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The Study of SAR Image Change Detection Algorithm Based on the Difference Graph Fusion

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Keywords: SAR image, change detection, and differential image fusion.

Abstract. SAR image change detection technology is the two picture in the same area, the different time periods for SAR image detection, quantitative and qualitative analysis of the change area, thereby gaining interest area change a technology of information. SAR image change detection technology is of great importance in social, economic, environmental, agricultural and military fields. Based on difference image and ratio image change detection in the complementary, with average filtering fusion ratio difference and median filtering the graph method, k-means clustering algorithm for classifier are in, get change regional integrity and background noise resistance are good change detection results. The experimental results of SAR image change verify the effectiveness of this algorithm.

1. Introduction

The change detection technique is often used to detect changes in the same area and different time periods, and it is widely used to obtain images for change detection by remote sensing image.

Synthetic Aperture Radar SAR image is a remote sensing image that can measure surface information at a distance, all-day, all-weather and widely.

Its strong penetrating power, the cloud cover and underground target has strong detection capability, and SAR imaging is not affected by factors such as climate, light, so the surface change information detection with SAR image is currently one of the important means.

However, there is a multiplicative coherence noise in SAR images, and the incorporation of noise has a great influence on the imaging effect. Therefore, improving the anti-noise performance is an important research content of SAR image change detection technology [1-3].

SAR image change detection is essentially consists of two of the same area differences in different periods of SAR image generation drawing area is divided into classes and the changes, to find out the change area and the area.

Therefore, SAR image change detection technology is mainly divided into differential graph generation and differential graph analysis.

Difference diagram is composed of two SAR image obtained by calculation, the difference of different figure for algorithms have different effects on the effect of the change detection, the differences of mainstream figure generation algorithm difference value method, ratio method, logarithmic ratio, average ratio, etc.

Difference analysis is to classify differences differences figure classification algorithm can be divided into the surveillance and the surveillance law [4], monitoring algorithm need human intervention, such as the threshold value method, threshold value is often selected according to the experience of the people.

Unsupervised classification algorithm without human intervention, the classical unsupervised classification method has automatic threshold segmentation algorithm, k-means clustering algorithm and so on.

In this paper, we study the SAR image change detection algorithm is designed to look for a kind of both can effectively suppress noise, and can realize the SAR image unsupervised change detection algorithm, so that the SAR image change detection technique can satisfy the need of practical application.

Aiming at the improvement of the anti-noise performance of the SAR image change detection results, based on the analysis of the complementary advantages of different differential graphs, this paper proposes a change detection algorithm based on the differential graph fusion.

First of all, the analysis of the difference image and ratio image complementary advantages, on the basis of the structural difference median filter and median filter ratio figure, figure obtained by linear fusion two differences in the changes in the regional integrity is good, good sex differences in background region noise figure, finally using k-means clustering algorithm fusion differences figure for binary classification, change detection results.

The measured SAR image experiment results show that the proposed method can effective fusion differences figure in a changing area ratio and figure in the background area advantage, can obtain complete and better anti-noise performance change detection results.

2. The Proposed Method

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The change detection algorithm mainly includes the difference graph generation and the difference graph analysis two parts.This paper focuses on the study of the method of generating differential graph.The difference graph generation is the preliminary determination of the two SAR images in the change area and the non-changing region.The resulting difference graph is a grayscale.The difference graph analysis is carried out on the basis of generating the difference graph.Set an area at the moment to obtain the SAR images is $I_1 = \{I_1(i,j), 1 \le i \le m, 1 \le j \le n\}$, at the moment for SAR image is $I_2 = \{I_2(i,j), 1 \le i \le m, 1 \le j \le n\}$, and then treated with different figure generation algorithm I_1 and I_2, and get different figure I_3, the differences here figure generation algorithm including differential method, ratio method, logarithmic ratio method and variance fusion algorithm etc. $I_3 = \{I_3(i,j), 1 \le i \le m, 1 \le j \le n\}$, is exactly the same image as l1 and l2.Figure for differences of operation process is essentially matrix arithmetic of image process, l3 is said differences between l1 and l2 matrix, and the difference between the image into the difference between matrix.This paper introduces the algorithm of the differential graph generation.

D-value

The difference method is to take the absolute value of the SAR images l1 and l2 of different periods, which are essentially the corresponding elements in l1 and l2 matrix.The absolute value is because there are negative elements in the matrix operation.It can be seen that the operation between images is actually the computation of the matrix, so l1 and l2 have to be strictly spatially matched to ensure that the matrix of the two images are identical [5].

Set I1 of the matrix is D1, I2 corresponding matrix is D2, difference, difference figure I3 corresponding matrix D3 = | D1, D2 |, apparently D3 characterization of the distance between I1 and I2 matrix D3 is identical with the size of D1 and D2.In the case of normalized, matrix changes in pixels and the pixels after subtraction after taking the absolute value is close to 1, did not change the pixel point is close to 0, see from figure to intuitive, change area close to white, not change area close to black.

value method in identifying change area when the operation is simple and effective, but because of SAR image is mostly coherent noise, differential method of coherent noise without inhibition, differences in income figure in reserves rich outlook information at the same time also contains more coherent noise.This is a great influence on the detection effect, especially the selection of threshold value when the threshold method is classified, so it is proposed to use the ratio operator to obtain the difference graph.

Ratio method

Ratio method is the I1 and I2 matrix corresponding to do than grey value directly, take larger as the return value of the difference figure matrix, set up corresponding matrix is D1 I1, I2, the

corresponding matrix is D2, the ratio difference D3 = Max I3 corresponding matrix (D1 / D2 and D1 / D2).The large value in the ratio can guarantee that the white and near-white areas of change in the difference diagram, black and close to black are nonvarying regions.But at this point, it should be noted that since the ratio is involved, the D3 matrix here is likely to be a matrix containing infinite points, which makes the subsequent filtering and clustering impossible.Because of the infinite point reflect is very obvious change pixels, so the solution can be infinite from point 1 to replace, so can say change region can make the subsequent work normal again.

Fusion method

In order to fully tap complementary advantages of difference image and ratio image, this paper studies based on the average filtering difference difference map and median filtering the differences of blending ratio difference figure figure generation algorithm, in order to significantly improve quality difference, the change of the high precision [6].

Median filter is a linear smoothing algorithm of image, namely take neighborhood average to replace the original pixels, first given a pixel template, template includes the target pixels surrounding pixels, and then use templates instead of pixels of average target pixel.

In the image, p(x, y), p(x, y), p(x,y) is replaced by p(x, y).

$$\mathrm{p(x,y)} = \frac{1}{m}\sum_{i=1}^{m} p(x_i,y_i)$$

This method can maintain the image's regional consistency and smooth the image.

The difference between the background noise and foreground noise is much higher, so the smoothing difference diagram is suitable for the difference diagram.However, after the mean filtering processing, the image can not retain the details of the image better, and the edge information of the image can be lost while removing the noise, resulting in the blurring of the image.The effect of mean filtering on isolation noise is also not ideal.Median filter is a nonlinear filtering algorithm based on the theory of the sort, namely the pixels around the pixels according to expand, in the order from large to small of grey value sorted, then select a sequence of intermediate value instead of the original pixels.Due to the isolated noise tends to be a bright spot, the pixel value, is the largest of the surrounding pixels, median filtering with pixels around the median instead of maximum, so the whereabouts of median filter can effectively isolate the noise.

Good suppresses coherent noise ratio difference the picture, but the ratio difference exists in the figure isolate noise, median filtering can effectively restrain noise isolation, and after a median filtering basic keep image definition, won't appear blurred images, edge information is basic.The median filter retains edge information and inhibits the isolation noise to suit the ratio difference diagram, but the median filter is no longer valid if there is a block noise in the image.From the above analysis, it is not difficult to draw the conclusion that the ratio image of the mean filtering output is complementary to the ratio image of the median filter output.The mutual complementarity shows that the mean filtering can smooth the image suppression effect of gaussian noise and the suppression effect of the isolated noise is not ideal.

The median filter has good effect on isolating noise, and can retain edge information better.The mean filtering will appear blurring edge of image.The median filter does not have the problem of image blurring.In addition, the difference diagram foreground information is rich, but the background noise is more.The background noise is very small, but the foreground information is weakened.By using this complementarity, we construct the fusion difference graph by using the linear fusion of the difference graph and the median filter after the mean filtering.

The original difference is shown in D1, the original ratio of the difference is D2.Average filtering after the difference between the differences in $D_1^{'}$, the ratio of the difference in $D_2^{'}$ after median filtering, then we can choose a coefficient of image α weighted sum again can realize linear fusion.

The fused image is:

$$D_3 = \alpha D_1^{'} + (1-\alpha) D_2^{'}$$

The D3 is used as the difference diagram for change detection, which is to achieve the purpose of denoising without losing too much foreground information.The experimental results also prove that this method is effective, but the selection of α has great influence on the experimental results, and the value of α is needed to achieve the best detection effect.

After the fusion difference diagram is obtained, the pixel points can be divided into two categories: change and non-change by using the unsupervised k-means algorithm.

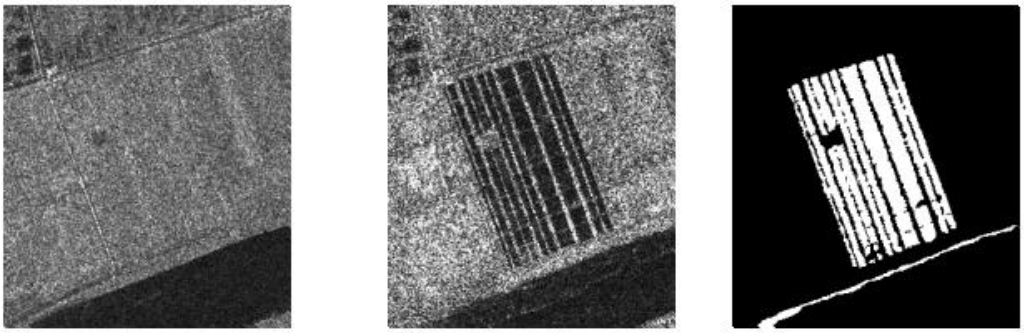
The main idea of k-means is to classify samples by calculating the distance from each sample point to the cluster center [7].Clustering algorithm is that the benefits of the algorithm is concise and efficient, the face of large data processing also has higher operation efficiency, but its selection of the initial clustering center is random, the selection of clustering center largely influenced the result of the experiment, so repeated the experiment many times to take on average, to obtain the overall detection precision.

3. Experiments

This paper selects four real SAR image data sets in two regions to conduct experiments. These SAR images are divided into two groups.The experiment of difference method, ratio method and fusion algorithm was performed in each group, and the experimental results were compared and analyzed.

The first group of SAR images is the Canadian province of Ottawa, which was taken by radarsat-sar satellite, which was recorded in July 1997 and August 1997 respectively, reflecting the changes of land surface area before and after the monsoon season.

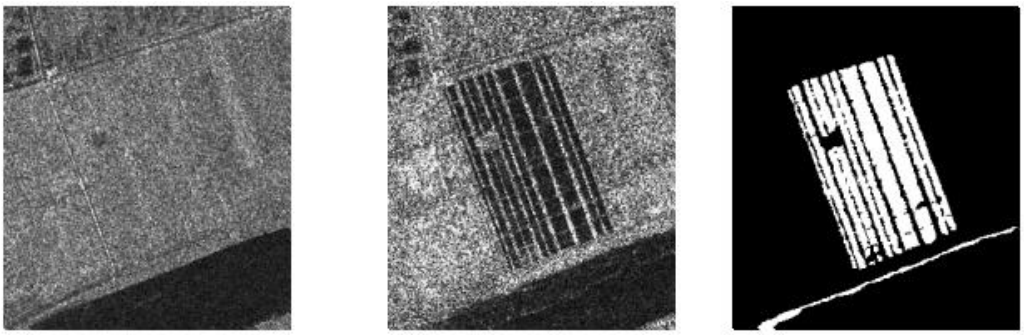
Figure 1 (a) is Ottawa area of bare ground before the rainy season, figure 1 (b) is the monsoon rain back cover ground, figure 1 (c) is the artificial definition of a real change of reference map, three resolution of SAR image is 12 m, size is.



(a) (b) (c)

FIG. 1 regional SAR image (a) July 1997 (b) August 1997 (c) reference graph

Forward a second group of SAR image is the shandong region of the Yellow River estuary part of SAR image, taken respectively in June 2008 and June 2009, the spatial resolution of 8 m, image size, artificial definition is really change the reference map, as shown in figure 2 (c).



(a) (b) (c)

Figure 2 SAR image of the Yellow River region (a) June 2008 (b) June 2009 (c) reference graph

Two SAR images are used to generate the difference graph by using difference method, ratio method, and differential graph fusion algorithm, and the corresponding binary detection results are obtained. The results are shown in fig.3 and fig.4.

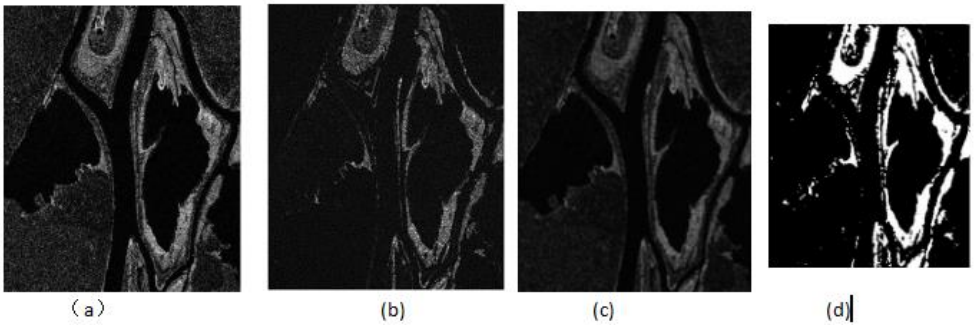


FIG. 3 results of change detection (a) of the variation test (a) in the region of Ottawa (a), (b), (c) fusion of differences (d), and the detection results of the k-means clustering algorithm

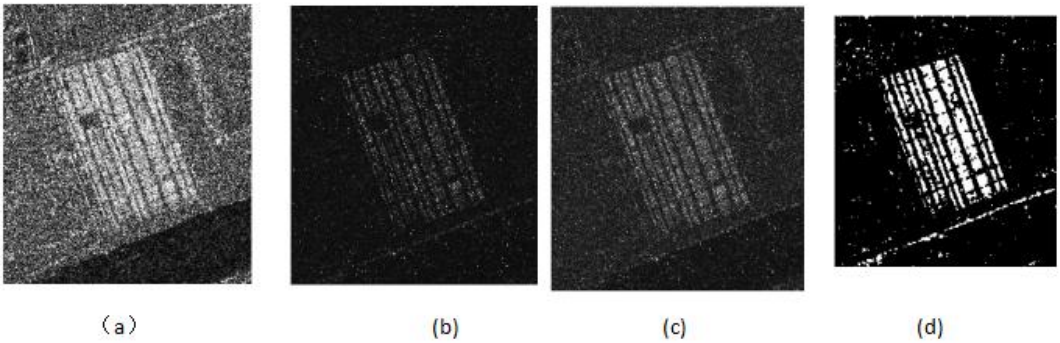


FIG. 4 variation test results (a) of the Yellow River area (a) difference diagram (c) fusion difference graph (d) integration of difference FIG. K mean clustering algorithm test results

It can be seen from the experimental results that the difference diagram is better in the area of foreground change, but it is affected by the speckle noise in the background area. Ratio figure in the region of the background noise ability is outstanding, but the prospects for change information loss is serious, two differences after filtering processing figure in information has made some compromise, and noise figure and average filtering fusion difference after median filtering ratio figure, differences in outlook and background noise reduction can be achieved better effect, significantly improve the overall precision of the algorithm. In addition, the algorithm is easy and efficient.

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