering algorithm

This paper is composed of four sections. In the next section, we will mention the proposed approach and our motivation. Section III will describe the proposed method in details, and in section IV result and conclusion.

## 2. MOTIVATION

Consider two SAR images x1 and x2 as input that is taken from same geographical area at not the same times. The main objective is to create difference image that consists of change information, then image exploration for change detection. The proposed change detection method involves mainly two steps 1) generate the difference image using DWT Fusion and Contourlet Fusion and 2) changed areas are detected by fuzzy clustering.

Because of the multiplicative effect of noise, the ratio images are symbolized in a logarithmic and mean ratio. These two methods have good results for the change detection in SAR images. But it has some drawbacks. In the instance of log ratio image, it is not able to mirror the information of changed regions entirely. For producing optimal difference image, it should detain the unchanged areas information and should advance the information of

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changed regions. An image fusion method is presented to produce the difference image. Generating the difference image by fusing log ratio image and mean ratio image contain better information than individual difference image. Discrete wavelet transform is mostly used for pixel level image fusion. But it has lack of shift invariance substance and directional fussiness. One of the important assets that require for change detection is shift invariance property. The image fusion based on data does not preserve the fine edges and curves. So we introduce image fusion by contourlet fusion. The main determination to analyses the difference image is to determine the changed regions and unchanged regions. Fuzzy c means clustering algorithm is suggested to evaluate the difference image.it is an unsupervised technique.

## 3. PROPOSED METHODOLOGY

The proposed method has two steps, which is as follow

1) Creating the difference image using DWT and contourlet fusion.
2) Detecting changed region using fuzzy c mean clustering

**I. Generating the difference image based on DWT fusion and Contourlet Fusion**

**DWT FUSION**

The DWT isolates frequencies in both time and space, allowing feature information to be easily taken out from images. The DWT concentrates on representing point discontinuities and preserving the time and frequency details in the image. Its easiness and its ability to preserve image details with point discontinuities make the fusion scheme based on the DWT be suitable for the change detection task, when massive volumes of source image data are to be processed.

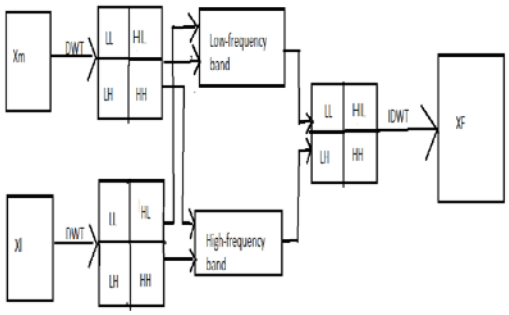


Fig 1: Fusion Based on DWT Fusion

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H and L represent the high-pass and low-pass filters. In addition, LL represents the approximate portion of the image, and LH, HL, and HH denotes the horizontal, vertical, and diagonal direction portions, respectively.xm is the mean ratio image ,xl is the log ratio image. xf is the fused image.

**CONTOURLET FUSION**

The contourlet Transform has multiresolution, localization, directionality anisotropy and local brightness properties. It also offer smoothness in a fused difference image .This tech-unique is understood by double iterated filter bank.it uses laplacian pyramid and directional filter bank. It mainly include two steps for implementation of this transform. That is transformation and decomposition

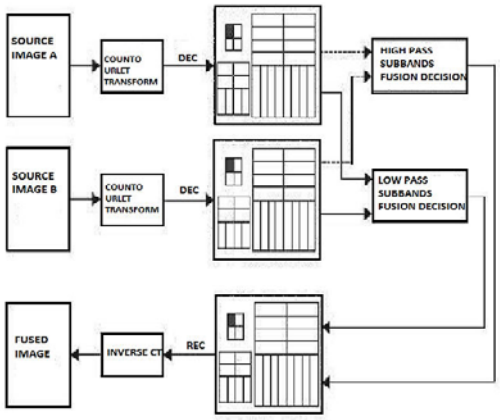


Fig 2:Process of image fusion based on the Contourlet fusion.

$A = \pi r^2$ transform being coined. First, multi scale decomposition by the Laplacian pyramid, and then a directional filter bank is applied to each band pass channel.

A. Decomposition Method

The decomposed sub bands of transformation step are fused by fusion rules. There are distinct fusion rules for low pass and high pass band. The coefficients in the lowpasssubband a represents the profile features of the source image. For this measurement local area energy contourlet domain is used. Then the selection and averaging modes are used to calculate the final coefficients.

The local energy E(x,y) is calculated by

$$E(x,y)= \sum m \sum n \, a_j(x+m, y+n)^2 W_L(m,n) \ldots (1)$$

E j ,k (x, y) is the local energy, d j ,k (x, y) is the high frequency coefficient. WL(m,n) is a template of size 3*3[17].Finally fused image is obtained from opposite contourlet decomposition method. The suggested method can provide fused image with better visual quality. And also the resultant fused image can preserve much information of edges ..

## I. ANALYSIS OF FUSED IMAGE USING FUZZY CLUSTERING

Clustering means separating a data set into a practical number of disjoint groups where each group containing Comparable samples. In this panels, patterns are similar within the clusters and different between the clusters.. That is samples with certain degree of fitting to all clusters. Among the fuzzy clustering methods, the FCM algorithm is one of the best common methods since it can recollect more information from the original image .Here clustering is done to distinguish changed regions from unchanged regions. For improving the presentation of image clustering, that is Reformulated fuzzy local information c means clustering algorithm. the local coefficient of variation is adopted to replace the spatial distance. The local coefficient of variation Cu is defined by

$$C_u = \frac{VAR(x)}{(\overline{x})} 2 \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The value of Cu reflects the grey-value homogeneity degree of the local window. It displays high values at edges or in the area corrupted by noise and produces low values in homogeneous regions. It also supports to get more local context information since the local coefficient of variation of each pixel is added in a local window. The RFLICM algorithm is described as follows:

Step1) Initialize the number of the cluster prototypes, fuzzification parameter m and the stopping condition ε.

Step 2) Initialize randomly the fuzzy partition matrix.

Step 3) Then set the loop counter b=0.

Step 4) Compute the cluster prototypes.

Step 5) Also Calculate the fuzzy partition matrix.

Step 6) max {U (b) - U (b+ 1)} <ε then stop ; otherw ise, set b=b+1, and go to step 4.

## 4. EXPERIMENTAL STUDY

By showing numerical results on ten data sets we will show the performance of the suggested method. By this quantative analysis we will prove the effectiveness of proposed Land Cover change detection method.. In this analysis ,the first data set contain a section of two SAR images of USA obtained in the years of 2000 and 2010 respectively shown in Fig. 5(a) and 5(b)

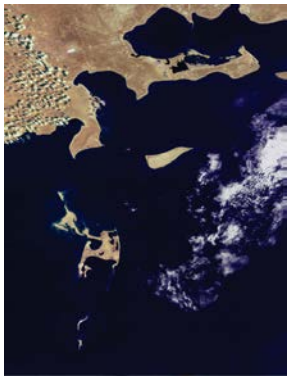

Fig 5(a): Land in USA 2000

Fig 5(b): Land in USA 2010

Fig 5(c): fused Image (Dwt)

Fig 5(d):change detected Image

Fig 5(e): fused image (cont)

Fig 5(d): change detected Image

Fig 6(a) Image acquired in 1975

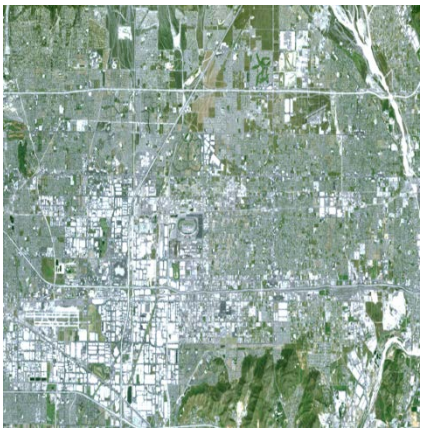

Fig 6 (b) Image acquired in 2011.

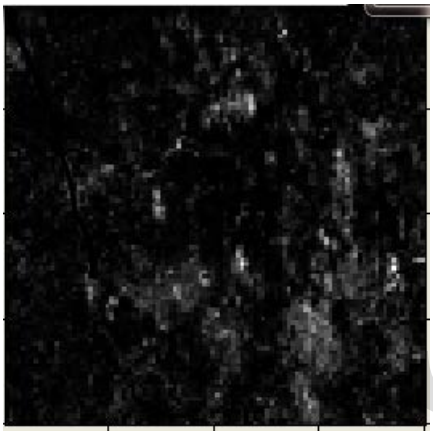

Fig 6(c): Fused Image

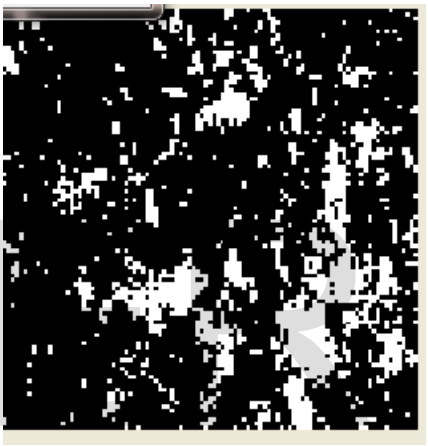

Fig 6(d): clustered Image (dwt)

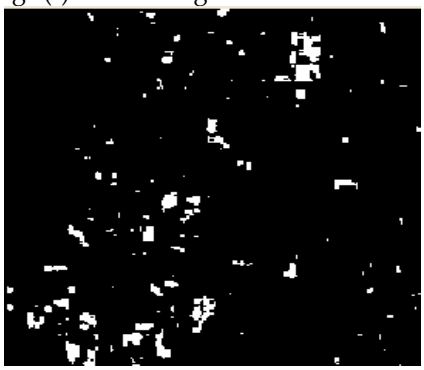

Fig 6(e) Fused Image

Fig 6(e): clustered Image (contr)

In fig 6(c) fused image is shown. The available ground truth is shown in Fig. 6(d). The experiments have been carried out for obtaining better fused image. That is here analysing the effectiveness of the contourlet fusion strategy

to generate the difference image. And, we compared the change detection performance of our algorithm with other two methods, including the DWT and the mean ratio operation.

We presented a comparative analysis for the suitability of the proposed approach for the fused difference image. .For quantative analysis of change detection, we calculate

the Percentage Correct Classification [13] which is given by [18].

PCC= (TP+ TN)/ (TP+ FP+ TN+ FN)……..(3)

Here, TP is the number of pixels that are detected as the changed area .TN is the number of pixels that are detected as the unchanged area. The false negatives (FN) are the changed pixels that an undetected. False positive (FP) is the unchanged pixels wrongly

| Image Set | PCC (DWT) | PCC (cont.) |
|---|---|---|
| Dubai | 93.56 | 96.05 |
| Istanbul | 89.57 | 91.63 |
| Aral sea | 87.50 | 88.32 |

TABLE 1: comparison of PCC values of DWT and Contourlet

In this experiment, we analysed The quality of the difference image depend on the image fusion technique. So we have also verified the goodness of proposed image fusion algorithm by well-known image fusion measure. That is entropy it helps better in assessing the information of images. Entropy can effectively reflect the amount of information in certain image. The larger value indicates, the better fusion result is obtained.

$$EN = -\sum_{i=0}^{L-1} P_F(i)\log_2 P_F(i)$$

Where PF is the normalized histogram of the fused image to be evaluated

…… (4)

| Images | Entropy(dwt) | Entropy (cont) |
|---|---|---|
| Dubai | 0.59 | .63 |
| Istanbul | .03 | .12 |
| Aral sea | .11 | .27 |

TABLE II: Change Detection Result

**AREA OF DETECTED REGION**

It is given by the no of white pixel on the image

| Image | Area(dwt) | Area(cond) |
|---|---|---|
| Dubai | 2616 | 879 |
| Istanbul | 6878 | 2129 |
| Chandler | 1060 | 972 |

TABLE III: Area of Change Detection Result

We have found that area detected by contourlet fusion gives accurate values than DWT

## 5. CONCLUSION

In this project, we have presented land cover change detection on SAR images based on DWT and contourlet fusion. In order to find unchanged areas and enhance the changed areas, fusion is used for producing the difference image. The limitations of wavelet transforms are catching the geometry of image edges. In these work, we have proposed a new edge preserving image fusion method based on contourlet transform. The image salient features such as edges, lines and contours are well characterized using the contourlet transform; the fusion process did not introduce any distortion to the original image. We will show that, this method can provide fused image with better visual quality with reformulated fuzzy clustering algorithm. The difference image produced in this method is better represented than that of dwt fused difference image. The obtained fusion image can preserve much information of edges and textures of SAR images. The experiment results also show that the suggested contourlet fusion strategy can join the advantages of the log ratio operator and the mean-ratio operator .It will also gain a better performance. The quantative analysis show that the pcc value of this method is better than DWT.we has also found the area of changed region, entropy also. In this project, the changes in images of land cover are found by Reformulated Fuzzy clustering algorithms. In future, we can increase the efficiency of fuzzy clustering by merging with another algorithm.

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