

CLASSIFICATION FROM AIRBORNE SAR DATA ENHANCED BY OPTICAL IMAGE USING AN OBJECT-ORIENTED APPROACH

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ABSTRACT:

Classification from Synthetic aperture radar(SAR) is known to be difficult because of the speckle and variation in scattering coefficient with incidence angle, especially for high resolution airborne SAR. In western China, most areas are cloud cover perennially, which hinders acquisition of optical images. Airborne SAR data will be a good choice for big scale mapping purpose. To make effective use of airborne SAR in the area with cloud cover, it is essential to find a proper way to classify SAR imagery accurately. This paper present a general airborne SAR classification frame, which is proved effectively by the following test. This frame consists in two main aspects: 1) Information enhancement, including SAR speckle removing; single polarisation airborne SAR merged with optical multispectral data. The improved spectral information was contributed to the classification afterward. 2) Object-oriented classification, the enhanced image is analysed by object-oriented approach of eCognition, It is based on fuzzy logic, allows the integration of different object features, such as spectral values, shape and texture.

1. INTRODUCTION

For some regions affected by cloud cover perennially, Synthetic aperture radar(SAR) provides a reliable means for the collection of imagery for mapping purpose. Airborne SAR imagery with a very high resolution make large scale mapping possibly in cloud cover urban, however, single polarisation SAR involves plenty of spatial informations and short of spectral informations, moreover the speckle and variation in scattering coefficient with incidence angle limit the accuracy of the airborne SAR classification, Thereby we enhanced single polarisation airborne SAR by merging it with optical multispectral data. Despite the improvement of color resolution, the classification for large scale mapping still was proved very difficult using traditional imagery analysis approach based on a pixel, in which only the spectral information is used for the classification. It is unsuitable to very high spatial resolution imagery. An object-oriented image analysis approach of eCognition is implemented in order to overcome the limitation. It classifies an image based on the attributes of the image objects rather than on the attributes of individual pixels. This study test object-oriented classification approach on enhanced airborne SAR image. The result shows this method can satisfy the extraction of surface features from airborne SAR for mapping.

The reminder of this paper is organized as follows. In section 2, airborne SAR information enhancement process is put forward: including the reducing of SAR speckles; the fusion of SAR and multispectral optical data. In section 3, object oriented techniques will be shown: including image segmentation of the enhanced SAR; the creation of class hierarchy and the classification by means of fuzzy logic approach. Finally, conclusions are given in section 4.

2. INFORMATION ENHANCEMENT

One of the strengths of airborne SAR data is its high spatial resolution. Radar data provides a wealth of spatial information that isn't present in many other types of image data. Conversely, however, SAR data doesn't have much spectral information, which is typically expressed in multispectral optical data sets. This situation leads naturally to the use of combined SAR/Optical data. In this paper, we combined SPOT5 multi-spectral image with airborne SAR, the selected test area is located in Hefei city, China. Figure 1. shows the original airborne SAR and SPOT5 multi-spectral image.

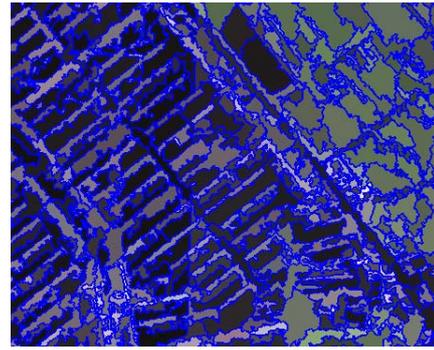


a.



b.

Figure 1. Original image (a. SPOT5, b. airborne SAR)



b.

Figure 2. a. fusion image b. segmentation image (corresponding white box part in a.)

2.1 SAR speckle removing

Speckle removing is a key point of the fusion technique. An efficient filter for speckle reduction is required to reduce the effect of the multiplicative noise on homogeneous areas without seriously affecting the spatial characteristics of the data. We apply Lee-Sigma filter to remove speckles, This algorithm is iterated once by once until all speckles are cleared up. In fact, the iterative number should not exceed two, because the Lee-Sigma filter has a smooth role on the image, and makes the filtered image looks blurry.

2.2 Data fusion

In this test, we use multiplicative merging method, Multiplicative is based on simple arithmetic integration of the two raster sets. This method applies a simple multiplicative algorithm which integrates the two raster images. This resulting merged image does not retain the radiometry of the input multispectral image, however, the intensity component is increased, making this technique good for highlighting urban features or higher reflecting components in an image. By comparison, for the test data presented, the fusion result using multiplicative method is the best one among those methods including PCA , IHS, multiplicative and Brovey Transform. The multiplicative merging result of SPOT 5 with SAR is shown in figure 2.



a.

3. OBJECT-ORIENTED CLASSIFICATION

3.1 Image segmentation

Image segmentation is the first and important procedure in object based classification. It means the groups of neighbouring pixels into homogenous image objects, which is based on the similar criteria such as scale, color and form. The segmentation was made in different scale levels, especially taking into consideration local contrasts. The result of segmentation (shown in Figure 2) acts as image objects which can be classified in next step.

3.2 Hierarchical fuzzy rule classification

Before the classification, the classes were assigned and the classification rules to description each class were selected . According to the ground truth, four main land use classes were distinguished in this test: vegetation, water, building, road, and another class shadow. Considering the convenient for creation of classification rules, we structured a class hierarchy frame shown in Figure 3. Classification rules based on knowledge were defined , according to object attributions such as object spectral values, form, texture, relations to adjacent regions or sub-objects, and other collected information. The objects then become assigned according to whether they have or have not met these properties(classifion rules). The classification is conducted by fuzzy logic.

In this study, first, we distinguished green(vegetation) and not green by rasion and stdev of objects in one layer; and then black and not black were divided using stdev feature of objects; at last, futher rules were made to classify detail classes. For distinguishing building from the similar spectral vegetation, Digital surface model was the best feature, but unavailable, so we chose length/width feature for substitution. Because there were not appropriate features to classify water, road and shadow at present, we applied manul image object classification tool, the whole classification results were shown in figure 4.

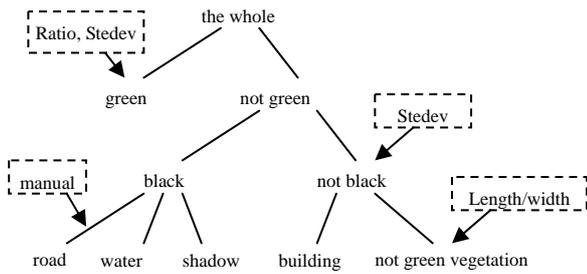


Figure 3. class hierarchy structure

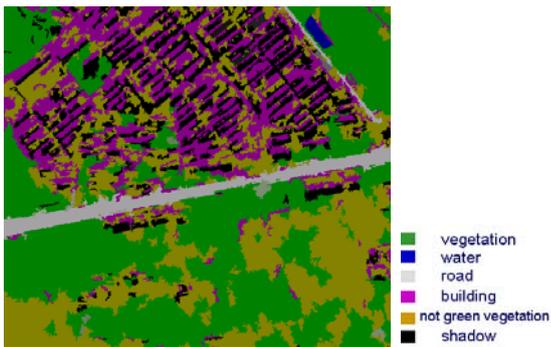


Figure 4. classification image

4. CONCLUSION

In the paper, object-oriented classification approach is applied to airborne SAR, in order to enhance the color information, we merge SAR with SPOT5 multispectral data by multiplicative arithmetic. For the test site presented, classification accuracy improves largely. This method can validly be used to the large scale urban mapping and investigations. Several conclusions are emphasized as follows:

1. Object feature analysis and fuzzy Classification rules definition are the keys .

2. Data fusion is a effective measure to improve classification accuracy.

3. The Combination of automatic and manual classification can improve the accuracy greatly.

4. Classification based on homogeneous regions can avoid salt-and-pepper effect in pixel-based classification.

5. The results can be exported in either annotated raster or GIS-ready vector information, which make map making and updating easily.

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