WATER BODY INFORMATION EXTRACTION FROM HIGH RESOLUTION AIRBORNE SAR IMAGE WITH TECHNIQUE OF IMAGING IN DIFFERENT DIRECTIONS AND OBJECT-ORIENTED

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ABSTRACT:

Water resources play an important role in region planning, natural disaster, industrial and agricultural production and so on. Airborne SAR images provide advanced means to get water bodies information quickly and accurately because it is not affected by clouds and lights. Water is confused easily with shadow since calm water surface induces mirror reflection when it gives birth to echo wave. Hence its color is similar to shadow so that it is difficult to distinguish between water body and shadow in airborne SAR image. In order to achieve the goal that make distinctions between water body and shadow, the article put forward an innovation that extract water body information from high resolution airborne SAR image based on technique of imaging in different directions and object-oriented.

1. INTRODUCTION

Synthetic Aperture Radar(SAR) is a powerful tool for information extraction. However, the shadow in SAR image becomes the major obstacle to extract water body. In order to solve the problem, the article utilizes the technique of imaging in different directions for the same region to eliminate the effect of shadow. However, speckle appearing in SAR images is due to the coherent interference of waves reflected from many elementary scatters (Gianfranco de Grandi, J., 1999). Speckle reduction is crucial to extracting water body from SAR image. The article selects adaptive window Lee local statistics filter to reduce speckle that influence precision of water body extraction. At the same time in order to achieve the goal that extract water body and shadow, the article put forward an innovation that extract water body information from high resolution airborne used objected oriented technique, which improve the traditional pixel-based classification method. The outcome of object-oriented classification gives birth to patch that help make distinctions between water body and shadow.

2. IMAGE REGISTERATION

The method of extracting water body from SAR image demands that register precisely one SAR image that range direction is from north to south to the other that range direction is from south to north. The article uses geometric correction based on polynomial model. The other image is regard as the reference image to select control point. After registering two directions image, we cut out two sub-image of same area through image subset. The raw images that imaged in two directions and the two images used to extract is as follows:

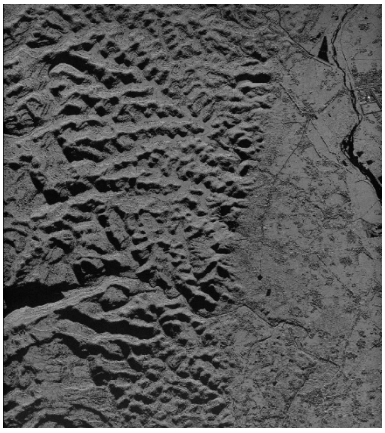


Figure 1. The raw image that range direction is from north to south

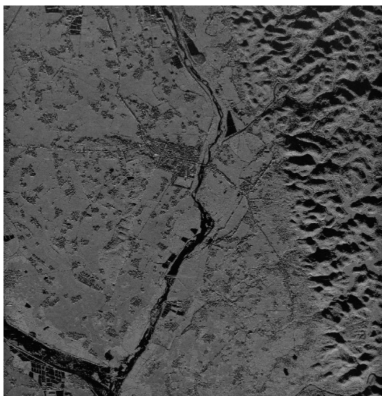


Figure 2. The raw image that range direction is from south to north

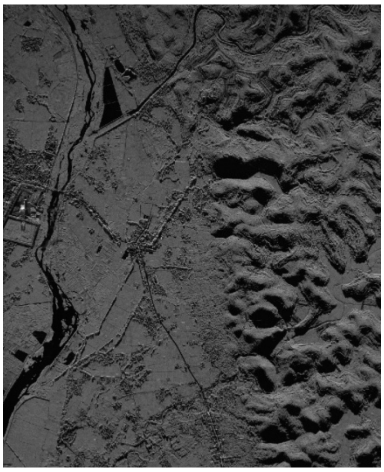


Figure 3. The image that range direction is from north to south is geometric corrected and subset

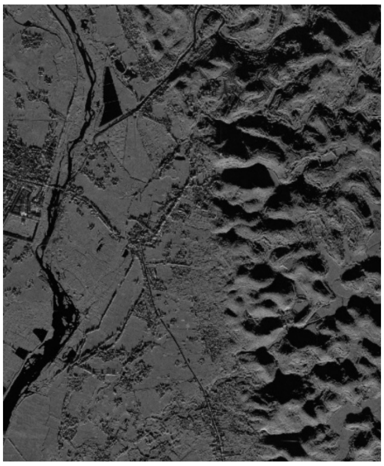


Figure 4. The image that range direction is from south to north is geometric corrected and subset

3. SPECKLE REDUCTION

The presence of speckle hinders human observer from analyzing the SAR image. Hence various method of speckle reduction is put forward. Although conventional speckle filtering algorithms can reduce speckle noise effectively, but also smear edges and blur images to some degree. The most well-known and widely used image-domain speckle filter is the local statistics adaptive filter proposed by Lee, which uses local statistics such as mean and standard deviation on fixed size window to determine the degree of smoothing (Yongwei Sheng,et al,J.). Although the Lee filter can preserve steep edges, the loss of fine details and degradation of spatial resolution may occur by using too large a window. On the other side, the use of a small window implies insufficient speckle noise suppression in homogeneous area. To solve the trade-off between the window size and the degree of speckle noise suppression, the article utilizes the adaptive window algorithm to reduce filter. The adaptive windowing algorithm was proposed to overcome the limitation of conventional image- domain speckle filters that have fixed size window(Dae-Won Do, et al., J., 2002).The steps are as follows:
Set the max and min of window size, set the threshold of coefficient of variance;

Calculate the sample mean and the sample variance of the boundary samples of current window;
The sample mean is given by

$$m_{ij} = \frac{1}{4*(L_{ij}-1)} \sum_{(k,l)\in b_{ij}} y(k,l)$$

Where L_{ij} is the window height or width (height=width), y(k, l) means the magnitude of complex SAR data.
The sample variance is given by

$$\sigma_{ij}^2 = \frac{1}{4*(L_{ij}-1)} \sum_{(k,l)\in b_{ij}} y^2(k,l) - m_{ij}^2$$

Calculate the coefficient of variance at (i,j) is defined as

$$C_{ij} = \frac{\sigma_{ij}}{m_{ij}}$$

The size of next window is determined by comparing the C_{ij} with the threshold value T_{ij} as following equation

$$N_{i,j+1} = \begin{cases} \min[N_{ij}+1, N_{max}] & if\ C_{ij} \le T_{ij} \\ \min[N_{ij}-1, N_{min}] & if\ C_{ij} \ge T_{ij} \end{cases}$$

$if\ C_{ij} \le T_{ij}$ go to the second step, the boundary samples becomes green pixels;

$if\ C_{ij} \ge T_{ij}$ apply the Lee's local statistics filter to the current window.

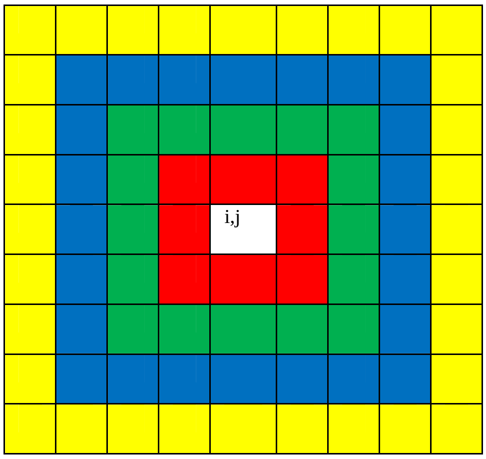


Figure 5. Adaptive window

The routine of the proposed method is as follow.

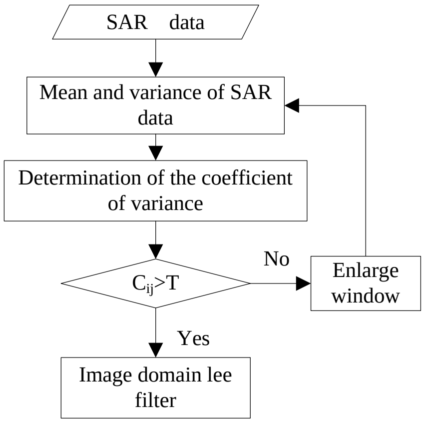


Figure 6.The routine of adaptive windowing algorithm

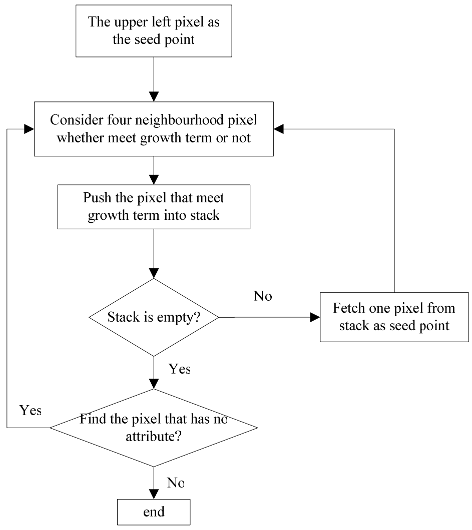
Figure 7.The image that filtered by Adaptive Lee local statistics

4. OBJECT-ORIENTED CLASSIFICATION

Object-Oriented classification is used to classify high resolution imagery successfully. It alters the defect of pixel-based classification (CAO Bao,et al,J.,2006). Experiment results indicate that the precision of classification of the method is higher than pixel-based classification. Hence the article introduces the Object-Oriented classification to airborne SAR image to extract water body from SAR images. The algorithm start from certain pixel, add neighbourhood pixel according to certain guideline, the algorithm end when satisfy certain term (Qiushi technology, J., 2006). The result of region grow lie on three terms: Firstly, the selection of seed point; Secondly, the guideline of growth; Thirdly, the term of end.

The experiment selects the upper-left point as seed point. The basic step is as follows:
The seed point is regard as the initial centre, take into account four neighbourhood points, if meet the growth guideline, incorporate the four point with seed point, at the same time push the point that meet the growth guideline into the stack;
Pop the top pixel from stack, regard it as seed point, return to step one;
When the stack is empty, find the first pixel that is not classify through scan the entire image, regard the pixel as seed point.
Repeat these steps, the growth end until each pixel has been processed.

The flow chart of region growth is as follow:



The algorithm gives birth to some small patches. These small patches hinder human observer from estimating and analyzing water body information. So the article merge small patch into the neighbourhood patch.

Figure 8. The result of water and shadow extraction of the image that range direction is from north to south

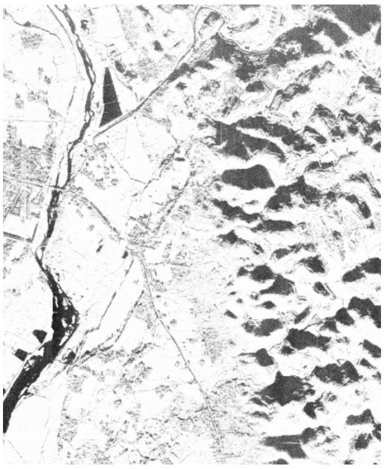


Figure 9. The result of water and shadow extraction of the image that range direction is from south to north

5. WATER BODY EXTRACTION

Through the object-oriented technique, the experiment extracts confusion of water body and shade. In order to extract water body from the confusion of water body and shade, we utilize the overlay analysis. The basic principle is that water body overlay geographically, whereas shades do not overlay. In term of Figure 8 and Figure 9, we can see clearly that the channel and pond lies in the left of two images overlay geographically. However, the shadow of mountain lies in the right of two images do not overlay geographically. So we get the conclusion that water body overlay in two different directions image through overlay analysis. Whereas shadow of mountain do not overlay in two directions images, hence it is easy to distinguish water body information from confusion of water body and shade.

6. CONCLUSION

Water is confused easily with shadow since calm water surface induces mirror reflection when it gives birth to echo wave. Hence it is difficult to distinguish water body and shade. Water body and shadow is confused so that it influences precision of classification and information extraction to a large degree. The article makes full use of multi-directional SAR image to differentiate water body from shade. But speckle appearing in SAR images is due to the coherent interference of waves reflected from many elementary scatters(Gianfranco de Grandi, J., 1999). The article utilizes the adaptive Lee filter to reduce speckle. At the same time the article introduces innovatively object-oriented method to extract water body and shade. Through much experiment of water extraction, it indicates that the result of water body extraction is satisfactory.

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