SAR Image Change Identification based on Features Detection and Description

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***Abstract*—The detection of changes in SAR images process makes use of two multi temporal radar images. Unsupervised method in change detection for multi temporal SAR images based on SIFT keypoint and region information. Scale invariant point feature transform is used to identify the blob like structure and it is robust to speckle noise. To detect changes in images first obtain the difference in two multi temporal images by using Log-ratio operation, Then detect noise robust SIFT keypoint from the difference image. Traditional method uses the fuzzy and fusion method to detect the changes but this method fails to give the accurate result due to speckle noise in the images. So to overcome these problems we are using noise robust SIFT method. After extracting keypoints perform segmentation and comparison to detect changes.**

Keywords—scale invariant feature transform(SIFT), Synthetic aperture radar (SAR), change detection, segmentation and comparison.

1. INTRODUCTION

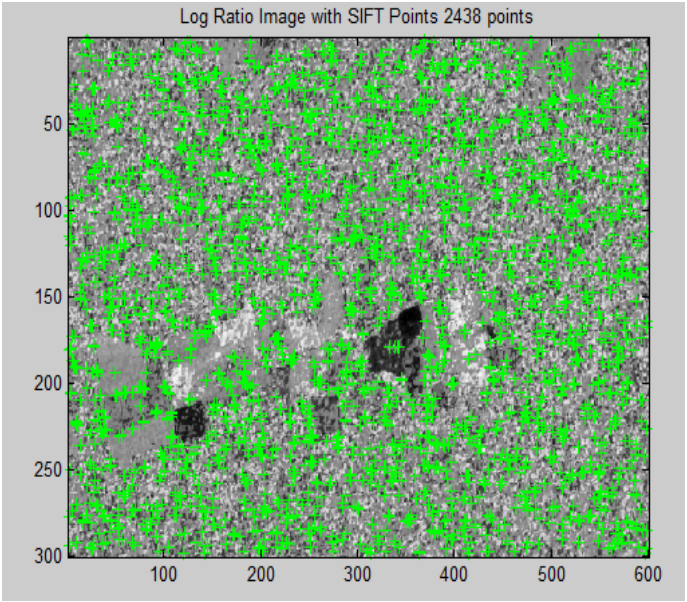
Change identification is the process of examining the remote sensing pictures acquire on same geometrical region to detect changes occurred between considerable times. Synthetic aperture radar sensor is the form of radar that is used to capture the image of objects and the images can be two or three dimensional representation of objects. Synthetic means motion of space craft and signal process suggest a larger antenna, aperture means antenna length and radar means ranging and detection of radio waves. Due to some insensitiveness in the remote sensor (particularly in rainy or cloudy), SAR images are better than any other remote sensing images. SAR sends out the rapid microwave pulses to capture the images. Due to this reason we can capture the images during night and in bad weather condition. SAR is in microwave region and other remote sensors are in visible or infrared region.

Change detection in SAR is applicable to agricultural survey, Land cover analysis, Change detection of natural resource, Terrain analysis, Automated detection of change in natural resource based on image availability at different time, Forest monitoring, Urban studies, Environmental monitoring, Damage assessment, Topography, Anthropogenic features, Surface roughness and Land/water boundaries. There are two types categories in change detection of SAR images: first is supervised method, it need the ground truth of an image and second is unsupervised method, it do not need any prior knowledge of an images. Semi-supervised method is also proposed, it need half prior knowledge of an image [3]. Based on statistical model we proposed an automatic change detection technique. Difference image is attained by applying the mean log-ratio operation. This difference image is the mixture of Gaussian distribution associate with changed and unchanged images.

There is some disadvantages in statistical modeling, distributed free change detection method. These methods are based on clustering algorithm. Traditional method uses the fuzzy c means method and fusion method. Traditional method first applies ratio of mean and ratio of log operation. Next apply image fusion method to take the combined image, then apply fuzzy c means clustering method to analyses and detect the changes. In this method there is no accuracy in detecting changes of images because the edges are blurred in changed region. To detect the changes in changed and unchanged region in fused difference image reformulated fuzzy c means is used. This traditional method directly perform the segmentation after the obtaining the fused image by using mean ratio and log-ratio operation [1]. In this method challenging task is to select the best thresholding values because pixel values in changed region is more than the unchanged region.

The traditional work uses the pixel information to detect changes in the SAR images. SAR images consist of speckle noise, so pixels comparison method is inefficient. So we propose an unsupervised classification of change detection method on multi-temporal synthetic aperture radar sensor images. This method detects the changes in SAR images by using scale invariant feature transform keypoint and also region information. General approaches of SIFT method are: 1. Finding interest point, 2. Consider the region around keypoints, 3. Compute the local descriptor from the region and normalize the feature, 4. Match the local descriptor. The proposed method first applies the log-ratio operation on the images captured at different time to obtain the difference image. Extract the SIFT keypoint in the difference image as shown in the fig 1. Scale invariant feature transform detect the blob like structure in the difference image [4]. Next perform segmentation around the keypoint in two original multi-temporal images then perform comparison between segmented images to detect changes in the images.

The accuracy is maintained by using this method because SIFT is robust to speckle noise, edge are not blurred (edges are preserved) and finally we perform segmentation around extracted keypoint in two original multi-temporal images.



Snapshot 1: log ratio image with SIFT points in image 1

2.MOTIVATION

Consider two SAR images captured at two different time, X1={x1(a, b), 1<a<h1 and 1< b<w1} and X2={x2(a, b), 1<a<h2 and 1<b<w2} of size H*W. These two SAR images X1and X2 are acquired on same place at different time's t1 and t2. The main goal of the system is to produce the difference image to characterizes the changed region between two images occupied at considerable times. As shown in fig 2, the proposed method consists of five main steps: 1) collecting the images from satellite; 2) producing the difference image by using log-ratio operation; 3) extract SIFT keypoint in difference image; 4) perform the segmentation around extracted sift keypoint in two original multi-temporal images; 5) comparison of segmented images to produce the change detection map.

3.RELATED WORK

The unsupervised distributed method change detection [1], is used for synthetic aperture radar sensor images. This approach uses method of fusion and RFCM (reformulated fuzzy c means clustering) method. This approaches uses multi temporal synthetic aperture radar images for change detection. First it apply mean ratio operator and log-ratio operator and perform fusion method to generate the difference image. Fusion image is used to obtain the explicit information of changed region. This method also used to restrain the background information. Next step is to apply RFCM (reformulated fuzzy c means clustering) algorithm to analyze the difference images and to obtain the map for change detection. Fusion and fuzzy c means is used to decrease the speckle noise effect.

The automatic thresholding and unsupervised method for change detection approach [2], used for testing of multi-temporal one channel single polarization synthetic aperture radar images. This approach consists of 3 main steps: 1)Pre-processing the radar images, 2) comparison between images x1 and x2 captured at t1 t2 based on log-ratio operator, 3) generating change detection map based on automatic analysis of the log-ratio image. The initial step is to reduces/eliminates all stain noise in the images to increase the capability of discrimination between altered and unaltered region. In next step two filtered synthetic aperture radar images x1 and x2 are compared to produce difference image (log-ratio image). The difference image Xd contains information about changed areas. In Final step reformulation of kittler Illingworth (KI) threshold selection criterion is used for obtaining the map for detection of changes.

Detection of changes [3], method performs in supervised manner. This approach is not efficient because of lack of ground truth for images. So overcome this problem semi supervised approach is used. It classified based on clustering neighbourhood kernel (CN) for finding changes in synthetic aperture radar sensor images. First build the composite kernel from kernel ratio with difference of kernel. Next build kernel of CN: 1) samples of cluster, 2) extract neighbourhood pixel value based feature, and 3) restructuring the combined ratio of kernel with extracted neighbourhood based statistical features.

4. METHODOLOGY

Initial step in the detection of change method is to collect the data from earth base station. Collected aperture radar images are captured at different time series. After obtaining the multi-temporal sensor images apply the operation of log ratio to produce the combined image Xd. Next we apply SIFT method to detect the SIFT keypoint in log-ratio images.

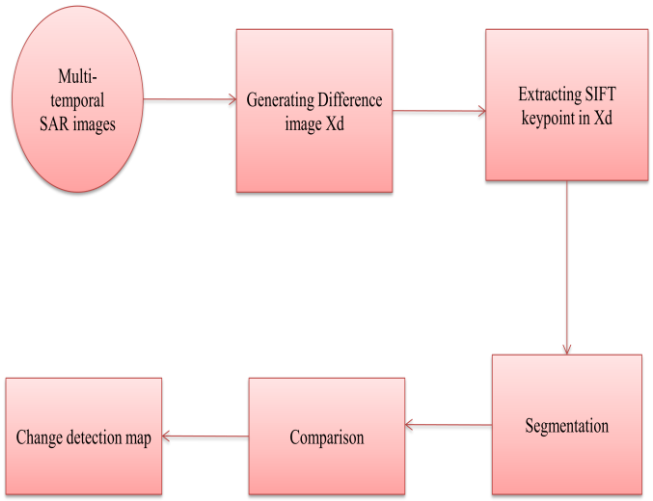


Fig 1: Architecture diagram for change detection in SAR images.

SIFT detect the blob like structure at the center. After extracting the keypoint apply the segmentation method around the extracted keypoint in two original images. Before segmentation first extract ROC (region of candidates) which contains the changed areas. Next apply the Otsu method for segmentation. Finally compare the segmented images to generates the map for detection of

changes. The process of change detection in SAR images is as shown in the fig 2.

1 Notions

The main parameters used to extract the SIFT keypoints in difference image is the parameters x, y, σ and f. There are totally 128 descriptor for SIFT keypoint. The extracted keypoint are stored in single column.

Table 1
Definitions of parameters

Symbol	Description
x, y	Spatial coordinates
Σ	Scale
F	Descriptor

The SIFT keypoints are extracted by using Gaussian distribution method. This method is used to blur the images to detect blob like structure.

4.2 Obtaining the SIFT keypoint in difference image

Apply the LR operator on two host multi-temporal images to obtain the Xd image. Log ratio method is better technique to obtain difference image even in the attendance of stain noise. Difference image is obtained by using the equation 1.

$$X_d = |\log_{10}(x_2/x_1)| \quad \text{.....(Eq1)}$$

After obtaining difference image, examine the Xd (difference) image to recognize the changed and unchanged areas. The pixel values are more in changed region than in unchanged region. Therefore the changed areas are brighter than the unchanged area. There is a speckle noise in synthetic aperture radar images. SIFT method is used to extract keypoint in the difference image because it is robust to the speckle noise. SIFT keypoint parameters are {x, y, σ, f}. For Scale invariant feature transform consist of 128 descriptors. Scale invariant feature transform keypoint is extracted by using the equation 2 that is Gaussian method.

$$G(x, y,\sigma) = 1/2\pi\sigma^2 e^{-(x2+y2)/2}\sigma^2 \text{ .....(Eq2)}$$

Where parameter x, y are spatial coordinates,

σ is the scale .

By using the equation 2 we are blurring the difference image. Here blurring is done in order to eliminate the unwanted interest point. Four time we are blurring the difference image with difference scale value. Then the more blurred image is obtained by using the difference of Gaussian method. Two blurred images are subtracted to get the more blurred image using the equation 3.

$$D(x, y, \sigma)=(G(x, y, k\,\sigma)-G(x, y, \sigma))*I(x, y)$$

.....(Eq3)

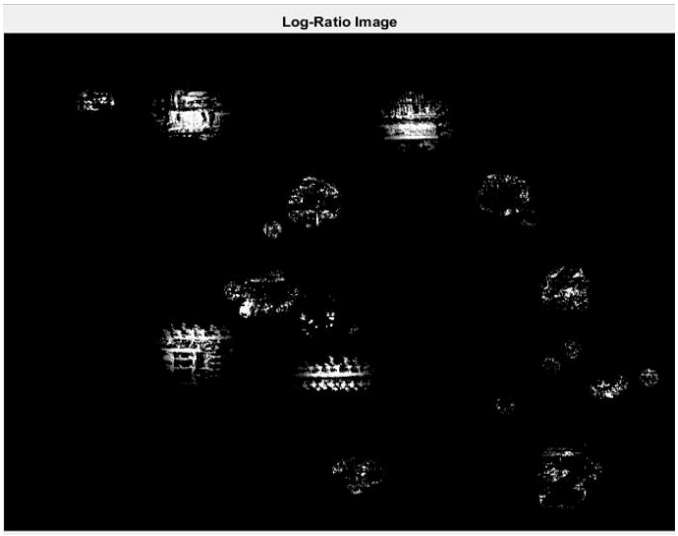
By using this equation edges are cleared and blob like structure are at the center.

4.3 Performing segmentation function around the SIFT feature keypoints in the two images x1 and x2

After extracting the point feature keypoint in the difference image Xd apply segmentation method in two original multi-temporal images around point feature keypoint. Before performing segmentation first obtain the ROC (region of candidates) which contains information about changed region. Obtained the Region of candidates with center (x ,y) and side l=k* σ where k is the size of window. After obtaining ROC then perform segmentation by using Otsu method. After segmentation perform comparison between two segmented images to generate the change detection map.

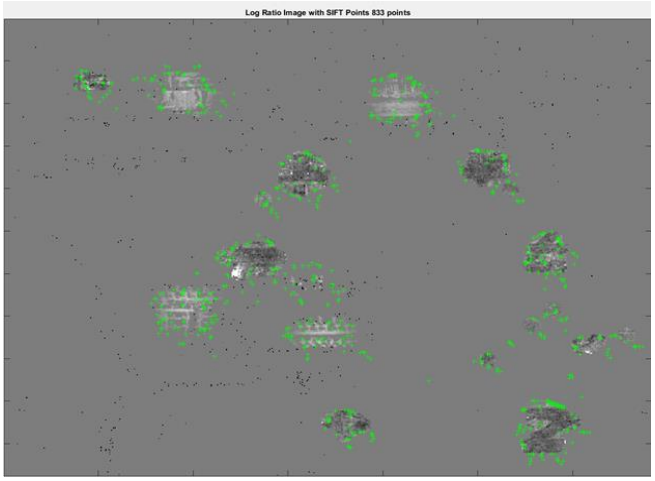
5. RESULTS AND ANALYSIS

Difference image is obtain to extract the change region information

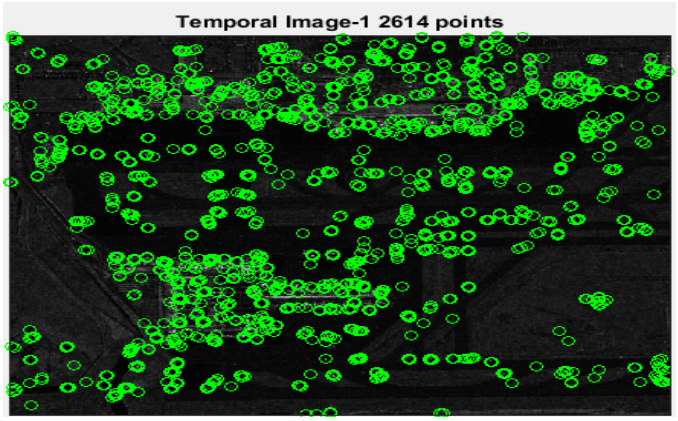


Snapshot2: log-ratio image

In the snapshot 2 shows the difference image from two multi temporal images y1 and y2. Xd is the combined image, which is computed pixel by pixel. Xd contains an explicit information about changed region.

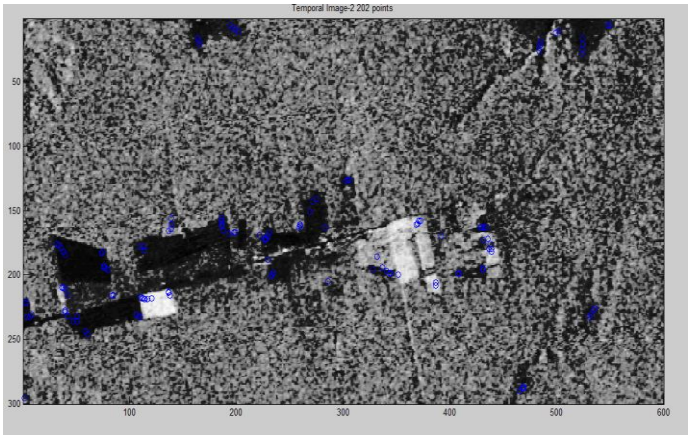


Snapshot 3: log ratio image with SIFT keypoint



Snapshot4: SIFT keypoint with ROC in image 1

In the snapshot3 and 4 show the keypoints with ROC, first extract the keypoint by using SIFT method then obtains the region of candidates. ROC contains the information about changed region in image 1.



Snapshot 5: SIFT keypoint with ROC in image 2

In the snapshot4 show the keypoints with ROC, first extract the keypoint by using SIFT method then obtains the region of candidates. ROC contains the information about changed region in image 2.

6. CONCLUSION AND FUTURE ENHANCEMENT

In this proposed method first difference picture is obtained then apply SIFT algorithm to mine the keypoints in the difference image. SIFT method is robust to the speckle noise accuracy is increased. Then obtain ROC and perform segmentation. Compare the segmented images to generate the change detection map. Here edges are preserved and the method is insensitive to the speckle noise. So accuracy is increased.

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